Keio Business School

For Revitalizing Japanese Manufacturing Business
—From the Perspective of Production Operation Improvements–

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Preface

As economic conditions surrounding Japan's manufacturing business continue to be harsh, more and more manufacturers are shifting their production operations to overseas facilities. This trend has hastened "hollowing out" of the nation's manufacturing business. The purpose of this paper is to point out ways, beyond developing new products and technologies, in which domestic companies can improve efficiency and flexibility in order to revitalize their manufacturing operations. The recommendations provided herein are based on a study of companies that are working hard to make on-site improvement activities. The paper discovered that each company is taking a variety of measures geared toward revitalization, such as implementing thorough improvements at shop floors, implementing training programs designed to encourage these improvements, and introducing organizational and managerial structural changes. The paper insists the importance of implementing, and maintaining, these improvement activities in manufacturing operations.

1. Introduction

As China and Southeast Asia continue to serve with abundant cheap labor and specialize in assembly-type operations, Japan's manufacturing business has seen its market dominance dwindle. Many domestic manufacturers have shifted their production sites to overseas, and this has worsened "hollowing out" of the domestic market. The overseas production ratio grew from 3.0% in 1985 to 13.4% in 2000(1). Moreover, Japanese manufacturers recently closed down as many as 100,000 domestic plants(2), laying off nearly one million employees(3). If Japan's manufacturing capacity continues to decline and valuable knowledge accumulated over the years is lost, it will have a direct and adverse effect on manufacturing and new product development technologies, ultimately compromising manufacturers' ability to compete in the market. Based on a recognition of these critical conditions, the purpose of this paper is to illustrate practical ways in which Japan can preserve and revitalize its manufacturing business.

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† This material was translated by Tokyu Selun Office and reviewed by Prof. Hirokazu Kono of Keio Business School. The original research paper was co-authored by Prof. Hirokazu Kono and Shintaro Kuranuki (MBA Graduate from Keio Business School, 2003) in Japanese and was printed in IE Review Vol.44 No.5 pp.99-109, December 2003.

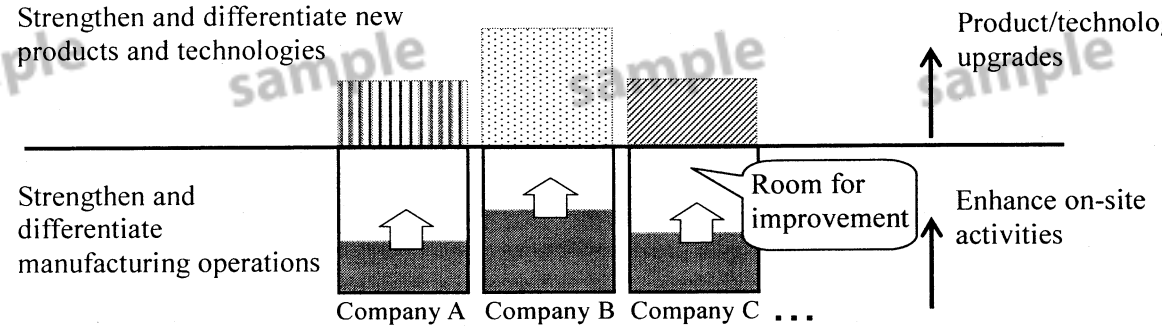
2. Purpose of the Study

In the past, discussions concerning how to stop the hollowing out have focused primarily on 1) developing new technology and value-added products, and 2) manufacturing technologies that enable makers to improve both production efficiency and flexibility[4]. It has been often said that the strength of Japan's manufacturing business lies in its ability to boost production capacity by implementing QC and IE techniques. These years, however, while domestic manufacturers increasingly shifted production operations to overseas, arguments supporting the development of new technologies and products seem to be the only ways for survival for Japanese manufacturers [5]. On the other hand, there were relatively few assertions concerning how to improve manufacturing operations – which have been so far Japan's strength – in order to revitalize the Japan's manufacturing business. Japan's labor and infrastructure costs, which are much higher than in China and Southeast Asia, seem to be regarded as something unsolvable[6].

From a macroeconomic perspective, developing new products designed to compete with foreign-made products, developing new markets, and developing new technologies and innovations are all viable strategies for domestic manufacturers, and when one considers developing overseas markets and coping with exchange rate risks, moving operations to overseas seems like a natural solution. From a survival perspective, however, merely placing an emphasis on new product/technology development and promoting production at overseas plants is not enough to sustain the whole domestic operations.

Meanwhile, companies that have devoted themselves to making on-site improvements have been able to achieve significant results in quality, cost, and delivery even in today's tough economy[7]. In light of this, it seems that there is still room left for Japanese manufacturers to bolster and revitalize their domestic operations by considerably strengthening their operations through on-site improvement activities (See Figure 1) .

Based on the above understanding, that there is still room left for manufacturers to take corrective actions, this paper has examined a number of manufacturing companies to determine what kind of on-site measures and mechanisms are necessary to revitalize domestic manufacturing, and what kinds of efforts and programs are necessary to ensure the effectiveness of these measures and mechanisms. The purpose of the paper is not simply to provide descriptions of the various improvement techniques employed by companies that excel in manufacturing activities. Instead, it clarifies 1) what prerequisites these companies hold in common that enable them to employ improvement techniques effectively, 2) how they approach improvement activities, 3) and fundamental conditions required for a company to successfully promote improvement activities and ultimately revitalize the domestic manufacturing business. In doing so, the paper hopes encouraging companies that have moved or are planning to shift production operations overseas, companies that have yet to break away from mass-production paradigms, and companies whose domestic production operations have fallen into a slump, to consider ways in which to improve their operations in order to benefit the Japanese economic growth.



Note:
The horizontal line indicates the standard level to which manufacturers should aspire by strengthening and differentiating their production techniques. The shaded portion of each bar under the horizontal line indicates the actual manufacturing level of Companies A, B and C. The portion left blank under the bar represents room for improving manufacturing operations.

Figure 1 Comparison of New Product and Technology Development and Improvement of Manufacturing Operations

3. Approach of the Research

The paper conducted close examinations of companies that excel in on-site activities in order to determine what conditions are necessary to revitalize the domestic manufacturing business. In the beginning, it surveyed various literatures in order to best determine the focal points of the research and how to format the interviews.

As manufacturing improvement techniques, TPM (Total Productive Maintenance), TPS (Toyota Production System), and TQC (Total Quality Circle) are widely known in Japan. The paper first examined how these techniques contributed to improved manufacturing performance and determined what activities and mechanisms are most important. Based on the findings, the paper created a cause-and-effect diagram[8]. The paper discovered that there is a close correlation between improvement/production techniques (i.e. "5S," waste elimination, *Jidoka*) and 1) training/education programs provided inside and outside companies to their employees, and 2) top management leadership and management's contribution to improvement activities (refer to Figure 2). Because it is difficult to gain a clear picture of the conditions required for these three factors to function effectively merely from the literatures, the paper conducted examinations of actual activities being performed in domestic plants.

This study covers 15 domestic assembly manufacturers all over Japan that have been featured in newspaper and industry magazine articles, or have received PM or Deming Prize (see Figure 3).

We spent an average of five hours studying each company, visiting their plants and conducting interviews with plant supervisors. After receiving an introductory orientation covering the history and contents of plant activities (between 30-60 min.), we conducted at each plant around a two-hour on-site survey, followed by an interview with the supervisors; using mostly the same format.

Interviews focused primarily on what companies were doing to ensure their results, and on the various innovative mechanisms they had developed. We took note of even the minutest features of internal activities and gave illustrations and graphs whenever possible. Furthermore, we asked each company to explain their views (based on their own respective strategies) concerning intensified competition with China, how they are positioning their factories to cope with this, and what concrete countermeasures they have undertaken.

In order to determine the best interview format, we conducted preliminary studies for two companies. Once the format was finalized, we revisited these companies to conduct an official survey.

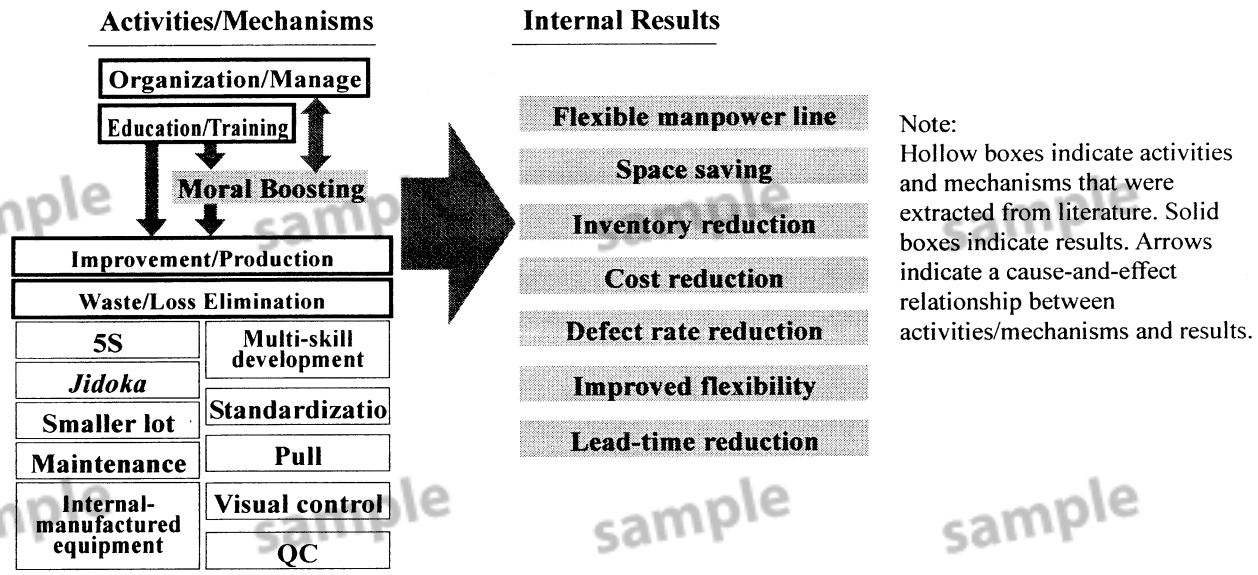


Figure 2 Three Factors of Improvement Activities

Company Name	Location	FY 2001 Sales *	Main Products	Company Name	Location	FY 2001 Sales *	Main Products
Company A	Kanto	C	Auto parts	Company I	Chubu	A	Precision instruments
Company B	Kanto	B	Office equipment	Company J	Chubu	B	Auto parts
Company C	Kanto	B	Measurement & control devices	Company K	Chubu	B	Auto parts
Company D	Tohoku	C	Electrical parts	Company L	Chubu	B	Car engines
Company E	Tohoku	B	Auto parts	Company M	Chubu	C	Electrical appliances
Company F	Kansai	A	Home appliances	Company N	Chubu	B	Home appliances
Company G	Kansai	B	Air conditioning equipment	Company O	Kanto	A	Office equipment
Company H	Chubu	C	Electronics parts				

* Sales results A: over 1 trillion yen; B: 100 billion-1 trillion yen; C: 10-100 billion yen, in fiscal 2001.

Figure 3 Researched Companies

4. Contents & Results of the Case Study

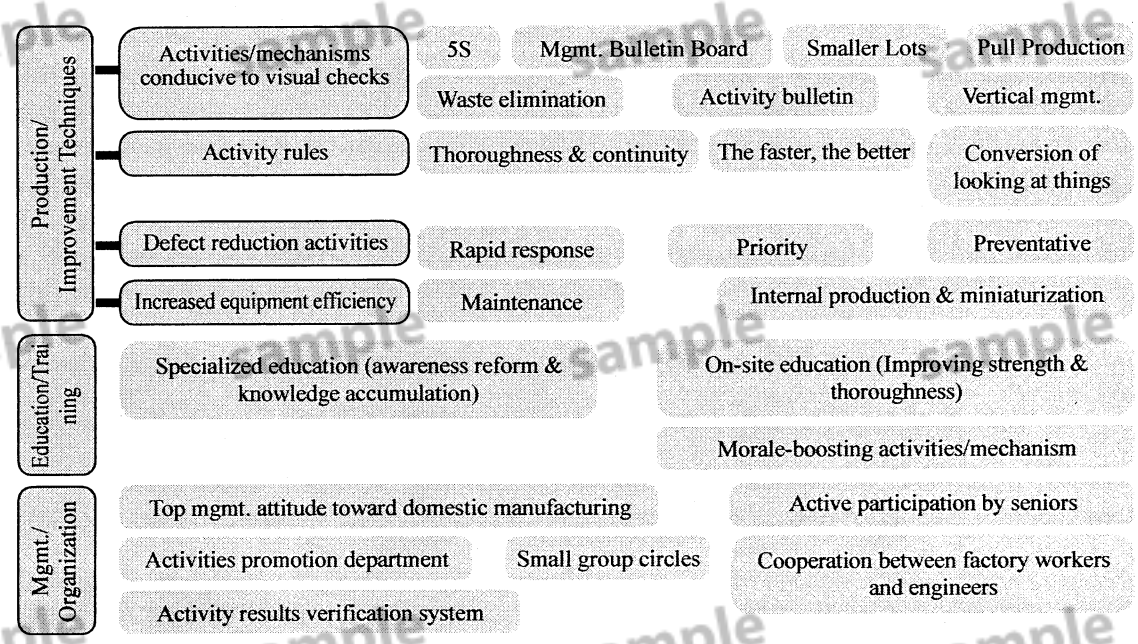
4.1 Case Study Outline

Figure 4 illustrates the results of the study. It is divided into three sections (top, middle, and bottom), according to the three factors identified in the literature survey. Figure 4 shows separate categories (left to right) for each activity/mechanism that are discovered during the on-site inspections. The paper will provide descriptions for only the most interesting findings, due to the restrictions of the volume.

4.2 Improvement and Production Techniques

(1) Activities/Mechanisms for Visualization[9]

An all companies are conducting the following activities in this category: 5S, waste elimination, management bulletin boards, and lot size reduction. At each company, these activities are designed to make visual verification easier. The traditional definition of "visual verification" refers to the ability to determine production status, amount of waste, and rate of defective products at a glance. The companies studied have broadened the definition to include the ability to easily verify the results of improvement activities and the ability to perform work customer in mind. The following paragraphs describe in detail ways in which companies have implemented 5S, waste elimination, and vertical line management activities.



Note:
The above diagram has divided the "Production/Improvement Techniques" category into four subcategories. Because it is difficult to do the same for the "Education/Training" and "Mgmt./Organization" categories, the paper has organized activities into three broad groups for the former and six broad groups for the latter.

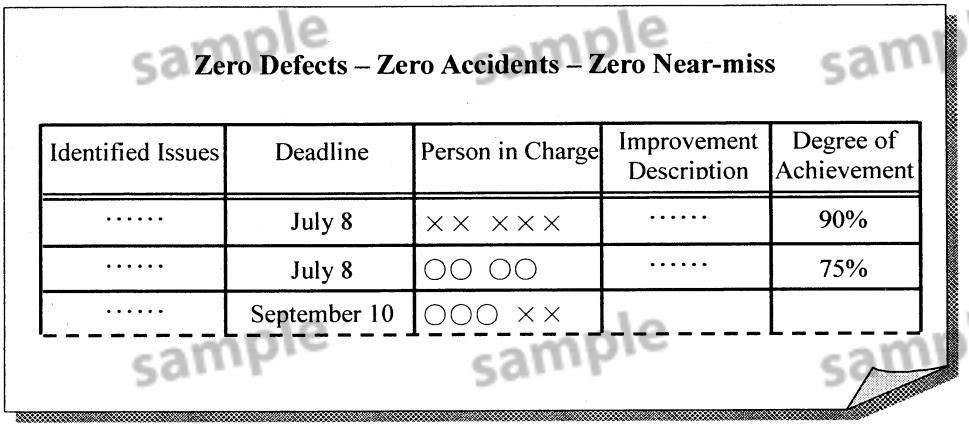
Figure 4 Activities and Mechanisms Employed by Most of the Studied Subjects

① 5S Activities

"5S" is an acronym for five Japanese words: seiri (arrangement), seiso (cleaning), seiton (tidiness), seiketsu (cleanliness), and shitsuke (discipline). It serves as the foundation for a wide variety of on-site activities. Still, many companies that we interviewed complained that, although they know how important "5S" is, it is difficult to implement it in a thorough manner.

Let us take a look at efforts undertaken by Companies A and L to ensure their 5S activities to be effective.

Twice each a year, the top management at Company A conducts special inspections that are followed by "follow-up" meetings held several months later. Its 5S activities are managed from the top down. Activity bulletin boards as in Figure 5 are posted in each workplace; these list all of the problem areas identified by the top management, in addition to the names of the workers assigned to solving the problems, what kind of actions were taken, and when the actions were taken. At the follow-up meetings, numerical evaluations are given to each individual improvement and the degree to which the improvement was achieved. Managers instruct workers on a daily basis to clean their workplaces as though they were retail shops, and to always perform work with the customer in mind.



Zero Defects – Zero Accidents – Zero Near-miss

Identified Issues	Deadline	Person in Charge	Improvement Description	Degree of Achievement
·····	July 8	×× ×××	·····	90%
·····	July 8	○○ ○○	·····	75%
·····	September 10	○○○ ××		

Figure 5 Company A's 5S Activity Bulletin Board

The top management at Company L also conducts special inspections. In addition to these, one and a half hours are set aside each month for safety supervisors (in charge of 5S activities) and plant foremen to visit each department in order to conduct inspections and to mutually verify what issues exist. The company refers to this activity as "5S Patrol." Furthermore, the level of 5S performance is requested to be enhanced when visitors come to the plant. Company L believes that 5S activities must be constantly performed and maintained, and that if this daily routine were ever broken, it would be very difficult to get back on track.

② Waste Elimination

As defined as "Seven Types of Waste" in the TPS and "Eight Major Losses" in the TPM, waste refers to any factor that hinders efforts for improving productivity. The companies studied use 5S and standardization practices in order to make it possible to visually verify waste and losses, resulting in a reduction of both. Furthermore, they have succeeded in changing the ways in which workers view things, and encouraging them to "take action first" and to "push to the limit" when conducting improvement activities. This, they hope, will enable them to improve the results of their activities.

Let us take a look at the case of Company M, which has succeeded in the thorough elimination of waste from its production lines. The company employs a relay production line whereby each worker who has finished performing his assembly task goes to a preceding assembly station to pick up an assembly unit from the preceding station to his station. Thus work-in-process unit shifts to the next station without any loss in man-hour operation. This system is effective at minimizing the amount of time wasted by workers who must wait for units to arrive from preceding assembly stations. Furthermore, if one of the production lines falls behind and workers are unable to catch up, a line leader will jump in and work alongside the other workers in order to help them return to the normal line speed. This has enabled Company M to keep losses due to material stagnation to a minimum.

When such a support mechanism is introduced into a relay production system, extent of each worker's operation is unexpectedly changed. This in turn increases the number of man hours required to complete a task and can easily lead to losses for the company. Company M is trying to avoid incurring such losses by thoroughly training all workers to perform the required tasks at any station in the assembly line. Moreover, it has been able to eliminate operation-related waste by reducing the space between workers and by placing parts just in front of workers, and to reduce the amount of works-in-process by supplying materials in a small lots.

③ Converting to Vertical Line Management

Shift from a conventional horizontal line management, with one-lot-at-a-time production by division of labor, to a vertical line management with "through" production of final products by multi-skilled worker, has become a common practice at assembly factories. Recently, "assembly cells" are being touted as the key to meeting diverse and rapidly-changing market needs by enabling companies to manufacture various types of products in variable quantities. Cell assembly is one of the means by which manufacturers can implement a vertical line management system.

Many of the companies that we interviewed had successfully boosted productivity by implementing assembly cells. However, this system requires time for cell workers to master a greater number of tasks, which makes it difficult to manage the pace of operations; furthermore, cell workers must frequently "switch gears" in order to cope with variable production volumes, and this can cause significant mental strain. Resolving these issues is crucial to making cell assembly operations pay off.

Company F has implemented cells in all of its final assembly stations. Simple profit and loss (P/L) statements like the one shown in Figure 6 are displayed in each cell. Each statement features a color photo of the cell's operator, who is instructed to think of his cell as a "shop" and of himself as the shop's "president." The amount of work completed each day represents the shop's "income," and the worker's own labor costs and "shop rent" are considered as "expenditures." So it is easy to determine a worker's productivity by comparing his "shop's" income and expenditures.

Company F has also implemented "pair cells," where seasoned workers are paired with new employees (see Figure 7) in an effort to train them to perform a wide variety of tasks (cross-training). The amount of work to be performed by each individual is determined at the discretion of the senior worker, and a computer monitor located between the two workers displays step-by-step instructions on how to perform the cell's required tasks. This enables the company to provide effective training that matches the worker's level of proficiency.

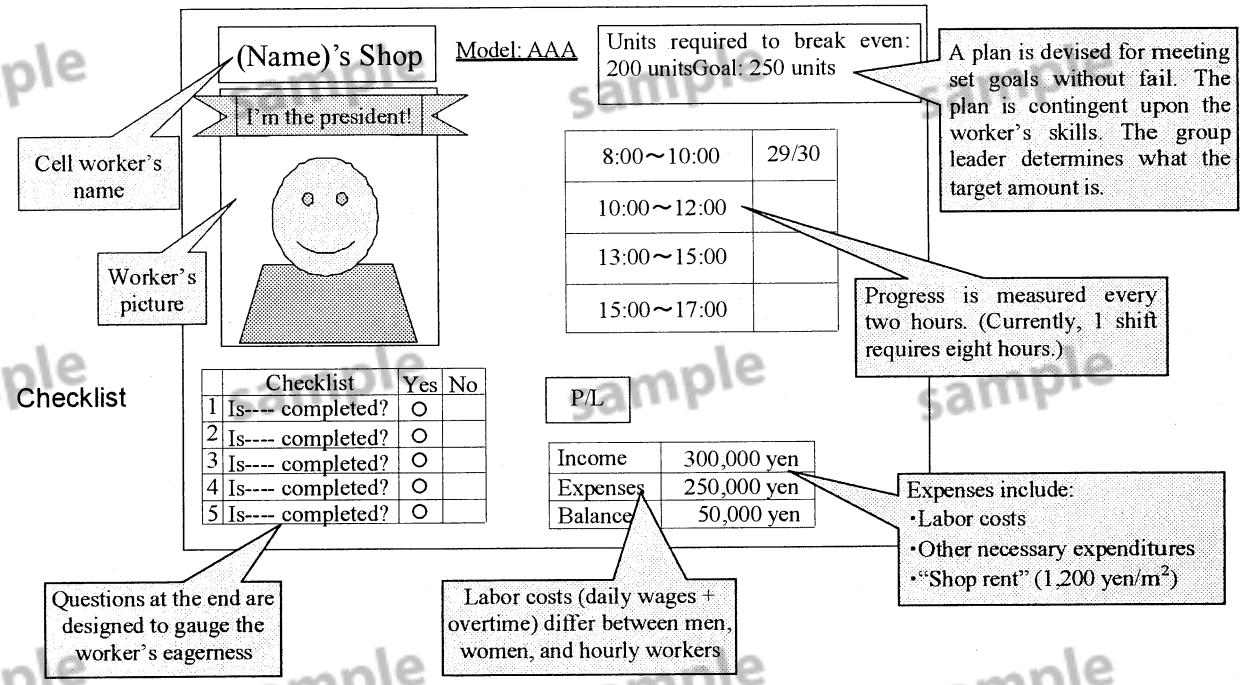


Figure 6 Individual Cell P/L Management (Company F)

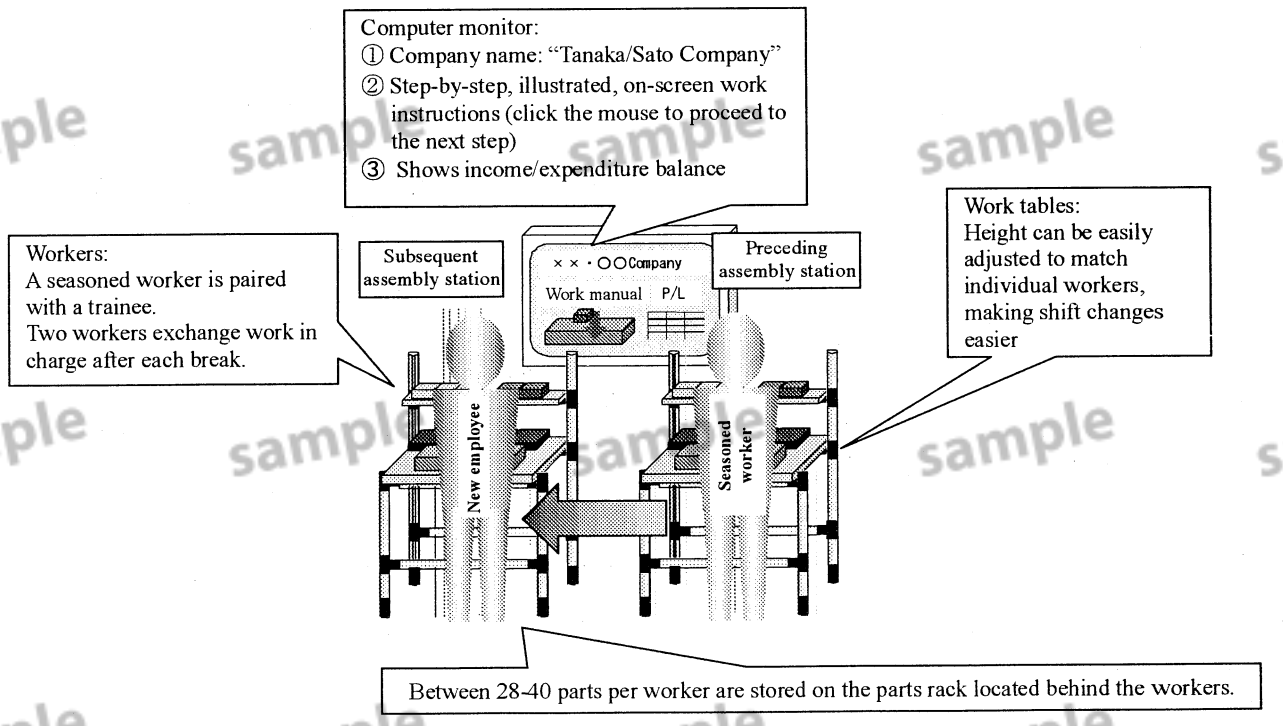


Figure 7 Cross-Training at Company F Using "Pair Cells"

(2) Reducing Rate of Defective Products

Like 5S and waste elimination, reducing the rate of defective products is also vital for improving manufacturing operations. Each company that we studied has implemented various measures to address this issue. We can categorize these measures into three groups according to their objectives: 1) "immediate response" policies used to prevent further increases in defects, 2) "priority management" policies used to determine the root causes of major defects, and 3) measures designed to prevent the occurrence of defects.

"Amazing Quality!" is the slogan that Company E has adopted for its own defect reduction activities. We will describe each of the three categories using the case of company E's activities.

① Immediate Response

When defects are detected in a production line, a quality supervisor (referred to as a "nurse") is immediately called to the location in which the defect is found out; this is referred to as a "nurse call" (see Figure 8). Whenever a worker detects a defect or malfunction, he presses the nurse call button located nearby which uses sound and lights to indicate where the trouble has occurred, and a nurse is immediately dispatched. The alarm will continue to ring until a nurse arrives at the scene to deactivate it. When demonstrated, the alarm made a shrill sound that echoed throughout the plant, and a senior nurse was on the scene in less than a minute.

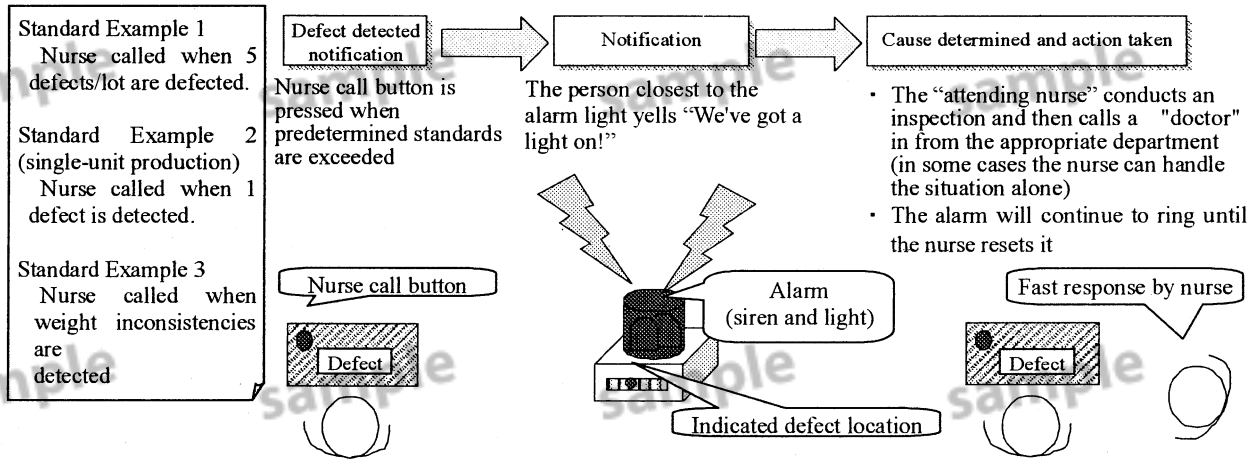


Figure 8 Nurse Call at Company E

② Priority Management

At Company E, yellow flags are attached to assembly stations where major and persistent defects occur in order to call attention to the problem. Shifts in the rate of product defects, the number of nurse calls placed, and other numeric data are used as visual management indicators. This practice enables the company to better manage priorities (refer to Figure 9).

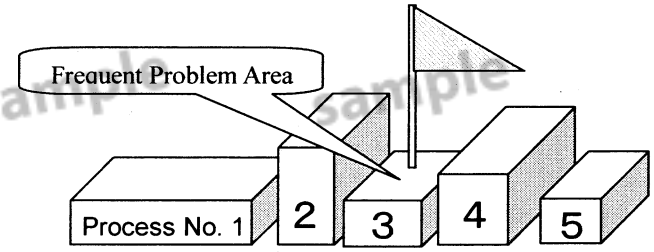


Figure 9 Company E's Yellow Flags

③ Preventative measures

An assembly worker who causes a defect to occur is required to fill out a form describing the defect and the conditions surrounding its occurrence at Company E. This form is displayed in the workplace. The company encourages employees to make their errors public by promising not to impose penalties. This practice has been effective in clarifying workers' true intentions and responsibilities, and in preventing future occurrences by pointing out defect causes and available countermeasures to other workers.

(3) Improved Equipment Efficiency

All companies under the survey have implemented aggressive measures for improving production equipment efficiency. Some companies try to achieve this by having their assembly line workers (not specialists) perform equipment maintenance. Other companies develop and install their own house-made equipments in order to take advantage of workplace innovations.

Because internally-manufactured production equipment is generally smaller and easier to operate than equipment manufactured by third parties, it offers a number of advantages: lower initial investment and running costs, more efficient use of space, easier/quicker repairs, and faster installation. By introducing internally-made jigs and equipment (refer to Figure 10) into all workplaces, Company E was able to dramatically boost productivity. It considers the introduction of internally-made equipment as a primary component of its improvement activities.

The internally-made jig shown on the left side of the figure is used to transfer parts that easily become entangled from one assembly station to the next. The parts (shown straddling the wires in the figure) are loaded onto two wires that are driven by an electric motor (creating a gondola of sorts) and transported to the next assembly station. Parts that happen to fall off are collected by a rain gutter that is placed below the wires. As a result, the company was able to directly connect two assembly stations located on opposite sides of a hallway and achieve one-piece-at-a-time production without man-hours for transportation.

Company E provides special training aimed at developing specialized engineers (gadget engineers) and maintenance experts in an effort to promote the internal development of production technology. Using the slogan "Join the Cause!" it also encourages engineers to participate in improvement activities. This practice enables engineers to better gain an awareness of problems in the workplace and to share improvement-related knowledge with manufacturing workers. Ultimately it is an effective way to provide on-site training and to raise the awareness of all involved. Improvement suggestions are stored in a database called a "theme bank," and engineers work to improve machinery until manufacturing workers are satisfied. Thus it is truly a joint effort.

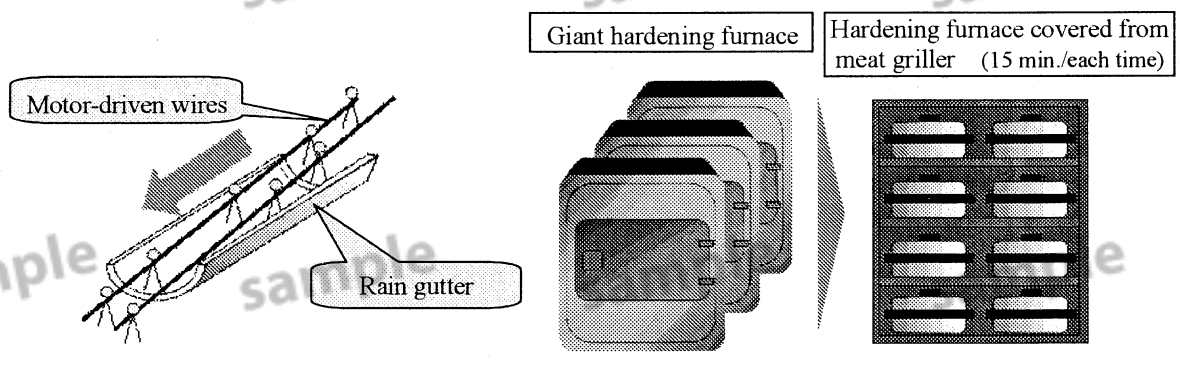


Figure 10 Examples of Internally-Made Equipment

4.3 Education and Training

This subject can be divided into two broad categories: 1) specialized training designed to change employees' ways of thinking and bestow specialized knowledge, and 2) on-site training designed to help employees acquire practical knowledge. There are various ways in which companies go about providing specialized training; some offer internal study courses and workshops, and others employ third-party consultants or require employees to attend third-party seminars. On-site training may include OJT training for multi-skilled workers and participation in "improvement practice meetings" designed for making improvements in the workplace. Some companies have established apprentice programs and internal "exchange programs" that provide employees with an opportunity to become involved in the improvement activities at other departments.

Company O has set up its own "dojo" (supervised by the plant foreman) to provide technical and skill training to its employees. The dojo offers to workplace leaders specialized training designed to boost improvement skills and disseminate valuable knowledge that the company has accumulated (see Figure 11). The company has also set up nearly ten different "cram schools," including the Quality Control School (teaches statistical quality control techniques), the Tool School (specializes in technology for developing production tools and jigs), and the OPS School (specializes in industrial engineering).

Employees who are highly experienced in their respective fields serve as instructors; course materials are developed in-house and focus primarily on case studies at the own company. Each cram school term lasts ten days. To receive a course completion certificate, attendees are required to make presentations before the plant foreman regarding improvements in their own workplaces. Their names are then added to a publicly-displayed list of employees. Each workplace makes provisions for their employees to attend training at least once a week to ensure program continuity.

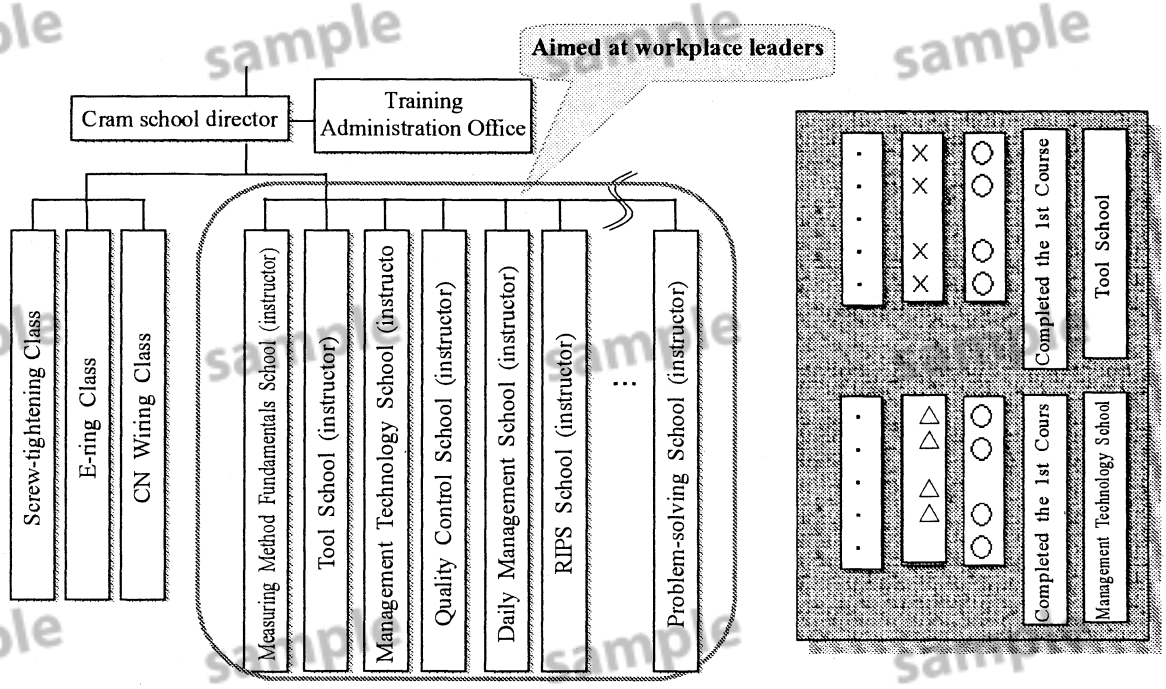


Figure 11 Technical and Skill Training Dojo (The Case of Company O)

Company N, on the other hand, provides a good example of practical on-site training. Its training courses are called "production innovation practice meetings" (see Figure 12). At the beginning of each week, teams are formed according to improvement theme and workplace. In order to effectively eliminate production line waste, these teams work on Mondays and Tuesdays to identify areas that require intensive improvement efforts. Wednesday afternoons are for workplace leaders to concentrate on removing waste, and

the results of these efforts are presented to the top management on Wednesday evenings. Before attending these presentations, department and section chiefs in advance visit the target improvement workplace. Consequently, critical comments/suggestions are pointed out at the Wednesday meetings. Finally, Thursdays and Fridays are dedicated focus on further improvement activities in the areas pointed out at the meeting.

For the past years since 1995, Company N has conducted this one-week-cycle Kaizen training on a weekly basis continuously for over eight years. As a result, it has not only been able to broaden employees' knowledge and improve their skills, but has also succeeded in boosting employee morale and significantly improving productivity.

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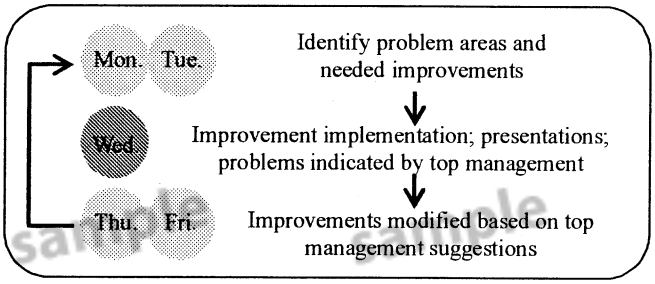

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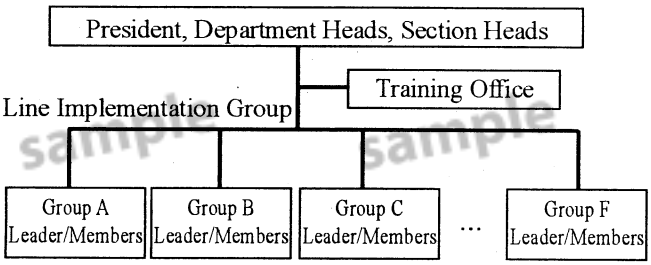


<Production Innovation Practice Meeting Notice>

Production Innovation Project Dec. 2, '02 (Seals of approval go here)

The 270th Production Innovation Practice Meeting (Organized according to line)

1. Time: Wed., December 4, 2002
2. Participating Workplaces: Manufacturing Section No. 1, Manufacturing Section No. 2, Mounting Dept., Lens Manufacturing Dept.
3. Schedule
   - 13:00 Meet in Conference Room No. 222
     Greeting Section Chief _____
     Confirmation of Improvement Activities
   - 13:30-16:00 Workplace improvements, divided by group (①→②→③→④→⑤)
   - 16:00-16:20 Group presentation (No. 2 Conference Room)
   - 16:50-17:00 Assessment by Department Chief _____
     Emcee: _____ (Manufacturing Section No. 2)
   - Option: Break
4. Participating Members

Grp.	Target Workplace	Theme	Members
A ③ 13:50	Production Equipment Section 2G1F1L	Adding inspection checklist items and reducing work hours Goal: Mounting 22,500 pieces/day Work hour reduction △1.25H/day (8.75→7.5 H/day)	★○○KK, ××, △△, ……
B ② 13:40	Manufacturing Section 1G2FSD-9	DSC-P51 Elimination of waste generated in parts supply, transport, and setup operations Goal: 1 free worker (reduce from 3 to 2 people)	★××L, ○○SL, △△R, ◇◇KK, …
C ⑤ 14:10	Lens Manufacturing 1G1FL16	L-1 Increase production volume (units) by inspection and improving jigs/tools Goal: Increase daily production from 600 to 650 units	……
D ① 13:30	Manufacturing Section 2G2FSB-7	Elimination of operation-related waste through keeping items Goal: 1 free worker (reduce from 44 to 43 people)	……
E ④ 14:00	Mounting Technology Section 2G1F-6L	Boost production line operating rate by reducing the flow shift time Goal: Mounting 72,223 pieces/day	……

Distributed to: Executive Director ○○, Company M Research Center (for reference) Manager ××, Section Chief ○○, MC, Participants

Figure 12 Company N's "Production Innovation Practice Meetings"

4.4 Organization and Management

All of the companies surveyed had established autonomous workplace circles and offices for production innovation activities. Moreover, the majority of companies had implemented systems for top management use to verify results of workplace activities (top-down), and systems that enable workers to submit improvement proposals (bottom-up).

Let us first look at the improvement proposal program implemented by Company O. Both regular employees and subcontractor employees (which account for 60% of Company O's workforce) participate equally in the program, which is called "Challenger 21." Each month, roughly one proposal is submitted per employee, a total of about 600 proposals. Not only do employees receive cash rewards compensate with the number of proposals they submitted, their proposals are evaluated by group leaders (who assign point values) and featured in monthly rankings, and awards are given twice a year to employees who have acquired the most points. Points are also given to groups in order to encourage them to compete with each other. The company also presents "Improvement Result Awards," "Idea Awards," and "Failsafe Device" on a monthly basis.

As an example of top management participation in workplace improvements, Company C's top managers hold annual "Workplace Instruction Conference" which provides the company president with an opportunity to review workplace improvements and give instructions. Similarly, Company N sets aside one hour each morning (starting from 8:30 a.m.) during which executive officers and department/section chiefs tour the plant. They do not set any meetings during this time period to dedicate themselves to on-site improvements. Armed with Allen wrenches, they conduct waste inspections and make on-the-spot improvements. This has been put into practice each and every morning and referred to as "Daily Check."

5. Things Suggested from the Case Studies

5.1 The Importance of Improvement Activities

From the process of this study, we learned that all 15 factories have aggressively implemented a broad range of improvement activities. Even though they have all received various manufacturing-related awards and/or been covered in industry magazines, we were surprised to discover that so many companies have devoted themselves to improvement activities, especially at a time in which Japan's manufacturing business is facing a major difficulty.

The improvement activities implemented by each company– 5S, management bulletin boards, defect reduction, maintenance and internal manufacture of production equipment – are all based on common sense concepts. Given that, why haven't other companies been able to achieve the same success? The difference is that the companies we surveyed have been able to thoroughly implement these activities in all levels of their respective

organizations, on a long-term basis; this has made it possible for them to reap considerable benefits.

There exists a tendency to place a greater emphasis on innovations than improvements. Still, it is important that Japanese manufacturers realize that 1) there is room for preserving and revitalizing the Japan's manufacturing business by devoting more resources to improvement activities, and 2) improvement activities can significantly meliorate business performance.

On the other hand, if observing these improvement activities from a cross-company perspective, we can realize that merely implementing specific techniques or specified production systems will not make it easier to implement improvements. Making improvement activities actually work requires a company to implement various activities and mechanisms that are designed to drive and sustain improvement efforts; it also requires a company's management to become actively involved. The following sections also illustrate a number of other factors that are vital to achieving fruitful results.

5.2 The Importance of Training and Management

As case studies of Companies A and L suggest that 5S activities are effective only when management (including top levels) becomes involved on a daily basis. Providing constant training to workers is essential to sustaining 5S activities. In order to build a relay production line, Company M has undertaken grueling efforts with active management participation. It also requires a phenomenal amount of time for the company to cross-train its employees to the extent that they can easily cope with frequent changes in line operations. One hour each morning is dedicated for daily improvement by company M's executives. Company M's management is closely involved in all aspects of the company's workplace improvement activities, encouraging workers to step up efforts to eliminate waste.

Company F has used innovative cross-training methods and management devices designed to boost worker motivation to greatly improve the productivity of its assembly cell operations. Company E was able to reduce defect rates by implementing a system under which workers who have caused defects are encouraged to identify defects themselves. This system creates opportunities for management to provide training and guidance to workers without blaming them, and has enabled the company to reduce defects.

Many plants have fully devoted themselves to educating manufacturing engineers and maintenance operators in an effort to develop production equipment internally. Such efforts have proven effective in promoting collaboration between plant workers (who use the equipment) and engineers (who design the equipment), and are essential to the development of superior manufacturing operations.

As described above, the effectiveness of activities related to improvements and the development of new production techniques relies on the provision of advanced training

programs and the systemization of thorough on-site training programs. Our research confirms that top management involvement (periodic on-site guidance and overall participation in plant activities) is also an essential factor. Effective results can only be achieved by integrating improvement efforts with training programs and management involvement, not by trying to superficially imitate existing improvement techniques or by implementing a variety of techniques in a reckless manner.

5.3 Thorough Implementation and Constant Dedication

The thorough implementation of and constant dedication to 5S activities at Companies A and L, morning improvement activities at Company M, and weekly practice meetings at Company N was made possible because the top management at each company actively participates in plant improvement activities. When Company N's newly-appointed president – a strong proponent of domestic manufacturing business – assumed his post, the company implemented a weekly improvement practice program that has been continued without interruption for as long as eight years. Moreover, Company F's profit/loss management technique at each cell, with workers' photo and figure of daily value added, and Company E's "nurse call" system and its practice of displaying defect-related information in the workplace, suggest that each individual activity must be thoroughly implemented in all of a company's organizations to be effective.

Beyond these cases, there are various examples of companies that have enhanced their employee training programs by supporting independent study groups and offering internal courses that cover a variety of subjects on a long-term basis. Other companies have, after thoroughly streamlining their manufacturing operations, been able to build production lines incorporating indirect functions. Still others have conducted waste elimination activities that have enabled them to reduce manufacturing costs to a point they can compete with rivals in China. A common factor in all of these cases is: thorough implementation and constant dedication. It should be pointed out that none of the companies that we examined achieved rapid results by relying solely on specific techniques.

5.4 Dedication to Domestic Manufacturing

The stance and attitude of a company's top management play a major role in the thorough implementation of and constant dedication to improvement activities. For example, the top management at Companies A, E, N, and O clearly indicated their position that "domestic demand should be met by domestic supply." They were determined not to lose out to rivals in China and Southeast Asia, and implemented activities that required internal organizations to unite and work toward common goals. By clarifying for all employees their dedication to supplying products domestically and their dedication to sustaining and revitalizing the domestic manufacturing plants, the top management was able to transform a sense of crisis into a desire to improve operations, and ultimately accelerate improvement efforts. We can therefore conclude that the dedication of a company's top management to sustaining the domestic manufacturing business and the declaration of this stance to the workforce are both extremely vital to the successful implementation and execution of improvement activities.

6. Summary

6.1 Recommendations for Domestic Manufacturers

Based on all of the study results discussed above, we can present the following recommendations to Japanese manufacturers:

(1) In order for Japanese manufacturers to sustain their domestic operations in the future, it is important not only to consider ways in which to distinguish products and technologies from rival companies, but also to deepen their awareness toward potential for implementing improvements in manufacturing operations.

(2) Improvements should not be made by merely introducing improvement techniques or new production systems. It is much more important to enhance employee training programs (which provide the foundation for making improvements), and to make sure that the top management is actively involved, with dedicated support.

(3) Top management should be fully prepared to make sure that improvement activities are implemented thoroughly and executed consistently, and that its dedication to manufacturing products at domestic plants is clearly understood by the workforce.

(4) Consequently, it is necessary to integrate improvement efforts with training programs and management involvement, and to place more emphasis on the "depth" of the activities being performed instead of worrying about the "width" or "variety" of improvement techniques including those that are in fashion.

(5) In consideration of 1) the enormous potential that exists to improve business performance by implementing improvements in manufacturing operations, 2) the amount of time that is required before a company first begins to see results, and 3) the rapid emergence of rival companies in China and Southeast Asia, Japanese manufacturers should not waste any time in implementing improvement activities.

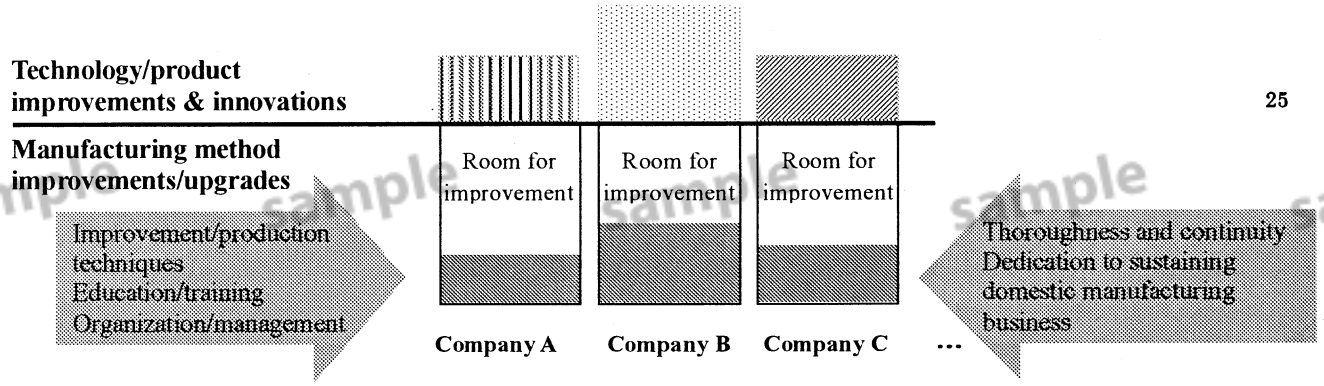
6.2 Conclusions

Based on a detailed survey of successful domestic manufacturing companies, we have clarified that improvement/manufacturing techniques, employee training, and organization/management involvement are three factors that are essential to sustaining and revitalizing Japan's domestic manufacturing business. We summarized in Figure 4 the various types of activities and mechanisms employed by each company surveyed, and discussed concrete examples. The results showed, as in Figure 13, that the effectiveness of improvement/manufacturing techniques is closely correlated with employee training and management participation, and that thorough implementation of and constant dedication to improvement activities, in addition to dedication to and belief in domestic manufacturing, is essential for achieving successful results. When thinking about the considerable amount of time required before a company can begin to see results, and about the huge amount of energy required to unite all organizations within a plant toward

common goals, domestic manufacturers must remember that manufacturing improvements and the thorough implementation thereof is one of the keys to revitalizing the domestic manufacturing business.

This is something that cannot be achieved overnight. In this age of global competition, it is much easier for a company to move its production operations overseas, thereby reducing production costs and boosting the company's competitive strength. When competing with plants in China and Southeast Asia, gaining inexpensive local resources, such as workforce, materials and infrastructure, means just getting ready for the production race with favorable conditions.

Implementing improvement/manufacturing techniques designed to take advantage of a company's resources, providing superior employee training, and effective, involved leadership are the true keys to building competitive strength. Companies that are quick to shift their production operations to overseas plants because of perceived limitations on streamlining domestic operations, and those that rely on cheap overseas resources while neglecting improvement activities at home, will one day find themselves lose in competition at foreign manufacturing operation. Consequently, the knowledge accumulated by companies that implement improvements in their domestic operations, can also be leveraged in their overseas plants, enabling them to compete successfully in the global manufacturing competition.



Note: The meanings of the elements used in the above diagram are identical to those used in Figure 1.

Figure 13 Thorough Implementation, Continuous Execution, and Devotion to Domestic Production

Footnotes:

1. "2001 Basic Survey of Overseas Operations," METI, 2002.
2. "Industry Statistics Chart," METI, 2001.
3. "Overseas Operations of Japanese Companies -1997," METI, 1998.
4. The observations of this paper are based on a perspective that focuses on plant activities; any efforts to distinguish, or make innovations in, manufacturing and product technologies are considered as efforts to strengthen products/technologies.

5. Typical examples of arguments that advocate the development of new products and technologies as a means of sustaining Japan's manufacturing business are covered in [7], [10], [11], and [12] in the bibliography.
6. Literature [13] is the only publication that argues the necessity of considering "hollowing out" countermeasures from both "products/technologies" and "manufacturing method" perspectives.
7. For example, Toyota's operating profits in FY 2002 amounted to about 1.4 trillion yen – roughly 300 billion of which was generated by rationalizing manufacturing operations. Canon's operating profits in FY 2002 amounted to about 346 billion yen – roughly 55 billion of which was also generated through rationalization efforts. Literature [5] offers numerous examples of companies that are taking improvement activities seriously, and the results they have achieved.
8. TPS, TPM, and TQC are described in publications [1], [2], and [6], respectively.
9. While it is possible that our decision to place the emphasis of the survey on manufacturing plant inspections may have influenced our findings to a certain extent, it should be pointed out that none of the plants we interviewed indicated that POS (Point of Sales) systems, scheduling techniques, and other IT applications were priorities. By contrast, all companies employed management and activity bulletin boards.

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