# THE JUST-IN-TIME SYSTEM
# AND ITS APPLICABILITY IN SOUTH AFRICA

by

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I, **KENNETH HARRY MORKEL HANDS**, submit this thesis for the degree of Master in Industrial Administration. I claim that this is my original work and that it has not been submitted in this or in a similar form for a degree at any University.

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C O N T E N T S

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| APICS | - | American Production and Inventory Control Society |
| CRP | - | Capacity Requirements Planning |
| CWQC | - | Company Wide Quality Control |
| EOQ | - | Economic Order Quantity |
| GT | - | Group Technology |
| HP | - | Hewlett-Packard Co |
| I/O | - | Input/Output Controls |
| JIT | - | Just-In-Time |
| MPS | - | Master Production Schedule |
| MRP | - | Manufacturing Resource Planning |
| $MRP_2$ | - | Enhanced Manufacturing Resource Planning |
| MVM | - | Motor Vehicle Manufacturers |
| OEM | - | Original Equipment Manufacturers |
| QC | - | Quality Control |
| R and D | - | Research and Development |
| RF | - | Repetitive Flow |
| SA | - | South Africa |
| SAPICS | - | South African Production and Inventory Control Society |
| SGIA | - | Small Group Improvement Activity |
| SPC | - | Statistical Process Control |
| TPS | - | Toyota Production System |
| TQC | - | Total Quality Control |
| UPL | - | Uniform Plant Load |
| US | - | United States of America |
| WIP | - | Work in Progress |

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## ABSTRACT

This thesis discusses the philosophy and techniques of the Japanese Just-in-Time manufacturing system and its applicability in South Africa. The Japanese system consists of two types of procedures and techniques. They pertain to: 1) productivity; (2) quality. The aspect of the system dealing most directly with productivity is known as the just-in-time system. Just-in-Time addresses the material cost component of productivity. The diverse indirect effects are even more pronounced. Just-in-Time partially covers Japanese quality improvements but there are a host of other Japanese quality improvement concepts and procedures. Total quality control describes the set of Japanese quality improvement procedures which in turn encompasses some of the Just-in-Time techniques and improves productivity through the avoidance of waste. The two entities of the Japanese manufacturing system overlap.

Contrary to the West, Japan concentrated their energy on improving quality and productivity rather than fight crude oil price increases. This thesis information was obtained from material researched by Westerners in Japan, writings of Japanese industrialists, Japanese subsidiary companies outside Japan and personal experience.

The objectives of this thesis are to:

i) Give the history of the Just-in-Time system.
ii) Describe Just-in-Time and Total Quality Control and discuss the advantages of the Japanese system.
iii) Compare Just-in-Time to Enhanced Manufacturing Resource Planning.
iv) Discuss the effects of the Just-in-Time system on management style.
v) Describe the implementation of the Just-in-Time system.
vi) Research its applicability in South Africa.

The Japanese system was first introduced to South Africa through companies operating under licence from Japan e.g. Toyota. It seems that certain companies expected their suppliers to tie in with the system of

smaller, more frequent deliveries. The suppliers perceived this as a transfer of inventory carrying costs to them in the name of Just-in-Time. It was decided to conduct a survey among original equipment manufacturers supplying the motor industry. Seventy replies to 150 questionnaires were received.

The Just-in-Time system can be applied successfully outside Japan and without Japanese management. One of the advantages of the system is its simplicity. It may be the answer to South Africa becoming more productive and competitive in the world marketplace.

Although the Just-in-Time system has been discussed in general literature, the author has found very little information on its applicability to South Africa.

# CHAPTER 1

## INTRODUCTION

In a previous era, 'Made in Japan' was a byword for shoddiness. Today, however, Japanese export goods have a reputation for superior quality and are attractive to buyers all over the world. Japanese management techniques stand out among several factors accounting for this radical change. The good quality of Japanese goods and the high productivity of Japanese firms in many industries have caused Western professionals to scrutinize Japanese management techniques closely. While early interest centred around Japanese human resource management and structural factors, recent interest has shifted to manufacturing management techniques, especially just-in-time and total quality control techniques.

The Japanese system consists of two types of procedures and techniques. The two types pertain to productivity and quality. The aspect of the Japanese system dealing most directly with productivity is known as the Just-in-time (JIT) system.

Japanese quality improvement is partially addressed by JIT, but there are also a host of other quality improvement concepts and procedures.

A term that is often used in Japan to describe the set of Japanese quality improvement procedures is Total quality control (TQC), which encompasses some of the JIT techniques and improves productivity through avoidance of waste. In other words JIT and TQC overlap.

Some companies in South Africa have begun to employ some of the JIT and TQC methods in their plants.

This thesis provides an overview of what JIT is and its applicability in South Africa, compares it to Enhanced Manufacturing Resource Planning (MRP2) and makes specific mention of Original Equipment Manufacturers (OEM) supplying the motor industry in South Africa.

JIT is a multifaceted manufacturing management system and several chapters are needed to examine each facet. As TQC plays such an important part in JIT being effective, considerable mention is made of this subject. A good place to begin is with the natural question 'How did the Japanese develop JIT ?'

# CHAPTER 2

## THE HISTORY OF JUST-IN-TIME

With all the recent journalistic attention given to Japanese industry, the fact that Japan is small, crowded and poor in resources is common knowledge. Nearly 125 million people inhabit the Japanese islands, whose land mass is approximately one quarter of South Africa's and has only 28% of that land available for habitation (11). The combination of masses of human resources with few natural resources may help to explain Japanese resourcefulness. The Japanese make do with little and avoid waste (1). The modern Japanese system of factory managmement, the JIT approach, featuring hand to mouth management of materials, with total quality control, seems in character with their historical penchant to conserve. To the Japanese factory worker, JIT and TQC objectives are reasonable, proper and easy to accept, inasmuch JIT/TQC attempt to control such costly sources of waste as:

: Idle inventories, which constitute waste of scarce material resources, and, indirectly, energy for basic material conversion and refining.

: Storage of idle inventories, which wastes limited space.

: Defective parts, subassemblies and final products, which are a waste of materials/energy.

### 2.1 THE ORIGIN OF JIT AND KANBAN

After World War II, Japanese industry was given a boost by the procurement of goods and services for the MacArthur Administration - and with the increased business came a demand for higher quality. The administration organised a lecture program in 1948 on stastical quality control techniques to which managers and engineers of suppliers were invited. The Japanese Union of Scientists and Engineers (JUSE) recognised the value of quality and invited Dr Edward Deming in 1950 for a further series of lectures.

The next phase in the quality movement came in 1954 when another American expert, Dr.J.M.Juran, gave lectures on the managerial aspects of quality control. His talks were a source of great inspiration for Japanese management and marked the beginning of the Company Wide Quality Control (CWQC) movement.

The Kanban concept was originated by Taiichi Ohno, vice president of Toyota Motor Co. Ltd in the 1950's. He observed that the mass production system devised by Henry Ford and used in the U.S. was effective in minimising the average unit cost of manufactured products during periods of high growth and production (2). The system was however ill equipped to handle periods of selective low level growth (such as experienced since the oil embargo of the mid- 1970's). He felt the mass production system created waste based on production excesses inherent in the system itself. He theorized that anything beyond the minimum amount of materials, parts, equipment and workers required to produce a given product is wasteful and therefore inflates costs throughout the system.

JIT came into wide use in the Japanese shipbuilding industry over 20 years ago (3). Japanese steelmakers had overexpanded. They had so much excess capacity that shipbuilders could get very fast deliveries on steel orders. The shipbuilders took full advantage of the situation, dropping their steel inventories from around one month's supply to a supply of perhaps three days. The shipbuilders were receiving their steel 'just in time'. The JIT idea spread to other Japanese OEM companies, who began demanding just-in-time deliveries from their suppliers - and began using JIT for internal operations as well. JIT refers to all manufacturing activities and not just the movement of material between customers and suppliers.

## 2.2 THE OIL PRICE RISE

The fivefold rise in the price of crude oil between 1970 and 1974 led to worldwide economic travail (3). The primary effects, the rapidly escalating costs for petroleum as a fuel for heating and for running automotive and other engines, were bad enough.

But the high cost and scarcities of petroleum products had numerous secondary effects, especially in high energy using material processing industries like aluminium, plastics, copper and steel from which much of the world's durable goods are made. Acute shortages of basic materials plagued industrial buyers and the costs of these materials rose drastically. Industry became resigned to elevated costs of materials. Many companies perceived the need to be more resourceful.

Somehow the Japanese took the task more seriously than did the rest of the world. The Japanese ideas on tighter material control began to be implemented in earnest immediately after the 1973 oil shock (3). The reason for the quick reaction may have had something to do with a lack of alternatives. Since Japan relies upon imported energy and materials for nearly all of its needs, better management of these imported resources is perhaps the only viable option for coping with runaway costs.

While Japanese industry was perfecting just-in-time materials management and factory control, the West searched for political and economic solutions to the energy/material cost dilemma (3). OPEC had to be pressured, the oil companies had to be watched, consumers had to conserve energy, and government had to tinker with taxes, tariffs and quotas. The results of the Japanese effort to streamline factory management began to show. They steadily gained additional world market share. The reasons were excellent product quality and phenominal rates of productivity improvement. Among nations, Japan seemed most susceptible to economic damage from the world energy crisis, but Japan rapidly gained economic ground rather than losing it.

## 2.3 TRANSFERABILITY TO OTHER COUNTRIES

The system of production and quality management that the Japanese have developed has cultural roots (3). That is, Japanese social behavioural tendencies, which are products of the unique Japanese environment, have accommodated the development of highly effective production systems. But the systems themselves consist of simple procedures and techniques, most of which do not require a particular environment or cultural setting for their implementation.

Throughout history good ideas that have sprung forth from a given set of circumstances that have been adopted elsewhere.

## 2.4 THE SITUATION IN SOUTH AFRICA

South Africa now finds itself in a situation , where necessity demands action. The commonly quoted factors of high inflation rate, weak Rand, increased cost of imported goods and poor productivity are all factors contributing to a weakening economy in South Africa.

This author has found that conventional production control techniques, utilize work in progress inventory as a buffer to help alleviate problems and prevent shortages in the production system. However, in practice, such a system can actually conceal problems and create an imbalance of stock between processes, a condition leading to dead stock. It can also result in excessive equipment and/or a surplus of workers being engaged in producing large inventories of parts which cannot be assimilated readily through final product assembly. Resultant inventories must be tagged, handled, stored and controlled until such time as they can be used. Not only is storage and handling costly, but such inventories are often financed by expensive high interest loans.

## 2.5 THE AIMS OF JIT AND TQC

The JIT production scheme seeks to produce the kind of units needed, at the time needed, and in the exact quantity needed. This concept is realized when initial, intermediate and finished product inventories are minimized or eliminated as parts and processes come together just in time to effect final assembly of the required number of products.

Among the Japanese techniques which have Western origins are the techniques of quality control, which the Japanese have extended and adapted into a comprehensive system of total quality control (TQC). As in the USA, quality control in South Africa is an established profession in its own right, and there are established quality control departments.

In Japan, quality control is not treated as an independent function or a specialised profession. What the Japanese have done is to train and arm all personnel, from inventory to design, and from production to sales, with the techniques of TQC, and transformed the Quality Control (QC) department idea into company wide quality control (CWQC). As a result of about thirty years of steady effort and total devotion to improved quality, the Japanese talk about defects in parts per million in some industries, a rate of quality that far exceeds that of Western industry.

# CHAPTER 3

## JUST-IN-TIME, KANBAN AND TOTAL QUALITY CONTROL

### 3.1 DEFINITIONS

The Automotive Industry Action Group of the United States definition of JIT (5) is, "JIT is a disciplined approach to improving overall productivity and quality through elimination of waste. It provides for the cost effective production and delivery of only the necessary quality parts, in the right quantity at the right time and place while using a minimum of facilities, equipment, materials and human resources".

JIT is not (4);

a) an inventory programme
b) for suppliers only
c) a cultural phenomenon
d) a materials project
e) a programme that displaces MRP
f) a panacea for poor management.

Under JIT, waste is considered anything other than the minimum amount of these resources, which are absolutely essential to add value to the product (4). The key operational phrase thus becomes "value adding". JIT identifies non-value adding activities and strives to eliminate them.

The simplest way to identify a non-value adding activity is to apply a few tests to each step of a routing (product flow route through the factory) (4);

a) Does the activity add cost, but not change the physical or chemical characteristics of the item? Examples would include inspection, transport, receiving, purchase orders and expediting.

b) Does an item stop or pause during its journey through the manufacturing site?

c) Is an operation performed to compensate for something that was not done properly the first time?

If there is a positive answer to any of the above questions, then the activity becomes a candidate for creative problem solving and thus elimination.

A common misconception is that JIT is an inventory control system and further, it is not uncommon to find 'Just-In-Time' used synonymously with "Kanban" which is the name of an inventory replenishment system developed by Toyota Japan. Kanban is most certainly an indispensable part of JIT production, but the JIT system refers to all manufacturing activities and not just the movement of material between customers and suppliers.

Waller (6), also plays down the inventory feature, which he says confuses people. Instead, he points to the "spectacular reductions in throughput time" achieved at Hewlett Packard's (H.P.) Greeley plant. The numbers are indeed striking: the time between pulling parts in and shipping products out went from six weeks to one hour.

Before discussing JIT in detail, an overview of JIT in relation to the Toyota Production System (TPS) is summarised in Fig 3-1. JIT and Autonomation are the pillars of the TPS (7). The word Autonomation, coined by Toyota, is not automation, but the autonomous check and control of defects in a process.

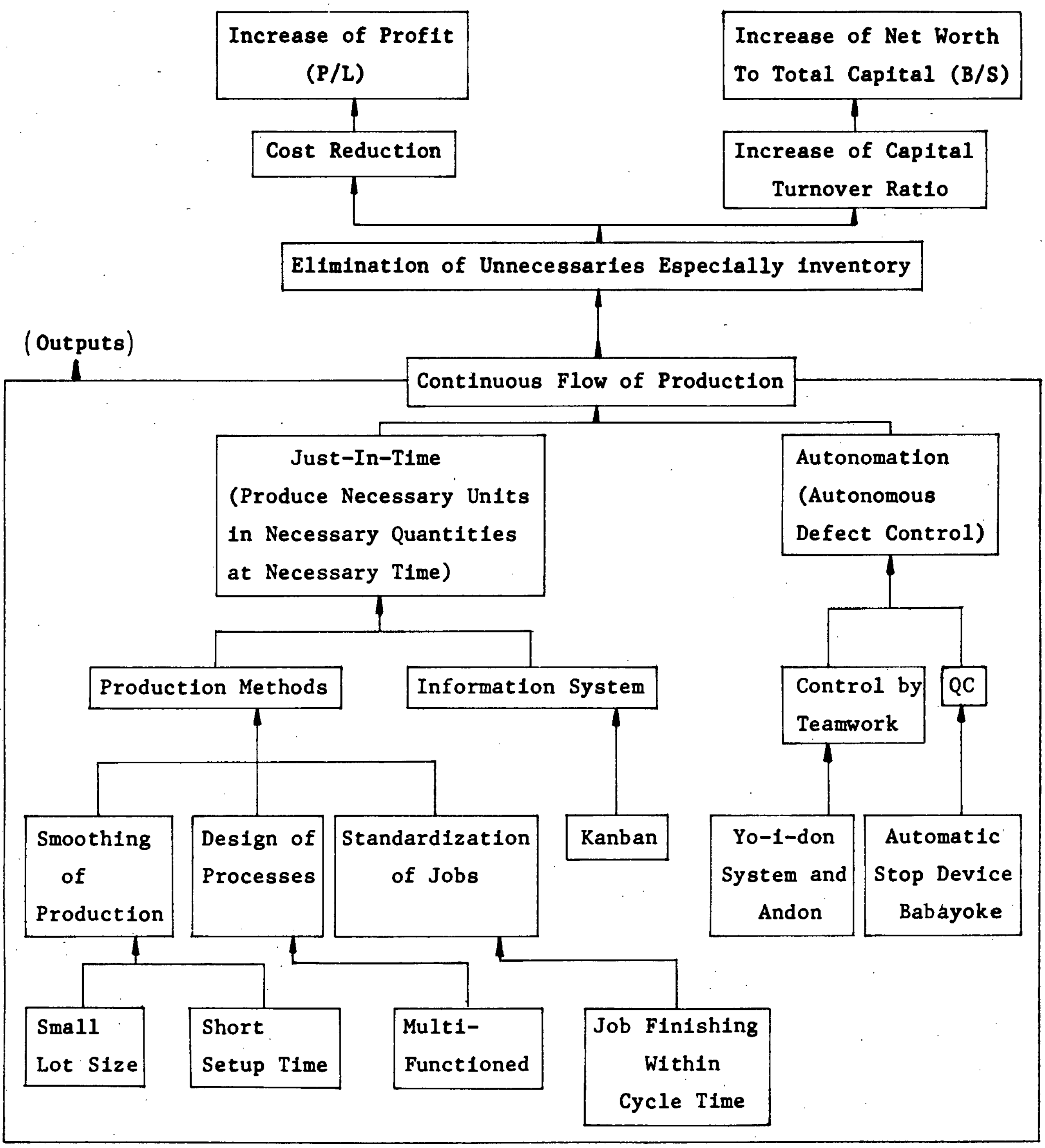
The autonomous machine has an automatic stopping device (foolproof device/babayoke) attached to it. In Toyota's factories, almost all machines are autonomous, so that mass production of defects can be prevented and machine breakdown are autonomously checked. The idea of autonomation is also expanded to the product lines of manual work. If something abnormal happens in a product line the worker presses his stop button, thereby stopping his whole line. The Andon/Yo-i-don system plays an important part in the operation of this autonomous check. (Appendix A).

"Just-in-time" production is explained by Monden (7) as "the production of the necessary products in the necessary quantities at the necessary time". Schonberger (8) describes the JIT ideas as "production and delivery of finished goods just in time to be sold, sub-assemblies just in time to be assembled into finished goods, fabricated parts just in time to go into sub-assemblies and purchased materials just in time to be transformed into finished parts".

The purpose of JIT is to produce a unit in such a way that there is only one unit of work in process and minimum stock of finished goods inventories. Therefore, unnecessary inventories which are a collection of troubles and bad causes will be eliminated. ~~Based on this idea~~, only those goods which are sold should be produced and replaced. Production of one unit just in time to go into the next process is an ideal situation which it is claimed no Japanese firm has attained, except in certain processes. However, this ideal is essential for many Japanese companies. They strive aggressively to get as close as possible to stockless production.

JIT is also described as a system that boosts production efficiency and helps prevent product defects by reducing inventory buffers (4). It highlights the fact that stocks in plant are undesirable for many more reasons then are generally accepted. They hide imbalance between work stations and departments: time when men are idle, overmanning, undermanning, excessive plant capacity and inadequate maintenance.

FIGURE 3-1 OUTLINE OF TOYOTA PRODUCTION SYSTEM



Basic tenets of JIT become evident from the above;

a) Identify and eliminate any causes of delay

b) If it is not needed, it is not to be made

## 3.2 THE COMPONENTS OF JIT

JIT employs a combination of several elements. These elements include smoothing of production, providing for process flexibility and versatility, standardization of jobs, and utilization of an ordering and delivery system called Kanban. Figure 3-2 shows how these elements lead to the formation of JIT. Smoothing production can be achieved by reducing set up time and thereby lowering lot size.

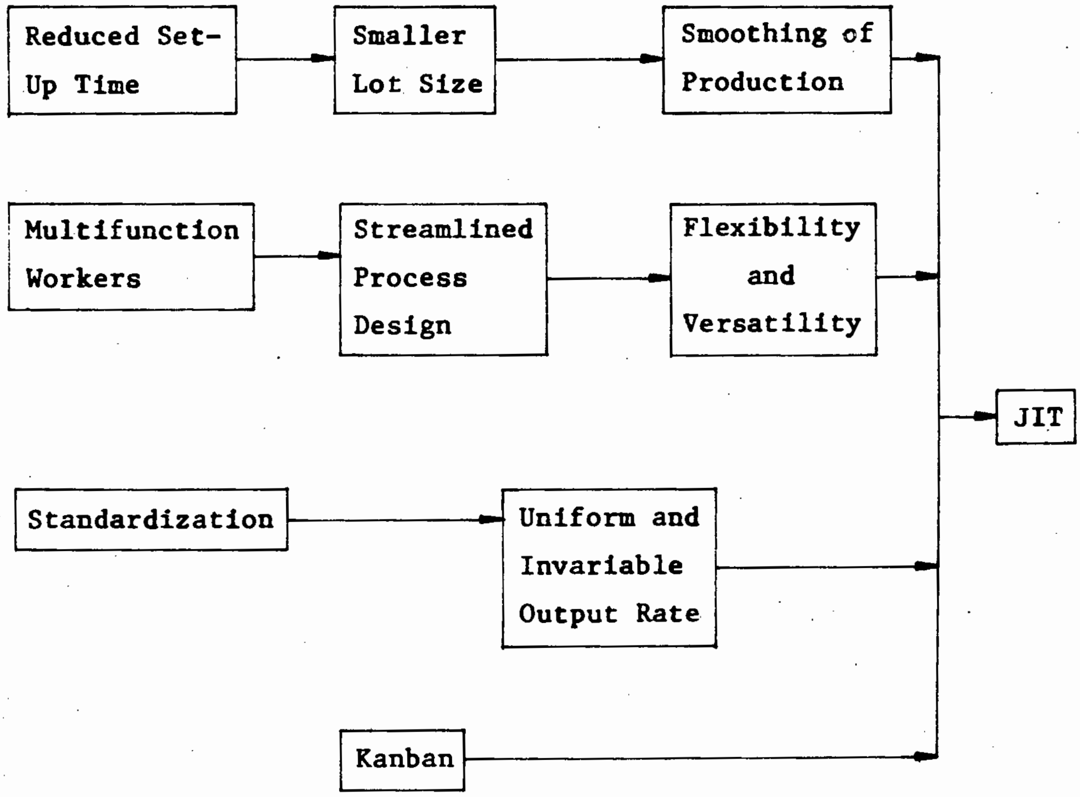



FIGURE 3-2

Japanese experience shows that when setup time and lot size are reduced, there will be a significant improvement in quality, scrap and worker motivation. There will also be reduced need for storage racks, storerooms, floor space, fork lift trucks, conveyers, computerized inventory control and support personnel.

Multifunction workers are a key factor in the design of streamlined processes. Processes are laid out or designed in such a way that one worker can handle two or more machines and move from one work centre to another. Multifunction workers perform maintenance, quality inspection and cleanup; they also participate in work improvement projects (32).

Utilization of multifunction workers not only decreases the number of workers and increases productivity, but it also increases teamwork and morale among the workers. Multifunction workers may be thought of as a special case of job enlargement/enrichment. The Japanese also make considerable use of group technology (GT), in which several processes are grouped into cells in order to streamline the product flow.

While process flexibility may seem to equate with lack of standards, that is not the case in the JIT system. Standardization of jobs is also characteristic. This includes standard cycle times, standard routings and standard quantities in containers holding work in process. Standardization of jobs leads to a more uniform, invariable output rate. This makes it possible to reduce the quantity of work in process to a minimum, which is a JIT goal.

Kanban is the tool or information system used to achieve this goal of J.I.T. production. Kanban is a "pull" inventory system aimed at parts feeder stages of production. Kanban employs manual cards instead of computers for planning and controlling parts movements (9,32).

Toyota Corporation, where JIT originated, uses two types of cards or Kanban. (Appendix B)

3.2.1 A withdrawal Kanban.
This card specifies the kind and quantity of product which a process should withdraw from its preceding process.

3.2.2 A production ordering Kanban.
This card specifies the kind and quantity of product which the preceding process must produce.

As the explanation implies, they form a circular interaction of supply and demand. The chain of Kanbans plays a part in the line balancing for each process so that the output is in accordance with the cycle time.

## 3.3 THE KANBAN SYSTEM, A JIT DEVICE

One may well wonder why the withdrawal Kanban precedes the production ordering Kanban? What was generally done in the past was that arrangements were made for a safe or "buffer" stockholding of raw materials, components and sub-assemblies (8). Production requirements were then withdrawn from stockpiles of work in progress and inventory. Commonly known as a "push" system of production.

The Kanban system however is a "pull" system of inventory replenishment with the basic objective of stockless production. The withdrawal Kanban therefore precedes the production ordering Kanban. The parts control features of Kanban may be augmented by a productivity improvement technique: Kanban and containers of parts are withdrawn, which deliberately exposes problems of output inconsistency so that the problem causes may be attacked. If the formal Kanban system is not employed, it is still reasonable to remove buffer stocks between processes in order to expose and solve problems (9,32).

There is a simpler Kanban system employing one rather than two Kanban per part number. Many Japanese companies are using a single-card Kanban technique, which is a push system for production coupled with a pull system for deliveries.

Single-card Kanban is simpler than dual card Kanban and is suitable where the total number of part numbers and production stages is not as great (1).

## 3.4 THE POTENTIAL BENEFITS OF JIT AND WHAT IT INVOLVES

The potential benefits of JIT include quality improvement, higher productivity, less scrap, less work in process, less raw material, fewer finished goods in inventory, saved space, increased teamwork, higher worker morale and motivation, and increased worker and equipment efficiency. However, implementation of JIT requires considerable co-operation between management and workers.

Kanban is indeed one device for moving toward J.I.T. production and stockless production captures the inventory control flavour of J.I.T.

Inventories comprise 50-60% of the total manufacturing costs of most companies and unnecessary inventories have become a major target of cost-reduction efforts (14).

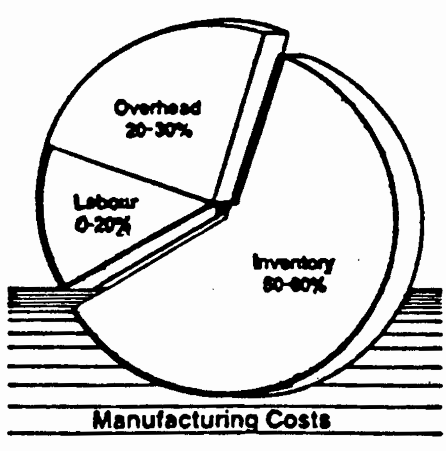



DIAGRAM 3-3

J.I.T. is not to be confused with the Toyota production system. It does however form such an integral and major part of the Toyota production system that it cannot be viewed in isolation.

Management of the JIT system involves:

a. an inventory control system
b. a quality and scrap control tool
c. a streamlined plant design or configuration
d. a production line balancing approach
e. employee involvement and motivation.

## 3.5 TOTAL QUALITY CONTROL.

In the Japanese situation, where everybody is responsible for quality improvements, the meaning of quality expands. The expanded view of quality includes "not only the degree of conformance of products to standards and specifications, but also their fitness for use. In other words, how the specifications and standards themselves should be conceived and applied in a more active approach that would include the product design and development phases as well" (10).

Implementation of Japanese TQC requires some essential changes in employee attitudes and in management perception of quality control. One of the most important steps toward TQC is the placement of primary QC responsibility with the production people rather than in a QC department. Also, quality is given first priority and output second. The Western notion of quality control centres on a certain acceptable level of defects; the idea is that quality costs money and thus should not be too good. This static view of quality contrasts with the dynamic TQC view in which everyone works continuously to improve quality, project by project, which leads to the ultimate goal of perfection or zero defects (30).

Some of the features of TQC, in contrast to Western techniques, are;

a. checking quality in all processes as opposed to the Western method of checking only selected processes.

b. inspecting all parts instead of relying on random sampling.

c. giving Japanese workers the authority to stop the line when there is a quality problem.

d. having rework performed by those who made the bad parts instead of the Western method of sending bad items to a separately staffed rework area.

e. scheduling at less than full capacity in order to avoid errors caused by haste.

There is also zealous maintenance of plant cleanliness. An immaculately kept plant, which in the authors experience is so often not the case in many South African factories, exposes at an early stage, potential areas of defect causation. Factors such as a minor oil leak in a machine would be detected and attended to immediately in a clean plant, thus alleviating a potentially major problem.

Japanese QC departments, smaller than their Western counterparts, are active in coordinating and instructing people in QC methods and techniques. Generally, the Japanese QC department functions as a facilitator and monitors the fulfillment of TQC concepts in the company. Production and purchase of parts in small lot sizes is an important step in the TQC concept, as well as being central to JIT production. Small lot sizes expose defects soon after production and delivery so that causes of defects may be nipped in the bud.

In Japanese TQC, analytical techniques and aids help to classify problems and causes, which assist in problem solution. Some of the techniques and aids are: "fool-proof devices","QC circles", "n=2", and "fishbone charts" (1).

(QC circles are small, formally organised, groups of workers). The agenda and procedures of a QC circle are usually quite structured, but the details vary from firm to firm. The objectives of QC circles are improvement of work methods, quality, morale and motivation. N = 2 constitutes a representative sample of two. These are the first and the last items from a production run. A Fishbone chart/Ishikawa diagram is a cause and effect display tool which gets its name because of its shape.

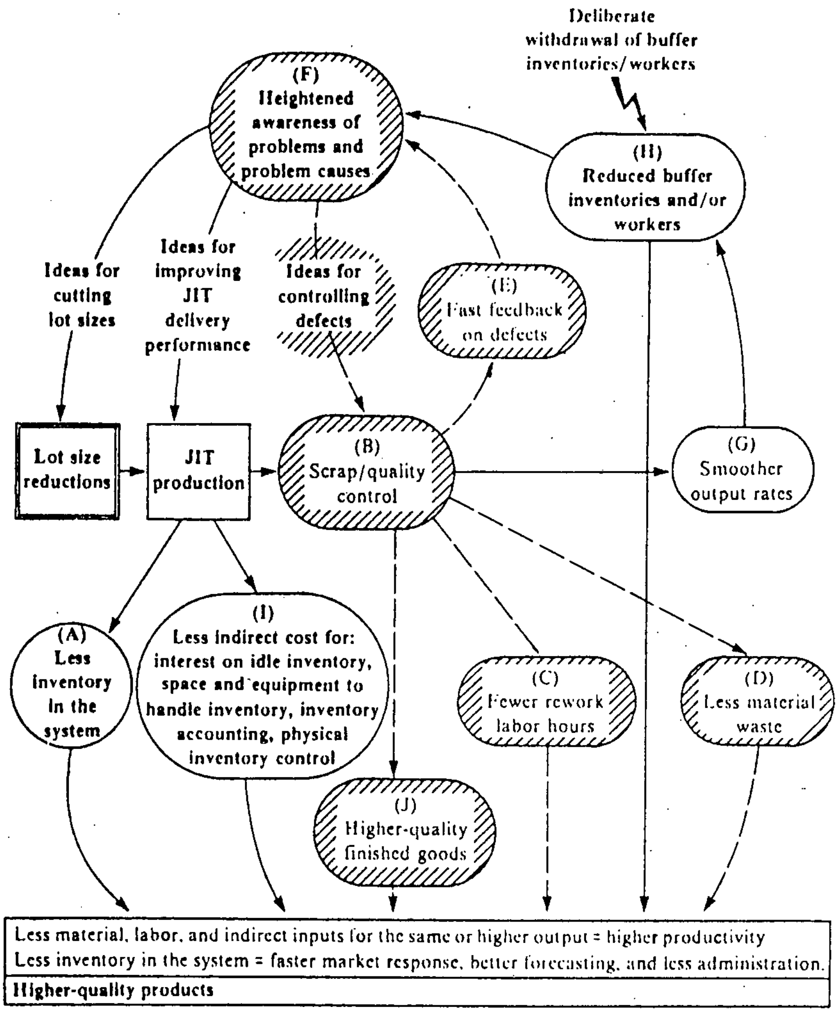
Putting all of the TQC features together properly requires years of extensive training, as well as involvement and commitment at all levels in the organisation. The Japanese experience over the past 30 years serves as a helpful model for companies elsewhere that might want to implement TQC.

TQC may stand alone or operate in concert with JIT production (1). In the latter case, TQC greatly enhances the quality control aspects of the JIT model, (Figure 3-4). Particularly affected are factors B,C,D,E and F in the model. These are shown as shaded in the JIT model.

With TQC, all plant personnel are inculcated with the view that quality control, factor B in Figure 3-4, is an end in itself. 'Quality at the source' is the slogan that best epitomizes the TQC concept. What it means to the people in the plant is that errors, if any, should be caught and corrected at the source, i.e. where the work is performed. This is in contrast to the widespread Western practice of inspection by statistical sampling after the lot has already been produced; defect detection as opposed to defect prevention. In the Western system, the inspection is performed by inspectors from a quality control department; in Japanese TQC, workers and foremen (not a quality control department) have primary responsibility for quality. Everyone else is expected to contribute, often at the request of the workers and foremen. Engineers build automatic error checking devices (aside from those supplied by equipment suppliers), personnel provide quality control training and management is quick to approve funding for any ideas that may enhance quality.

With quality control at the source, "fast feedback on defects," factor E in Figure 3-4, is automatic. It is the job of the worker (or of automatic checking equipment) to immediately check the quality of the part produced.

Figure 3-4 Total Quality Control Blended with Just-In-Time Production



Thus the worker learns right away if the part is bad, which leads to factor F 'heightened awareness of problems and problem causes,' in Figure 3-4. Ideas for controlling defects are generated by the worker, the work group, the foreman, engineers or others who may be called in to help. New controls on defects further enhance scrap/quality control (factor B) and the cycle is repeated. It also blends in with the JIT cycle of cutting lot sizes and streamlining production.

The effects of TQC are factor C 'fewer rework labour hours' and factor D 'less material waste,' in Figure 3-4. In addition there is a new factor J 'higher quality of finished goods,' in the figure. In an earlier description of the JIT concept, higher quality of finished goods was not claimed as an effect of JIT. It may be argued that equally high product quality could be attained in a Western plant by means of extensive final inspection, rework lines and scrap bins. JIT will not necessarily improve product quality, but it will lower costs. Total quality control, by contrast, certainly will improve product quality.

## 3.6 JIT/TQC IN CONTRAST TO WESTERN MANAGEMENT TECHNIQUES

Three cherished principles of Western management have been overturned by the Japanese experience with JIT/TQC (3). These three principles relate closely to three Japanese words, Muri, Muda and Mura. Muri means 'excess,' muda means 'waste,' and mura means 'unevenness.' The alliterative quality of the three words, as well as their symbolic brevity, has made them a popular expression among Japanese manufacturing people.

3.6.1 Muri. The Western principle of ordering in economic order quantities (EOQ) is, in the Japanese just-in-time system, an example of muri, or excess. JIT calls for ordering in lots that are smaller than the EOQ, ideally just one unit, because;

a. The EOQ formula fails to account for several benefits of smaller lot sizes. These include scrap/quality improvement, less rework and fast feedback on errors. These all lead to problem awareness and solution.

b. The EOQ formula takes setup/order cost as a given, but in the Japanese system setup/order cost is continually reduced.

3.6.2 Muda. The Western principle of statistical sampling of lots by quality control department inspectors presumes and allows for a certain percentage of defectives, which the Japanese view as Muda, or waste. JIT/TQC prescribes:

a. Elimination of lots altogether (ideally) so that there can be no lots to sample from and no chance of a certain percentage of defects per lot.

b. Quality inspection at the source featuring workers, in charge of preventing defects from occurring and then moving on, undetected, to subsequent processes.

3.6.3 Mura. The Western buffer stock principle, calling for inventory to protect one work centre from the output variability of the preceding work centre is, in the JIT approach, irrational acceptance of mura, or unevenness. The JIT solution is to do exactly the opposite: remove buffer stock to expose the variability and correct the underlying causes.

# CHAPTER 4

# THE ADVANTAGES OF JUST-IN-TIME

## 4.1 THE EFFECT ON PRODUCTIVITY

Proponents of JIT in the U.S. say that it improves quality and reduces manufacturing costs to a level that approaches that of Japan (6). Improved quality also means faster production because rework drops dramatically. U.S. companies that have implemented JIT have reported striking results, from radically reduced defect rates and throughput times to greater worker involvement in decision making.

A JIT pilot program run at Northern Telecom Inc.'s Data Systems Division in July 1984 gave four primary benefits of the system;

a. a 40% reduction in labour time to build the model 298 display monitor.

b. a drop in defects from 24% to zero.

c. a 70% reduction in manufacturing space.

d. a greater involvement of workers in the process of decision making.

Experience at Hewlett-Packard Co. (HP) and other equipment makers also shows how difficult implementation on both worker and management levels can be. "The one thing that makes it hardest is mental. It's the mindset, a different way of life, a different way of running your business", says William Sandras (6), a manager who helped initiate JIT for HP at several division.

Another HP crusader for JIT, Bruce Harvey (6), is a consultant to the company's Systems Group in San Jose, California, working with suppliers and customers. Formerly materials manager at the Vancouver Division, he also reports dramatic savings with JIT.

Work in progress fell by 80%, manufacturing floor space was cut in half, and total lead time dropped by 85%. The big surprise, he says, was a 30% reduction in direct labour. Sandras (6) says throughput time went from eight weeks to two days.

Results of this magnitude are compelling arguments for JIT, and a handfull of other large companies, e.g. Northern Telecom are not far behind HP. Apple Computer Inc.'s highly automated Fremont, California, plant is a show-case JIT operation. Such major companies as Motorola and Tektronix are also implementing JIT.

IBM Corp. includes JIT under the umbrella of "continuous-flow manufacturing," and made it an official part of corporate strategy in early 1984. Its results are already highly impressive (6). Cycle time was reduced by 75% for disk-drive ferrite heads at Rochester, Minnesota; at Ranleigh, N.C., manufacturing costs were cut in half for the model 3178 terminal as compared with a previous model; and model 4173 printers took half the time to build at Fujisawa, Japan. IBM is running an internal education program to inform employees of JIT's potential.

According to Hall (6), who has worked with clients in implementing JIT since the late 1970's, less than 10% of U.S. industry production currently uses JIT, but the interest is starting to mushroom.

Western companies who have implemented JIT in the proper manner have realised spectacular results (4) (Figure 4.1).

There are several basic advantages in JIT that Western manufacturers, including successful users of other systems, should know about:

a. The Japanese originally used to be job-lot producers (3). They got to be giants not by catering to consumer whims but by producing a few models very well, often in market segments that were being ignored by other companies. Low cost, high quality production leads to growth in market share. With greater market share and the resultant increased volume, the plant moves toward long production runs, year round repetitive production for some product models.

OPPORTUNITIES
( % IMPROVEMENT )

| Reductions: | Automotive Supplier | Printer | Fashion Goods | Mechanical Equipment | Electric Components | Range |
|---|---|---|---|---|---|---|
| Manufacturing Lead Time | 86 | 86 | 92 | 83 | 85 | 83-92 |
| Inventory | | | | | | |
| Raw | 35 | 70 | 70 | 73 | 50 | 35-73 |
| WIP | 89 | 82 | 85 | 70 | 85 | 70-89 |
| Finished Goods | 61 | 71 | 70 | -- | 100 | 0-100 |
| Changeover Time | 71 | 75 | 91 | 75 | 94 | 75-94 |
| Labour | | | | | | |
| Direct | 19 | 50 | 29 | 5 | -- | 0-50 |
| Indirect | 60 | 50 | | 21 | 38 | 21-60 |
| Exempt | ? | ? | 22 | ? | ? | ?-22 |
| Space | 53 | n/a | 39 | ? | 80 | 39-80 |
| Cost of Quality | 50 | 63 | 61 | 33 | 26 | 26-63 |
| Purchased Matarial (net) | ? | 7 | 11 | 6 | n/a | 6-11 |
| Additional Capacity | n/a | 36 | 42 | n/a | -- | 0-42 |

FIGURE 4-1

Repetitive operations make it possible to tighten JIT inventory control still further, which leads to even greater quality and productivity levels being reached. Soon the product becomes so good that it becomes attractive not just to consumers who must economise but to all income groups including the wealthy. At that point Western manufacturers that have tried to compete by offering variety will have been pushed out of much of the market.

b. Growth spawns variety (3). The company that has become rich making 'basic black' will then build a plant to make some other model or product. The company then ends up with a full line or models, all produced and sold in volume and manufactured more or less repetitively. This is the present situation at Nissan, Sony, Canon and other top Japanese companies. The Western job-lot competitor no longer even has the advantage of more product variations.

c. Even manufacturers who are locked into a job-lot future can gain some quick benefits from JIT. Plants, or departments within plants, that produce a wide variety of parts generally try to batch several orders for the same part so that there can be one setup and one long production run. The idea is to avoid having to set up for several smaller runs spaced out over time, and there is sound economic wisdom in this EOQ concept. However, the Japanese have made us aware of the important benefits (never included in EOQ calculations) of smaller lots and smaller inventories: better quality, less waste and rework, greater awareness of sources of delay and error, higher levels of worker motivation and greater process yield and productivity. You don't have to achieve one at a time production to gain some of these JIT benefits. Any move toward smaller lots will help.

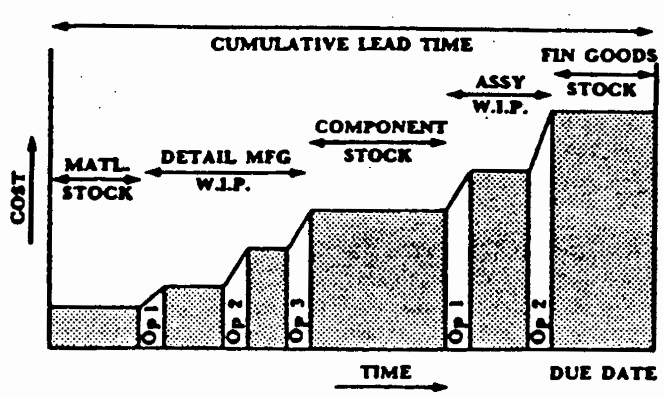
## 4.2 THE JIT CAUSE-EFFECT CHAIN

Japanese plants have been recognised as being leaders in Manufacturing Management. It is not a question of getting to where they are now (12). It is rather a question of aiming at the level they will be at in five years time. The Japanese have ongoing programmes for improvement. Various programmes have been adopted in an effort to catch up with them (1). Examples of these are: employee participation groups, generally called quality circles; plant modernization, including robotization. More recently the emphasis has been on JIT and plants are looking for ways to cut setup times, production lot sizes and supplier delivery quantities.

Figure 4-2 shows how many companies in S.A. currently manufacture their products. Purchased materials are put into stock either because it is an economic lot size or because it is believed that the supplier cannot be trusted to deliver the materials when they are needed. After a period of storage the material has value added, operation 1. The partly processed material then spends time as Work in Progress between operations 1, 2 and 3. Time is spent as component stock before being assembled into finished goods stock. Generally more are manufactured than are immediately required because of the production run being based on the E.O.Q (32).

FIGURE 4-2

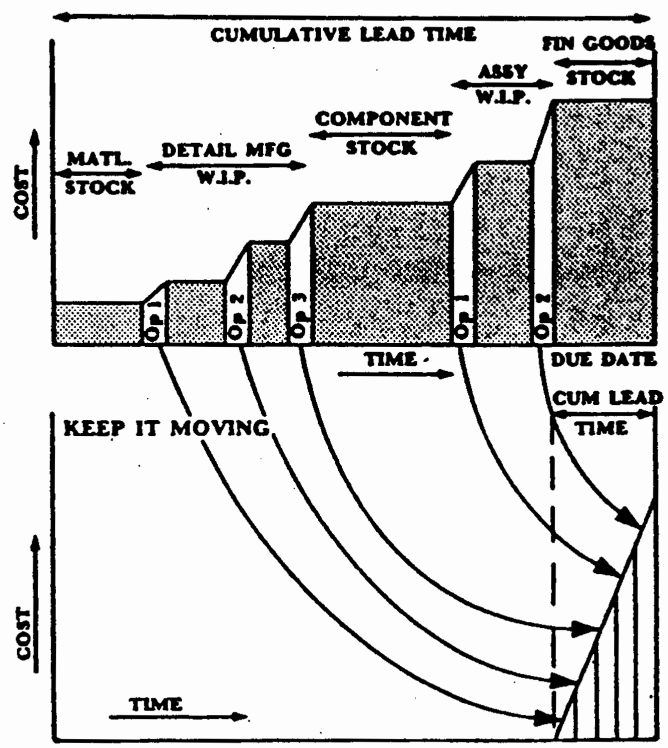
THE REAL COMPONENTS OF LEAD TIME



Adoption of the JIT philosophy exhorts the reduction of lead times and hence the inventory to zero. This changes the description of current practices shown in Figure 4-2 to those illustrated at the bottom of Figure 4-3. The real lead time is the time it takes a company to respond to a change in demand. The time the material takes to move from supplier release to the despatching dock (32).

FIGURE 4-3

THE REAL COMPONENTS OF LEAD TIME

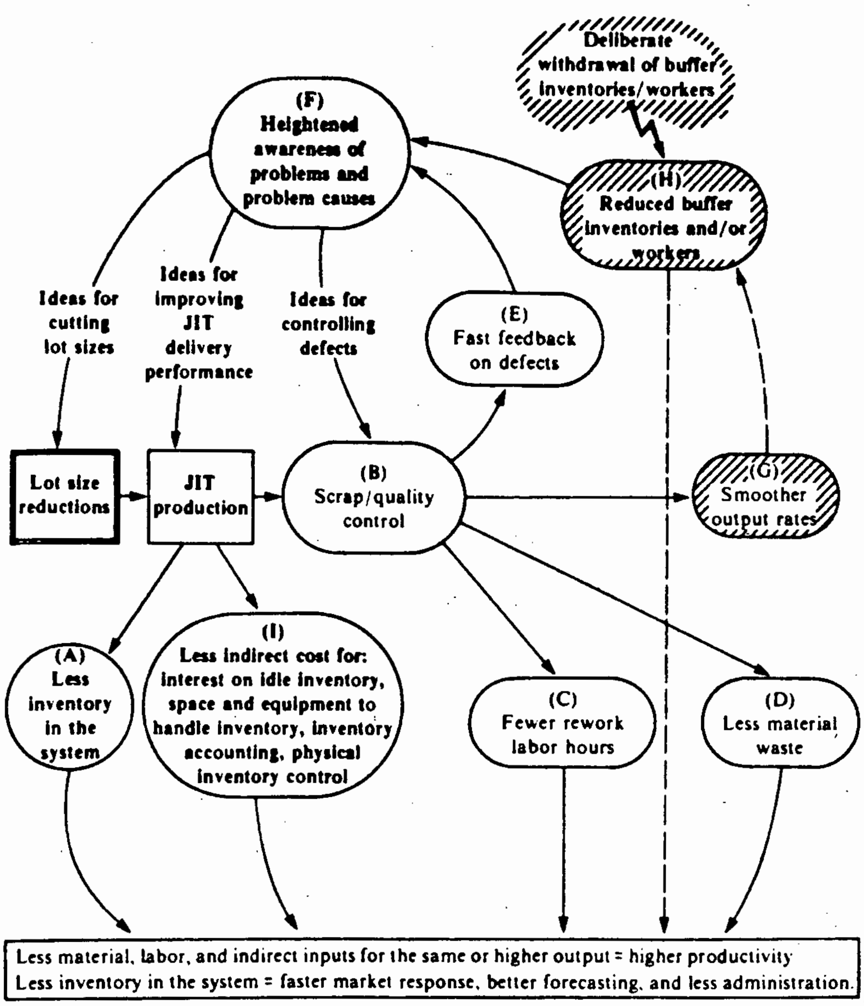



The latter approach is especially attractive in that cutting lot sizes triggers a chain reaction of benefits, including motivational, quality and plant improvement benefits (13). The chain of JIT effects is shown graphically in figure 4-4. Lot size reductions, shown in the double-bordered rectangle, set the chain in motion. The initial benefit is less inventory to carry and control (labeled A in the figure). Probably more significant are the scrap and quality improvements that are likely to occur when lot sizes are reduced.

## 4.3 Scrap/Quality Improvement

The reason for minimum lot sizes leading to lower scrap and better quality is simply explained: If a worker makes only one of a given part and passes it immediately to the next worker , the first worker will soon hear about it if the part does not fit at one of the next work stations. Defects are discovered quickly and their causes may be nipped in the bud. Production of large lots before a defect is discovered, is avoided. Not only is the cause of the problem immediately attended to but production of large batches of scrap is prevented.

FIGURE 4-4 Effects of JIT Production



Scrap/quality improvement effects (labelled B in Figure 4-4) are at a maximum when lot sizes drop all the way to one item at a time, production. However, any lot-size cuts should help. If, for example, a lot size is halved and a defect is discovered in another department after the run has been completed, the expense of attending to the problem is considerably reduced. In the author's experience, runs are often completed before the part is used in another department, e.g. metal pressing, plating or heat treatment may be done by a sub-contractor.

By reducing lot size, the operation becomes more closely linked to the next process. For example, if you are supplying an assembler with a bracket, the assembler may begin to see you and your stamping machine as the source of more brackets. Previously the source had probably seemed to be the lot-size inventory of brackets, before the lot-size pile was halved. You are aware of the widget assembler's new feeling of dependence upon your steady output of good brackets and have a greater incentive to do better work.

The end result is that the customer is going to get better quality goods. What is more, they will cost less. When JIT leads to reduced scrap and more good parts, the time and money spent on rework drops (labelled D in the figure). As said in quality control, "Quality is value added, all the rest is waste" (3). However the benefits of better employee motivation may be just as significant.

## 4.4 THE MOTIVATIONAL EFFECTS

We may expect (following psychologist B.F.Skinner's principles of reinforcement) that the worker who quickly learns the effects of his workmanship will naturally become motivated to improve (3).

When JIT is in operation, there is no particular need for supervisors steeped in behaviour modification lore to provide pats on the back. The consequence of the worker's workmanship are visible quickly (labelled E in Figure 4-4) as well as the workers own reward or penalty.

Even if the principles of fast reinforcement were inoperative, the JIT mode would be likely to make the worker more conscientious. Under JIT, if a part does not fit at the next work station, the worker who made the bad part will probably not find it hard to guess what he did wrong. In short, the worker's awareness of defect causation is heightened (labelled F in Figure 4-4). To borrow a metaphor, under Western large-lot production the inventories, as a result of a large-lot size, obscure problems much like high seas covering dangerous rocks for the boatman. When the lot-size is reduced, inventory is cut (the tide goes out) and the causes of error (dangerous rocks) are exposed (14). Workers don't want to make bad parts any more than boatmen want to go aground on the rocks. Provide visibility and each will steer a truer course.

More specifically, there seem to be three kinds of positive response triggered by heightened awareness of problems and their causes. The workers, bosses and staff advisers may generate:

a. Ideas for controlling defects, which are fed back to further improve scrap/quality control.

b. Ideas for improving JIT delivery performance e.g. more convenient placement of parts to minimize handling delays, which are fed back to further streamline JIT production.

c. Ideas for cutting setup time, which are fed back to further reduce lot sizes.

These three responses are shown by the three arrows leaving F in Figure 4-4. Each good idea for improvement ripples through the JIT cause-effect chain once more. Improvements feed upon improvements.

## 4.5 RESPONSIBILITY EFFECTS

A further deficiency of the large lot size is that it can provide convenient rationalisation for carelessness on the part of the worker, the worker's peer group and perhaps the labour union and management as well. They may feel, with some justification, that a certain percentage of reject parts in a large lot causes little harm. In a large lot there may be plenty of acceptable items for every reject one.

In contrast, with small JIT lot sizes, a few defective parts pinch right away. The need to avoid errors is apparent, which improves the workers' feeling of responsibility.

Japanese workers come to the aid of one another to resolve problems. We might expect such behaviour in a JIT plant as with small-lot-size inventories, one worker's problem threatens to bring subsequent processes to a halt. All the workers and their foremen, have production quotas to meet. Withheld praise, enforced overtime or reprimands are in store for those who fail to meet quotas. So it is natural for each affected worker to want to come to the aid of the worker who has problems.

## 4.6 SMALL GROUP IMPROVEMENT ACTIVITIES

One thing leads to another. Committed workers carry their concerns about defects, bottlenecks, slowdowns and breakdowns. In Japan, even during leisure time activities when fellow workers meet, shoptalk enters the conversation. Some employee peer groups in Japan even go so far as to organise themselves into so-called small group improvement activities (SGIAs), which is Toyota's name for what is also known as quality control circles (or quality circles). "With good housekeeping it is not unusual to realise a 10% productivity improvement" (4).

## 4.7 LABOUR

### 4.7.1 INDIRECT LABOUR REDUCTIONS

JIT inventory control yields indirect benefits (labelled I in Figure 4-4) as well as directly affecting workers and worker output. With less inventory there is less cost of interest on capital tied up in inventory. There are also fewer and smaller storerooms, much less space taken up on the factory floor by work in progress , less inventory accounting and less physical inventory control. Less people are therefore required for controlling these factors.

Western industry features large materials management staff compliments, numerous storerooms that have control on access to them, shop floors loaded with inventory and many material control forms and computer output reports and files. By contrast, the Japanese prefer the sub-contractor to deliver materials directly to the line and production with a minimum of work in progress, buffer stock and material movement in the plant (12). Stock movement alone, after all, does not add value.

### 4.7.2 LABOUR STABILITY

Historically the motor industry in South Africa has great peaks and troughs in demand. This results in a fluctuating labour and management complement in the factories. The benefits of an investment in training and the experience the employee has gained are lost when the employee is retrenched. When there is an upturn in demand there is a generally expensive learning curve with the new incumbent. The effects of retrenchment on the workforce that are retained can also be very demotivating.

The JIT system enables manufacturing to act quickly to changes in the mix of products and models sold in the market place. This is providing the company has labour flexibility so that employees may be reassigned as necessary to produce the products and models demanded. Such labour flexibility affords some protection against worker layoffs. That is, when total demand is down or higher productivity reduces the number of workers needed, they may be reassigned rather than layed off. However, if demands keep dropping, layoffs are necessary.

Toyota S.A. have gone to great lengths to avoid retrenchment. Productivity drives have lead to less workers being required. Toyota S.A. are at present utilising surplus factory workers as builders on a new staff housing scheme (17). This job security encourages support for new systems and productivity drives.

## 4.8 PRODUCTIVITY AND MARKET RESPONSE

The rectangle at the bottom of Figure 4-4 is a collection of all the JIT productivity enhancements. These are;

- : less lot size inventory
- : less buffer inventory
- : less scrap
- : less direct labour wasted on rework
- : reduced interest through elimination of idle inventories
- : less space needed to store inventories
- : less equipment needed to handle inventory
- : less inventory accounting
- : less physical inventory control

The output component is also improved (13).

- : more production
- : improved quality
- : improved awareness
- : improved worker motivation

All of which lower the input component of the productivity equation. At the same time, the output component will be improved, since sources of delays and scrap are removed. Labour will also be more willing to move to where the work is and thereby stay productive, as opposed to Western labour's frequent insistence upon fixed work assignments.

A further benefit of JIT is a faster response to the market's needs. The production scheduling system is more flexible due to a shortening of the pipeline between the initiation of an order to its completion. Changes in work load and demand can be adapted to more easily. Marketing can thereby promise deliveries faster and can effect a change in the product mix or quantity faster. It is also no longer necessary to forecast as far into the future.

In the author's opinion, a degree of forward commitment from the customer is necessary if the raw materials are of a specialised nature.

In South Africa certain design specifications called for necessitate a special production run to produce what is required, or alternatively necessitates the importation of raw materials. With the lead times involved, changes at short notice are not possible. The real advantages of implementing JIT, are in the plant, which to the manufacturer is the more controllable aspect of JIT.

## 4.9 JIT PURCHASING

The most apparent benefit of JIT buying is the reduction of inventory carrying cost which is the cost of capital tied up in inventory plus storage cost. There are also the quality benefits. Receiving inspection (inspection of incoming goods) is eliminated as the onus is on the supplier to ensure that they are delivering goods of a high standard of quality.

The supplier is looked upon as being a co-worker. Communication links are essential so that the supplier is aware of what the plans for the future are and how these plans affect them. As the supplier has better knowledge of their product than anyone else, it is advisable to utilise their assistance. When a bought-out product forms part of a new item that is to be designed or of an item that is to undergo a design change, the supplier should be involved in the design process.

There are also secondary benefits such as reduced paperwork. Conventional lot-size economics would imply more paperwork and order processing cost with more orders per year to process. However, JIT buying functions best in an environment in which:

a. the buyer's production schedules are relatively level so that demand for bought materials is steady and predictable.

b. supplier excellence and loyalty are encouraged by giving larger, steadier orders to a smaller number of suppliers.

c. long-term purchase agreements provide for frequent deliveries with minimal paperwork. With smooth demand, few suppliers and long term agreements, paperwork costs may be lower rather than higher.

JIT purchasing brings about closer, friendlier and mutually dependent relationships between companies doing business with each other. JIT purchasing interlinks the supplier company with the chain of work centres in the user companies plant (3). Each company is an island in the present South African system.

JIT purchasing would bring S.A. companies into alliance, making them accomplices. The resultant benefits of better quality and greater stability are unquestionably worth pursuing.

In summary, a strategy of market dominance in top Japanese firms is likely to be viewed mainly as a production achievement, with marketing and pricing aggression providing momentum to speed up the rate. By contrast, the production function is likely to be seen as secondary in Western firms that have managed to capture market share.

# CHAPTER 5

## A COMPARISON OF JIT AND MANUFACTURING RESOURCE PLANNING MRP2

The goals of JIT and MRP2 are identical, to aid manufacturing companies to improve customer service, inventory turnover and productivity. Spectacular results can be cited by companies employing either of the two systems. However, the tools used by JIT are dramatically different to the tools used by Manufacturing Resource Planning (MRP2).

MRP2 is a push system which in reality is a schedule based system. A schedule based system is a multi-period schedule of future demands for the company's pruducts, called a master production schedule (MPS). The computer breaks the MPS down into detailed schedules for making or buying the component parts. It is a push system in that the schedule pushes the production people into making the required parts and then pushes the required parts out and onward.

Before there was computer power to do all the planning and scheduling a haphazard pull system was used and still is being used in many companies. The system works as follows: customers place orders and manufacturing finds out whether there are parts on hand. Parts not on hand are pulled through or expedited. Even if substantial amounts of parts are kept on hand there will be a few missing that will have to be expedited. This is disruptive and causes delays.

After visiting Japan to compare the pros and cons of JIT with those of MRP2, Goddard came to the following conclusions (15):

a. JIT can only succeed where the user produces highly repetitive pruducts. MRP2, however works equally well for highly engineered products that are for one-of-a-kind, make-for-stock and finished-for-order products.

b. MRP2 has better tools than JIT, but these tools are more costly. It is very important for a company to evaluate properly not only the costs, but what the paybacks will be.

Unless the general manager or his staff can visualize sizeable returns, they will not invest enough of their time and energy to ensure that the company will become a successful user.

A push or MRP2 system would appear to be a better management system than a pull/expedite system. However, contrary to Goddards conclusions, a weakness of MRP2 is that there is some guesswork involved (3). Customer demand is a variable and is a prerequisite for preparing the schedule. The system allows for correct predictions, called shop floor control. Nevertheless, incorrect predictions result in excess inventories of certain parts but not nearly as much total inventory as in the old pull/expedite system.

MRP2 is also lot oriented. With MRP2 the computer collects all demands for a given part number in a given time period and recommends production or purchase of the part number in one sizeable lot. MRP2 companies order in lots rather than piece for piece. The reason for this is that they have not lowered setup times in order to make small lots ecconomical. If this was not done then the simple manual Kanban system would be the logical choice, rather than the complex, expensive, computer based MRP2 system. The MRP2 paradox is that if the company removes the setup time obstacle in order to make MRP2 truly effective in cutting inventories, then MRP2 is no longer needed as Kanban would be preferable (3).

This point may be further exemplified by the following: MRP2 correctly calculates parts requirements by precisely associating them with the master schedule of end products. But what is correct at the time of calculation is subject to error later. The reason is that lots are sizeable and the production lead time is long - from one to several weeks. During that lead time there will be delays and schedule changes so that the lot being produced no longer is correct in relation to the master schedule of end products. The lot size and lead time erode the close association between parts requirements and end product schedules.

Until recently it appeared that pull systems would be totally replaced by computer based MRP2. This applied to small companies as well as to the low cost of microcomputers and the price maintaining a downward trend. The Toyota pull system, known as Kanban, upset that prediction (3). Kanban provides parts when they are needed but without guesswork and therefore does not have excess inventory resulting from bad guesses. But there is an important limitation to the use of Kanban. Kanban will only work well in the context of a JIT system and more particularly with the setup time or lot size reduction feature of JIT. A JIT program can succeed without a Kanban subsystem, but Kanban cannot succeed without JIT.

Table 5-1 How Toyota's Kanban Philosophy differs from a typical Western Philosophy

| FACTORS | TOYOTA's KANBAN | WESTERN PHILOSOPHY |
|---|---|---|
| Inventory | A liability. Every effort must be extended to do away with it. | An asset. It protects against forecast errors, machine problems, late vendor deliveries. More inventory is "safer". |
| Lot Sizes | Immediate needs only. A minimum replenishment quantity is desired for both manufactured and purchased parts. | Formulas. We're always revising the optimum lot size with some formula based on the trade-off between the cost of inventories and the cost of set up. |
| Set Ups | Makes them insignificant. This requires either extremely rapid changeover to minimize the impact on production, or the availability of extra machines already set up. Fast changeover permits small lot sizes to be practical, and allows a wide variety of parts to be made frequently. | Low priority. Maximum output is the usual goal. Rarely does similar thought and effort go into achieving quick changeover. |

| FACTORS | TOYOTA's KANBAN | WESTERN PHILOSOPHY |
|---|---|---|
| Queues | Eliminate them. When problems occur identify the causes and correct them. The correction process is aided when queues are small. If the queues are small, it surfaces the need to identify and fix the cause. | Necessary investment. permit succeeding operations to continue in the event of a problem with the feeding operation. Also, by providing a selection of jobs, the factory management has a greater opportunity to match up varying operator skills and machine capabilities, combine set ups and thus contribute to the efficiency of the operation. |
| Vendors | Co-workers. They're part of the team. Multiple deliveries for all active items are expected daily. The vendor takes care of the needs of the customer, and the customer treats the vendor as an extension of his factory. | Advisaries. Multiple sources are the rule, and it's typical to play them off against each other. |
| Quality | Zero defects. If quality is not 100%, production is in jeopardy. | Tolerate some scrap. We usually track what the actual scrap has been and develop formulas for predicting it. |
| Equipment maintenance | Constant and effective. Machine breakdowns must be minimal. | As required. But not critical because we have queues available. |
| Lead Times | Keep them short. This simplifies the job of marketing purchasing, and manufacturing as it reduces the need to expediting. | The longer the better. Most foremen and purchasing agents want more lead time, not less. |
| Workers | Management by consensus. Changes are not made until consensus is reached, whether or not a bit of arm twisting is involved. The vital ingredient of "ownership" is achieved. | Management by edict. New systems are installed in spite of the workers, not thanks to the workers. Then we concentrate on measurements to determine whether or not they're doing it. |

## 5.1 LESSONS TO LEARN FROM JIT.

There are lessons to be learned through understanding the JIT System (15).

5.1.1 Teamwork. The Japanese companies operate with a tremendous amount of team effort. The workers pull together. They realize that as a team they will be stronger.

5.1.2 Education, the common denominator. This is as true for the successful Toyota Kanban System as it is for all successful MRP2 systems. It is better to have a technically imperfect system that the users understand and want to make work, than a technically correct one without user understanding.

The success that Toyota has achieved is not only the result of the JIT tools. The key is what they do before implementing the system that permits it to work so well.

Without a clear distinction between these JIT tools and the attitude and philosophy of the JIT users, we could easily import the wrong message from Japan (15).

Most manufacturing companies in S.A. do not have the volume or repetitive characteristics necessary to work in the same way as, for example, Toyota or Hewlett Packard. All companies, however, require some method of Material Requirements Planning (MRP). This means accepting orders or forecasts for an end product and using a bill of material to generate the required production and purchase orders. Every production shop has to go through this process whatever their production volume may be. To get this process mechanised through MRP2 was a major breakthrough in manufacturing, but it does have its problems. A number of these have been spotlighted by JIT (18).

There are further lessons to be learned from JIT.

5.1.3 Commitment. When MRP systems are installed, some lip service is usually paid by top management to being committed to such a course of action. However, that is often where the commitment stops (18). An example of commitment in Japan is Mr. Taiichi Ohno, Senior Managing Director of Toyota. He was interested and knowledgeable enough to worry about the time that was taken to exchange dies on their presses. The commitment does not end at this level. There is a requirement for the commitment of every man in the company for JIT to be successful.

In Japan this phenomenon could be seen as an outcome of their culture. In S.A. the tendency has been to ignore the necessity of this commitment. In the Western nations the trade unions have ensured that this commitment has had to be developed. In S.A. there is ever increasing awareness of the power of the workers. More positive attention will have to be given to the education of all members of the company in order to achieve the commitment of the whole company.

5.1.4 Discipline. MRP systems have tolerances built into them such as scrap and lead time allowances. If in a manufacturing process, there is a percentage allowance for scrap there is no discipline needed to ensure that no scrap takes place. MRP makes allowance for a percentage level of scrap that is regarded as being acceptable. The focus of JIT is on doing things correctly and with the first attempt. If there are problems as there are in any manufacturing business, then the discipline should be there to rectify the situation immediately. The practice in Japan is to stop the product/assembly line if there is a problem at any one station on the line. This however, can only be followed at an advanced stage of JIT implementation as there are many fundamentals that have to be rectified first. As is quoted by Shingo (19), "Now you might think that 'Toyota Motor' is wearing a smart suit called 'Kanban' system but your body was bubbled up so fat that you could not wear it". The principles of JIT insist on disciplines. An employee is to accept the responsibility of his area of the company production, do his job and not blame others for his failures.

5.1.5 Weaknesses. In the above disciplines weaknesses are highlighted. An MRP system often helps to cover up weaknesses with its allowances. For problems to be eliminated they must first be exposed so that there is an awareness of them. The common reaction to a quality problem is to step up inspection. However, "increasing inspectors is increasing efficiency of inspection and does nothing to control defects" (19).

5.1.6 Morality. Western attitudes are built on selfishness. There is perhaps not the right attitude of interdependence in S.A. which is necessary for implementing the ideas promulgated by the proponents of JIT.

a. The tendency is to blame others for mistakes rather than identifying the reasons. The reasons may be personal pride and also the fear of the consequences of making a mistake. These fears in certain situations are perhaps not unjustified. There are instances of employees being dismissed for making mistakes rather than the reason for the mistake being identified and corrected.

b. If there is a problem with a supplier the tendency is to look for an alternative source of supply instead of first endeavouring to solve the problem with the supplier.

c. It is often quoted that staff are the greatest asset to a company and loyalty is demanded from them. However, staff is too often a variable that is manipulated. Constructive thinking and improvement from a labour force cannot be expected if they feel they will lose their jobs through improvements in productivity leading to a drop in the labour required.

## 5.2 THE MECHANICS: KANBAN VERSUS MRP2.

Every manufacturing company has certain functions that it must perform (15). Eight of these functions are summarised in Table 5-2, which also lists the tools that both the Kanban System and MRP2 use to aid these functions.

The same functions are performed by every manufacturing company. However, the tools used by JIT differ greatly from the MRP tools. Under JIT the tools are manual Kanban cards, Andon lights, visual checks and verbal orders. With MRP2 the most important tool is the computer.

In reviewing Table 5-2, it is important to note that the Kanban Cards (the physical instrument of information transferance) simply represent one key element within the JIT system. In a similar manner, MRP is simply one key element within MRP2. Neither MRP nor Kanban Cards is a stand alone system. In both cases, if they were installed by themselves, they would produce few if any benefits.

What follows is a review of the eight functions in Table 5-2. The functions serve as a basis of comparison of JIT and MRP2 and the tools used in both systems.

### 5.2.1 Establishing rates of output.

With Toyota's (Japan) emphasis on life-time employment, great care and effort goes into determining the rates of output for their facilities. It is top management's responsibility to determine these rates. The objective is to level output to stabilize the labour force required.

In the U.S.A. and S.A, without debating whether the executives in these countries put the same amount of emphasis on avoiding layoffs, the process of production planning is exactly the same. The objectives are identical. In companies with MRP2, the top management of the company establish rates of output which becomes their policy for the other resource planning functions.

### 5.2.2 Determining what products need to be built.

The master schedule specifies what products are to be built in the future. At Toyota the master schedule extends three months ahead. The first month is considered firm and all changes are resisted. The next two months are considered tentative, with a good chance of being held firm.

EIGHT MANUFACTURING FUNCTIONS;
HOW THEY ARE CONTROLLED BY JIT AND MRP2.

| Functions | Categories | JIT System | MRP2 |
|---|---|---|---|
| Rates of output. | Families of products | Levelling | Production plan |
| Products to be built | Finished goods for make-to-stock customer orders for make to order | Master Production schedule | Master Production schedule |
| Materials Required | Components, both manufactured and purchased | Kanban Cards | Material Requirements planning (MRP) |
| Capacity Required | Output for key work centres and vendors | Visual | Capacity Requirements Planning (CRP) |
| Executing Capacity Plans | Producing enough output to satisfy plans | Visual | Input/Output Controls (I/O) |
| Executing Material Plans Manufactured Items | Working on right priorities in factory | Kanban Cards and unofficial orders | Dispatching Reports |
| Feedback information | What cannot be executed due to problems | Andon | Anticipated Delay Reports |

TABLE 5-2

The approach is the same to maintain a good master production schedule in an MRP2 system. The planning horizons vary greatly from company to company, as well as the guidelines for managing changes. Yet, a major difference occurs in how the products are lot sized and sequenced within the JIT master schedule.

### 5.2.3 Determining what materials are required.

There are two types of Kanban card, a requisition card (withdrawal Kanban) and a production card (production ordering Kanban) (9). It is a non-computer based system.

With MRP2 computer generated reports advise the material planners what they should order. This process requires a structural bill of material, inventory records (what's on hand in the stockroom plus what's on order) and is driven by a master production schedule. In essence, the analysis compares what is available for inventory to what is needed to advise the planners of what is missing.

With an MRP2 system, the planner issues a shop order along with a pick list to the stockroom. The pick list authorises the stockroom to issue the proper material to make the needed item. The shop order is the authorisation for the operators to perform the required functions to make the needed item.

With the Kanban system there is no bill of material explosion on the computer. Once a component is depleted on the final assembly line, it triggers the replenishment cycle, top to bottom, similar to computerised MRP2.

The two cards of Kanban perform the same functions as the pick lists and the shop order. But they do it manually. In the author's opinion, as this all happens on the shop floor there is a considerably faster transfer of information. The depletion of stock is patently apparent to the operator. He does not need what can very often amount to a rather impersonal instruction on a computer card to take action. The motivation of the worker utilising the Kanban system to react to the situation, is therefore also considerably greater.

### 5.2.4 Determining what capacity is required.

With Kanban it is a non-computer approach. Through knowledge of the daily output volume, the factory foreman and operators determine what they have to do in terms of capacity to support the master production schedule.

There is one other key objective: to keep a minimum amount of inventory on the floor. Every operation in the factory is to 'prepare' to accomplish both missions. They are aided in this task by having multi-skilled operators and sometimes extra machinery. The combination provides great flexibility in responding to the capacity needs.

With Capacity Requirements Planning, the computer produces reports displaying the time phased loads per key work centre. These reports reflect not only open shop orders that have not passed through the work centre in question, but additionally include all of the MRP planned orders to gain sufficient planning visibility.

This information is typically reviewed by both the planning department and by the appropriate factory managers. They determine the ability to respond to any predicted upturns or downturns in the capacity required.

### 5.2.5. Executing the capacity plans.

At Toyota, if not enough parts are being produced, the final assembly line will shut down shortly. On the other hand, if work is accumulating behind a particular work centre, this queue means that inventory is not at a minimum and steps must be taken to correct it. Thus, the factory personnel have the responsibility to plan and react if adjustments are required to alter the output. In the author's opinion, if a fault occurs in a product at a particular work station, it is the operators responsibility to detect it. Detection of rejects is not left exclusively to quality control personnel. Due to the immediate detection of the fault, large quantities of rejects are not manufactured. The problem is also given immediate attention to prevent a line stoppage.

The emphasis in on making it correctly the first time and not on leaving it to a rectification department to correct the fault.

With MRP2, input and output reports are produced. The objective of these reports is to provide a formal monitoring system . The flow of hours into the key work centres should match the prediction that came from the CRP. The flow of hours out of the work centre should reflect the capabilities that the factory agreed to in order to satisfy the capacity plans. If a significant deviation occurs in either, it would signal a problem and cause corrective action to be initiated. According to the writer the monitoring is very much a staff function with MRP2 as opposed to an intrinsic line function with JIT.

### 5.2.6. Determining what manufactured items should be worked on

The Kanban cards provide this function. The production cards become authorisation for the operators to make more. Basically, it is a first come, first serve system. Whatever production card arrives first identifies the job that should be worked on next. In the author's opinion, this self explanatory simplicity of the Kanban system, is one of its greatest advantages.

### 5.2.7. Determining what purchased parts are required.

The actual authorization for a vendor to ship more material is a Kanban Card. The absence of a card means that the vendor is not permitted to deliver material. The objective of their relationship with the vendor is to have a process similar to the relationship within the factory. That is, small lot sizes and frequent replenishment. This leads to the targeted low inventory level with all its advantages.

Under Kanban, vendors do get advance notification to permit prior planning to occur. From the master schedule, the customer sends to each of his suppliers a rolling, ninety days projection. The notices to the vendors are treated as unofficial orders. They are used to aid the vendor in material and capacity planning, but do not constitute a firm commitment on the customer's part.

Original Equipment Manufacturers' (OEM) supply the motor vehicle manufacturers in S.A. and get a projection in writing from them which is referred to as a suppliers release. Cumulative figures of what has been delivered in the current financial year are also recorded. This enables the OEM supplier to determine at a glance what has been dispatched, and been received in the plant by the manufacturer.

With an MRP2 system, computer reports advise purchasing people what should be bought. The reports also suggest what existing purchase orders should be rescheduled to either arrive earlier or later, based on the changing needs of the company. The planned orders permit purchasing to provide visibility to the vendors beyond the lead times.

### 5.2.8. Feedback information.

In both systems the notification that problems have occured is manually generated. However, the systems communicate this information differently.

Toyota employs an Andon System (Appendix A) which translated, means 'light' or 'lamp'. The Andon is hung over the assembly line. It is large enough to be seen throughout most of the factory. If an operator is having trouble keeping up with the required production, he signals this potential problem by lighting up his work station in yellow. If the problem cannot be corrected, this is communicated by lighting up the station in red. This is a warning that the final assembly line will soon shut down. Obviously this will generate activity to either keep that from occurring and/or minimise the length of the shutdown.

With MRP2, 'anticipated delay reports' are generated by the appropriate people in the factory as well as in purchasing to notify the material planners that delays in achieving schedules will occur. This will lead to a re-assessment of the plan.

### 5.2.9. The Master Production Schedule.

A COMPARISON OF A JIT AND MRP2 SCHEDULE.

| | :: | Week 1 | :: | Week 2 | : |
|---|---|---|---|---|---|
| Toyota | :: | A B:A B:A B:A B:A | B::A B:A B:A B:A B:A B:: | | |
| (Kanban) | :: | A C:A C:A C:A C:A | C::A C:A C:A C:A C:A C:: | | |
| USA | :: | A A:A A:A A:A A:A | A::B B:B B:B B:C C:C C:: | | |
| (MRP2) | :: | A A:A A:A A:A A:A | A::B B:B B:C C:C C:C C:: | | |

TABLE 5-3

There is a big difference between the master schedule for a JIT System and for a typical MRP2 manufacturer (Figure 5-3). Suppose a company has an output of a 100 products per day and that marketing forecasts that 50% of the sales will be Product A, 25% will be Product B and 25% Product C. The typical MRP2 plant might make Product A for five straight days, change over to Product B for two and a half days, then produce product C for the balance of the week. However, under a JIT System, a Japanese plant will make Product A, followed by B, followed by C. Their goal is to schedule every product, every day and in a sequence which intermixes all products.

The mixed model, single line configuration sharply reduces the number of stations, amount of equipment and required floor space compared to multiple dedicated lines. Inventory is reduced because there is buffer stock at the end of only one mixed model line rather than buffers at the end of several dedicated lines. Furthermore, it is easier for the downstream processes to communicate or physically interact with a single line, an advantage that makes it easier to introduce Kanban or physically merge the processes. A single line also simplifies the interaction with preceding work centres and may cut buffer stocks of parts coming from those work centres.

There may also be less need for supervision and shop floor control, since workers stay at a single line. By contrast, with multiple dedicated lines it is common for workers to be moved from line to line during the day to make different models.

The advantages of mixed model assembly are numerous (16). It provides a continuous flow of each model, reduces finished goods inventory, eliminates line changeover and provides greater flexibility in production. Continuous flow of models and reduced inventory of finished goods are clear and important advantages, but the other two points appear to be conditions for use of mixed model production rather than advantages. For example, key reasons for the Japanese being able to employ the mixed model concept are:

a. their attacks on changeover and setup time, and

b. their production flexibility: flexible labour, foreman level control of balancing/rebalancing, labour assignment, line speed up/ slow down, U-shaped and parallel lines, work stations located close together and multiple copies of small machines.

The Japanese approach to mixed model assembly lines is disciplined (3). Colour coding, one colour for all parts, containers and labels for a given model, is often used to cut down search time. Precise positioning of feeder parts racks has the same purpose. Kanban may be used to match parts usage with parts delivery and parts production to cut down on inventory that is used in support of the assembly line.

## 5.3 The apparent limitations Of The Kanban System.

If a knowledgeable person were to assess the Kanban System by only looking at the tools, his conclusion would be that we have stepped backwards into the 1960's (15). Kanban Cards operate in much the same manner as a two-bin system, which is a reorder point approach.

The two-bin approach has been in existence for a long time. The inventory is separated into two bins or locations. One bin is used to satisfy the need for a particular part. As soon as this bin is empty, replenishment of this part number is triggered. Until it is replenished, the second bin is used to supply the part.

With both the two-bin system and the Kanban System, what has been used is being replenished. The presumption is that if you have used up your inventory you will need more.

The flaws of the reorder point apply if a company is not manufacturing a highly repetitive product. The items that are replenished are not necessarily the items that will be needed in the future. This results in overstocking. The reorder point system also does not identify the need to reschedule. As all manufacturing companies are confronted with a steady stream of changes this also results in overstocking.

The advantages of MRP2 are that it ensures that only stock items needed for production will be replenished. This is however, dependant on the accuracy of the information used to draw up the works order.

Then how do the Kanban cards work?

The answer does not lie in the cards. Rather, Toyota has done five things to overcome the reorder point flaws:

5.3.1 A uniquely structured master production schedule. The master schedule is put together to ensure that the future resembles the past. Great care is taken to plan a mix of the same products, not only every month, but within each week and even down to within every day. Goddard (15) feels that this is only possible where a company is manufacturing a highly repetitive product. Without this environment, the Kanban cards would be replenishing the wrong items.

The objective of a Kanban system is to schedule every product every day, and in a sequence that intermixes all products (Figure 5-2). If such a plan can be executed, then every day all components are being consumed and all are being replenished.

Moreover, all that are being replenished will be needed. It is this sequence that puts the Kanban replenishment system in step with the master schedule.

The typical South African manufacturing company schedules products differently. It seeks economies and efficiencies through economical lot sizes and would batch build these products. This is largely due to the emphasis that is given to "the longer the production run the better". If tooling change overs, machine set-up and raw material and component ordering were to be streamlined, this would no longer be necessary.

5.3.2. <u>Extremely small lot sizes.</u>

The ultimate goal of Kanban is to "use one, make one". The combination of making products repetitively, as well as in very small quantities, causes a continuous demand on all of the component parts (15).

If the lot sizes are larger, say a month's supply, there will be infrequent demands for high numbers, the demand at the lower levels will occur twelve times a year, a month apart. Inventory will be increased due to larger lot size and having to make it some time before it is next needed.

5.3.3 <u>Very short lead times.</u>

A reorder point system does not identify the need to reschedule. All manufacturing companies are confronted with a steady stream of changes: forecasts are wrong, bills of material are revised, parts are scrapped, vendors are late and tooling breaks. However if lead times are short, rescheduling is not critical.

With long lead times, if the schedules are not changed to reflect the up to date needs, then expediting will replace scheduling. The factory and purchasing will be responding to hot lists to answer the question, 'what do you really need?'.

This is obviously costly and either the supplier or the customer have to absorb the cost. Either way, the expenses incurred do not add any value.

### 5.3.4 Top down replenishment.

The master schedule and the Kanban cards are not linked together as a computer is linked with MRP. Nevertheless, if something is not used in final assembly, no replenishment action will take place underneath it. In essence, Kanban ties everything together via the consumption at the master schedule level. This link is right on the shop floor and the reaction to any change is immediate. The change is then not at all disruptive. There is also an automatic communication of the change to all who need to know about it. This is done by merely changing (re-shuffling) the production ordering and withdrawal Kanban cards.

A conventional order point system does not have these ties. It assumes each item is a stand alone item, to be replenished independently.

### 5.3.5. Informal capacity planning.

The burden is on the factory as well as the vendors to gear up to handle increased or decreased volume in the master schedule. This is not a problem because of the good relationship the JIT philosophy generates between customers and their vendors. This results in co-operation when there is a burden of any increase or decrease in volume. Because the master schedule generates the need for a steady, repetitive flow of parts, capacity planning in all work centres is fairly straightforward. Without this feature, the suprises caused by manufacturing a wide variety of parts in a non repetitive manner would make this job extremely difficult without a computer (15).

## 5.4 MRP2 without works orders, a further enhancement of MRP2

Many manufacturing companies have operated for years without works orders. They can still benefit from implementing a computer based system, particularly for co-ordinating their distribution, manufacturing and purchasing functions, the overall logistics system.

However, a significant weakness of MRP2, or the way MRP2 has been applied with software companies trying to fit everyone into a standard system, is that the whole design revolves around works orders. This can lead to excess paperwork on the shop floor. "A shop order may be needed for some specific purpose, but it's not for material or production control" (20). There is a tendency among cost accountants to insist on works orders so that variances can be provided for analysis.

The JIT mixed model, single line configuration system (described in 5.2.9) gives an environment of repetitive/flow (RF) manufacturing.

To define the environment of RF manufacturing it is necessary to look at the Rate of Flow, which it determines. A traffic flow (with machines being compared to intersections) creates a usefull picture to explain a rate of flow. In a job shop, long convoys compete for possession of these intersections. Experience has shown that 4-way stops are only effective for light traffic. In a job shop, batches can arrive from many more than four directions. The tendency in S.A. is to concentrate on machine utilisation. This makes sure that the machines (intersections) are always in use, but ignores the queues as they are built into the lead time. Overlapped operations (like synchronised traffic lights) eliminate these queues and improve the rate of flow.

From this description of flow environment it is apparent that MRP does not model it very well. Why plan for a lead time which shows the rate of flow, which is based on queue, set-up, run and move between individual operations, if it can be eliminated. Rather plan to produce at a certain rate per day or week and use a schedule rather than works orders.

This would mean that the following standard MRP features would no longer be needed and would probably make implementation ineffective if they were to be used (20).

a. works order numbers
b. standard calculation of start date
c. pick lists time phased for the start of an order
d. despatch lists

If a start has been made on implementing a standard system before realising that works orders can prove to be a problem, certain adaptations can be made.

a. the pick complete transaction is used at order completion
b. only planned orders are to be used
c. lead times must be targeted at zero or one day
d. programs should be written so that works orders are automatically split into a series of sub-orders

There are two types of package which specifically address the problem, repetitive system packages (typically developed from scratch) and enhanced MRP systems (MRP2). These may involve batch updating which poses potential problems in keeping the add-on module aligned with the rest of the system.

One of the largest selling MRP2 systems has a new module which (20);

a. eliminates shop order release and close
b. gives backflush and floor stock features
c. lets MRP recognise Works in Progress for netting
d. establishes schedules defined by item/quantity/start and end date

This is after a realisation by software suppliers that standard MRP does not suit everyone. When implementing MRP2 in a repetitive flow environment, great care must be taken to avoid a flood of paperwork.

## 5.5 Conclusion:

JIT has also been presented as a two stage process (23). The first stage is concerned with preparing the facility for production with high quality, low cost, minimum leadtime and high flexibility.

The second stage follows from the first and allows the ultimate JIT objective which is to produce only as needed with perfect quality and minimum cost. As necessary as both stages are to achieve the ultimate goal of JIT, the stages are detachable. Instead of using the second stage of the technique it is quite possible to use MRP2 or both JIT and MRP2. This has interesting implications, with experience having shown the following (23).

a. MRP has limited potential on its own. It would in effect serve as the second stage without the very necessary first stage. Conversely;

b. If the first stage is undertaken, the effectiveness of MRP2 can be vastly improved, even without JIT Scheduling or any of the other second stage techniques.

In the author's opinion, changes are being made to MRP systems to enhance them. However, these changes utilise JIT concepts. The choice of a suitable system would largely depend on the company and its stage of development. The company may not be in a state of readiness to "fit the JIT suit". However, MRP could serve as a transition tool to JIT (4).

# CHAPTER 6

## JIT'S EFFECT ON MANAGEMENT STYLE

### 6.1 PRODUCTIVITY IN SOUTH AFRICA

Industry in South Africa has extremely low levels of productivity. Just as professionals must constantly upgrade their skills, factories must be constantly upgraded if they are to maintain cost leadership in their fields.

It is an apparent phenomenon that South African management has tunnel vision. When business is poor, management tends to assume it will be poor forever, so there is no incentive to invest in new capital equipment. When business is booming they see no need to plan for the downswing.

South Africa has the advantage of having an abundant supply of it's own raw materials. There has however been an over dependance on gold as a source of revenue. The poor productivity in the country's industry has also been driven home by the fact that overseas manufacturers are able to produce products a lot cheaper than South Africa utilising South Africa's raw materials. Institutions such as the National Productivity Institute are also generating an additional awareness of the country's productivity predicament Table 6-1 (S.A. Dept. of Statistics).

South African management seems to have a polar attitude towards Japanese management (27). One view is that Japan's management is culturally based and has no relevance to S.A. What is not realised is that Japan followed American management methods, expanded on them and modified them to suit indigenous patterns.

Initially, Japan naively thought that methods used in the USA had general applicability. They soon learned that adaptation to the corporate environment, sociological and psychological needs is essential. Indigenous, socio-cultural differences must be recognised and adaptations made. Japanese successes in South East Asia, America, Britain and South Africa, show that Japanese management is applicable in both a developing and a developed economy. Both Japan and S.A. entered the industrial age at the same time. Both societies have capitalised on their natural resources: in Japan it is human resources, and in South Africa it is abundant natural resources. Given these similarities and taking note of the differences, it is believed that many of the principles of Japanese management can be successfully applied in the South African environment (11).

GROSS DOMESTIC PRODUCT PER CAPITA IN CONSTANT 1975 PRICES AND EXCHANGE RATES IN RAND

| COUNTRY | R | AVERAGE ANNUAL GROWTH RATE (1972-1973) |
|---|---|---|
| Republic of China | 1154 | 6,1% |
| Japan | 4394 | 3,2% |
| Portugal | 1458 | 2,4% |
| USA | 5963 | 1,3% |
| UK | 3411 | 1,2% |
| SA (including the independent states and SWA) | 1000 | 0,3% |

TABLE 6-1

S.A. Management is now forced to rethink the whole idea of the factory and take a long hard look at why South Africa is not competitive in the world marketplace. If the inflation rate is prevented from eroding the benefits of the current exchange rate, South Africa will be in an ideal position to take full advantage of its export potential.

## 6.2 JAPANESE INVESTMENT VIEWPOINT

The Japanese take a long-term view of investment. Japan now leads the world in technological innovation and holds about one third of total world patents. Expenditure on Research and Development (R&D) by Japanese industry as a whole increased by 300 per cent during the 1970's; and the percentage of R&D to sales by Japan's top ten manufacturers is now 9 per cent. This investment has paid handsome dividends and shattered the long held opinion of the Japanese being copiers only. They also have a positive investment policy in plant and equipment. The average life of Japan's plant and equipment is currently 10 years as opposed to the USA's 20 years. Their investment in new plant and equipment is also double that in the USA (11). They believe that the only way they can be competitive in the world marketplace is to drive toward the lowest possible level of cost. JIT which has taken close to thirty years to be developed to its present stage in Japan, is an example of this management approach. The Japanese are not only ahead in many areas but the rate at which they are improving is much faster than in the West.

"The Japanese are in a stage of leadership. They are setting goals to reduce their costs by a considerable percentage every year" (24). It is a case of Management not only aiming to achieve what the Japanese have already achieved but to aim at, or ahead, of where they are going. Management commitment to achieving this objective has to start at the top and work down.

Management has to look at a different set of benefits from short term return on investment. The conventional financial approaches of 'how many people are you going to eliminate' and 'what kind of payback can you get' have to be modified.

## 6.3 SOME SOLUTIONS TO BECOMING MORE COMPETITIVE

The entire management team needs to realize that there is not a single solution to making South African factories more competitive. There are generally several major factors that contribute to the desired end result.

JIT can therefore not be viewed as a specific concept in isolation. There are certain very definite prerequisites for it's success.

An effective maintenance and TQC approach are a couple that immediately come to mind, but what about management? Employee involvement at all levels is essential for JIT to be a success. The need is for the meaning of JIT to be professionally communicated with the full backing of management.

Once the staff are aware of why JIT is needed, how it will increase output in terms of quality and quantity, and how it will make the business more competitive, staff are to be motivated to accept it. All staff are to be convinced that it is necessary, that it is really going to happen and are to be shown the benefits of the system.

### 6.3.1 Participation at all levels

Participation of all employees is to be encouraged and they are to be brought into the decision making process. For this to be effective, training is essential.

"JIT is not anything to be entered into casually. The consensus is that it takes at least three to five years to implement a full blown JIT programme. All sources agree that top-down planning is vital. For successful implementation, any JIT program must be fully endorsed by top management and any enduring change must be initiated at that level. Restructuring to JIT requires that top management develop long range strategic and business plans" (14).

### 6.3.2 Management and suppliers

Another key element required for a successful JIT project, is development of a new partnership between raw material suppliers, processors and end users. This will create an open communications network throughout the manufacturing loop for quick responsiveness to strategic and logistical problems.

This may result in a shrinking supplier base with fewer vendors, quite contrary to the way business has been done in the past.

In S.A., the relationship between buyer and supplier plants tends to be precarious and maintained at arms length. Adding to the uncertainty is that the buyer plant will decide to make something itself rather than purchase it. Vertical integration has been regarded as a desirable path to growth and success. Some of the corporate giants in S.A., are examples of this process.

### 6.3.3 The Focused Factory

The focused factory opposes this form of approach. There is a development of special manufacturing competency in more narrowly focused areas. The focused factory is likely to be small and resist vertical integration (25).

The focused factory is a favoured strategy in many Japanese industries, especially the automotive industry. For example, Toyota's expenditure for purchased materials accounts for nearly 80 per cent of its dollar sales, whereas the figure is less than 50 percent for General Motors. Toyota does, however, have an ownership interest in a number of its supplier companies (3). In the author's opinion, this applies to Toyota S.A. as well.

Although many of the companies in Japan do not appear to be vertically integrated, they exercise extensive control over their suppliers. Buyer representatives regularly visit the supplier plants and come to know the suppliers' capabilities and weaknesses. Japanese companies that are highly vertically integrated are organised into small units, so that overcontrol does not stifle local initiative and pride. Japanese corporations try to hold their plant size down to below 1,000 employees and have small, clearly identifiable work groups within each plant.

### 6.3.4 Forecasting

A further fundamental point is accurate forecasting. Anything that affects a schedule affects the next point along the chain; the further down the chain the problem occurs, the more likely it is to shut the entire chain down. With JIT utilising a pull system the furthest down the chain in this instance is the supplier. With JIT it is however possible to view the system as having three fundamental divisions: supplier, in-house and customer.

For JIT to be optimised it is necessary that it's principles be applied to all three divisions. This is not always practically possible particularly during the introductory phase. There are still very definite advantages to JIT being successfully applied to any of the three divisions mentioned.

### 6.3.5 The Philosophy of JIT

The cultural or philosophical changes in a company required to implement JIT affect these three divisions and virtually every facet of a business. Another key element necessary for the success of JIT is quality. TQC, the quality imperative of JIT, means doing everything right the first time. The key is part quality; parts have to be manufactured exactly to specification or the whole system breaks down. There literally is no time to waste on rejects.

An example of the necessity of this is the gearing of organisations which no longer allows space for the storage of buffer stocks in the design of their new plants. There is a total dependence on the right quantity and quality of raw materials and components arriving at the right time. The objective of zero inventories necessitates zero-defect manufacturing.

"The key to zero defect manufacturing lies in the partnership between the vendor and the buyer. The quality and functional requirements of the part must be thoroughly understood at the earliest possible point so that quality can be engineered right into the tool. Q.C. is not enough.

Merely moving parts inspectors around, auditing or adhering to acceptable quality levels (AQL) is not enough. What's required for successful JIT projects is statistical process and quality control" (14).

"Japanese productivity improvement philosophy is based on development, research and innovation and covers both management systems and enhancing productivity techniques, but most importantly, it is not a superimposed package of systems but a lived commitment based on awareness, mutual interdependence and common goals" (11).

### 6.4 Change in Approach

JIT does necessitate changes in how managers run their companies. Managers in the USA have had difficulty in accepting this aspect of JIT. For example, when Northern Telecom Inc.'s Data Systems Division began a single pilot JIT manufacturing program in July 1984, the biggest obstacle was people problems, notably the need to overcome the natural distrust between hourly workers and management (6).

The company overcame that hurdle, says Burghard (6), director of quality control at the Minnetoka, Minn. operation, and JIT has succeeded so quickly that the entire plant is being converted. In fact, the company plans to implement the process in all of its 50-odd manufacturing plants.

One key to good JIT implementation is total management involvement. For example, management must fashion close relationships with a short list of vendors. This is not seen as a problem if the necessary preparation is done. "But you'll look at many, many suppliers before you choose the one you want to do business with." (6)

Management must be flexible in their outlook and be open to accepting what often amounts to major changes that revolutionise existing concepts. Managers that have an entrepreneurial approach are described as being the most suited to the JIT environment (4).

An example of the management approach required was applied at Kawasaki's Lincoln plant. The plant manager there was persuaded by a team of JIT experts from Japan to abandon an existing MRP project. The plant manager initially believed that he should have "old war horses" in key production positions. He changed his mind. Several of the old-timers were replaced with young people who had the flexibility or outlook mentioned above. They did not find it as difficult to accept new ideas. They came to accept the Japanese approach, at least to the degree necessary to make some progress (3).

## 6.5 ORGANISATION

The tendency in S.A. is to organise the analysts and decision makers by function or into groups of related expertise and specialisation. Examples are Industrial Engineers in an I.E. department, inspectors in a QC department and maintenance people in a maintenance department. The result is that functional goals and personal career paths often conflict with the good of the whole organisation. If the entire plant is envisioned as a series of stations on the assembly line whether physically there or not, an attitudinal change develops. This concept exhorts all managers, whether staff or line, to work toward integrating the entire plant configuration needed to support JIT production.

## 6.6 DECISION MAKING

Many reports on Japanese industry give special emphasis to Japanese cultural attributes favouring decisions based on consensus of opinion. The Japanese allow plenty of time for all affected parties to have meaningful inputs when alternatives are being evaluated (22). However, the ultimate decision is ensured of full support and is generally quickly and smoothly implemented.

Japanese management has always known that any large organisation is comprised of small groups, so group activities have become an integral part of the quest for productivity improvement. This system allows for participation in the decision making process of all staff. Everyone who will be affected has the opportunity to express opinions, reservations and recommendations. The focus is always on gathering and analysing factual data.

Facts convince, whereas opinions confuse, so groups must first determine the facts through which problems can be detected and recognised.

Seven tools are used - check sheets, histograms, pareto, cause and effect diagrams, graphs and control charts. These serve as a common statistical language which everyone can utilise and comprehend. This group emphasis on the facts also has the advantage of focusing attention on the problem, rather than on the individual. Meetings are then held to gather the information. The belief is that once in-depth information has been obtained, the issue can be defined, and once defined, the decision is usually self evident. There is a saying in Japan that "an idea devised in motion is a million times more effective than one worked out while static". (11)

This decision sharing and setting process must cover all departments that will be affected by the consensus decision, and a consensus decision it must be. A document is eventually produced for top management approval. Approval is generally granted due to the preparation prior to its compilation.

All these small group activites focus on a number of themes, e.g. quality, productivity, safety and many others. However, the main reason for small group activites that is constantly emphasised, is the improvement of human relations. This was the main reason for the initial promotion of Quality Control Circles in Japan. Since they serve to benefit quality by 2 to 3 per cent, Quality Control Circles were primarily aimed to improving the relations between foremen and workers.

Other small group activities in Japanese companies are Value Engineering, Quality Engineering, Operations Research and Industrial Engineering. All these activities are constantly monitored by the promotion centres to ensure dynamism, commitment and enthusiasm (11).

The S.A. approach is more individualistic and there is generally inadequate consultation and communication with those that will be affected by the decision taken.

Again, decisions are often taken in the interest of personal career paths. The result is a low success rate which is more costly than the extra time that could have been spent on making the decision.

The result of not taking time to gain consensus is (22);

a. Many doubters remain and they passively or actively resist.

b. Issues outside the area of expertise of the innovator are not properly considered, which makes the decision somewhat prone to failure whether there is resistance or not.

"Individualistic decision processes are not all bad and consensus processes are not all good. Folklore dictates that groups stifle creativity. The Japanese have been accused of being poor innovators. However, sheer engineering power and very high literacy makes Japan an innovative leader, as well as the world's preeminent copier. If there is consensus with regard to objective, the process of reaching the objective is inconsequential" (3).

The ratio of white-collar staff specialists to line workers is lower with a JIT system than conventional management structures. Shop floor workers and foremen are given greater responsibility. This generally results in decisions being taken a lot faster as they are taken by those directly in touch with the nature of the problems and requirements.

## 6.7 ONGOING SEARCH FOR IMPROVEMENT

Removing workers from the production line is a method of taking the productivity drive further. This is necessary to:

a. ensure that the plant remains competitive.

b. expose and solve methods and facilities problems.

c. sustain the habit of improvement and employee motivation.

The Japanese do not accept the buffer principle. Instead of adding buffer stocks at the point of irregularity, Japanese production managers deliberately expose the work force to the consequences. The response is that workers and foremen rally to root out the causes of irregularity. To ignore the causes results in having to face the consequences of work stoppages.

The Japanese principle of exposing the workers to the consequences is not applied passively. In the Toyota Kanban system when workers succeed in correcting the causes of recent irregularity, the managers remove a further amount of buffer stock. The workers are never allowed to settle into a comfortable pattern as the pattern becomes one of continually perfecting the production process. Toyota's small group improvement activities (SGIA's) never run out of new challenges. Whether the cycle can be maintained indefinitely remains to be seen (3).

In figure 4-4 the portion that is affected by deliberate removal of buffer stock is highlighted. The managerial intervention is indicated as a lightning bolt which serves as a just illustration of it's effect.

## 6.8 MIXED MODEL SEQUENCING

An advantage of mixed-model sequencing is that the range of models produced every day are close to the range of those sold. This avoids the usual cycle of a large build up of inventory of a given model, followed by depletion to the level of potential lost sales while the next model is being produced. Furthermore, when mixed models are run in final assembly, the same mixed model schedule may in a mature JIT system govern the making and delivering of component parts. This would ideally apply to outside suppliers as well. Planning and control are simplified, capacity requirements are reduced and buffer inventories are slashed, with all the related quality and JIT benefits.

## 6.9 CONVEYOR REMOVAL

There are several good reasons for removing conveyors;

a. Inventory. Conveyors hold inventory which has holding costs, delays feedback on quality, leads to more scrap and rework and less quality consciousness and is an administrative burden.

b. Quantities. WIP control is not precise with conveyors and goes against the JIT philosophy of zero inventory.

c. Flexibility. Conveyors 'push' inventory forward whether it is needed or not. A 'pull' system only draws parts from the supply points as they are needed.

d. Breakdowns. Conveyors are subject to breakdown. This would be a serious problem in a JIT factory in which there is little or no buffer inventory.

e. Cost. Conveyors are expensive to buy, install, maintain and relocate. The tendency has been for Western management to support the conveyor system as they fit the notions of automation and assembly line efficiency. There is however no better way to move parts than for one worker to physically hand the part to the next worker or if the next worker is busy, to place the part on his work bench. This is achieved by placing work centres close together so that they overlap.

## 6.10 CONCLUSION

A number of philosophies and religions have been instrumental in moulding Japan's world view. A trait perculiar to this view has been their openness to outside religions and philosophies, providing these do not disrupt or destroy the framework of their traditional society. In many ways, Japan, once borrower and copier, now leader and innovator, derives unique advantages from this flexibility and opennesss to new systems.

In the final analysis, the human relations approach of Japanese management is characterised by mutual trust and obligation between management and worker. The Japanese have shown that this trust is not a miracle achievable only in their culture and have achieved it elsewhere in the world where they have subsidiaries, factories and agents. Remarkable success has also been achieved in companies with no connection to the Japanese, but which have adapted the principles of this management style (11).

## CHAPTER 7

## THE IMPLEMENTATION OF JIT

JIT manufacturing is not an easy concept to apply, however, "JIT is deceptively simple: cutting down on inventory seems like a simple cure for manufacturing ills," says Maxwell Hall, a consultant closely associated with the technique (6). But, "it cannot be applied blindly as a remedy to bloated inventories and ballooning costs."

What many prospective users fail to grasp are the philosophical and organisational underpinnings of JIT which, despite appearances, are aimed more at improving poor quality than attacking out of control inventories. The Japanese consider the latter a symptom, not the cause, of manufacturing ills and they reduce inventories to uncover sources of breakdowns in the production process.

Hall defines the underlying JIT principles as "total quality control", or total commitment of management to eliminate all defects. He defines Kanban, as tightly synchronising and balancing different elements of production through better communication and scheduling among departments (6). When augmented by long term supplier contracts, which make vendors nearly a part of the company, real JIT can take place. One HP manager's definition of JIT is: "Eliminating those things from manufacturing that add cost but no value". Even after a company has implmented all the psychological and organisational changes, it is necessary to maintain good relations with suppliers. Quality components must arrive promptly at production lines or else all the striking statistics are reduced to wishes. According to HP's Harvey, "The vendor relationship was the last programme that we dealt with, but it's still the major program that we need to work on" (6).

To get started in JIT production, a company should understand the concept thoroughly, then relate its own production needs to it, says consultant Hall (6). Ideally, "there should be an internal champion at the top level pushing it." Next he counsels that initial JIT be done only as a pilot project, with a relatively mature product line.

"Then make sure it pays for itself first, before funding other projects" (6).

Catching up with the Japanese depends not so much on changing tax, trade, regulatory and labour laws and policies as it does on changing our industrial management policies, procedures and systems. Happily, most management concepts and approaches are readily transportable, and the basic simplicity and logic of JIT and TQC enhance their transportability from Japan to industry in America and the West generally (1).

While every manufacturing operation is slightly different the basic sequence of implementation is roughly the same. Figure 7.1 represents an overview of the JIT effort (7).

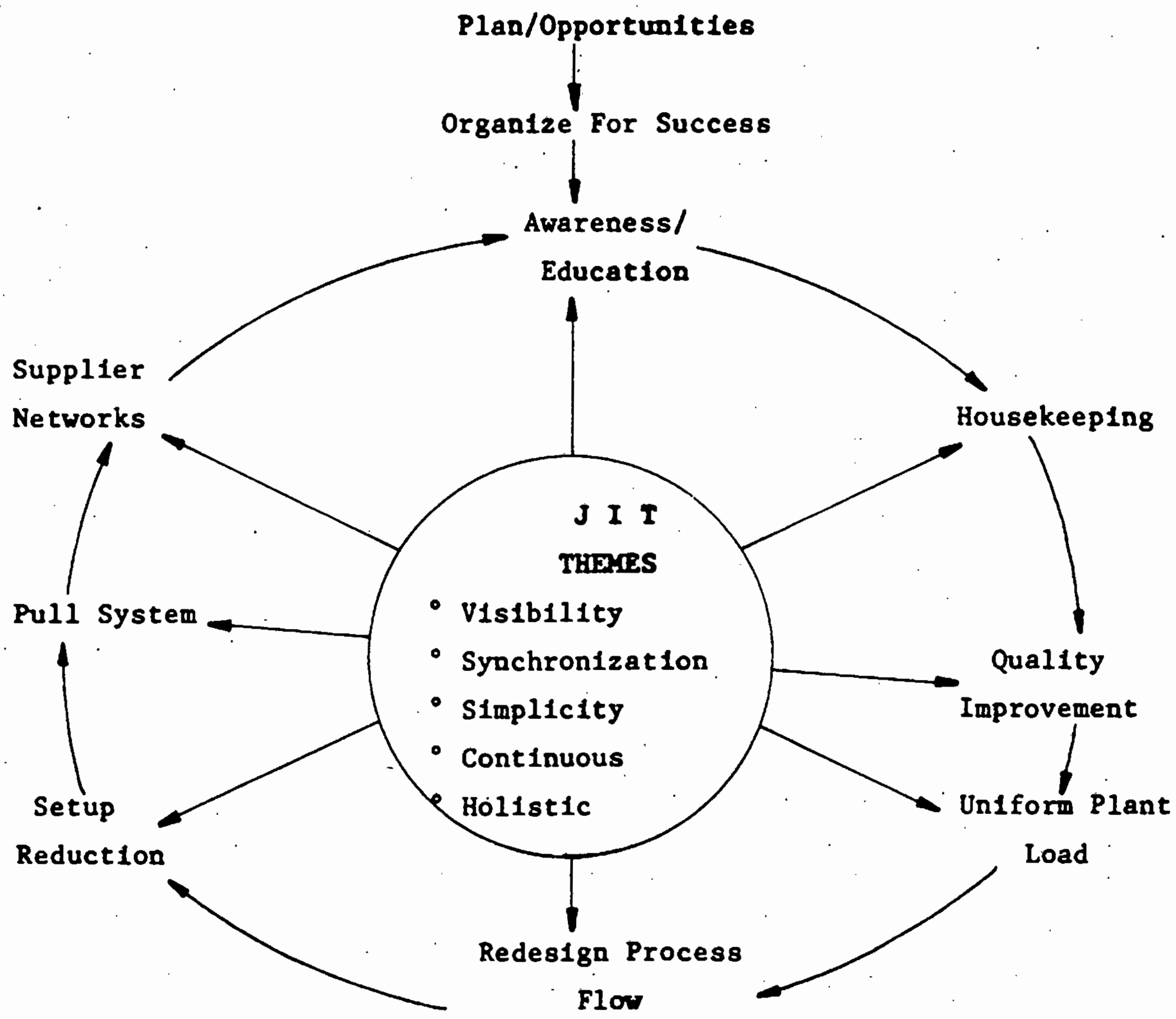



Figure 7-1

## 7.1 PLANNING

Many companies have invested too little time learning JIT principles before commencing the installation of a JIT system. After approximately a year they discover that they have created 'islands of JIT' and have not realised significant overall improvement. The reasons for the limited improvement can be due to one or more of the following:

a. a haphazard choice of areas for implementation
b. problems encountered with policy or accounting procedures
c. the programme being confined to a functional entity of the company
d. acceptance of a few partial improvements without maintaining ongoing improvement.

Applying a few of the fundamentals is easy but it takes excellent management to achieve the real opportunities (4).

A further possible reason for limited improvement is described by JIT viewed as a two stage process (23). The first stage is concerned with preparing the facility for production with high quality, low cost, minimum leadtime and high flexibility. The second stage concerns producing only as needed with perfect quality and minimum cost which allows the ultimate JIT objective to be approached. The second stage is in general risky and at the very least fairly ineffective, unless a fair amount of progress has been made in the first stage.

JIT brings about major changes to manufacturing systems and principles that currently apply. Such a profound change will not be successful if approached haphazardly with only a production manager or supervisor in charge of the implementation. The major change requires a carefully conceived plan which provides a clear, significant, strategic advantage in the marketplace. It becomes manufacturing's contribution to the business plan. Figure 7.2 provides an overview of the planning and task initiation methodology. The six phases of the programme are all directed towards achieving an environment of continuous and meaningful improvement.

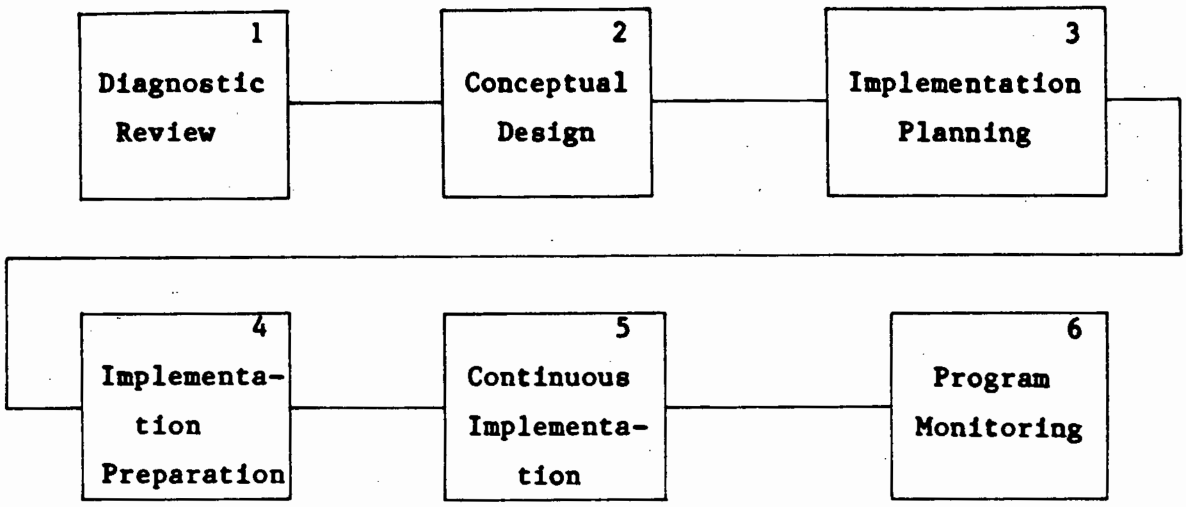



Figure 7-2

The first three phases provide the base and direction of the programme. They gather facts, assess the opportunities and deliver a company-wide, time scheduled plan. This plan gives a five year improvement projection.

The fourth phase, Implementation Preparation, is required to achieve continuous improvement. It is during this stage that all who are involved are trained in improvement leadership skills. Performance tracking mechanisms are also installed.

The fifth phase launches the actual improvement programme via Task groups with specific project assignments. As the programme matures, there is a need for re-evaluation of the priorities and occasionally for those involved to be reminded of the principles of JIT.

## 7.2 ORGANISE FOR SUCCESS

7.2.1 Goal awareness. Each and every person in the organisation should understand where the company is going and what their contribution to the improvement goals is to be. The first three phases of the methodology provide the input for this awareness.

a. Implementation steering committee. This group is charged with the execution of the JIT plan. It establishes priorities and assigns problems that are to be solved.

b. Task groups. Numerous task groups are established. These groups are multi-disciplinary and trained in specific JIT techniques such as variation research, setup reduction and procurement strategies. Each group, once assigned a task, recommends a specific solution to the steering committee. Once accepted, the line organisation implements the recommendation and the task group is assigned a new problem.

c. Ongoing improvement. After the task groups recommendation has been implemented, there is a need to continuously refine the improvement. Problem solving groups, similar to Quality Circles, then attend to problems in order of priority. Factors such as the Andon lights help establish this order of priority.

## 7.3 EDUCATION/AWARENESS

There is a great need for all personnel to gain an awareness of JIT technologies and to get involved in the implementation of the techniques introduced during the awareness portion of this activity. Everyone should be involved in trying to improve operations. In the long run it becomes the only means to ensure ongoing improvement.

## 7.4 HOUSEKEEPING

Good housekeeping in the JIT sense of the word means more than just a clean work place. Good housekeeping seeks to establish an attitude that each person is responsible for his or her equipment, assure that the necessary tools are placed correctly and that everything is clearly visible. This also serves to communicate the state of the work place.

## 7.5 QUALITY IMPROVEMENT

This activity should commence early in JIT implementation. It takes more time to achieve a situation of "zero defects" than any other element of JIT (4).

There are some differences between JIT and standard Quality programmes. With JIT Quality programmes;

a. The emphasis is on continuously reducing variance to improve the suitability of the item for manufacture. Staying within accepted or engineered tolerance limits is not the goal of JIT. JIT strives for the constant elimination of variance. Consequently, techniques such as Statistical Process Control (SPC) are not enough. SPC becomes the stepping stone for pre-control and Variation Research techniques.

b. The operator, not the inspector, is responsible for "zero defects". It is the responsibility of management to provide the necessary tools and mechanisms to ensure the operator can manage the quality process.

c. Whenever an error or problem is discovered, the operator should be allowed to stop the process and take immediate corrective action.

d. Setting priorities for quality problem solving leans toward the sporadic and not the routine, previously accepted, percentage level of defect occurrence. This does not imply that the latter is acceptable but that the sporadic defect occurrence has been found to impede the material flow more significantly. The reason being that the routine defect occurence can be compensated for on a temporary basis until the cause is eliminated.

e. Preventive maintenance of equipment becomes the operator's responsibility. The quality principles in c. apply to preventive maintenance activities.

f. A policy of all functions being responsible for new product development, not only ensures proper quality from the start, but also should result in suitability for manufacture.

g. Operators and supervisors require extensive training in quality assurance techniques. The long range goal is to eliminate inspectors since they add no value to the product and they cause queues.

## 7.6 UNIFORM PLANT LOAD

The significant contribution of Japanese practitioners of JIT was the concept of uniform plant load (UPL). The concept is simple. Only make daily what is sold on a daily basis. This means that every model within the product group is manufactured in small lots on a daily basis. Whenever possible, the end product is manufactured to meet demand and not for stock.

UPL is not the Master Schedule or the Final Assembly Schedule. It is the cycle time required to meet but not exceed demand. It is not how fast a machine or process can operate, but rather a production rate for all components and assemblies that is synchronous to the demand rate*. The primary benefit of UPL is to eliminate any indirect labour that is required to manage or transport excess inventory and to allow direct labour to operate mutliple machines because they have been slowed down to the UPL rate.

### 7.6.1 Redesign Process Flow

In order to achieve rapid throughput and the productivity opportunities afforded by UPL process flow or functional layout usually requires redesigning.

....................

Footnote:

* Example: If the demand for a given product group is 480 per day and the operation works one 8 hour shift, then the UPL rate is one completed item per minute (480 units per day divided by 480 minutes per shift = 1 unit per minute). All component and raw material receipts should theoretically be produced at a rate of one per minute.

In order to realise a 'make for demand' environment, most companies have to dramatically reduce the manufacturing lead time. How to reduce the lead time is discussed in the following sections.

The objective is to eliminate any non-value adding operations and then group dissimilar, but dedicated equipment (used for the manufacture of the same product group) together in a cell configuration. Wherever possible, cells should be dedicated to a product group. Maximum flexibility to meet UPL demand as cycle times can then be achieved. The UPL rate will vary with demand. Once the cell has been optimised for direct labour application "keep the man busy, not the machine" (4) the UPL rate determines the operations rate in the cell. A higher demand leads to a shorter cycle time and more operators being assigned to the cell. The test of a good cell is to always pay the same labour hours regardless of the demand rate. This also means having to change from fixed to assignable tasks.

Multi functional workers along with a streamlined process design, provide the flexibility and versatility necessary for effective JIT. Research has began at the University of the Witwatersrand in both Industrial Sociology and Industrial Engineering on possible labour legislation and Union barriers (23).

However, management could take the following precautions. When Unions request higher wages they are inclined to pitch their requested increases at a high level. This forms part of the negotiating strategy, as anything ventured by the employer that is less than the requested amount is regarded by the Union as being a compromise. It is during such negotiations that it is important for the employer to point out the importance of higher wages in some way being linked to improved productivity. It must also be pointed out that worker flexibility is important for the success of JIT. Job demarcation, the insistence upon fixed work assignments is therefore not to be accepted by the employer.

### 7.6.2 Cutting Lot Sizes

Inventory has carrying costs and the larger the inventory the larger these costs are. To cut carrying costs smaller quantities could be ordered more often. However, more frequent ordering has its costs too. In a factory, every time a component part is ordered, there is a setup cost.

These settings sometimes take a considerable period of time before they are correct and production proceeds. The general solution to this problem is to have longer runs. The question then arises as to how long the run should be. The compromise quantity is known as the economic order quantity (EOQ) or economical lot size or run size.

The EOQ formula dates back to about 1915, when it was independently derived by Ford Harris and by R. H. Wilson (3). For years EOQ has been the cornerstone of inventory management. It is time, however, to discard some of our EOQ training. The Japanese provide two reasons:

a. Carrying cost and setup cost are the only obvious costs. Quality, scrap, worker motivation and responsibility, and manufacturing productivity are also significantly affected by manufacturing lot sizes.

b. Setup cost is real and significant, but not unalterable. We are stuck with most carrying costs, but with ingenuity and resolve, setup costs can be driven down. By dedicating equipment to product groups some setups or changeovers are completely eliminated. Where multiple components must be produced on the same manufacturing resource, it becomes necessary to significantly reduce the changeover time in order to economically make just enough for each days demand. Eight years experience has shown that there has never been a setup that cannot be reduced by 75 per cent and often by more than 90 per cent (4).

When the Japanese explain in detail how they achieved their big increases in productivity, the biggest 'war stories' from the plant floor involve hard fought battles to reduce setup times on a piece of equipment which at first was regarded as an insurmountable obstacle. Accounts of these battles detail changing the design of bolts and the fit of pieces together on the machine. They describe the building of special tools to speed changeover (Figure 7-3) and practice sessions to learn how to perform changeovers quickly (3).

In the author's personal experience the tendency is not to have standardised die sets for tooling. The result is considerable time spent in adjusting the machine to accommodate a tool changeover.

Simple disciplines that would save time are also very often overlooked. Examples of these are:

a. Ensuring that the tool or die that is to be used is fit for use. The 'last off' of a production run should be retained for carefull inspection to ensure that there has not been deterioration of the tool or die. On certain manufacturing equipment such as high pressure die cast moulds, toolroom maintenance should be done on the mould after every run.

b. Preparation for the following production run. The author's experience is that the tendency is to complete a run, remove the tool and then to collect the following tool that is to be used from the toolstore. This results in the machine, very often an expensive item of capital equipment, standing idle.

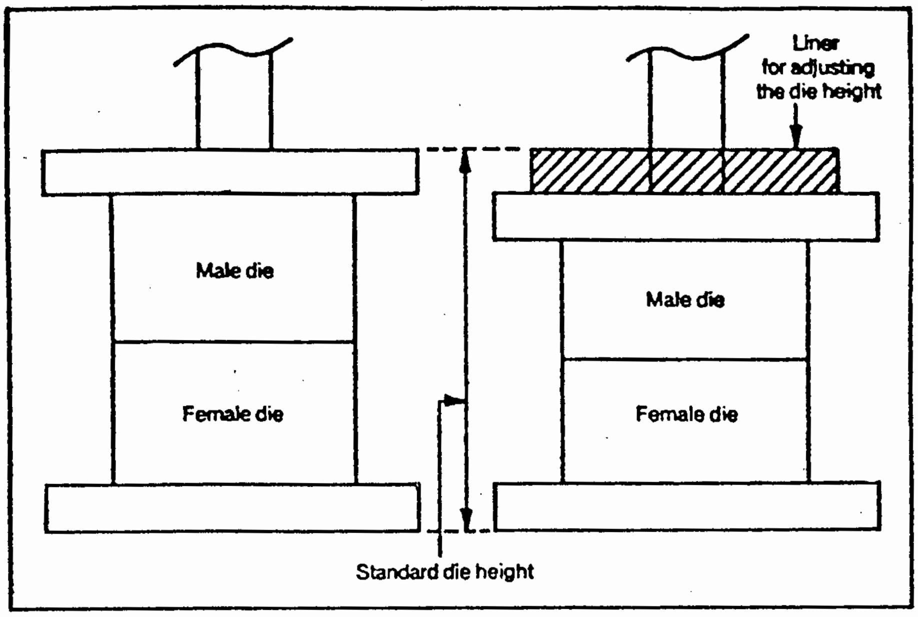
c. Methods of machine setting are also very often 'hit and miss' exercises. The machine is progressively reset while producing reject material until the item complies to specification. This is a considerable waste of both raw material and machine time.

The following is an example of a Japanese innovation to cut machine setup time (12):

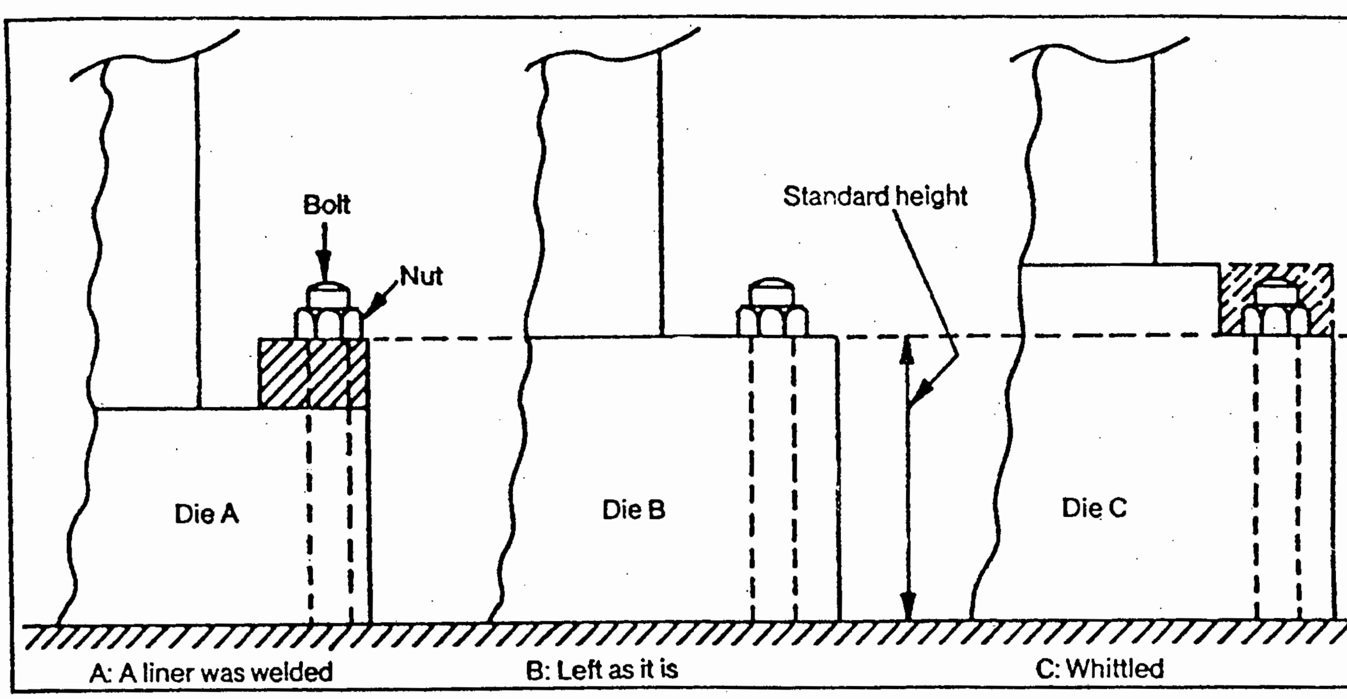
It was found that a very expensive item of machinery had a long setup time that initially appeared to be unavoidable. On further investigation, it was found that all the set-up time was related to a specific part of the machine. It was also found that this part of the machine could quite simply be removed and replaced. It could also be pre-set independent of the machine. It was decided to conduct a viability study to see whether it was worthwhile duplicating this expensive part of the machine. The results of the study were conclusive. The cost of purchasing the additional part was far outweighed by the savings in idle time on the machine.

FIGURE 7-3 SIMPLE EXAMPLES OF STANDARDIZING TOOLING

USING A LINER TO STANDARDIZE DIE HEIGHT




STANDARDIZING DIE-HOLDER HEIGHT
REDUCES THE NEED TO EXCHANGE FASTENING TOOLS



Another example of Japanese persistence in attacking setup problems is cited by representatives of Toyota's production control department (3). A Toyota campaign to cut setup times began in 1971. In that year it took an hour to setup 800 ton presses used in forming car hoods and fenders. After about five years of intensive engineering work, the setup time was down to 12 minutes. In comparison a U.S. competitor takes six hours. Toyota was also running lot sizes of just one day's worth of output per setup versus a reported 10 day's worth for the U.S. competitor.

But Toyota still regard the 12-minute setup time as still being too long. Toyota strives for 'single setup', which means single digit, ie., less than ten minutes. Toyota has often been able to reduce setup time to less than one minute, which is called 'one-touch'. The two terms, single setup and one-touch setup, are now used in many Japanese companies.

How is it possible to achieve these times? Hall provides further information about Toyota's hood and fender press operation (3):

The press was modified to allow the old dies to quickly slide out of the press onto a waiting table while new dies are pushed in from the other side. The workers performing the changeover additionally first 'dry ran' the procedure.

Altering commercial machine tools for quick setup is widely practised in Japanese industry. But the Japanese do not stop there.

In many cases the solution to the setup time problem is to retire the commercial machine and to have the company's toolmakers build their own machines (3). Self developed machines and tools may be special purpose, lightweight, easily movable and low in cost. Furthermore, setup time may be cut to zero! All the worker needs to do is load and unload. Since the machine is only designed for one job, all dies and fixtures may be built in so that no settings or adjustments are necessary.

### 7.6.3 Setup Reduction in S.A

In the South African context there may be sense in keeping certain old machines. Machines that are written off on the books are very often sold at low prices or discarded. This is done with machines that are regarded as having too slow a cycle time. Opportunities may however arise to utilize these machines with permanently setup tools or dies. There is the added advantage of there being no outlay to purchase the machine or the expense of having to build a special purpose machine from scratch.

Economic conditions in S.A. have perhaps paved the way for the JIT concept of using the smallest, least expensive machines consistent with quality and reliability requirements. Several companies have deliberately chosen not to scrap old machines, but to leave them permanently set up for flexibility, even though utilisation is low. One Brits based firm has even imported older written-off machines from their overseas parent for this purpose. Another local factory has decided to replace one large machine with two smaller ones which will be permanently set up. The costs nearly balance since fixed dies on two machines nearly compensate for two interchangeable dies on one machine (23).

Machine setup costs are such an obvious limitation to cutting inventories that one may wonder why only the Japanese have given such attention to them. Some possible reasons are:

a. Companies in South Africa often have a variety of different brands of a given type of machine. These have often been bought on the basis of what appears to be a bargain price or the managers personal preferance at the time.

b. Concern about a drop in the real value of the machine due to modification.

c. What was regarded as being acceptable in the past has not been changed. Setup time is regarded as necessary and is costed into the job.

d. A lack of awarness of the chain reaction of benefits set in motion by cutting lot sizes. Dennis Butt developed a set of graphs showing how the EOQ may be pushed downward toward one unit by cutting setup time and cost (3,21) (Figure 7-4).

Who should participate in the changeover reduction activity? "Companies who try to 'engineer' improvement via technical or capital intensive solutions, usually do not achieve the goal. Experience has dictated that the most effective setup task groups are those that have the actual operators as members. The operator knows the problems and by participating in the solution he/she will make the improvement work." (4).

### 7.6.4 The Pull System

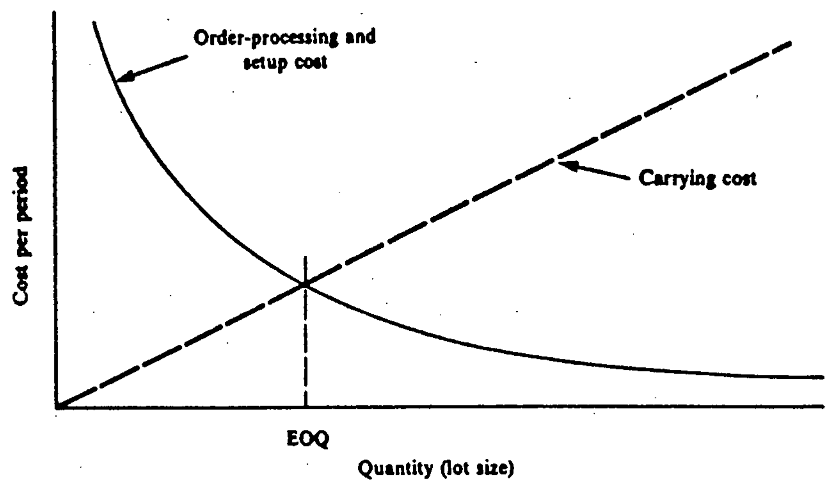
Once the UPL has been established and the cells put in place, it is usually time to establish the pull system. In isolated instances it is advisable to select a few critical part numbers and institute the pull system prior to cell completion. However, the full benefit of negative feedback (self-regulating mechanism) will not be realised until the UPL and cells are all in place.

JIT has two types of pull system:

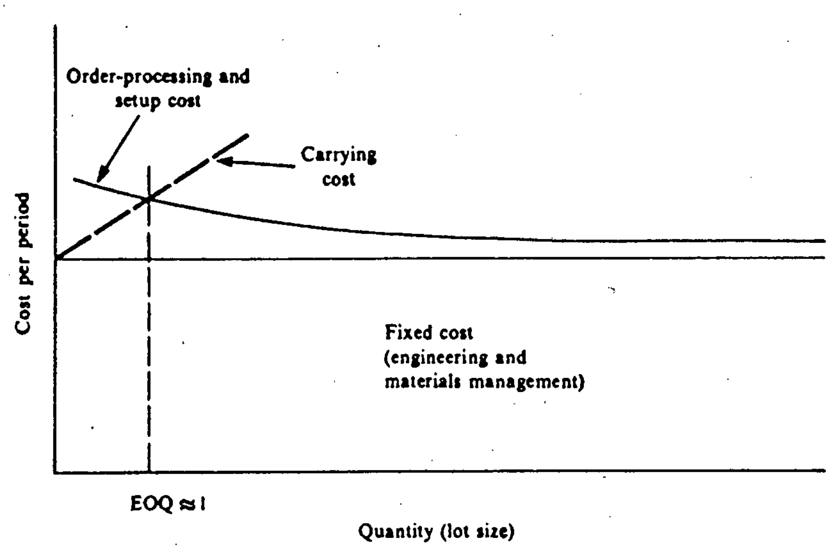
a. Overlapped. When a continuous flow has been established on a line or cell then the empty space previously occupied by a part is the signal to make one more part.

b. Linked. Where parts compete for the same resource and they cannot be made one part at a time or have to travel significant distances as lots, then it is advisable to use a production ordering Kanban to authorise the manufacture of the components. When a higher level, nearer to the end of the line work cell requires more parts, the replenishment container or bin is fetched.

FIGURE 7-4 ECONOMIC ORDER QUANTITY DRIVEN DOWN BY SET UP TIME AND COST REDUCTIONS




PRODUCTION IN LOTS




"LOTLESS" PRODUCTION

When picking up the parts from the point of manufacture, a Production Ordering Kanban card is left behind. This card is the authorisation for the point of manufacture to produce enough parts to fill another container. Order of priority is controlled by the order the Kanban cards were received in (FIFO). Violations of the sequence cause the entire system to collapse. Furthermore, if there are not authorisations to produce, nothing is made.

In order to realise the JIT purpose of Kanban, the following rules apply (7):

a. The subsequent process should withdraw the necessary products from the preceding process in the necessary quantities at the necessary point in time.

b. The preceding process should produce its products in the quantities withdrawn by the subsequent process.

c. Defective products should never be conveyed to the subsequent process.

d. The number of Kanbans should be minimized.

e. The Kanban system should be used to adapt to only small fluctuations in demand.

With reference to rule d. the number of Kanbans is determined by the following equation: (refer Appendix B for derivation)

$$Y = \frac{\bar{D}L + W}{a}$$

With reference to rule e., increased demand can be met by inserting early attendance and overtime. This maintains a constant number of workers on the line. If the frequency of Kanban movement decreases, idle capacity or idle time results. Simultaneously, inventory carrying time is prolonged. With a short lead time, the loss associated with carrying inventory will not be great.

The number of Kanbans tends to be fixed despite variations in demand. Experience at Toyota has shown that a 10 to 30 per cent variation in demand can be handled by changing the frequency of Kanban transfers. The number of Kanbans does not have to be revised.

In the case of seasonal or monthly changes in demand from predetermined loads, the number of Kanbans would have to be changed.

### 7.6.5 Supplier Networks and Cutting Purchase Order Costs

The last activity in the JIT cycle is to get the supply continuum extended to the supplier. Deliveries are only to be made when the items are needed. Quality improvement commences at the beginning of the JIT program, but the pull system is not implemented until the flow and demand have been sufficiently smoothed out. The key criterion for specifying JIT deliveries from the supplier is a smooth demand at commodity level.

A commodity is defined as a group of items which share the same manufacturing resources and/or raw material processes.

Purchasing at commodity level smooths the suppliers resource utilisation and extends the 'in-house' UPL to include the supplier.
The Japanese have attacked purchase order costs with the same zeal as setup costs. One way of cutting purchase order costs is to simplify the buying process. Common examples of ways to reduce cost in the West are:

a. blanket orders
b. stockless purchasing
c. vendor contracting
d. petty cash and approved supplier lists.

The Japanese go much further into cutting purchasing activities. Buyer companies exercise close control over supplier companies. Many Japanese suppliers routinely make deliveries of parts one or more times a day to large manufacturers. The delivery quantity may be slightly changed daily, based on just a telephone call. This is made possible by the relationship that is built up between the end users and their suppliers.

In the author's opinion however, S.A. suppliers by contrast, typically deliver in larger quantities and lower frequencies. Formal paperwork such as purchase orders, packing lists, bills of lading and invoices, precede, accompany and follow each delivery. The tendency in South Africa is to play one supplier against another to bring prices down. Changes are often made from one supplier to another. Two sources of supply are also used where one would be adequate. All these factors tend to push the purchase price up as the expected savings are more than outweighed by the following:

a. When a change is made from one supplier to another the new supplier has to contend with the learning curve of dealing with the new end users requirements. The items to be supplied are often quite specialised. Different tooling and test fixtures are involved. Communication links have to be set up. If tooling is required, new tooling has to be manufactured or old tooling has to be modified to be compatible with different machines.

b. When two sources of supply are used, considerable duplication of effort on the part of the buyer takes place, pushing the cost of purchasing up. This results in there being far less potential of as good a relationship being built up with the necessary level of confidence. However, if a supplier is assured of the business they will go to endless lengths to ensure that their customers needs are satisfied. There is also the obvious advantage that the larger the order to a single supplier the greater the potential for cost reductions which can be passed on to the end user.

The root of the problem is that manufacturers have traditionally purchased components from many vendors, playing one against the other on pricing, and warehoused months of supply for safety. This procedure creates adversaries, fosters short term goals and undermines quality. To meet JIT objectives, manufacturers have to turn this process around. Not an easy task observes Joseph Sullivan, "It's a relationship that American business is not used to, with discomforts on both sides of the table" (5).

Apple's Fremont plant followed another basic tenet of JIT manufacturing when it cut down the number of suppliers. Two years ago it had 300, today there are only 70 and the facility produces a wider variety of products. Furthermore, the quality of incoming goods have climbed so sharply that there are now only six inspectors. There were 33 in April 1984.

For a supplier, a contract is attractive if it is exclusive or nearly so, long term and invariable. These are characteristics that will be strived for in a JIT purchase agreement. Such a contract affords the supplier the opportunity to share peak capacity and retain a trained labour force. The supplier also has the opportunity of cutting their own inventories, possibly through a JIT buying policy from their suppliers.

For suppliers to become flexible to their customers demands, they must also actively pursue the implementation of JIT. The customer also plays a significant role in the supplier's JIT implementation.

A good supplier/customer relationship can bring about considerable savings. Studies have shown that a third of the unnecessary cost in the unit price is directly as a result of the customer's actions or lack thereof (4).

The 40-30-30 rule, states that of the unnecessary additional expense in a product; (23)

40 per cent is due to defects in the design,
30 per cent is due to the supplier and
30 per cent is due to inefficiency in the factory.

# CHAPTER 8

## THE APPLICABILITY/POTENTIAL FOR JIT AND TQC IN SOUTH AFRICA

### 8.1 AN UNPRODUCTIVE SOCIETY

In contrast to Japan, South Africa, like many other Western countries, has abundant space and natural resources. Inefficiency in manufacturing companies such as unreliability of suppliers, machine breakdowns and high reject rates have been remedied at considerable expense by maintaining high raw material, component and finished goods inventories. In a previous era of low interest rates, cheap materials and plentiful storage space, this strategy was affordable. This is no longer the case.

### 8.2 WHAT CAN BE DONE?

As attractive as Japanese manufacturing management techniques are for Western industrialised countries, they may hold even greater promise for developing countries. Basic simplicity and low requirements for staff expertise and capital investment are features of JIT and TQC that would appeal to most developing countries. For example, JIT production does not require computers and both JIT and TQC rely on simple and direct means of production, quality control and problem solving on the factory floor, without extensive need for expert assistance. Furthermore, JIT and TQC are mutually reinforcing: small lot production of goods exposes defects early so that diagnosis and correction may proceed while evidence is still fresh; TQC reduces defectives, thereby removing a key reason for high inventories of buffer stock. While Japanese industry has recently embarked on a robotics campaign, most manufacturers make use of equipment that tends to be smaller, simpler and less expensive than that typical in Western manufacturing companies. These are important factors for developing countries where there is a constant shortage of manpower and capital.

## 8.3 TECHNOLOGY TRANSFER

In considering the potential of TQC and JIT for South Africa, the underlying concept of technology transfer warrants brief scrutiny. The advance of technology has been among the most important reasons for the acceleration of economic growth and prosperity in the industrialised countries. For example, a study of economic growth in the USA reveals that "advance in knowledge" has accounted for about 31,5% of the economic growth while "increased work output", "capital gains", "increased education per worker" and "improved resource allocation" accounted for 28,7%, 15,8% and 10% respectively, of the economic growth between the years 1929-1969 (1).

This important role of technology in the developement process should also apply to less developed countries as well, in the current era. The transfer of technology from industrialised countries to less developed countries may be as important as the transfer of capital. Dunning argues that the important missing elements for development in non-industrialised countries are the acquisition of knowledge, research and development techniques, production technology and marketing and managerial skills. Constraints and barriers in the way of smooth transfer of technology include legal, economic, political, social and humanitarian factors, in both developed (technology supplying) and underdeveloped countries (1).

To ease and eliminate some of these barriers, there are several sources and channels of technology transfer, some of which are: (29)

a. direct foreign investment and the operation of multi-national corporations.

b. exchange of data and personnel through technical co-operation programmes.

c. agreement on patents, licensing, and know-how.

d. import of machinery, equipment and related literature.

e. movement of people between countries.

In addition to the above, another important channel is the key role of the host government. In Japan's industrial development, her government had a great influence in encouraging the flow of technology, borrowing and adapting it to Japan's needs (1). The success of Japan suggests that, although managers and employees think and behave differently in different countries, the learning and transferring of technology is not prevented by social and cultural values, though those values can result in some transformation of technology. For example, Japan's approach was to learn Western concepts and technologies and, by adaption, make them function in the Japanese environment: overcrowded and scarce in natural resources.

Today, Japan competes with industrialised nations and in some industries has assumed leadership in quality, quantity of production, and productivity. Japan not only challenges Western countries with more production, but also in the export of technologies and manufactured goods. Japanese multinational companies are spreading throughout the world, from South-east Asia to the Middle East, Europe and North and South America.

Japanese firms are investing extensively in foreign countries, both developed and less developed. They are active in both direct and indirect investment. (Indirect investment means producing an item in the home country and then exporting it, while direct investment means establishing the enterprise in the host country, so that production and sales are both taking place from the base-host country). In 1979, Japan ranked third, along with West Germany, in terms of direct investment overseas (1). More than half of Japan's foreign investment is in less developed nations and in some cases Japanese multinationals are the number one investor in the host country. One example is Indonesia, where in 1979 Japanese investors had 39% share of the total foreign investment, compared to the second investor (USA) with 19.2%.

Studies show that Japanese investment in foreign countries created more than 777000 jobs, of which 420000 were in Asia alone. Direct investment in foreign countries brings about the necessity of managing the enterprises established in host countries. This means that Japanese management experts are sent to these countries to lead the company or guide the local management (1).

In one survey of foreign-based Japanese managers, about 43% believed that the Japanese style of management could be applied with minor modification. Another survey showed that some 60% of Japanese companies operating in other countries are trying to combine Japanese management techniques with the local system. The transfer of technology to improve quality and productivity in developing countries is important not so much to compete in the international market as for survival in their own local environment (1).

## 8.4 THE POTENTIAL BENEFITS OF JIT/TQC IN SOUTH AFRICA

Three Key Issues:

8.4.1 Temperament. In the author's experience, there is an individualistic "every man for himself" temperament of workers in many South African companies. This contrasts sharply with Japan, where there is cooperation, dedication, harmony and a group-think decision process (1). Can JIT systems, which forge closer bonds between workers by closing the time or inventory gaps between them, work in a more individualistic setting?

8.4.2 Geography. In Japan suppliers can make deliveries in small quantities daily or certainly with greater regularity, as distances between customer and supplier are not great. Can JIT deliveries of raw materials and components be feasible in South Afirca? There are great distances involved and certain of the raw materials and components have to be imported.

8.4.3 Education and training. Japan has been immersed in quality control training for over thirty years. Is there any hope of catching up?

## 8.5 JIT's DEVELOPMENT IN SOUTH AFRICA

In the last 2 years there have been some developments in JIT in South Africa.

There are some 20 South African companies, known to the author, which could be regarded as being well along the road to JIT. These include Toyota, Rowen, GEC (at various sites), Dresser, MSN, Afrox and Fedmech. Others such as Lumex and Dorbyl have made interesting advances by using one or more JIT techniques. A number of small companies are also known to be implementing JIT with excellent results. Some of these companies have also made considerable progress in pursuading their suppliers to change their delivery patterns, so the JIT snowball effect is beginning (23).

Toyota S.A. is the highest on the motor vehicle sales ranking at the time of writing and is the forerunner of JIT development in S.A. This sparked off great interest in JIT among OEM's supplying the motor vehicle assemblers. This author conducted a survey in the latter half of 1985 to determine the awareness and stage of advancement of JIT among OEM's in S.A. Questionnaires were posted to a representative sample of OEM's to which there was a 50 per cent response. Details of the questionnaire and a report on its findings are in Appendix c.

Several consultants have set up JIT specialisations, often with an overseas link to provide basic material. Courses held at the University of the Witwatersrand have been well attended and repeated.

A gathering of senior managers from companies implementing JIT was also recently held. The results of the meeting showed quite clearly that JIT does not require Japanese culture to be successful. A GEC subsidiary improved labour productivity by 40 per cent, reduced inventory from six weeks to five days, the rework of final products has dropped from 40 per cent to less than 1.5 percent and the rewinding of motors has been cut from between 7 and 8 percent to less than 0.5 percent (26).

## 8.6 TRANSFERABILITY OF JIT AND TQC

Despite all the factors mentioned in 8.5, a number of myths and preconceptions remain in S.A. (27). These include "With our suppliers we can't do it", "We are doing MRP first", "We are trying to decide between MRP and JIT", "We can't do JIT with our work force", "We expect to automate to a large degree when the economy improves, so we don't want to do JIT", "Our demand pattern is so unpredictable we could never do it", and even "JIT is a Hewlett packard system and we already have another type of computer" (23).

However, the evidence suggests in general that technology is transferable from country to country. But some technologies are undoubtedly more transferable than others. What about JIT production with TQC? The question may be addressed by considering some of the typical problems that stand in the way of industrial developing countries.

Studies of manufacturing firms in developing countries show several common problems, as follows (1):

(1) Underutilisation of both workers and equipment
(2) Inferior quality
(3) Unreliable and long lead time
(4) High rate of scrap and defects
(5) Poor and inadequate maintenance
(6) Shortage of raw material
(7) Shortage of skilled workers
(8) Lack of appropriate supervision
(9) Informal and casual quality control
(10) Low productivity

All these problems in developing countries can be diminished by JIT and TQC. Table 8-1 gives a summary explanation, which is elaborated upon below.

The first problem of underutilisation of resources is lessened, chiefly because JIT workers are multifunctional; they run multiple machines and are capable of moving where the work is. This keeps the workers and the equipment busy. In addition, under TQC, workers keep busy on quality improvement projects when production quotas have been met. Utilisation of equipment can be good, because in plants designed for quick set up and JIT, small special-purpose machines may be developed by the plant's own toolmakers as the need arises. When no longer needed the machines may be dismantled. On the negative side, developing countries tend to have neither talented tool-makers nor multifunctional workers however, JIT/TQC encourages development of these skills.

Next in the table is the problem of quality, which JIT deals with naturally: with small production quantities, errors are soon discovered. All aspects of TQC apply directly to quality problems and many plants in developing countries already follow one key TQC principle: quality responsibility assigned to production people rather than to a quality control department. However, these production people in many cases lack skills in measuring quality and analysing defects, which Japanese workers and foremen have developed.

TABLE 8-1 Problems in developing countries and the use of Japanese techniques.

| Industrial problems in developing countries. | Improvements afforded by Japanese techniques: Just-in-Time | Improvements afforded by Japanese techniques: Total Quality Control |
|---|---|---|
| (1) Underutilisation of both workers and equipment. | Multifunction workers run several machines and go where the work is. Self-developed equipment is tailored to the production plan so that production utilisation is high. | Workers have quality responsibilities and projects to keep them busy when production quotas are met. |
| (2) Inferior quality | With low inventories parts are used soon; defects are thus revealed and corrected early. | All aspects of TQC serve to improve quality. |
| (3) Unreliable and long lead time | Multifunction workers GT, and quick setups cut lead time and improve productivity. | Less stoppages due to bad quality improves lead time and reliability. |
| (4) High rate of scrap. | Small lots prevent occurance of long runs high in defectives. (potential scrap) | All aspects of TQC serve to reduce scrap. |

| | | |
|---|---|---|
| (5) Poor and inadequate maintenance | Multifunction workers keep workplaces clean and also do some repairs and preventative maintenance. | Less-than-full-capacity scheduling permits stops for preventative maintenance. |
| (6) Shortage of raw material | Scrap avoidance (see 4 above) helps conserve materials | Scrap avoidance (see 4 above) helps conserve materials. |
| (7) Shortage of skilled workers | Simpler machines decrease need for skilled workers; worker involvement in multiple functions improves receptivity to training; simpler production system cuts needs for production and inventory control staff. | Less need for quality control staff since workers have quality responsibility |
| (8) Lack of appropriate supervision | With little inventory to hide problems, workers become on the spot trouble shooters thus assuming some of the supervisory role. | Workers check their own quality thus avoiding some problems calling for supervision. |
| (9) Informal and casual quality control | Buffer stocks are cut to deliberately expose causes of poor quality – which increases awareness of the need for QC. | All personnel are trained in QC and involved in QC improvement projects. |
| (10) Low Productivity | Less material, labour, space and indirect inputs with higher output equals greater productivity. | Less quality control staff, scrap, re-work and customer returns cuts costs of inputs which raises productivity. |

The third problem is unreliable and long lead time. JIT dramatically cuts lead time by reducing setup times and lot sizes at each process. That is, running small lots through successive stages of production takes less 'make' time than running large lots. Furthermore, when small lots are the norm, material handling may be simple and quick.

Ideally, work stations along the flow path are close enough together to permit fast hand-to-hand transport which cuts the transit-time component of lead time. By contrast, large lots tend to require pallets, fork trucks and intermediate storage. Purchase lead times are improved if suppliers adopt JIT because the suppliers manufacturing time is similarly affected by lot sizes. Multifunctional workers and group technology provide flexibility so that lead times are more reliable. On the other hand, less inventory in a JIT plant may seem to suggest longer lead time, but experience in both the West and Japan tends to show that large inventories are too often of the wrong items to provide for fast response to customer demand. On the TQC side, there are lead time benefits because potential quality bottlenecks and stoppages are avoided. The set up time cuts and the TQC changes will take time to achieve in developing countries.

High rates of scrap, fourth in the Table, is forcefully attacked by JIT and TQC. The JIT rationale is the avoidance of large lots high in defectives. Again, time and training are the main obstacles for plants in developing countries.

The fifth problem is poor and inadequate maintenance. JIT workers pitch in to clean up their own areas and also perform some preventative maintenance and repairs. These tendencies are more apparent in developing countries than in the West, where they have grown used to separate janitorial and maintenance staffs. One TQC concept, less-than-full-capacity scheduling is helpfull, since it provides reasonable time for preventative maintenance.

Shortage of raw material, the sixth problem in developing countries, cannot be eliminated by JIT/TQC. But waste of materials (scrap) is avoided through fast detection of errors in JIT and through all aspects of TQC. Also, JIT reduces the amount of idle inventories.

Shortage of skilled workers, the seventh problem, is worsened in one way but improved in another by JIT/TQC. JIT needs not only skilled but multi-skilled workers and TQC requires that workers and foremen become knowledgeable and skilled in the use of quality control techniques. On the other hand, machines are simpler and easier to set up and the JIT climate of worker involvement improves receptivity to training. There is also less need for a skilled indirect workforce, especially production control, materials control and quality control staff.

The eighth problem, lack of appropriate supervision, is diminished somewhat by JIT because workers assume much of the burden for trouble-shooting and analysing problems. First-line foremen have a demanding leadership role, but middle management ranks tend to be thin in the Japanese system. TQC reduces the need for supervision over quality matters, since workers inspect their own quality.

Informal and casual quality control, ninth in the Table, is a problem in small, fast growing companies in industrialised countries as well as in industry in developing countries. Our Western solution is to add a QC department. It is more natural in developing countries to keep the responsibility in the production department and train the workers and foremen in quality measurement and analysis. At the same time, JIT helps to make it clear that quality must be controlled at the source, because with low JIT inventories bad quality leads to work stoppages.

The tenth and final problem is that of low productivity. JIT increases productivity by cutting the cost of material movement and waste, space, labour per unit and indirect inputs, while at the same time raising output. TQC improves productivity by averting scrap, rework and customer returns arising from poor quality. There are also fewer inspectors and other quality control staff.

An eleventh problem in developing countries has been cited in some writings: high labour turnover. Ebrahimpour and Schonberger do not agree that it is a common problem. Their own experience and observations have convinced them that workers in developing countries tend to be thankful for a job and not prone to job-hop. There may be exceptions.

Where labour turnover is a problem, JIT and TQC may dampen it inasmuch as they involve workers in problem solving, which can raise morale and commitment (30).

There are obstacles to implementing JIT and TQC in developing countries. The chief obstacle is training, which takes time, costs money and requires training cadres and institutions - which developing countries lack. While many developing countries put large numbers of young people through college, often in the West, the education emphasizes complex and costly Western technologies rather than Japanese simplicity and frugality (24).

## 8.7 EDUCATION RELATING TO JIT IN SOUTH AFRICA

At S.A. Universities and Technikons there has been the unfortunate recent tendency to concentrate on the high technology and automation aspects of the "first" stage, rather than on the JIT "second" stage basics (Figure 8-2). There is much to be gained by a switch in emphasis, particularly in the South African context (23).

## 8.8 IMPLEMENTATION IN SOUTH AFRICA

South Africa does not differ from any other country as far as the implemention of JIT is concerned. There are however, factors that should be brought into account in the S.A. context.

Resistance to change is a common denominator and phrases and concepts such as "machine utilisation, direct labour efficiency, direct/indirect ratios, acceptable quality levels, overhead recovery" are replaced by new concepts of zero inventory and zero deviation from schedule. When planning to introduce a JIT system fears and doubts among all staff must be dispelled. These fears may be of a personal or technical nature, e.g. that there are too many problems and changes to be made for JIT to work (28). However, good communication and the involvement of staff at all levels before and during implementation should eliminate these fears.

### 8.8.1 A Framework against which to view JIT.

The framework is represented in Figure 8-2 in the form of a modified Ishikawa diagram, a technique which has been found to be very useful in JIT applications.

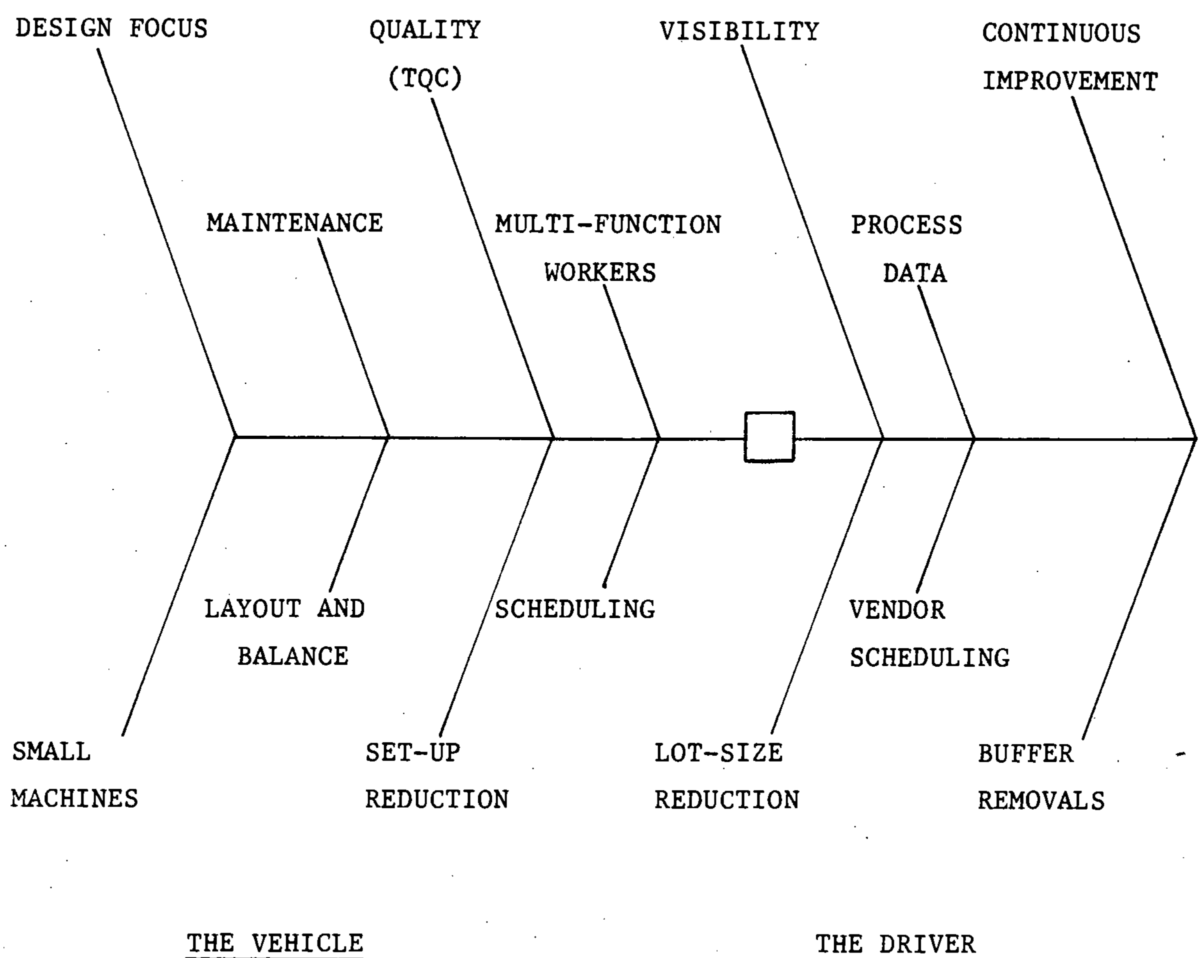



FIGURE 8-2 ISHIKAWA DIAGRAM

It will be seen that JIT is presented as a two-stage process (Chapter 5). These may be referred to as the first or "vehicle" stage and the second or "driver" stage (23). The first stage is concerned with "preparing the facility for production with high quality, low cost, minimum lead time and high flexibility". The second stage follows the first and allows the ultimate JIT objective "To produce only as needed with perfect quality and minimum cost".

The various contributing factors into each stage are shown in figure 8-2. These can be further broken down to any degree of detail, as is usual with an Ishikawa diagram. For instance "scheduling" could contain some or all of the following elements.

a. The Pull System
b. Under Capacity Scheduling
c. Regularity in End Product Scheduling
d. Mixed Model Scheduling
e. Synchronised Scheduling
f. Overlapping

The conceptual diagram (Figure 8-2) of JIT Production can now be understood to make the following points.

8.8.2 Systems Approach. JIT Production is a set of techniques and methods which combine to allow previously unheard of manufacturing competitiveness. The techniques are mutually reinforcing or facilitating, and when combined with deliberate feedback and ongoing 'enforced problem solving' form a 'systems approach' to productivity improvement.

8.8.3 The "Vehicle" Stage. In the first or "Vehicle" stage the techniques are engineering oriented. Most of these techniques and individual methods could well be and are often pursued independently. They also have nothing at all to do with culture, Japanese or otherwise. Again, it is their combination which makes them a powerful set. These techniques are essentially scientific and have the characteristics of the 'repeatable experiment'.

The vehicle stage has no barriers to entry and there is considerable existing competence in all these techniques in S.A., even though the practitioners may not call themselves JIT experts.

8.8.4 The "Driver" Stage. The second or "Driver" stage concerns the set of techniques that allow the ultimate JIT objective to be approached. Most, but not all of these are techniques rather than culture oriented ways of working. The second stage is in general risky and at the very best fairly ineffective, unless a fair amount of progress has been made in the first stage.

The Driver stage is detachable. Instead of using the JIT Driver techniques, it is quite possible to use MRP2 or both JIT and MRP2 (Chapter 5).

## 8.9 JIT DEVELOPMENTS, OPPORTUNITIES AND LIMITATIONS IN THE S.A CONTEXT

"Vehicle Stage" Developments Figure 8-2 (23)

8.9.1 Products and Focus. S.A. suffers heavily from product variety proliferation. The poor economy of the last few years has led to a number of manufacturers having to review their product ranges critically, even though they may not have been considering JIT. In general terms therefore, S.A. manufacturers are much better placed for JIT than they were two years ago. In specific terms, those companies which have adopted basic Group Technology concepts as a precursor to JIT have been able to achieve considerable reductions in unnecessary part variety.

The concept of the "Focused Factory" has become more acceptable (25). A small survey two years ago at the University of The Witwatersrand showed a general ignorance of the term, but a recent survey showed a notable swing.

8.9.2 Small Machines. Current poor economic conditions are perhaps conducive to the smallest, least expensive machines consistent with quality and reliability requirements being used (Chapter 7).

8.9.3 Quality and TQC. Quality is enjoying a boom in S.A. not necessarily associated with JIT. The SABS 0157 specification is being widely adopted and has much in common with JIT/TQC concepts, particularly as regards working with suppliers.

8.9.4 Maintenance. The last two years have seen significant growth in the maintenance area, both computer and concept driven. 'Reliability Centred Maintenance' is being used to an increasing extent.

Japanese style 'Total Productive Maintenance', incorporating plant training, worker involvement, maintenance shifts, aircraft style checks, machine modification and the like is still rare. There is a tendency to favour the computer solution rather than the technology.

8.9.5 Layout. Moving machines together is one of the most crucial steps towards JIT (3). Several local applications have discovered the advantages of this. One producer of small electrical products moved machines together which allowed instant rework, space saving, as well as a change from batch to flow production in one part of the operation. What were several work centres are now one. Similarly, Afrox has been able to adopt a hierarchy of Group Technology cells with multi functional workers, allowing improved control, identification with product and dramatic inventory savings.

8.9.6 Setup Reduction. Several local firms have demonstrated that a 30% reduction in setup time is achievalble with minimum cost. In general however, Shingo's SMED (single minute exchange dies) system is still to make an impact.

"Driver Stage" Developments

'Driver Stage' developments have been slower since they often presuppose 'Vehicle Stage' developments. Nevertheless, there have been exciting developments:

8.9.7 The Pull System. At least three companies are known to have introduced a pull system with very little prior preparation, other than some adjustments in layout. What they did was to regard a sequential set of operations as a mini factory with before and after buffers. Stock is merely 'pulled' by Kanban squares from one machine to another, leading to dramatic decreases in W.I.P. inventories and throughput time between the first and last machine. In one case, the implementation took only one week.

8.9.8 Synchronised scheduling is in operation at Toyota and GEC. The effect is to start making components that eventually come together just in time.

8.9.9 End Product Scheduling. The problem is usually uncertain forecasts. However, setting up stable and repeating mini schedules (Table 5-2) has had very positive results. This is because near optimal engineering and parts synchronisation can be arranged with an efficiency that no job shop can match.

8.9.10 Supplier and delivery procedures (as described in 7.6.5). Rowen delivers several times per day directly to the section of the Toyota factory where panels are required. Gull wing trucks are used. Several companies led by Toyota have arranged for a series of trucks to visit a sequence of suppliers each day to pick up small lots. At least one company on the reef and one in Durban use Kanban cards to control deliveries. Several companies are known to be sharing containers so as to move small lots to the coast. Even SATS (S.A. Tranport Services) has responded with their Mini Container service, allowing quick pick up and delivery. To help overcome the leadtime problems of overseas surface deliveries, one company arranges for regular small lots to be sent but has the documentation arrive by air, thus allowing prediction of future problems.

Another company insisted that chemicals be delivered in small lots. The supplier found this uneconomic and so set up a tank near the customer at their own expense.

# CHAPTER 9

## CONCLUSION

There have been great technological advances in the last three decades, most notably in computerisation. There have also been great advances in productivity and quality. Japan has been the leader in this field. Despite poor resources and a small, crowded country Japan has enjoyed great prosperity.

This has not gone unnoticed with the West feeling the effects of Japan capturing an ever increasing market share. This caused Western professionals to scrutinize Japanese management techniques more closely. While early interest centred around Japanese human resource management and structural factors, recent interest has shifted to manufacturing management techniques, especially Just-in-time and Total Quality Control techniques.

Research into these techniques has shown that they are not only simple but are also extremely effective. There has been a tendency in the West to build elaborate systems for production control utilizing computer power. These systems however, overlook the fundamentals and build in allowances to cater for shortcomings. Just-in-Time has been presented as a two stage process. The first stage is concerned with preparing the the facility for production with high quality, low cost, minimum leadtime and high flexibility. The second stage follows from the first and allows the ultimate Just-in-Time objective which is to produce only as needed with perfect quality and minimum cost. Although both stages are needed to achieve the ultimate goal of Just-in-Time, the stages are detachable. The first stage may therefore be usefully applied in companies that have already introduced other systems.

The success of Just-in-Time is dependant on a host of factors and a breakdown of any of them will not only limit the advantages but could lead to failure. Management style is a particularly important phenomenon of the system.

Commitment and participation at all levels is essential for successful implementation. Just-in-Time is not to be entered into casually. The consensus is that it takes at least three to five years to effectively implement Just-in-Time. All sources agree that top down planning is vital, that the program must be endorsed by top management and that any enduring change must be initiated at that level. Restructuring to Just-in-Time requires that top management develop long range strategic and business plans. This is to incorporate the development of a new partnership between raw material suppliers, processors and users.

The survey conducted among Original Equipment Manufacturers supplying the motor industry elicited a sense of confusion as to what Just-in-Time actually is, how applicable it is and how profitable/improfitable its adoption might be. The answer to this is that as attractive as Japanese manufacturing management techniques are for Western industrialised countries, they may hold even greater promise, for developing countries. Basic simplicity and low requirements for staff expertise and capital investment are features of Just-in-Time and Total Quality Control that would appeal to most developing countries. Although managers and employees in different countries think and behave differently, the learning and transferring of technology to South Africa is not prevented by social and cultural values. However, these values can result in some transformation of the technology. For example, Japan's approach was to learn Western concepts and technologies and by adaption, make them function in the Japanese environment: overcrowded and scarce in natural resources.

In the last two years, there have been some developments in Just-in-Time in South Africa. There are some twenty South African companies which could be regarded as being well along the road to Just-in-Time. Several consultants have set up Just-in-Time specialisations and a gathering of senior managers from companies implementing Just-in-Time was also recently held. The results of the meeting show quite clearly that Just-in-Time does not require Japanese culture to be successful. However, a number of philosophies and religions have been instrumental in moulding Japan's world view. A trait peculiar to this has been their openness to outside religions and philosophies, providing these do not disrupt or destroy the framework of their traditional society.

In many ways, Japan, once borrower and copier, now leader and innovator, derives unique advantages from this flexibility and openness to new systems. A lesson to be learned in South Africa.

The favourable response to the questionnaire indicates not only an awareness, but also calls for some answers to the productivity predicament in South Africa. A deeper survey might bring useful results. The author has found very little information on a suitable costing system to apply with Just-in-Time. The revolutionary concepts that Just-in-Time introduces undoubtedly would alter the existing costing systems. This may well justify useful research into this important aspect of managing a business.

The outcome of this thesis indicates that the Just-in-Time system is applicable to South Africa and can make a large contribution to improving South Africa's poor productivity and competitiveness.

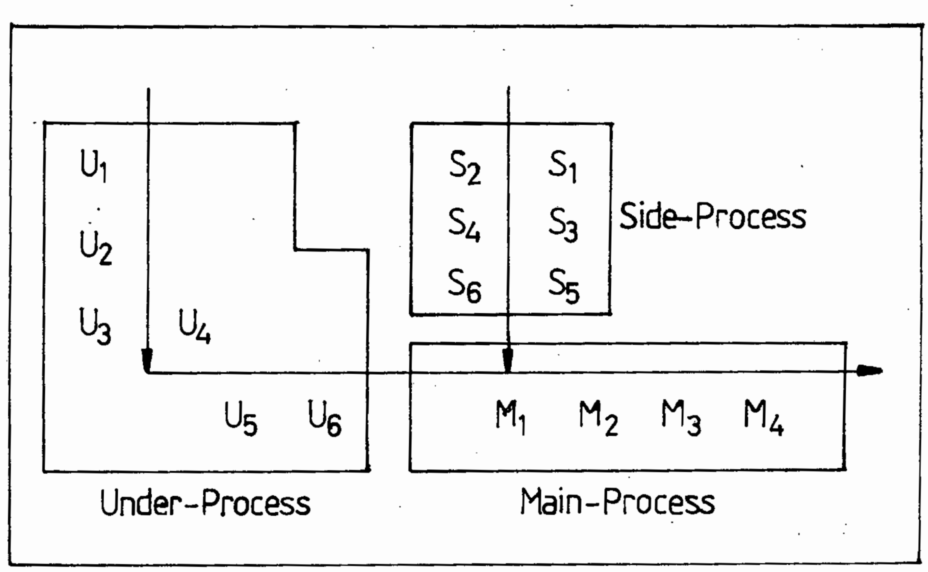
## APPENDIX A : THE YO-I-DON SYSTEM USING ANDON

Yo-i-don means 'ready, set go'. The Yo-i-don system is one method of smoothing the flow in a process and of autonomation.

This system uses Andon as a method of communication to achieve the interpersonal help necessary for effective teamwork. Andon is an electric light board that is strategically positioned in the factory so that it is easily visible to the workers. When a worker needs help to adjust to a delay in the work he is doing, he activates the yellow light on the Andon. If the line is to be stopped to adjust some problem with his machines, the red light is activated.

As an example of the system, suppose that a sheet-metal factory consists of six under-processes ($U_1$, $U_2$ ........$U_6$), six side-processes ($S_1$, $S_2$ ....... $S_6$) and four main processes ($M_1$, $M_2$, .......$M_4$), depicted in Figure A-1.

FIGURE A-1 : PROCESSES IN A SHEET METAL FACTORY



This sheet-metal factory has to produce one unit of its product in 3 min 35 sec (which is the cycle time of this factory). By dividing this cycle time into three equal portions accumulatively as $^{1}/_{3}$, $^{2}/_{3}$ and $^{3}/_{3}$ when time elapses, the standards for completing each process are established. This is shown in Fig A-2 and this table, called Andon, is hung where it is visible to the factory workers.

FIGURE A-2 : EXAMPLE OF ANDON

<table>
<tr><td colspan="4">1/3</td><td colspan="4">2/3</td><td colspan="4">3/3</td></tr>
<tr><td colspan="2">$U_1$</td><td colspan="2">$U_2$</td><td colspan="2">$U_3$</td><td colspan="2">$U_4$</td><td colspan="2">$U_5$</td><td colspan="2">$U_6$</td></tr>
<tr><td colspan="2">$S_1$</td><td colspan="2">$S_2$</td><td colspan="2">$S_3$</td><td colspan="2">$S_4$</td><td colspan="2">$S_5$</td><td colspan="2">$S_6$</td></tr>
<tr><td colspan="3">$M_1$</td><td colspan="4">$M_2$</td><td colspan="2">$M_3$</td><td colspan="3">$M_4$</td></tr>
</table>

The workers of under-processes have to complete their operations from $U_1$ to $U_6$ within 3 min 35 sec and the labourers of side-processes also have to finish their job from $S_1$ to $S_6$ within this time period. Moreover, the workers in main-processes must complete their processings, $M_1$ through $M_4$, within this cycle time. At the starting point of a cycle every machine in each process has it's work in process. If the work in process is completed in each of the three processes and transferred to the next process within the cycle time, then this sheet-metal factory as a whole can produce one unit of finished product per 3 min 35 sec.

The worker in each process will push his button when his job is finished, and after 3 min 35 sec have passed, the red light on Andon will go on automatically at those processes where the job is not yet completed. Since the red lamp indicates a delay in processing the whole line stops operation while a red light is on. For example, the red lamp might be turned on at processes $U_4$, $S_5$ and $M_2$. When this happens, nearby workers help the workers at these processes finish their belated jobs. In most cases all red lamps will turn off within 10 sec. At this stage, the next cycle time will start and again the operations in all processes start together. This is called Yo-i-don, which will realize the continuous flow of production by teamwork with Andon, cycle time and multi-process holding.

## APPENDIX B : THE KANBAN SYSTEM

Kanban, translated literally means 'visible record' or 'visible plate'. More generally, Kanban is taken to mean 'card'. A Kanban card is usually put in a rectangular vinyl sack. There are mainly two kinds used: a withdrawal Kanban and a production-ordering Kanban.

A withdrawal Kanban specifies the kind and quality of product which the subsequent process should withdraw from the preceding process. A production-ordering Kanban specifies the kind and quantity of the product which the preceding process must produce. Samples of these are shown in Figures 1 and 2.

### FIGURE B-1 WITHDRAWAL KANBAN

| | |
|---|---|
| Store | |
| Shelf No. 5E215 Item Back No. A2-15 | Preceding Process |
| Item No. 35670S07 | FORGING B-2 |
| Item Name DRIVE PINION | |
| Car Type SX50BC | Subsequent Process |
| | MACHINING SB-8 |

| Box Capacity | Box Type | Issued No |
|---|---|---|
| 20 | B | 4/8 |

### FIGURE B-2 PRODUCTION-ORDERING KANBAN

| | |
|---|---|
| Store | |
| Shelf No. F26-18 Item Back No. A5-34 | Process |
| Item No. 56790-321 | MACHINING SB-8 |
| Item Name CRANK SHAFT | |
| Car Type SX50BC-150 | |

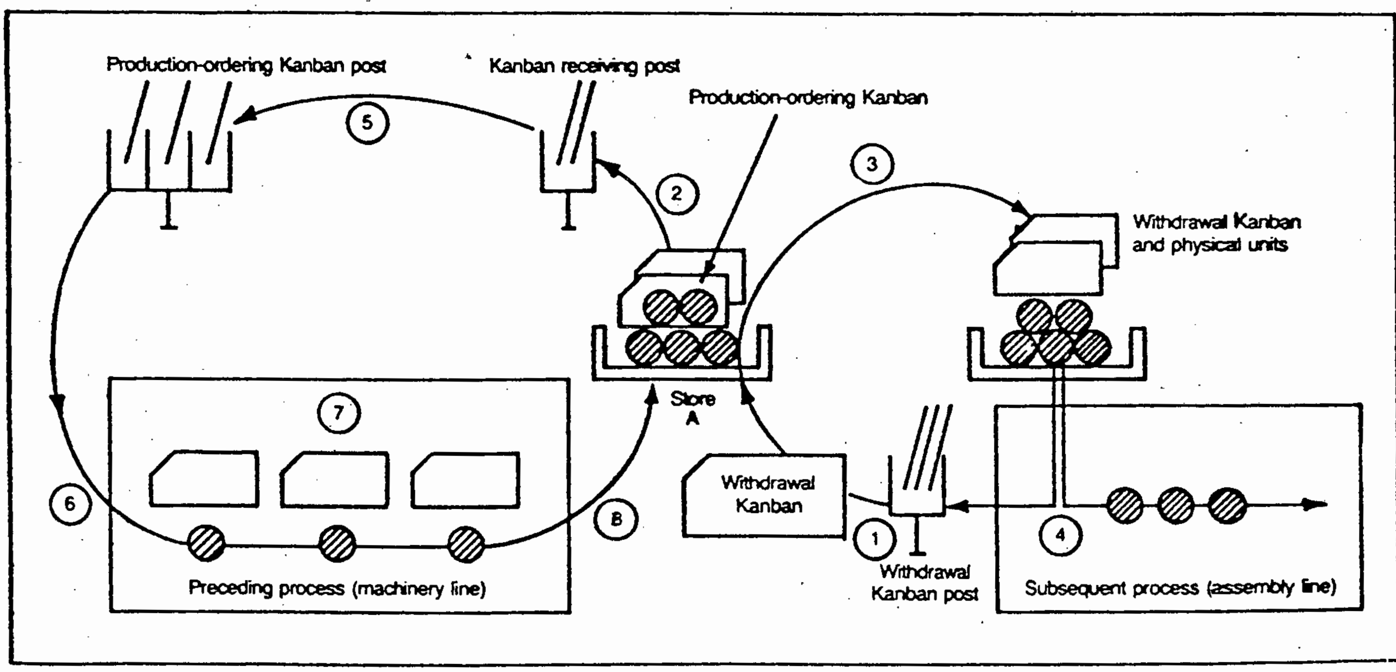
The Kanban in Figure 1 shows that the preceding process which makes this part is forging and the carrier of the subsequent process must go to position B-2 of the forging department to withdraw drive pinions. The subsequent process is machining. Each box contains 28 units and the shape of the box is B. Kanban is the fourth of eight sheets issued.

## B.1 How to use these Kanbans

Figure 3 shows how these two types of Kanbans are used. Starting with the processes in sequence, the various steps are:

Step 1. The carrier of the subsequent process goes to the store of the preceding process with the necessary number of withdrawal Kanbans and the empty pallets (containers) on a fork-lift. This is done when a sufficient number of detached withdrawal Kanbans have accumulated in his withdrawal Kanban post (i.e. receiving box or file).

FIGURE B-3 STEPS INVOLVED IN USING THE TWO KANBANS



Step 2. When the subsequent process carrier withdraws the parts at store A, the production-ordering Kanbans which were attached to the physical units in the pallets (each pallet has one Kanban card) are placed in the Kanban receiving post. The empty pallets are left at the place designated by the preceding process people.

Step 3. For each production ordering Kanban that is detached, a withdrawal Kanban is attached in its place. When the two types of Kanban are exchanged, the withdrawal Kanban and the production-ordering Kanban are carefully checked for consistency.

Step 4. When work begins in the subsequent process, the withdrawal Kanban must be put in the withdrawal Kanban post.

Step 5. In the preceding process, the production-ordering Kanban should be collected at a certain point in time from the Kanban receiving post in the same sequence in which it had been detached at store A.

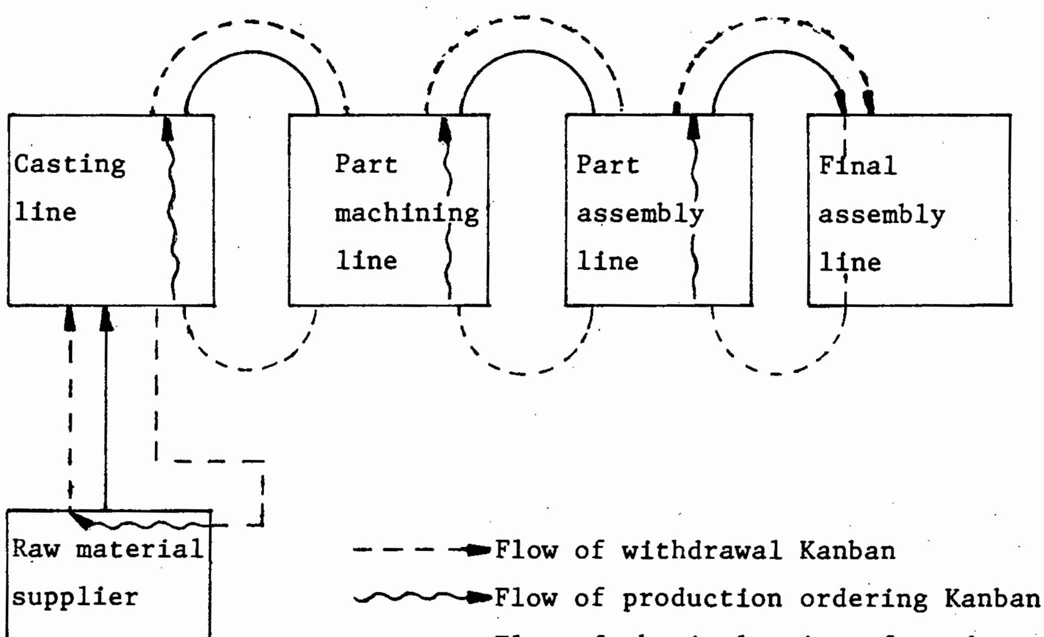
Step 6. The parts are to be produced according to the ordinal sequence of the production-ordering Kanban in the post.

Step 7. The physical units and the Kanban must move as a pair when processed.

Step 8. When the physical units are completed in this process, they and the production-ordering Kanban are placed in store a, so that the carrier from the subsequent process can withdraw them at any time.

Such a chain of two Kanbans must exist continuously in many of the preceding processes. As a result, every process will receive the necessary kinds of units at the necessary time and in the necessary quantities, so that the 'just in time' ideal will be realized in every process. Therefore, the chain of Kanbans will help realize the line balancing for each process to produce its output in accordance with the cycle time. The chain is shown in Figure B-4.

FIGURE B-4 CHAIN OF KANBANS AND PHYSICAL UNITS




Other types of Kanbans

There are several other kinds of Kanbans, which are differentiated by unique colours and formats. However, the basic types are the two Kanbans just described.

Single-Card Kanban

The number of Japanese companies that have implemented the complete Toyota dual-card Kanban system is rather small. Yet there are probably hundreds that claim to have a Kanban system. These employ a single-card system, which is a withdrawal Kanban. It is easy to begin with a withdrawal Kanban System and then add a production-ordering Kanban later (3)

In single-card Kanban, parts are produced and bought according to a daily schedule and deliveries to the user are controlled by withdrawal Kanban cards. In effect, the single-card system is a push system for production coupled with a pull system for deliveries.

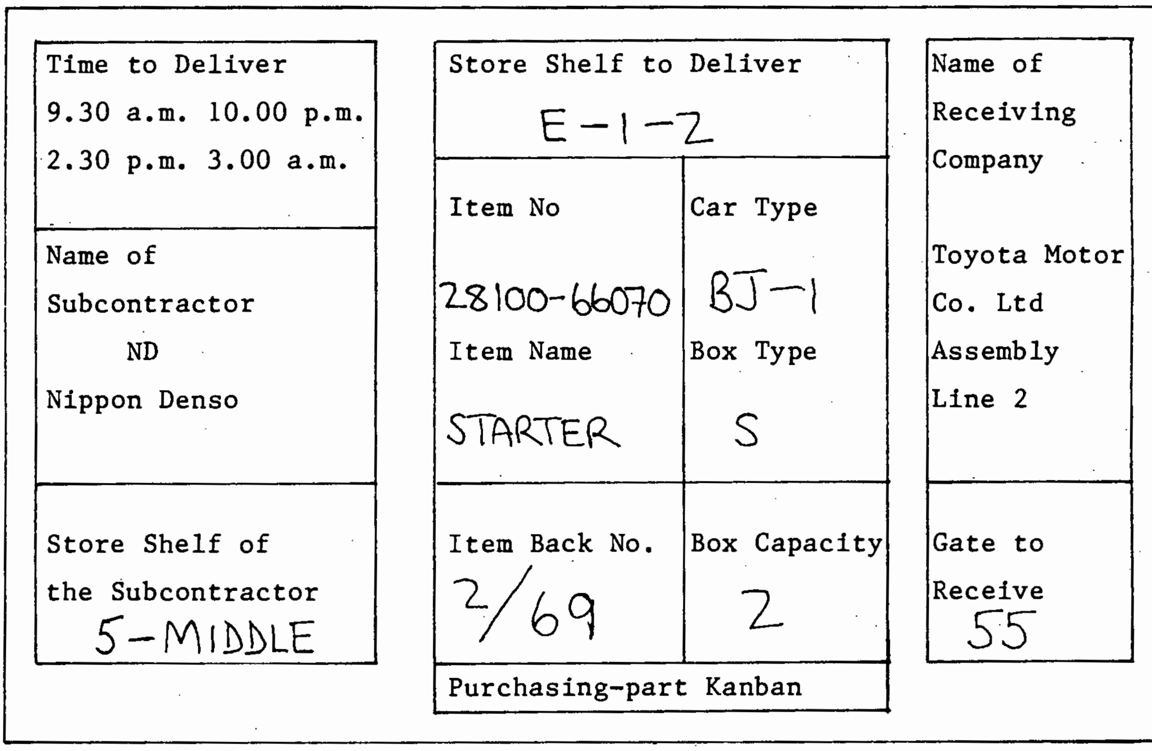
<u>Subcontract Kanban</u>

The subcontract Kanban contains instructions which request the subcontracted supplier to deliver the parts. This is a kind of withdrawal Kanban.

In the case of Toyota, the company withdraws parts from the subcontracted factories. However, since the shipping costs are included in the unit price of the part based on the contract, the subcontracted company generally delivers the parts to Toyota. (If Toyota actually withdraws the parts, the shipping cost must be deducted from the part price). Therefore, the subcontract Kanban is another type of withdrawal Kanban.

The Kanban in Figure B-5 is used for delivery from Nippon Denso (a subcontractor) to Toyota's main factory. The number 55 refers to the receiving gate at the factory. The starter delivered to gate 55 will be conveyed to store 5. The back number of this part is 69.

FIGURE B-5 SUBCONTRACT KANBAN




Since the Toyota production sytem engages in small lot-size production, frequent transport and delivery will be necessary each day. Therefore, the delivery times must be written explicitly on this Kanban. Because Toyota has no special warehouse, the receiving gate must be written clearly on this Kanban. Sometimes in the space marked with an asterisk a notation is written such as "1.8.2" It means that this item must be delivered eight times a day and Kanbans may be kept until two sheets have been brought. Figure B-5 is based on a real subcontract Kanban (7).

## Emergency Kanban

An emergency Kanban is a temporarily issued Kanban for defective work, extra insertions or for a spurt in demand. Although both the withdrawal Kanban and the production ordering Kanban exist for this purpose this Kanban is issued only for extraordinary needs purposes and should be collected just after its usage (Figure B-6).

FIGURE B-6 EMERGENCY KANBAN

<table>
<tr><td colspan="3">Production-ordering Kanban</td><td rowspan="5">Process</td></tr>
<tr><td>Store</td><td colspan="2">Back No</td></tr>
<tr><td colspan="3">Item No.</td></tr>
<tr><td colspan="3">Item Name</td></tr>
<tr><td>Car Type</td><td>Container Capacity</td><td>Issued</td></tr>
</table>

Single-card compared with dual-card Kanban

Single-card Kanban controls deliveries very tightly, so that the using work center never has more than a container or two of parts and the stock point serving the using work center is eliminated. Relieving the clutter and confusion around points of use is thus an advantage.

On the other hand, produced parts are allowed to build up to some excess in the stock point serving the producing work center. But the buildup need not be serious in companies where it is relatively easy to associate the required quantity and timing of component parts with the schedule of end products. An example is a motorcycle plant which does not have too great a diversity of components and sub-assemblies. Single card Kanban effectively controls deliveries of parts from one stage to the next; the daily parts schedules, appropriately offset for lead time, provide the parts when needed with rather small inventory buildups.

In comparison with the motorcycle plant, the automobile plant could have as many as ten times the number of parts and colours, hundreds of customer choices and many more stages of production. There is a far greater potential for delay, which is the compound effect of: a) large numbers of parts, b) variable usage of the parts and c) multiple stages of manufacture. Daily schedules for producing each part number would have to provide for sizeable buffer stocks (by means of extreme back-scheduling) in order to avoid running out of parts when the delays are bad. Toyota's ingenious solution to the problem is dual-card Kanban, which signals production of each part number to match the up-and-down output rate of succeeding production stages.

Dual-card Kanban is doubly effective in that it has the productivity improvement feature of removing Kanban to expose and solve problems. Unfortunately, single-card Kanban cannot employ that feature because there is no control on the number of full containers of a given part number. Therefore, companies that use single-card Kanban must get their productivity improvements in some other way. For example, Kawasaki, a single-card company, gets productivity improvements by removing workers from final assembly until yellow lights come on signifying problems in need of correction (3).

## Kanban in combination

Kanban is often very effective when used in combination with a cart. In the main factory of Toyota, in order for the final assembly line to withdraw unit parts such as engines or transmissions, a cart is used which can load only a limited quantity. The transmissions carried by this cart have, of course, attached Kanbans, but the cart itself plays a role as a Kanban. In other words, when the number of transmissions at the side of the final assembly line is decreased to a certain reorder point (say three to five pieces), then immediately the people engaged in putting transmissions into carts will bring the empty cart to the preceding process, i.e. to the transmission assembly process and withdraw a cart loaded with the necessary transmissions in exchange for the empty cart.

Although, as a rule, Kanban must be attached to the parts, the number of carts in this case has the same meaning as the number of Kanbans. The subassembly line (transmission department) cannot continue to make its product unless an empty cart remains, thereby preventing excessive production.

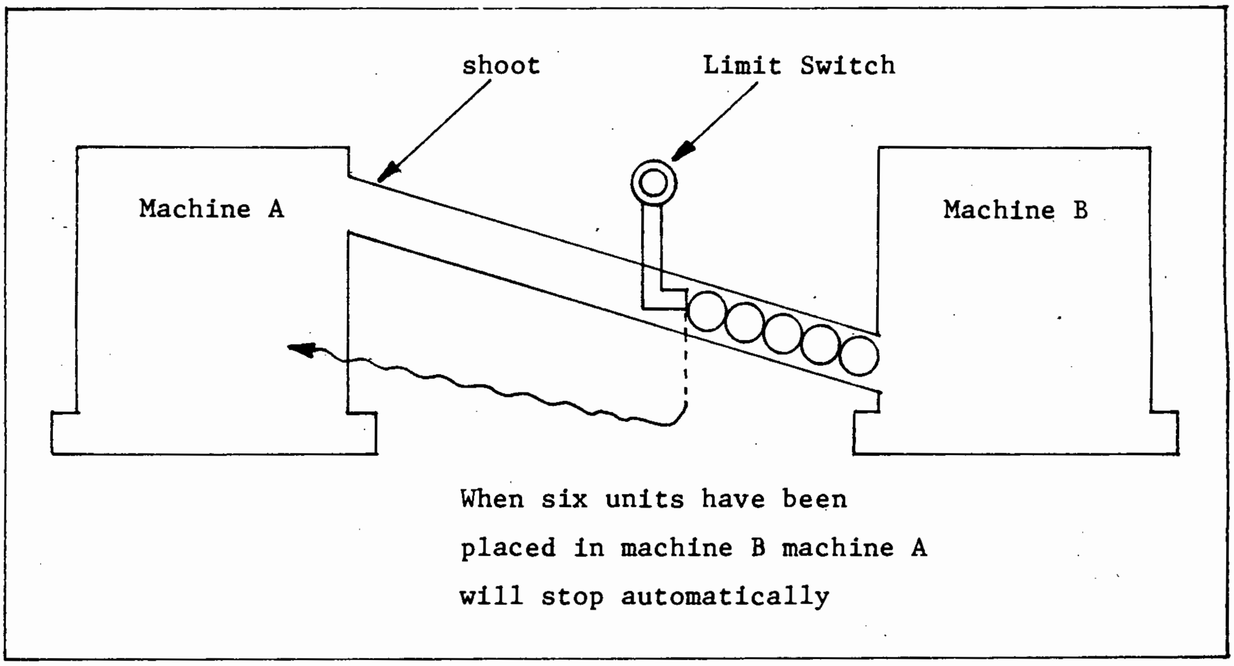
As another example, consider the chain conveyor which is used to convey the parts to assembly line by hanging them on hangers. The Kanban specifies which parts, are to be attached to each hanger, thereby enabling the subassembly process to produce only the required parts. Such a hanger with a Kanban is called "reserved seat" at Toyota (7).

Full-work system

Where there are machining processes and no workers it is possible for the preceding machine to produce units only in the quantity withdrawn? There are differences in capacity and speed of production among various machines. The preceding machine might continue its processing without considering any problems which might occur in the subsequent machining process.

This can be solved by what is called the 'full-work system'. Suppose, for example, that the preceding machine A and the subsequent machine B are connected to each other and that the standard inventory level of work in process on machine B is six units. Then, if machine B has only four units in process, machine A automatically begins to operate and produce its output until six units are placed in machine B. When machine B is full with the predetermined quantity (six units), a limit switch automatically stops the operation of machine A. Thus, the standard quantity of work is always placed in each process, preventing unnecessary processing in the preceding process (Figure B-7).

FIGURE B-7 FULL WORK SYSTEM




Because of the similarity between such a limit switch and a Kanban in a workplace where there are labourers and processes situated far from each other, the full-work system is also called an "electric Kanban".

For example, suppose the blanking machine, a machine which punches the sheet metal, can produce 90 units per minute. The pressing machine in the punching and bending process can produce only 60 units per minúte. In this case, due to its high capacity, the blanking machine usually operates only during the first two-thirds of the month and is idle the last third. But this method may produce unnecessary inventory in the blanking machine.

Suppose that the blanking machine was directly connected to the pressing machine, with the magazine set between the two. Then, if the magazine becomes full with punched metals, the blanking machine stops automatically. If only a few units remain in the magazine, the blanking machine automatically starts to operate again. In other words, the blanking machine operates for about two minutes, then rests for about a minute.

At Toyota, in order to attain line balancing with regard to production quantities, either intermittent operation like this full-work system or slow operation is adopted in high-capacity machines. The merits of line balancing are the elimination of unnecessary conveyance, which can lead to further shortening of the lead time, the minimization of the final-product inventory and the prompt adaptability to changes in demand.

How to determine the number of Kanbans

The number of Kanbans should be minimized. In Toyota the number is computed by the equation:

$$y = \frac{\bar{D}L + w}{a} \qquad (1)$$

where $y$ = number of Kanbans

$\bar{D}$ = expected demand per unit time

$L$ = lead time (i.e. waiting time and between processes)

$a$ = container capacity (not more than 10% of daily demand)

$w$ = policy variable (not more than 10% of DL)

Equation (1) implies that the maximum inventory level (m) is:

$$M = ay = \bar{D}L + w$$

The maximum inventory level (M) can also be expressed by:

$M = Q + 2S$

Where $Q$ = lot size

$S = k\sqrt{L\sigma_{\bullet}}$ and reorder point (p) $= \bar{D}L + S$

$\sigma_{\bullet}$ = Standard deviation of demand per unit time,

$k$ = Safety coefficient

Then, from equation (2) and (3)

$$Q = \bar{D}L + (w - 2S)$$

or $$w = Q - \bar{D}L + 2S$$

If the lead time (L) is relatively small and the demand per unit time ($\bar{D}$) has a relatively small variation, then the policy variable (w), the inventory level (M) and hence the number of Kanbans would be smaller. In Toyota, the policy variable (w) is expected to approach zero.

## APPENDIX C: THE SURVEY OF JIT AND OEM'S SUPPLYING THE MOTOR INDUSTRY

### C1 OBJECTIVES

The objective was to assess the OEMs' perception of JIT, its complications, applicability and usefulness.

The questionnaire sought information on two main aspects:-

- Knowledge of JIT, perceptions about it and reasons for any interest in it.

- The comparison of opinions about JIT from those who had produced it and those who had not.

### C2 THE COVERING LETTER

RESEARCH PROJECT AT THE UNIVERSITY OF CAPE TOWN

The following "QUOTE" is an extract from a motor manufacturer's letter on the subject of leadtime, that was recently addressed to their suppliers.

> "If we consider the current economic slump, the unfavourable exchange rates, as well as the new philosophy of "KAN-BAN" or "JUST-IN-TIME" deliveries, coupled to the need for minimum inventory carrying levels, we cannot support the need for additional leadtime requirements any longer."

Our industrial engineering section has instituted a research project with the subject "THE JUST-IN-TIME" manufacturing production system (JIT/MPS) and its effects on suppliers of components to manufacturers of motor vehicles in South Africa.

Our investigation is focused on the following questions.

- What awareness is there in South Africa regarding JIT
- How have companies gone about introducing the JIT system?
- Do those companies that have not already introduced the JIT/MPS system intend doing so in the future, and if so their planned method of introduction.
- The reasons for companies not wishing to introduce JIT/MPS.

## C3 THE QUESTIONNAIRE

Name:

Position:

Company Address:

Telephone No:

Please circle your answer. Should you feel that more than one answer applies to you, please do not feel limited to one answer only. Space is provided after every question for additional comments you may have.

1 "STATE OF THE ART" OF JIT

1.1 Have you had any exposure to JIT?

a. None at all.
b. A little e.g. through odd articles and general discussion.
c. Have an associate/friend in another company who is actively involved with, or has introduced JIT
d. Have a customer who has adopted JIT
e. Have researched the subject actively/thoroughly.

1.2 Have you considered introducing JIT to your Company?

a. Have not given it consideration as yet.
b. Have given it consideration but have no intention of adopting JIT
c. Have given it consideration but feel that not ready for the introduction as yet.
d. Have given it consideration but feel that only the Japanese can successfully apply it.
e. Waiting to let a few more companies "try" the system first.

1.3 If you have not already started introducing JIT to your organization do you:-

a. Regard it as essential that you at some stage do so?
b. Regard it as impractical for your type of manufacturing process.
c. Regard it as suitable to only certain of your manufacturing processes?
d. You have already adopted a system other than JIT which you do not intend to change from. If so what system have you adopted?
e. You regard the expense of introducing JIT as being too high?

1.4 Do you view JIT as;

a. A general philosophy to be applied without any changes to existing systems, factory layouts, plant and equipment?
b. A general philosophy with only minor changes to factory layout, stock control and production scheduling?
c. A system requiring major changes in management approach, factory layout, production scheduling and ordering systems?

2. If you have actually embarked upon JIT have you:-

a. Done so purely on a trial basis in a small sector or department of your organization.
b. Done so on a large scale?
c. Made a start but are encountering major problems?
d. Made a start and are encountering problems but find that the advantages outweigh the problems?
e. Made quite large inroads into introducing JIT without encountering any major problems?

3. What do you view as the drawbacks of JIT?

a. Expense.

b. Unsuitability to your production processes.

c. Unsuitability to Eastern management and labour.

d. Getting ones suppliers to "tie-in" with the system.

e. Geographic location relative to suppliers and/or customers.

4. Phasing in of JIT

4.1 Having introduced, or prior to introducing JIT to your organization, would you regard specific management training on the subject as essential or would you rely on consultants to advise on and administer the introduction?

a. Specific training not necessary.

b. Purely in-house training.

c. Purely consultants.

d. Consultants to train management.

e. Consultants in conjunction with pre-trained management.

4.2 If you decide to maintain JIT as a purely "in-house" exercise would you:-

a. Send one or more of your management overseas to learn the system there?

b. Consult with a customer/customers of yours who may be advanced in the system, for advice and assistance?

c. Send management on a course locally should such a course be available or made available.?

d. Try and get as much information as possible from whatever literature/films there may be on the subject?

4.3 Method of introduction.
Having introduced or with the intention of introducing JIT to your organisation have/would you: -

a. Gradually phase in JIT without any specific management and manpower training and changes to machinery?

b. Arrange thorough pre-planning and pre-training of staff before a very active and full commitment to introducing JIT to ensure an active and full commitment to the introductory programme?

c. As in b. but start with only certain departments?

d. None of the above. Please comment?

5. Do you view the questionnaire as having been constructive in its approach and content?

a. Yes

b. No

Any comments ..........

C4 THE FINDINGS (27)

Seventy replies were received to the 150 questionnaires sent. Of the 70 only 3 reported having no knowledge of JIT. Of the remaining 67, 34 (51%) reported having a customer who had adopted JIT

C.4.1 DOES JIT PRESENT PROBLEMS

Twenty-seven (40%) of the respondants had actually embarked on a JIT programme. This is a large percentage. Of these 27, seven were on a trial basis in a small sector of their factory, four had done so on a large scale. Fifteen reported having encountered problems, but 11 of these felt that the advantages outweighed the problems. Five of those who had embarked on a programme to introduce JIT felt that the system was applicable to only certain of their manufacturing processes.

## APPLICABILITY OF JIT

Of the 43 who had not embarked on J.I.T, 15 felt that the system was only applicable to some of their processes and a further 10 felt that it was totally impracticable for their type of manufacture.

A total of 32 said that they had given it consideration but had no intention of adopting JIT However, 15 of these 32 had also ticked the question which asked if they regarded it as essential that at some stage they adopt JIT.

## EXPENSE

Only 6 respondants regarded the expense of introducing JIT as being too high. Two of these were of the group that had embarked on a programme and had reported encountering major problems.

## MAJOR CHANGES NECESSARY

Fifty-one of the 70 respondants viewed JIT as a system requiring major changes in management approach, factory layout, production scheduling and ordering systems. Twenty of these were of the 27 who had embarked on a JIT programme.

## DRAWBACKS

Of the 27 respondants who had actually embarked on JIT, 17 felt that it's drawback was getting suppliers to tie in with the system.

Fourteen pointed to the geographic location of their factory relative to their suppliers and customers as inhibiting the success of JIT.

## TRAINING

Of the 27 who had embarked on JIT there was a fairly even split between those who felt that pure in-house training was appropriate and those who would rely on consultants.

There was a similar division among the 43 who had not yet introduced JIT.

General conclusions that can be drawn from this questionaire survey.

The first is that there is an interest in improving manufacturing efficiency and in considering new methods. This interest is brought about by pressure from the customer.

The clearest outcome is the envisaged problem of 'tying ones suppliers into the system'. This has considerable relevance and leads to a need to research attitudes and relationships between industrial customers and their suppliers. This applies to both big customers and small suppliers. For example, JIT will never work throughout a complete industry whilst steel must be ordered in large batches many months before the industry can possibly quantify its production plan. Indeed, it is significant that in Japan JIT was made workable by the over production of the Japanese steel works. This forced the steelworks into satisfying their customers' order plans instead of their own.

A second clear outcome is the need for innovation in small batch deliveries between geographically distant locations. The coordination of a group of small suppliers to make up economic container loads may be a solution.

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