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THE JUST-IN-TIME SYSTEM IN SELECTED PHILIPPINE MANUFACTURING COMPANIES

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The study evaluated the performance of the Just-In-Time System in four Philippine manufacturing companies. Research results indicate that the JIT concept can be applied successfully in the Philippines, and that the impact on operations is likely to be comparable with that in typical Japanese firms. However, there are indications that the system may not be readily applicable to raw materials and finished goods inventory. Findings also tend to show that the most important factor contributing to the success of the JIT effort is top management support, and the most important factor that influences the choice of specific JIT projects is the nature of manufacturing processes and equipment used in the company. There were also indications that differences in JIT results exist between companies engaged in assembly operations and companies engaged in continuous manufacturing.

The study employed the case study approach and relied mostly on information obtained from plant visits and interviews with key officers of the selected firms. Average annual inventory reduction was the key measurement variable. Disparities in the levels of success were explained in terms of four success determinants — top management support, employee readiness and cooperation, engineering support, and supplier cooperation — and three project selection factors — manufacturing processes and equipment, product demand patterns, and product characteristics.

Given the findings of the study, a four-phase JIT implementation program was developed.

1. Introduction

Various strategies and techniques have been developed and implemented by managers and decision-makers in the hope of being able to solve the problems of increasing costs, high defects rate, low turn-around time, poor morale among workers, low productivity, and declining profits. During the last two to three decades such programs as management by objectives (MBO), zero-defects (ZD), quality circles (QC), sensitivity training, worker-manager workshops, profit sharing, suggestion systems, and attitude surveys, have become popular among many organizations, both in the Philippines and abroad. More advanced technologies have also started to emerge and are finding their way into the country's industry sector. These include computer-aided

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design/computer-aided manufacturing (CAD/CAM), material requirements planning (MRP I), manufacturing resource planning (MRP II), and the just-in-time (JIT) system, which is the subject of this paper.

JIT originated in Japan and has since gained worldwide attention because of the simplicity of its underlying principles, and the way it is able to bring together existing improvement programs. Those who have successfully adopted JIT claim that the effects of implementing the system are far-reaching, to include quality and productivity improvement, strengthening of the company's motivational basis, and substantial increases in profits. But the focus of JIT is on the reduction, if not the complete elimination, of inventory. This is a major shift in the traditional thinking that inventory is a necessary element of operation.

Purpose of the Study

In the Philippines, a number of firms have already taken interest in JIT. However, only a few have accepted the JIT challenge by actually implementing some of its features. Whether JIT has succeeded in these companies and will eventually gain nationwide acceptance is a critical question, considering that many of the Japanese ideals depart from those which local firms have been accustomed to, as a result of Western influence.

The primary concern of the study is to evaluate the performance of the JIT system in selected manufacturing companies in the country. Specifically, the objectives of the study are:

1. to describe and assess the extent and manner of JIT application in the selected firms;
2. to look into the problems which have been encountered in implementing the JIT system;
3. to evaluate the degree of success of JIT in reducing inventory levels;
4. to identify the major factors which influence the success of JIT implementation; and
5. to develop guidelines for JIT implementation suitable under local conditions.

2. Previous Research

There are, as yet, no formal studies relating to the application of the JIT concept to Philippine manufacturing, owing to the recency of local JIT adoption. However, several investigations have already been

made by foreign researchers, mostly from Japan and the U.S. Many of these are accounts of how certain companies were able to evolve a JIT system, the problems encountered, and the benefits that were derived.

Transferability of JIT

An extensive study of how a JIT system was implemented in a glass manufacturing operation in the U.S. was conducted by Byrd and Carter (1988) from the spring of 1986, when the company was instructed by its corporate parent to introduce JIT, to 1988, at which time a full-blown JIT system was already in operation. Glass manufacturing is a continuous flow process and not the typical JIT application, but Byrd and Carter observed that JIT could be used to solve a number of problems encountered with the lehr cycle and all subsequent operations. These problems included high rejects level, poor materials flow and handling, and long production cycle. Byrd and Carter summarized the JIT effort of the glass manufacturer as a 12-step program directed towards attitudinal change. Another prominent feature of the program was the design of a JIT portfolio based on the insights of various production managers. The portfolio included production control, production capacity flow, production organization, and production scheduling. Byrd and Carter noted several benefits derived from the JIT program. The blowroom received quicker feedback on its quality — from two days down to 75 minutes. This reduction in feedback time reduced the defects level from 20 per cent to 12 per cent. WIP inventory also decreased by 81 per cent, and 1,000 square meters of floor space became available for production. Byrd and Carter found the total cost savings to be approximately $500,000 during the two-year period.

Raia (1986) compiled reports on the results of JIT implementation in a number of large American companies. Among the firms included in his account were General Motors, Motorola, Xerox, Hewlett-Packard, Harley-Davidson, Briggs & Stratton, Jasle Steel, IBM, Ford, and General Electric. All of these companies have successfully adopted various features in varying degrees. However, the results were similar: substantial reduction in inventory-related costs, quality improvement in terms of defects rate reduction, savings in floor space, reduction in manufacturing lead times, setup time reduction, and productivity improvement.

Sadhwani and Sarhan (1987) also studied the impact of JIT application on several U.S. companies, but concentrated on the smaller ones. They found that since large manufacturers started adopting JIT, smaller companies that supply parts and components to these firms are

being pressured to adjust their business practices and manufacturing operations. Vendor analysis programs are being launched to identify only the promising suppliers because under the JIT setting, suppliers should be limited to a few reliable ones. Because of this and the move to require suppliers to comply with JIT delivery, these smaller companies are themselves shifting from traditional production systems towards JIT.

While the preceding researches tend to show that there are no significant barriers to JIT application outside Japan, another group of authors cite certain difficulties which may be unavoidable. Koten (1982), in his study of the U.S. automotive industry, identified major reasons why JIT may not work for American car companies. According to him, some automobile manufacturers in the U.S. find that their existing production system favors large stockpiles of parts. A major reason for this is the dispersed geographic distribution of suppliers and their physical distances from corporate facilities. Some parts take weeks to be shipped making parts inventory necessary to ensure uninterrupted operations. Raia does not entirely agree with this, however. He points out that the situation is not unique to America. In Japan, Raia (1986) cites a carburetor supplier located some 600 miles away from a Mitsubishi plant in Hiroshima which was making daily deliveries.

Koten cites other reasons. According to him, the relatively larger number of suppliers of American car companies makes their production systems less manageable. For instance, he mentions the case of General Motors which had in 1982 approximately 3,500 suppliers, as compared to Toyota Motors which had less than 250 during the same period (Koten, 1982). The more recent study by Raia (1986) shows, however, that car manufacturers, including General Motors, have started moving toward fewer but carefully screened suppliers. The result is a tremendous reduction in parts inventory, at least in General Motor's Lansing plant, from 60,000 tons of steel sheets daily down to 4,000.

Another difficulty which Koten (1982) mentions is in setting accurate production forecasts on the part of U.S. car manufacturers. In another study, however, Shingo (1985) discloses that the efficiency of Toyota Motors is not really attributable to accurate predictions about market demand. Rather, efficiency is achieved through the shortening of the production period. According to Shingo, Toyota adheres to a policy of small lot production and initially produces based on accepted orders from customers. However, the firm adapts production to sea-

sonal fluctuations in real demand quite easily through a system whereby the production period is substantially shortened, allowing delivery in 10 days from receipt of order (Shingo, 1985).

The long-standing practice by U.S. manufacturers of offering customers numerous options and different trim packages was also cited by Koten (1982), as a probable reason why American companies would find difficulty in implementing JIT. He reasons that if a company does not know exactly what future customers will need, it would be forced to maintain large stocks of different parts and trimmings. This observation is supported by the findings of Plenert and Best (1986) who headed a research program at the California State University in Sacramento. They examined case studies of how materials requirements planning (MRP I), optimized production technology (OPT), and JIT techniques fared when they were applied. Results of the study indicate that JIT may not be appropriate in view of the high product variability in the U.S., which accounts for the fact that U.S. companies typically have very large buildup of inventory necessary to handle product variability requirements.

Meleton (1986) suggests in his paper that JIT may not work in America because of cultural differences. On the other hand, Wheelwright (1981) explains that the most important differences between Japanese and American manufacturing are not cultural and environmental in nature. In his comparison of selected Japanese and U.S. firms, Wheelwright found that the success of the Japanese is attributable to the equal attention that they give to short-term and long-term decisions. In the Japanese company, top management gets involved even with operational matters which to them have a cumulative effect at the strategic level. In contrast, Wheelwright found that a U.S. company usually gets top management involvement only when the issues pertain to decisions which require capital investment.

Japanese Success Factors

Studies have also been undertaken which deal with factors responsible for the success of Japanese production systems. Matsumoto (1986) identified three major factors: (1) the high level of plant investment which promotes systematic introduction of new technologies, (2) more efficient use of facilities, which makes operators take less time to complete the same task, and (3) freedom from worker absenteeism, job-hopping, loss of will to work, and other problems. Matsumoto explains that the third factor has been a key to the substantial increase in productivity among Japanese firms. According to him, this is

attributable to (1) the high degree of authority and freedom that the worker enjoys within the workplace, (2) the participation of the worker in determining standards of work, (3) flexible organization which promotes teamwork, (4) emphasis on collective rather than individual skills, (5) workers' voluntary participation, (6) effective suggestion systems, and (7) the encouragement and support given to workers to learn various skills (Matsumoto, 1986).

Coates (1988) observed that most Japanese companies maintain employees for life, using part-time labor only to cover peak periods. This allows them the luxury of keeping a core of employees dedicated to the company. According to Coates, by contrast, U.S. employees are frequently dedicated only to their own work specialties, and recognitions or pay raises are easily obtained by changing jobs than by performing well for one company. Furthermore, Coates (1988) noted that Japanese companies encourage workers to participate in decision-making because they understand that the operator who actually performs the task is in the best position to recognize problems.

In the course of Hayes' (1981) research, he visited six variously-sized Japanese companies belonging to a broad range of industries and ownership histories. Among the many things that he saw was the willingness of workers to work up to about three hours of overtime per day when demand was high. He also noted that workers with managerial potential work their way up the ladder, but a sense of identification with the workers remain. In the plants visited by Hayes, everybody from the most junior production worker to the plant manager wore the same uniform.

Hayes (1981) also found, contrary to expectations, that the general level of technological sophistication in these companies was not at all superior to that observed in comparable U.S. plants. However, he noticed that there were certain aspects of operations which were given special attention. For instance, Hayes observed that comprehensive monitoring and early warning systems were installed throughout the workfloors of the companies he studied. These, along with a policy of avoiding machine overloads, guarantee the smooth functioning of production equipment which normally last two to three times longer than similar types of equipment used in American factories. Moreover, Hayes (1981) found that most of the companies he visited had approximately 50 per cent of their production equipment built by their own engineers and machinists, and most of the remainder designed in-house as well.

Wheelwright (1981) observed that the success of factories in Japan is attributable to their policy of making operations and strategy mutually supportive. In fact, the Japanese have turned the factory into a strategic weapon. Thus, top management concerns itself not only with broad long-term goals, but with details of day-to-day production which are believed to have strategic significance.

3. Research Design

Figure 1 shows the model which was developed based on the results of previous studies. It specifies the most probable determinants of JIT success. Based on this theoretical framework, two hypotheses have been formulated, namely:

1. The level of success of the JIT system in reducing inventory in Philippine manufacturing companies is comparatively lower than in Japanese firms.

2. There is a difference in the level of JIT success between those companies engaged in assembly and those engaged in continuous production.

Methodology

This study is, by necessity, exploratory. Not many local companies have gone into JIT and the ones that have been included in the investigation are still in the initial stages of implementation. The case study approach was therefore used.

Owing to the amount if detailed data that was required, the study was limited to four local firms. Data were collected in three phases: (1) an ore-plant visit interview, (2) on-site interviews and observations, and (3) a survey of workers.

In order to validate the study's hypotheses, the following steps were undertaken:

1. The results of the JIT program in terms of average annual inventory reduction as of 1988 for the selected companies were compared with the JIT performance in Toyota Motors. The comparison was made with Toyota for two reasons. First, it is the proponent of the JIT concept and, as such, adheres the closest to the JIT framework. Second, the success factors identified earlier are clearly evident in this company, making

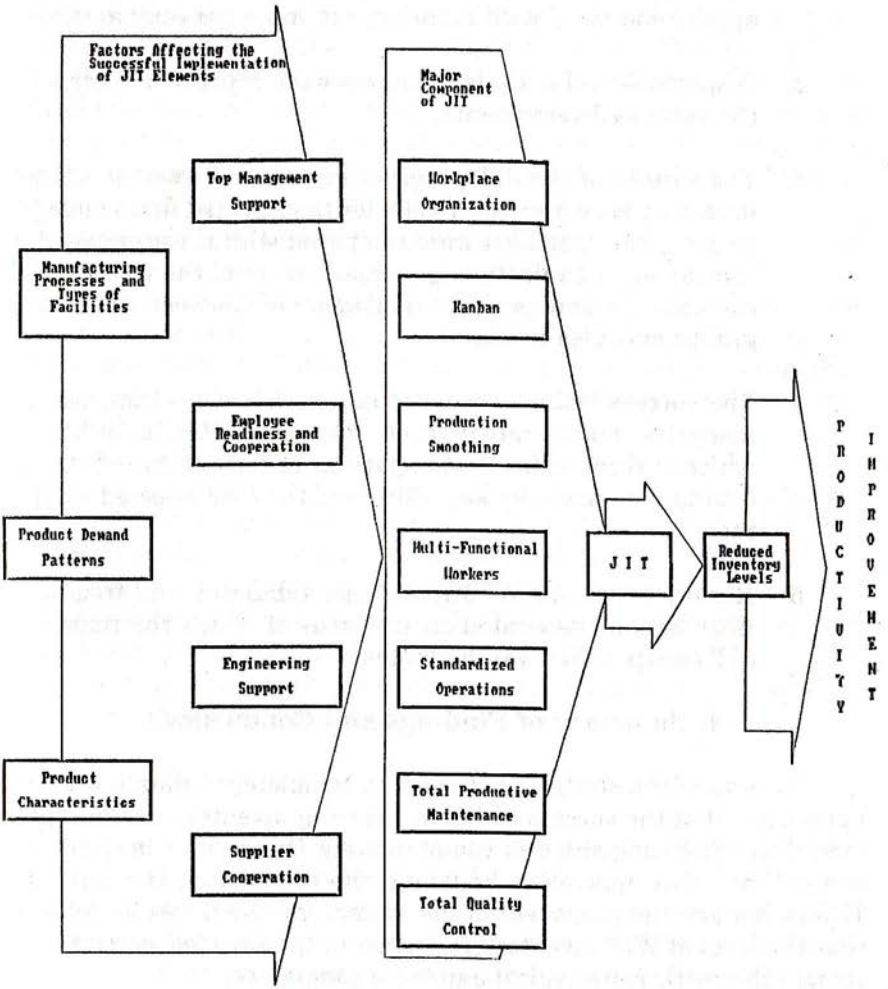

Figure 1 — Theoretical Model of the JIT System

it the best possible point of reference in assessing the effects of these variables on JIT performance.

A comparison of results with selected Japanese industries was also performed in order to determine how local JIT application fares with more typical Japanese companies.

2. Disparities in the levels of success were explained in terms of the success determinants.

3. The results of the JIT program in terms of average annual inventory reduction as of 1988 for the selected firms engaged in assembly operation were compared with those engaged in continuous manufacturing. A comparison of the types of JIT components and projects implemented between these two groups was also made.

4. The success factors were also ranked in order of importance using the analytical hierarchy process (AHP), a technique which utilizes pairwise comparison of factors, based on the evaluations made by key officers of the four selected companies.

5. Results of the worker survey were tabulated and frequency distributions generated on the basis of which the impact of JIT on operators was evaluated.

4. Summary of Findings and Conclusions

Results of the study do not seem to completely validate the first hypothesis that the success of JIT in reducing inventory in Philippine manufacturing companies is comparatively lower than in Japanese firms. While this appears to be true if the comparison is made with Toyota Motors, the proponent of the system, research results indicate that the level of WIP inventory reduction in the selected companies is comparable with more typical Japanese companies.

On the other hand, findings tend to support the second hypothesis that there is a difference in the level of JIT success between companies engaged in assembly operation and those engaged in continuous production. The difference seems to be related to the choice of JIT projects which in turn appears to be influenced by differences in manufacturing processes.

A data set of four companies prevents the drawing of broad generalizations about the results of this study. It cannot be said that the factors and relationships examined are comprehensive or that they are generalizable to all firms who have implemented a JIT program in the Philippines. But several conclusions may be drawn. First, it appears that the concept of a generic JIT program makes little sense. The diversity in the small sample group used in this study shows that, from the standpoint of JIT projects selection, these firms cannot logically be lumped into one category that would require one standard JIT program. Second, the results of the study show that the JIT concept can work in the Philippines, and the impact on operations is likely to be comparable with that in Japan. The extent of actual improvement, however, would tend to differ from company to company depending on the status of certain factors, most important among which is top management support. Third, the overall success of the JIT effort seems to depend more on the company's ability to sustain the program rather than on the program's initial performance. In other words, acceptance of the new system during the introduction phase does not guarantee that it will generate the expected improvements. On the contrary, a JIT campaign might meet resistance in the beginning but eventually succeed as long as efforts are intensified or at least sustained. Fourth, results of this study do not seem to support the generalization that worker readiness and cooperation is the most important determinant of JIT success. The findings from the worker survey also show that even if workers are not happy with the changes in work content brought about by the adoption of the JIT concept, they might still cooperate. But whether they would have exerted more effort had they been satisfied, remains a question.

Selective JIT Implementation

Results of this study indicate that it is not necessary to apply the whole JIT system, or to adhere strictly to the rules and techniques required by the pure JIT concept. For instance, under a total JIT environment, all parties who have something to do with the final product, including suppliers and end customers must be linked together into a network in order to achieve JIT delivery of raw materials and purchased parts, JIT production, and JIT delivery to end users. However, none of the companies studied went as far as deliberately including finished goods inventory reduction in their JIT portfolio. Those who produced to order did not find it necessary while those who produced to stock had no choice, owing to specified customer service goals. Although this may not exactly be the most optimal reaction, finished goods inventory may actually be necessary especially during

the initial stages of JIT implementation, as a protection against problems that are bound to surface. In addition, the stocks of finished goods could serve as a breakwater against demand fluctuations, thereby permitting WIP reduction through production smoothing without having to sacrifice service objectives.

JIT purchasing, on the other hand, may not be possible for all situations. Sourcing is the most critical consideration in the case of the companies studied, most of whom used largely imported raw materials. Overseas suppliers cannot and most probably would not deliver materials in small quantities and at short notice. One company which imported only about 40 per cent of its raw materials decided to launch a JIT purchasing program which involved only local suppliers. Even then, it did not concentrate too much on the concept of JIT delivery, but instead focused on the elimination of incoming inspection because the company felt that the requirements on suppliers may be prohibitive.

Where JIT purchasing would not be possible, companies applied JIT within the production area wherein WIP inventory could be minimized. Here, there were also differences in the selection of JIT projects. The most important factor considered was the nature of manufacturing processes and facilities. Companies whose production setups were more process-focused rather than product-focused, as in the case of assembly operations, found a plant re-layout necessary. This can be explained by the fact that the pulling action required by the JIT system can be best achieved by connecting together machines of different types to form product-focused lines. However, the rearrangement could not be done for all equipment because some were massive in size and by nature immobile. There were also structures which divided certain sections of the plant to separate specific operations. The re-layouts in these companies were therefore carried out only for those operations which involved small and movable equipment. Where the production process was predominantly product-oriented and equipment were huge, as in the case of one company, the plant layout was not altered. Since overhead conveyors already linked major operations, a re-layout was not easily possible, if at all necessary.

Theoretically, the more a company produces to order, the more it can forecast demand for specific products and models accurately. Conversely, a company which produces a variety of products for which demands are unpredictable would tend to have a process-oriented layout. Among the firms studied, those who based production on firm orders found it possible to establish dedicated lines which minimized WIP inventory.

As mentioned earlier, there are two ways by which production smoothing may be achieved. One is through mixed-mode assembly with frequent setups and the other is through single-unit flow production. JIT mixed-mode assembly requires substantial modification in procedures, implements, and even equipment in order to cut down on setup time. Results of the study show that the companies found SPF projects more applicable where small equipment were involved and dedicating lines was possible. Where operations involved large and immobile equipment, on the other hand, companies found reduction of setup time difficult considering the nature of the machines.

The kanban system and its rules need not also be adhered to strictly. In fact, there are situations where the kanban concept may not be applicable. Where work centers are adjacent to each other, kanban systems are not needed because inventory signals would suffice. Kanban is neither required between work centers linked by transfer devices such as conveyor belts. Three out of the four companies studied implemented a kanban system, but only for selected operations, particularly where items must be transferred between distant points. It was not applied within dedicated lines.

An adaptation made by the companies who introduced the kanban concept was the use of a single-market system. (Only one company actually used kanban cards. The others used kanban squares, and tags, respectively.) This differs from the original concept in that products are produced according to a daily production schedule, and parts are delivered or "pushed" to subsequent work centers, but the kanban marker controls the amount of WIP inventory by authorizing production. After a container is emptied of parts at a succeeding work center, the container and kanban marker are returned to the preceding work center.

TQC projects also differed from company to company. There were no clear indications about what factors actually influenced the selection of a quality control project. One company had a comprehensive QC program. Another focused on visual control through the use of JIT pyramids, production control boards and similar devices, while another concentrated on a zero-defects program involving suppliers.

Sustaining the JIT Program

Results of the study show that the JIT programs of companies who had carefully planned their projects and maintained the same, if not a higher, degree of intensity in their efforts performed better. In

addition, top management support appears to be the most important factor in ensuring the stability of the JIT campaign. This is understandable because while the participation of every worker in the plant would significantly contribute to the JIT effort, it is the full and demonstrated commitment of top management which would guarantee that all resources — financial, technical, managerial — would be made available to sustain the program.

Worker Participation

Results of the study indicate certain disturbing attitudes among workers affected by the JIT program. While most of them still cooperate and perform the tasks assigned to them, they are likely to harbor some negative feelings about the new system. This could be attributable to one of two things. Either they have the wrong perception about the changes that are taking place, or that the company has not completely or properly explained the nature of these changes and the benefits that would accrue to them. There is a tendency for workers to feel that their workloads have increased as a result of the change in system, although this may not in fact be true.

Developing multifunctional workers may become controversial if the concept is not understood by the workforce. It could be wrongly interpreted by those who have been used to being assigned to single operations.

5. Recommendations

Findings show that there were problems which were encountered in the course of introducing JIT, most prominent among which is the resistance from parties involved. In order to avoid these problems and the possibility of the JIT program's failure due to these problems, the following guidelines have been drawn.

It is strongly recommended that a JIT program be implemented in four phases, namely. (1) preparation, (2) workplace organization, (3) groundwork for (further) inventory reduction, and (4) inventory minimization.

Phase 1 (Preparation Phase)

This is the most critical phase in the introduction of JIT. The amount of time needed to complete this phase cannot be generalized. It depends to a large extent on who is initiating the program, whether

it has a number of believers, or only a handful, and the availability of an individual or a team to manage the introduction of the new concept. In general, this phase should involve the following steps:

1. *Organization of a project team* who will plan, coordinate and monitor implementation of the program.

2. *Identification of the JIT components* which are applicable in the company particularly, in the production system.

3. *Identification of specific areas or units in the production floor where pilot tests can be run.* It is not advisable for the company to immediately launch a plant-wide or total-system JIT implementation because if problems may arise it may be difficult to backtrack.

4. *Preparation of a detailed plan for conducting the pilot test,* including the resources needed, the time frame for implementation, the nature of changes which will take place, how operators and their jobs will be affected, and what the top management's role will be.

5. *Presentation of the plan to top management.* There are situations wherein the pilot test can be carried out without having to solicit top management support for it. If the pilot test is successful, then the results can be reported to top management, and hopefully encourage their support. However, this may not guarantee their long-term commitment to the project. Thus, before any project is undertaken, it would be best to first ensure not only support in terms of resources, but direct and active involvement in the program. If necessary, an orientation on the JIT concept should be arranged for top management.

6. *Presentation of plan to workers in the pilot unit.* Operators and their supervisors must be technically and emotionally prepared for their new responsibilities. If new skills must be learned, a training program must precede JIT implementation. If there are serious objections from the workers, it would not be good to force the issue. Instead, workers' suggestions must be entertained.

7. *Assessment of pilot unit's readiness and willingness to participate in the project.* As long as the general attitude towards the

planned change is negative, the project team should determine the probable reasons and find ways of explaining the beneficial effects of JIT to the workers. Discussions among the operators and their foremen should be encouraged.

Phase 2 (Workplace Organization)

Among the components of JIT, workplace organization may be considered the easiest and the least costly to implement provided Phase 1 has been carried out properly. This phase may be thought of as the transition phase where the main objectives are to put order on the plant floor, establish visual controls, and allow problems to surface so that directions for succeeding phases can be set. Phase 2 involves the following steps:

1. Implementation of the pilot project

   a. Introduction of simple housekeeping activities such as designation of specific locations for parts, materials, WIP inventory, defective tools, and implements. Color coding of items, containers, and lot travellers for visual control may be done, along with enforcement of rules on tidiness of each operator's work station.

   b. Review of existing processes and facilities layout of the pilot unit to determine if conversion to single-unit flow is possible. If it is not possible to re-layout all of the equipment, those which are movable must be identified and if regrouping can be done so that lines may be dedicated, at least partially, then this should be done around immobile equipment.

   c. Monitoring and evaluation of results of the pilot project. As much as possible, all results must be documented, especially problems which have been encountered. Corrective action should be instituted immediately so as not to frustrate those involved.

2. Replication of the project

   a. Announcement of pilot project results. First, the pilot project must turn out to be a success story, otherwise, replication is out of the question. Thereafter, results must

be publicized to generate acceptance and interest from the rest of the units and the workforce.

b. Preparation of a detailed replication plan which provides for the gradual expansion of the JIT coverage.

c. Development of a training/operation package to prepare all managerial, supervisory, and rank and file personnel. This package will eventually become a permanent feature of the system.

d. Implementation of the workplace organization project on a larger scale.

e. Monitoring, evaluation, and documentation of project results.

Phase 3 (Groundwork for Further Inventory Reduction)

In phase 2, substantial reduction in WIP inventory may already be realized, especially with the establishment of SPF lines. However, WIP may still accumulate between units or work centers. It is likely that some work centers would continue to be separated by physical distance. Whereas the inventory reduction in Phase 2 may be incidental, Phase 3 makes a conscious effort to bring down the level of excess stock of WIP. The following steps should be undertaken:

1. Development of methods for dealing with problems associated with WIP inventory reduction which should have surfaced in Phase 2.

   a. Standardization of workloads, cycle times and work sequences. This should begin with final assembly and then backwards through the system.

   b. Development of an information system that would link work stations together. A kanban-like system is suggested, although one which is simple enough not to overwhelm the operators. What is important is that there should be visible signals that control inventory levels, but at the same time permit flexibility of the system during periods of fluctuating demand.

c. Development of a total productive maintenance program to counter problems associated with unexpected machine failure. Initially, a preventive maintenance program will do. However, as the JIT program is expanded, it is advisable for the company to adhere to the concept of TPM, where every operator is fully acquainted with the equipment he handles and can, therefore, perform at least minor maintenance jobs.

d. Development of a total quality control program to counter problems associated with product defects. Establishment of quality inspection points at various stages of the process may suffice in the beginning. However, to fully realize the potentials of JIT, the company must adhere to the concept of quality at the source, that is, quality should be every operator's responsibility

2. Cross-training to develop multi-skilled or multi-functional worker, enhance teamwork, and build flexibility into the factory floor. Along this line, the company must review its compensation and incentive systems, performance measurements, and policies on labor utilization.

3. Establishment of a program for small group activities to generate suggestions for improvement on the production floor. This need not be a full blown QC or productivity improvement program, although such projects would greatly facilitate the attainment of JIT goals.

Phase 4 (Inventory Minimization)

It may take a long time for a company to reach this phase, if at all. In the first place, continuous retuning of the system in Phase 3 may be sufficient to bring WIP inventory to a very low level. However, there are more that can be done to realize the objectives of JIT. These are listed below:

1. *Automation or mechanization of processes to eliminate WIP inventory altogether.* This, of course, has serious implications for the labor force. Thus, unless this is done with utmost care, much resistance may be encountered. Selective automation is, however, suggested where the process to be automated is dehumanizing, or where the result of automation is a job upgrade.

2. *Autonomation (jidoka) to prevent product defects.* Special equipment are needed for this, such as machines designed to detect abnormalities, andon or trouble lights, and advanced fool-proof mechanisms.

3. *Implementation of JIT purchasing.* Unless a company is already operating near-JIT, it cannot and should not require suppliers to deliver JIT. However, as soon as the plant has progressed far enough to be used as a demonstration project for suppliers, management can invite these suppliers to observe, and encourage them to set up their own JIT programs.

4. *Implementation of JIT delivery of finished goods.* This may be applicable only if the company produces to order. Otherwise, the company can only try to bring finished goods inventory to a minimum level as long as the manufacturing lead time allows for quick response to demand surges.

Final Word on JIT

JIT is no doubt a multi-dimensional concept, that is, it integrates several subsystems together towards a single goal — productivity improvement through wastes elimination. As such. it should not suffer from the problems associated with one-dimensional programs. However, since the JIT philosophy evolved in another country, it is understandable that it cannot be transplanted in its pure form to local industries. In other words, Philippine companies can only adopt general ideas and adapt them to their specific corporate environments.

The strategy for implementation of the JIT concept is just as important as the concept itself. Evolutionary development and gradual expansion seem to be integral features of JIT manufacturing in which the reduction in inventory and careful attention to quality are intended to uncover hidden flaws in the production process. Thus, a firm cannot go to JIT overnight. Progress has to be made in small steady steps while involving everyone in the production system. And the process of retuning never ends.

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