CHAPTER II

THE JAPANESE PRODUCTION SYSTEM:

POINTS OF DEPARTURE

Japanese industrial development has from its initiation during the Meiji period, been marked by extensive learning from the West. As America came to dominate the industrial world the Japanese managers visited numerous factories there and returned with a plethora of ideas. Whether it was kanban or quality control, the source were distinctly western and could be traced to the pioneering works of American management gurus like W. Edward Deming and J.M. Juran.

One of the first ideas to strike roots in Japan was America's long established mass production system. However, economic and social constraints forced Japanese industry to modify this system. The Toyota Motor company was the first to introduce changes and experiment with the new system. By trial and error it developed production techniques that was able to solve the problems arising from the use of America's production systems in Japanese conditions. In the process of adapting the production system to suit its own needs, Japan transformed the system. So much so, when the West started looking into the secrets of Japan's success, it erroneously believed the production techniques developed were culture-specific. In reality, however, most techniques in vogue in Japan have their roots in West.
Chronologically the Japanese production system was established after the mass production system. The Japanese system emerged from unproductive attempts to adopt a typical Ford model. Its origin can be traced back to the 1950s, though it came into public focus during the turbulent 1980s, when ardent followers of Fordism encountered serious obstacles in the changing market environment. However, calling it a direct progression from mass production is stretching the point too far. What was established in Japan was, as much a, consequence of an economic need as a cultural one. An appreciation of the Japanese production system is possible only if the basic operation of the mass production system is understood.

THE MASS PRODUCTION SYSTEM

Beginning with the factory system of production, the beginning of specialisation and mechanisation, the mass production system developed matured over a period of 150 years. Henry Ford is credited with pioneering a production system that could cater to mass consumption in a stable market. He recognized the importance of a predictable procedure in product design, component manufacture and factory organisation. By this time, the concept of standardised interchangeable components had established itself as a source of increased productivity, as it reduced the time for assembly, and craft content in work. Standardisation of the final product, Ford reasoned, was essential, as each change in product specification necessitated resetting of machinery and was expensive. So, a single product produced in one go would lead to efficient machine utilisation. Further,
bulk production could lead to lower cost. This principle dominated the mass production system, even as it evolved, to large and complex product manufacturing.

The production system based on the principal of bulk production at lower cost worked through three main objectives. The first objective was reduction and rationalisation of operation time. This was achieved through maximum utilisation of plant. This motive, in turn gave birth to the concept of "machine must go on." Unanticipated breakdown on the shop floor, or non-availability of intermediate goods or raw material, was perceived as the bottleneck. It was always feared that production could stop owing to some failure or the other and this could affect work down the line. Thus hoarding of raw material as well as work in progress inventory was the norm, to take care of uncertainty. This came to be known as Just-in-Case. The Just-in-Case concept encouraged accumulation of large inventories, locking a large amount of capital in the form of stock.

Outcome of rationalisation of operation time was increasing attention given to mechanisation and technical innovation. By this, the manufacturer was able to cut down production time, increase production and lower cost. Further, high degree of mechanisation contributed to synchronisation of production flow.

The second objective was reduction of relative price to stimulate mass consumption. Mechanisation which resulted in speeding production, enabled the manufacturer to keep cost low even in the event of increasing wages. Bulk
production of standardised goods at reduced price found credence because of the belief that there is always a buyer in the market for a low cost product, encouraged companies to focus on cost control. In addition, cost control was achieved by spreading the maintenance sum over a larger base of produced units.

Since bulk production at low cost was the motto, quality was of less consequence. Even with, mediocre quality, products gained access to the market on the tripod of price, advertisement and penetrative distribution. Reduction of relative price made up for less quality by stimulating mass consumption. Only when satisfaction of the customer gained significance was more attention given to quality. The system incorporated the need for maintaining some quality by stationing skilled workers at the end of the production line, to check and remedy defects.

Third objective was to sell whatever was produced. Thus the system required lesser coordination among various units. The operational system was compartmentalised, to ensure product design, production and sales departments work fairly independently. The production department produced under specification of the design department, the sale department sold through extensive advertisement. There was little systemic positioning of changing product attributes through feedback from consumers.

The principle and the objectives of mass production system created a highly centralised organisation, with various divisions, each responsible for design, production, personnel management, finance and so on. As large American
corporations gained global success, development of organisational structures to
direct various operations took place. This led to specialisation of various
managerial skills. Professionalisation under a mass production system implied that
management skills were like a chest of tools and techniques that could be acquired
through classroom training, studied and improved through research and analysis,
and applied in all managerial and administrative situations.¹

Consequently, this led to centralisation of information, and established
hierarchies for dissemination of information. Thus, managerial initiative in the
operating unit, even on day-to-day basis was curtailed. The hierarchy also served
the purpose of control over employees. Productivity-linked wages and salary
incentives were considered the major control whips and managers used it in
multiple forms to exert control. At the shop floor, simple specialised jobs became
the norm, as they required less time for training. The system came to rely more
on utilisation of the available pool of talent rather than training them. Since there
was no or little training given, skills of managers and workers were acquired from
outside sources and were not firm specific. Thus, both managers and workers
were treated as replaceable components.

Centralised decision-making divided employees into two sets: those who took
decisions and those who functioned according to the decision. Decision-making
became the prerogative of managers and engineers while the shop floor workers
perform mechanical functions. Thus workforce was a resource to be exploited in
pursuit of corporate goals. According to Schonberger, "Factory efficiency had been

¹ Sethi Prakash,Namiki Nobuaki,Swason Carl L,'The False Promise Of The Japanese Miracle Illusions and
Realities Of The Japanese Management System,' P126
enhanced by standardisation of product design, component parts, and tools and by the widespread use of standard engine driven machine tools. What remained non-standardised was the labour component. For lack of better way, carrot and stick (mostly stick) foremanship continued to be the chief means of controlling the undisciplined labour.\(^2\)

The production system that relied on standardisation and mechanisation advocated division of labour, a principle recommended by Adam Smith in the *Wealth of Nation*

\[\ldots\ldots\text{In every other art and manufacture, the effects of the division of labour are similar to what they are in this very trifling one (here the reference is to the making of a pin by one craftsman or dividing the work between four of them).} \ldots\ldots\text{The division of labour...so far as it can be introduced, occasions in every art, a proportional increase of the productive powers of labour.}\]

(Smith, 1776/1986, pp. 109-110)\(^3\)

Thus labour was made to do a single task and the worker would become conditioned to perform that in the least possible time. Since the system was based on production push, it meant in all circumstances the worker would continue production and allow stock accumulation. Remuneration was based on the number of pieces produced, irrespective of whether it was used or not. Division of labour

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\(^3\) Sheldrake John, *Management theory From Taylorism to Japanization*; p2
and extreme specialisation finally led to 'one man, one machine' concept at the
shop floor and 'one man, one department' in the administrative division. Centralised
decisions and hierarchical control left little power in the hands of employees down
the line.

As managers were all-powerful and took decisions on behalf of the
management, whatever training was imparted was given to the managers and the
shop floor workers were relegated to perform less stimulating work with little scope
for improvement. The speed of production criterion conditioned labour to be
disciplined and the management responded by the rigorous use of Taylorism⁴.

Given that labour was a component in the production process and managers
were the decision-makers, various methods for optimum utilisation of the labour
were considered. The key question was how to manage labour effectively. Douglas
McGregor in his book The Human Side of Enterprise said every management
decision was based on assumptions about human nature. These assumptions
could be classified into two types. He named them Theory X and Theory Y. Theory
X says, an average human has a dislike for work. As a corollary, people must be
coerced, controlled, directed and threatened with punishment to get effort towards
achievement of organisational objectives. Further, humans preferred to be directed
and were reticent to taking responsibilities. It was because of this inherent
assumption that the system followed the carrot and stick policy. According to
McGregor, “principles of organisation”, which comprised the bulk of the literature
on management, could only have been derived from such assumptions as those

⁴ The systematic and scientific time study which conducted timings of basic elements, weighted them to
construct standard times for various jobs. This approach provided an accurate information on how long a job
should take. Once standard time and method was fielded workers were trained in standard method of operation.
The job was scheduled, supervised and controlled with reference to standard method and time. Task
management thus allowed for great control by the management on all aspect of production. This system also
put forward by Theory X. Other beliefs would have led to quite different organisational principles\textsuperscript{5}.

Theory X provided an explanation of the consequences of the scientific management approach on employees. Criticising Theory X he said, “So long as the assumptions of Theory X continue to influence management strategy, we will fail to discover, let alone utilise, the potentialities of the average human being”.\textsuperscript{6} He then turned to give a different set of assumptions which he called Theory Y.

To him, human beings are not averse to work. They see it as either a means of satisfaction or punishment, depending on the work environment. Also, threat of punishment is only way means for bringing about effort towards organisational objectives. Commitment is a reward the company gets for providing an environment in which an employee enhances his self esteem. In the process, broader organisational objectives are achieved. Human beings learn under proper conditions and are not reluctant to shoulder responsibility. Given an opportunity, labour can be creative in providing innovative ideas and solving problems arising during work. The division between planning and execution of work, which is one of the pillars in scientific management, is a waste of labour resources. McGregor suggested the limits to human collaboration in an organisational setting sprang not from human nature but management’s failure in understanding it. He proclaimed the work force is a resource with substantial potential and its utilization can be best achieved through integration.

\textsuperscript{5} Ibid p157
\textsuperscript{6} Ibid p159
Theory X, on the other hand led to an organisation with a conflicting relation between employer and the employee. Since managers were party to the decisions of the company, they were considered to be the voice of the employer by the lower ranking employees. Unions accepted dictates of the management in terms of organisation, technology and product policy in return for financial benefit. In many countries, strong labour conflict associated itself with distrust and feeling of exploitation.

McGregor ideas had limited acceptance. So also was Maslow's hierarchy of needs. This too could not find a place because of nature of the organisations. However, by the 1960s, some companies began to pay attention to the workers and developed programmes to humanise work. Automation in factories to eliminate tedious and dangerous job was initiated. Since the Fordist linked rationalisation and mechanisation to the institutionalisation of wage formula, guaranteeing improvements in standard of living to the dynamics of productivity, the conflict between the management and workers continued to centre around financial compensation, rather than attempting to achieve a more egalitarian work environment.

As economies reconstructed and modernised the insufficient, attention paid to employee know-how made its presence felt in the slowing of labour productivity. The oil crisis and ensuing economic instability of the 1970s and the 1980s revealed the limitation of design and produce, and principle of the of mass production. The system was not conditioned to handle quality, durability and effective after sales.

According to Maslow human needs arrange themselves in hierarchies. Once basic needs are fulfilled the employee needs manifest in other forms like self esteem and self actualization. Since scientific management left limited scope for these higher needs it invariably resulted in conflict between the employer and the employee.
service. Hence the system that manifested itself with dynamism during the 1950s and 1960s started showing its drawback as demand became uncertain and electronics made its presence in factories allowing for small production run.

THE JAPANESE PRODUCTION SYSTEM

While the West was trying to adjust to the drawbacks thrown up by mass production, due to changing market conditions, an Asian country, Japan, was slowly but surely making inroads into sectors like automobiles and electronics, considered to be the Western domain. The Japanese success, on a cursory glance, was attributed to more automation and robotisation. On a deeper analysis, it was realised Japanese factories were following a different set of principles in their production system, such as synchronising the utilisation of all factors of production to optimise overall productivity, rather than labour productivity alone. It was following a flexible mode of production by multi-skilled employees and effectively cutting unit costs through a better operational systems. It was realised the Japanese production system was better adapted to market changes, as the system was conditioned by consumer demand. Thus production was limited to what can be sold and the product was of high quality and fine-tuned to consumer preference.

According to Robert Boyer the Japanese had, in the process of finding solutions to the problems faced by the business environment, inverted the mass production philosophy. "In place of a frantic search to reduce the unit cost of a

10 Product may be classified according to volatility of demand, quality-intensivity, and short order items.
poor-quality product for which it is difficult to find a buyer in the market, why not continually aim to optimise both quality and productivity, even if it means overturning established idea about organisation?" was the view.

The Japanese production system, interpreted and codified by Western commentators, was based on the system followed in Toyota. At the core, was the ‘minimum factory’ concept. This meant a factory would produce what could sell and accordingly adjust the variable factors of production, including workers, at the shop floor level. Elimination of waste was fundamental to growth and profitability. The Japanese identified waste as those arising from large amount of raw material and work in progress inventory and finished goods stock, defective products and operational time. The Japanese companies then set about attacking these wastes by optimising overall productivity of all factors, integrating research and development, production and sales net works in such a way that a constant feedback of consumers were incorporated into the future product. Japanese companies were soon producing differentiated goods of high quality at a continuously falling cost and outwitting the world leaders in the international market. Their management techniques resulted in an organisation resting on decentralised decision-making, a complex communication network, a longterm subcontracting goal and a loyal and competent employee base. The discussion of the various management techniques will throw light on the effect it has on the organisation and the employee.

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8 Robert Boyer, 'After Fordism'; p28
9 For detail see Appendix V
Just-in-Time Management Technique

Just-in-Time management technique works on the principle of producing the right quantity at the time. The central ideas is to produce and deliver 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 material Just-in-time to be transformed into fabricated parts. It is a hand-to-mouth production process, where the component undergoes continuous transformation from the time it enters a plant till it is dispatched to the customer. Just-in-Time essentially takes care of inventory waste by matching production to sales. The Just-in-Time management technique to often confused with the kanban system, which is actually a tool in the hands of the management for applying Just-in-Time technique. Just-in-Time became a popular management concept in the 1970s, when the Western world's interest in Japan was awakened. The concept, according to Schonberger, existed some 20 years earlier in the ship building industry, which found it could get steel at short notice, because the steel industry had over expanded and had excess capacity, and, therefore, could deliver at short notice. Though the fundamental function of the Just-in-Time management technique is an inventory control system, a closer look reveals that its operation has a far-reaching effect on organisational structure and the employees.

Inventory reduction and initiation of Just-in-time

Just-in-Time is initiated when the management takes the policy of reducing
waste and therefore production cost by cutting inventory. Inventory consists of raw material, work in progress and the finished stock. By lowering inventory the company reduces working capital and warehousing cost. Reduction in raw material inventory and finished goods stock is largely dependent on how effectively the company sources the raw material and distributes its products. This needs proper linkages with raw material suppliers and marketing chain. Reduction in work in progress inventories necessitates the production organisation to target a reduction in lot size as well as batch size. The objective is a single-unit-flow production that operates through minimum lot size. The work in progress inventory is reduced by following cellular manufacturing units, cutting set-up time and the kanban system. Let us examine these.

**Cellular manufacturing units**

As consumer demand for goods became volatile the mass production system adjusted by adopting a functional layout. This led to all sorts of difficulties in production control, involving long lead times, excessive intra-factory transportation and wasted effort and space. The cellular lay-out calls for identifying different groups of product that share common characteristics. This allows the plant to group production together into mini-factories and production cells, each of which is responsible for one of these product families. The cell type layout is ‘U’ shaped. This saves space. Two, it allows workers to observe what is happening in other areas and when defects occur it is rapidly identified and sorted. Third, it encourages communication among workers. Finally, and most importantly, it breaks

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10 Product may be classified according to volatility of demand, quality intensity and short order items.
the 'one machine one man' concept, as the workers are able to observe and operate more than one machine at a time.

Cutting Set-up Time

When having a small quantity of work in progress is encouraged, it essentially means producing a small quantity of components. This has an inherent cost, because it means changing the set-up of machines for different specifications. There are two types of waste involved: time wasted between setting up the machine and the waste of labour plus scrapped material and overhead cost. The Toyota company was the initiator of Just-in-Time. It encouraged workers and engineers to find ways to minimise set-up time. A campaign in Toyota began in 1971 to cut set-up time for 800-ton presses, used for forming auto hoods and fenders. The duration of operation when the campaign started was one hour. In five years, it was brought down to 12 minutes. This was made possible by engineering modification. For instance dies used for a particular model slipped out of the press on to the worktable while the dies for a new model were pushed in through the other side. Engineers of the production and the R&D departments and the shop floor workers worked closely to achieve this. The shop floor workers were trained and the procedure was dry-run several times, so that when the actual time came, they worked with clockwork precision. According to Hall, "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 set up times on a piece of equipment which at first was regarded as an
insurmountable obstacle. Accounts of these battles detail changing the design of the bolts and the fit of pieces together on the machine. They describe the building of special tools to speed changeover, and practice sessions to learn how to perform changeovers quickly."11 Since most of the methods of cutting set-up time were developed in-house by team efforts of employees, the modified equipments and tools were designed by the tool makers according to their specification. Thus, machine tools were mainly firm specific. Overtime, automation further improved machine set-up times and the workers just loaded and unloaded the dies or fixtures. The rationale behind cutting of machine set-up time was that the duration of the work-in-progress was shortened and this, in turn, curtailed accumulation of inventories.

The Kanban System

The Just-in-Time concept links production to real demand. The system works on the basis of pull system instead of push. Kanban literally means visible record or card. The use of kanban is simple. It is usually, though not always, a printed card in a clear plastic box, or a metal plate or just a coloured card. Every item or box of items that flows through the production process carries its own kanban. The kanban are of mainly two types: the parts withdrawal kanban and production instruction kanban. The kanban cards bear lettering and bar codes that identify the items, the locations of the work-sites where they are used and the production line or supplier from which they came. The kanban card is attached to specific components in the production line, giving detail of quantity, the workshop from

11Robert W. Hall ' Driving the Productivity Machine: Production Planning and Control in Japan' p.13
where it originates or the supplier from whom it is delivered and the delivery time of the component. When the part has been used/ delivered the same sign is returned to the place from it originated, and it becomes an order for more. The concept of kanban is supposed to have originated from Mr. Taiichi Ohno's (then the marketing head of Toyota) visit to the U.S. supermarkets where shelves were stacked with minimum goods and each item was replaced when it was bought. Thus, as against Japanese supermarket shelves which were filled to the brim just-in-case customers wanted something, U.S. supermarket had lesser shelf space. Coming back to Japan he implemented this system to reduce work in progress waste. The system took over 10 years to establish itself and work flawlessly. While a number of Japanese companies follow the dual card system as established by Toyota, many others follow a single-card system namely, the production instruction. In the single card system, parts are produced and bought according to a daily schedule and deliveries to the user are controlled by the card. The single card system is a push system for production and a pull system for deliveries.

The _kanban_ system works effectively only when some rules are adhered to. First, no parts should be produced in a particular work-site unless the _kanban_ card authorises it. Thus, if need be, the work-site may be brought to a halt rather than continue production. The _kanban_ card ensures nothing is produced if there is no demand. It thus brakes production when a component is not in demand or if there is a problem of utilisation of already demanded components. Thus, the _kanban_ system pulls the production system. Second, there should be precisely one production instruction _kanban_ and one withdrawal _kanban_ in each container.
The number of containers per component is to be decided by the production manager. Third, only standard containers are used, always filled with a prescribed quantity, neither more nor less. Thus, with such a careful procedure, inventory waste is controlled in more effective ways than the computer-based Western system. The kanban help enforce a link between work preceding the process and work following the process. This makes paper work minimal and raises efficiency.

**Effect Of Just-in-Time on Employees**

Just-in-Time is a streamlined production configuration that raises process yield, acts as a balance in the production line and, more importantly is used as an employee involvement and motivational mechanism. This aspect is considered in detail in the following pages.

The cell lay-out and cutting set-up time abolishes narrow division of labour. Workers are required to perform a complex set of tasks. Hence, a worker instead of performing single task is required to develop multi-skills. It thus, necessitates training him in a wide range of tasks.

Just-in-Time calls for a bufferless production and material movement. This means the worker has to work at a certain speed, so that the work progresses without a hitch. This necessitates the worker to be skilled in his job and often requires training. The cutting of set-up time also necessitates the management to draw a training programmes for the production department. Since production
is demand oriented, there is regular product variation on the production line. This encourages the workers to be multi-skilled.

With, production conditioned to consumer demand, a flexible production system emerges. Among other effects, this system confers power of decision to teams. Many decisions that are take in authoritarian and heirarchical manner in mass production is taken by teams at the work site. Teams takes decision regarding the production, reorganisation within plant as they are directly affected by it. Under this system, teamwork rather than individual productivity is valued and recognised.

Just-in-Time delegates the power of how much to produce to the worker at the shop floor and makes workers more responsible at the work-site, it necessitates managers to keep vigil to ensure that there is a smooth flow. The manager has to take account of any dysfunction and coordinate with other work sites. If need arises, he has to work along with shop floor workers to complete a task. He is required to build a harmonious work environment for in his work site. He has to identify the need for training to workers to increase productivity and also keep them motivated.

TOTAL QUALITY CONTROL

The concept of Total Quality consists of a confusing array of terms like Total Quality Control, Total Quality Management and Total Quality Leadership to name
a few. Quality refers to just about everything that enhances production and which fulfills requirement customer. Total means everybody and every process. Control is embedded within, and driven by, the organisation. As the pioneers of Total Quality philosophy pointed out, it is the organisational system itself which needs to be examined to judge quality of product and performance process. Thus, efficient management of an organisation which satisfies the customers is central to the total quality concept. Building confidence and loyalty of the customer is a key to success.

Traditionally, a customer was one who used the final product. These sets of customer are termed end-use or external customers. The total quality concept has included another set of customer. These customers are the fellow workers, supervisors, facilitators and coordinators in an organisation. They are customers because the goods worked upon by the worker contribute in making their work easy. A defect that originates at one work station leads to a dissatisfied fellow worker at the next work station. Thus the very next person who works on the product is the customer. This customer is defined as internal customer. If each worker is conscious about satisfying his next customer, then total quality is achieved. Thus human satisfaction is the scale for achieving total quality12.

Evolution of the quality check under mass production system was the function of a special set of workers, like quality inspectors or supervisors, who used the quantitative approach popularised by Taylor and his contemporaries under scientific management. This system fitted the employee to the job. Under this

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12 For detail see Ishikawa Kaoru, "Guide to Total Quality Control, Tokyo, Asia Productivity Organisatiion, 1972.
system, quality had a very restricted meaning, namely removal of a defective part.

Total Quality management technique goes beyond any expected and required quantitative target. It is not merely quantity, but quality which matters. To excel, the organisation should go beyond delivering of goods or services and target customer satisfaction. Since customer satisfaction under a broader base involves satisfying the next worker or work station, the responsibility for quality shifts to the worker involved in doing a particular job. Under Total Quality management, responsibility for quality of the product moves from the domain of the quality control department to each worker in the production department.

Historically, till the Second World War, products from Japan had a reputation for bad quality. When Japan started its transformation process, it had looked towards the West for concepts and methods for quality control. Works of two Americans, W. Edwards Deming and Joseph M. Juran, had influenced the Japanese and the highest quality management award was named the Deming award for quality. Deming placed considerable importance on statistical tools and Japan trained its workers to use these tools effectively. However, the Japanese moved much ahead of what Deming recommended. Overtime, they built certain concepts into the production system that enabled them to ensure quality and improve their image and become competitive globally.

Quality has two facets. Computerisation and robotization help achieve quality to a certain extent. To achieve the current level of Japanese quality, where defect
is one per million, it requires committed effort from employees involved in production. Further, it is essential for top and the middle management to channelise the workforce to become quality conscious by training and developing schemes that encourage concentration on quality.

The years of experience with the Total Quality technique has led to various concepts. The initiation of Total Quality necessitates a shift of responsibility from the quality department to the production line where the product is being made. Quality is a goal which requires an attitude to continuously improve and seek perfection. Quality checks essentially set criteria for the product, which has to conform with the design specification. Since better quality is believed to automatically increase the market share, the Japanese target quality control at 'zero defect'\(^{13}\). Schonberger states, 'Japanese TQC system with a goal of perfection, organisational responsibility for quality is realigned ...Japanese are more likely to use zero defect than perfection. I have chosen to use the latter term, because perfection more than captures the Japanese marketing strategy of pressing onwards for better and better quality in order to increase the market and their own company share of it.'\(^{14}\)

Quality is controlled by checking each product on the production line while the next step in the production process is attended to. Therefore every production worker is, in effect a quality control man. Each worker is trained not only to work on a particular machine but also to check the component coming into his work area. Total Quality Control encourages workers to go back to the previous process

\(^{13}\) According to Richard J. Schonberger zero defect programmes of the West rely on persuasion, is forced to exist in same old company set-up and is geared for statistics rather than improving standards of quality. This belief has persisted in countries that followed the Western model.

\(^{14}\) Op.cit. 102
on the production line and seek out the cause of the problem. To find a solution to a problem the Toyota plant started with five Whys, one H. It was found that the first Why is often not the root cause and the hidden cause comes out by asking Why at each stage. Taiichi Ohno of Toyota Motors gave the following example.

Q1, Why did the machine stop?
A1, Because the fuse blew due to an overload
Q2, Why was there an overload?
A2, Because the bearing lubrication was inadequate.
Q3 Why was lubrication inadequate?
A3, Because the lubrication pump was not functioning right.
Q4, Why wasn't the lubrication pump working right?
A4, Because the pump axle had worn out
Q5, Why was it worn out?
A5, Because the sludge got in.

In the above example, by repeating 'Why' the worker is able to reach the root cause. Changing the fuse and continuing to work could have, in the long run caused the machine to stop frequently. By this process, one is able to identify the root cause of the problem and valuable work hours are saved. Overtime these questions have become more focussed and the five Why's have transformed to “who”, “what”, “where”, “when”, and “why” followed by a “how”

The concept of total quality control does not end at the shop floor or with the

\[15\] For detail see Appendix VI
production department. To enable better quality and customer satisfaction, it is not only essential to move quality check to the production line but it is essential to coordinate between research, design, production and sales. According to Deming the four stages were to be rotated constantly, with quality as the top criterion. Japanese recast the Deming wheel and named it the PDCA cycle. This was extended to all phases of management. Table (2.1) below gives the focus area and the nature of job of major department.

<table>
<thead>
<tr>
<th>DEPARTMENT</th>
<th>FOCUS</th>
<th>NATURE OF JOB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Plan</td>
<td>Product design</td>
</tr>
<tr>
<td>Production</td>
<td>Do</td>
<td>To produce according to specification of the product</td>
</tr>
<tr>
<td>Sales</td>
<td>Check</td>
<td>Sales figure establish customer satisfaction</td>
</tr>
<tr>
<td>Research</td>
<td>Action</td>
<td>According to the feedback from the sales and after sales service department the research department has to take positive step towards next round of effort</td>
</tr>
</tbody>
</table>

Source: The Kaizen Challenge. P 284

Figure (2.1) (given below) illustrates that all departments cooperate and work in unison to achieve high quality product. The application of the wheel in the early stage was restricted to the shop floor and used as a corrective measure by the worker and the supervisor. The inspector checked the worker's result. This
was based on the division of labour concept. However, it was soon realised the post corrective application of quality checks was not enough and PDCA was elevated to a new level.

**FIGURE: 2.1 PDCA CYCLE WITHIN PDCA**

In the revised model, ‘Plan’ meant improvement of present practices and not just product design. Statistical tools like Pareto diagrams and fishbone diagrams were built into the system. ‘Do’ meant following the specification of the plan. ‘Check’ meant seeing if it had brought about the desired improvement and action meant preventing the occurrence of similar problem and standardising the new practice. Within ‘Do’ itself another PDCA cycle revolved, which provided a continuous check on the quality. Further the PDCA cycle was self-evolving. As a thing was standardised it was challenged, revised, and replaced by another for newer, better standards.

In the process of achieving better quality, the Japanese made quality more visible. Visibility can be of many types. Easy to see quality is one of them.

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16 For detail see Appendix VII
Measurable standards for quality introduced by Deming and Juran into Japan were worked upon by the Japanese and was made more transparent. Schonberger elucidates it by a first-hand experience. At a conference with Mr. Takashige Yamane, manager of quality control at Mitsubishi Belting Co. in Kobe, related to him how the customer plant inspectors who were designated for quality check by the customer plant would invite themselves to tour Mitsubishi’s plant and poke their nose into everything from quality control chart to maintenance record to the food in the cafeteria and generally left a list of demerits. The inspectors particularly demanded visual, obvious indicators of quality at every process and indicators that were easy to understand and not computer listing which is comprehensible only to technicians, clearly indicating the need for succinctly defined parameter. According to Mr. Yamane, the company that has no clear and simply defined visible parameters for what is good quality and, conversely, what constitute defectives, cannot continue in a competitive market. Thus in a Japanese plant one finds display boards showing what factors are measured for quality, the current performance, projects for improvement, awards won for quality and so forth.

Visibility is made easy because of small lot size operation under the Just-in-Time technique. Small lot size allows for defective parts to be noticed early and ensures many defective parts do not accumulate. The small-lot size, therefore, is a vital tool for quality control. Along with the small lot size, workers are allowed to stop the line in case of defects. This is significantly different from the mass production system. Quality precedes productivity. Most companies design equipment to detect abnormalities and stop whenever a defect occurs. Further
workers are given the authority to stop production whenever there is anything suspicious. The mechanical halt by automation and human *Jidoka* prevent defective parts from progressing to the next stage and, in turn, prevent wastage in the form of manpower and material. Automation allows for stopping the equipment exactly when the problem occurs and calls for attention to the problem immediately. Since the machine stops immediately, the workers are required to act upon and solve the crisis. It eliminates the need for workers to watch over each machine continuously and leaves them free to concentrate on tasks in hand. It also encourages group or team operation because when the defect arises, it becomes the responsibility of the entire line. *Jidoka* thus is a humanistic approach to the configuration of human-machine interface. The attitude towards recognition and assignment of responsibility to the production enables the workers to correct their errors and thus eliminate waste. All this is strengthened by the principle of less than full capacity operations, thus avoiding pressure on workers, taxing of equipment, tools and support people. Defects arising out of hasty operations are avoided. PDCA is proactive in nature. The system allows early detection of the possible failures. This prevents elimination of waste in the form of defective intermediate and final product and smoothens quality output.

Total quality control not only involves every process and every one and is effective only when 100 per cent check is ensured. This means inspection of each item. This is applicable to all finished goods and wherever possible, to components.
Total quality control necessitates daily machinery check, as faulty machines cause defective parts. Housekeeping is also important, as neat and clean work areas provide improved work habits, which in turn enhance quality. Since housekeeping contributes to quality, every worker is responsible to keep his work-site neat and clean. The practice of 5Ss, *seiri* (straighten up), *seiton* (putting things in order), *seiso* (clean up), *seiketsu* (personal cleanliness) and *shitsuke* (discipline) is prevalent.\(^{17}\) It is common for workers and foremen who are not required at the primary job to engage in cleaning operations. According to Harvard case writers\(^ {18}\), when Sanyo took over a TV plant in Arkansas, management attacked the quality problem by cleaning the plant on a weekend and laying polythene flooring mats on the shop floor. This not only brightened the shop floor but also made visible anything that was dropped on the floor. Since the workers were working on a clean area, they automatically picked up whatever was lying on the floor. The Sanyo management believed the cleaning operation was a major contributor towards reduction of defective parts.

Total quality control requires managers to coordinate with other departments. It necessitates managers to support workers in their endeavour to find methods for improvement of product quality and reduction of cost. As managers their responsibility to quality also involves designing and developing new products and to ensure policy deployment. These they carry out through certain tools known as “New Quality Tools”.\(^ {19}\) These tools are applicable in various departments\(^ {20}\). It is a comprehensive systems approach to problem solving. It is characterised by attention to detail and providing visibility to subjective matter.

\(^{17}\) For detail see Appendix VIII
\(^{18}\) Sanyo Manufacturing Cooperation- Forrest City Arkansas. “Harvard Business School” case number 2-682-045(981)
\(^{19}\) The new quality tools are described in detail in Appendix IX
\(^{20}\) The departments that make use of these tools is listed in Appendix X
FIGURE: 2.2 Application of Total Quality Control

IDEAS TO IMPROVE JIT

LOT SIZE REDUCTION → JIT MANAGEMENT

AWARENESS OF PROBLEM AND PROBLEM SOURCE

LESS INVENTORY

LESS LABOUR REWORK TIME

LESS MATERIAL WASTE

QUALITY PRODUCT

IDEAS TO IMPROVE QUALITY

LESS INVENTORY

LESS MATERIAL WASTE
Total Quality Control, borrowed from the West by the Japanese, was transformed through practice to make it more effective. It requires high commitment from management and workers and rests on relationship of trust.

Figure (2.2) shows the early awareness of the problem leads to faster detection of defects and reduces waste of time and material. The worker awareness of defect causation is highlighted. He also learns quickly whether the component leaving his work area is meeting the requirement of the next station. This acts as a natural motivating tool and is an inherent reward or penalty system to workers within the peer group. The visibility of defects also encourages looking into ways to improve the product and the process.

Realising the cause of the defect and rectifying it leads to further improvement of quality and/or removal of waste. Since the need to avoid an error is vital it calls for responsibility of each individual workers to do his work conscientiously.

Further, each worker is fully aware that a problem with his product can bring the entire plant to a stop. As all the workers at the shop floor have a quota to fill, a problem with one worker would lead to the group being unable to fulfil their quota. While this puts peer pressure on a worker to perform well, it also builds an attitude among co-workers, foremen, supervisors and floor managers to help a worker in trouble, as a delay will cause loss of time for everybody. Thus, while
making individual workers more responsible, it encourages team spirit and makes each worker responsive to resolve problems which may not be in his domain.

A committed worker will often carry his concern for defect, slowdown, bottleneck, and other problems back home or to other workers. This is encouraged by the management and resulted in formation of "quality circles" and small group activity which have helped in improvement of quality, production efficiency and work environment.

Table (2.2) gives the Total Quality Control methods at a glance. As the Table shows, quality control methods are employee centered. Total Quality implementation requires an employee to have quality awareness and understand the role he plays. It necessitates worker to be multi-skilled and work in teams. It requires downward devolution of authority.

**TABLE:2.2 Methods In Use For Total Quality Control**

<table>
<thead>
<tr>
<th>Methods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Andon status</td>
<td>An electronic board provides visibility of floor and information to help coordinate activity at several work station</td>
</tr>
<tr>
<td>Automation</td>
<td>Machines have autonomous</td>
</tr>
</tbody>
</table>

21 Compiled from various sources.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celebration</td>
<td>Accomplishments celebrated in open ceremony.</td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>All employees focus on on-going improvement.</td>
</tr>
<tr>
<td>Cross training</td>
<td>The workers are trained to handle several task and equipment.</td>
</tr>
<tr>
<td>Design</td>
<td>Work processes are experimented in many different combinations with the objective of optimizing them.</td>
</tr>
<tr>
<td>Employee</td>
<td>Employees are asked to suggest ideas to make improvements and are involved in implementing changes.</td>
</tr>
<tr>
<td>Fool proofing</td>
<td>Machines and fixtures are</td>
</tr>
<tr>
<td>Topic</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>House keeping</td>
<td>Work stations are cleaned and organised by the workers who work in the area</td>
</tr>
<tr>
<td>Kanban</td>
<td>Signalling device used to communicate the level of parts required between work in progress</td>
</tr>
<tr>
<td>Mini companies</td>
<td>Each process regards the preceding process as the supplier and the following process as the customer</td>
</tr>
<tr>
<td>Preventive</td>
<td>Machine utilisation is ensured through regular maintenance. Scheduled maintenance and early detection of abnormalities.</td>
</tr>
<tr>
<td>Problem</td>
<td>Root cause of a problem is identified through whys, how and modified so that inexperienced workers can master certain operations.</td>
</tr>
</tbody>
</table>
the use of fishbone chart and Pareto diagram techniques.

Quality circle  Small number of workers meet on regular basis for the purpose of uncovering and solving problems.

Quality rotation  Workers are rotated through different workstations to learn different types of quality problems.

Set-up reduction  Time required to prepare machine for new production is reduced.

Standardisation  Work processes are simplified and organised into common components across several different jobs.

Visual control  Inventories are controlled by having designated areas and designated levels that are visually detectable and obvious.
Visual management

Work related information is communicated through display at each work station and on the wall.

Work cell

A production line is laid out in a U-shape for the workers to handle multiple tasks and minimise time and distance.

CONTINUOUS IMPROVEMENT [KAIZEN]

*Kaizen* is probably the most innovative idea put across by Japanese management. To state simply, it means an improvement that is continuous. It is an on going process that involves the top management, the middle management and the workers. According to Imai, "the *kaizen* philosophy assumes that our way of life—be it our working life, our social life, or our home life—deserves to be constantly improved."\(^{22}\)

Any successful company operates at two levels. One, of maintaining the current standard and two, innovating on the current situation, for higher productivity. Maintenance means the company must establish procedures like policy rules, directives, and regulations for all major operations and ensure they are followed by one and all. If the given standard is found functional, but is not

\(^{22}\) Masaaki Imai, *The Key to Japan's Competitive Success*, 1986:p3
FIGURE: 2.3 Japanese perception of job functions

<table>
<thead>
<tr>
<th>Top Management</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Management</td>
<td>KAIZEN</td>
</tr>
<tr>
<td>Supervisors</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Workers</td>
<td></td>
</tr>
</tbody>
</table>
adhered to, the management has to discipline the workers. On the other hand if it is found that the workers are unable to follow the set standard, the management would have to review and decide if it can be done by training the workers or have the rule revised to suit workers, which is often shouldered by the worker. Innovation which results in higher productivity is often in the form of machinery or new process in production, and involves a section of the management or a division like R&D. Once an innovation takes place, it results in a spurt in productivity and the company is at a competitive advantage till other companies catch up. Once this time lag is over, there is a decline until another innovation takes place.

The Japanese production system has added a level between maintenance and innovative levels which they call *kaizen*. Between maintenance and innovation lies an area for continuous improvement (see fig (2.3)). This occurs when the worker not only does his job but also tries to improve upon it through individual suggestions or through group suggestions. Once the management approves it becomes the standard and the management is bound to ensure that it is followed. This improvement leads to a high standard of operation. Though innovation too is an improvement, it is drastic in nature, whereas *kaizen* is small in nature and often results in only a miniscule improvement. As figure (2.3) suggests *kaizen* improvement is achieved by contribution from all employees. It requires different inputs from the same employee. This is because at each level different problems are attended to. *Kaizen* practice can be divided into three categories, depending on complexity and level.
a. The management-oriented category

b. The group-oriented category

c. The individual-oriented category

Management Oriented Kaizen

Management oriented *kaizen* concentrates on logistics and strategic issues and provide thrust to *kaizen*. The manager who practices *kaizen* has to, not only, bring improvement his job but must also apply his judgement about the suggestions of improvement given by other employees. Thus, he is required to have knowledge and expertise of quality tools\(^{23}\) professional understanding and a broad based company information. Most of management oriented *kaizen* is project based and necessitate managers from different departments to work in teams. These projects tackle questions on facilities improvement, system development and procedural improvement. The objectives are usually efficiency in production, quality of product and elimination of waste. At the procedural level, concentration is on facility improvement like changing the factory layout for better efficiency, using tools and facility to maximise quality and efficiency and minimising effort by concentrating on areas to eliminate hard work and refine capacity planning. The system improvement focuses on planning and control, decision-making, organisational and information systems. These projects lead to greater productivity, upgradation of product and boost managerial performance.

\(^{23}\) See Appendix VII and IX.
**TABLE: 2.3** *Kaizen* at various levels

<table>
<thead>
<tr>
<th>Top Management</th>
<th>Middle Management</th>
<th>Supervisor</th>
<th>Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have the motivation to introduce kaizen</td>
<td>Deploy kaizen through policies and cross-functional management</td>
<td>Use kaizen tools and formulate plans to implement and guide workers in kaizen</td>
<td>Engage in Kaizen through suggestion system and small group activity</td>
</tr>
<tr>
<td>Build systems, procedures, and structure conducive to kaizen</td>
<td>Make employees kaizen conscious through training and develop tools for problem solving.</td>
<td>Improve communication channel with the workers. Introduce discipline and support workers in their endeavour</td>
<td>Continuously strive towards enhancing skills through training</td>
</tr>
</tbody>
</table>

Source: The Kaizen challenge. P 320

From Table (2.3) it is quite clear that management is central to the practice of *kaizen*. Since kaizen is ubiquitous, most of managers jobs pertains to it. *Kaizen* obligates continuous improvement and the managers look for areas where improvement can be brought about without large investment. Thus, often improvement is sought within the given constraints. This requires the managers to involve employees who are directly affected by it. The result of all this is that it
improves the system and proves beneficial to the workers and management and heightens communication and mutual bonding.

**Group-oriented kaizen**

Group-oriented *kaizen* involves a set of workers who form a team to identify the problem areas, find the causes, analyse them and establish new standards and procedure. Under *kaizen*, group activities focus on continuous improvement. The group-oriented *kaizen* works through the PDCA\(^{24}\) system. The members identify problems, set objectives, coordinate among themselves to achieve results. The members use various forms like the small group activities, QC circles and suggestion system\(^{25}\). The groups are trained to utilise analytical tools to solve problems. Motivated groups work in teams to solve problems and often use their leisure time to work on the problems. If problem involves other departments, the groups take the initiative to consult these to find a viable solution. The group-oriented *kaizen* is driven by team enthusiasm, with support from the management.

Two approaches to group activity can be found. In the permanent approach, the members of a group go through problem solving and decision-making process on problems that originates in their work place. The PDCA cycle (figure 2.1) thus has a PDCA cycle within it. The activities of the groups are confined to problems arising in their workshop. Under the temporary approach, ad hoc groups are formed to solve a particular problem. Often members of a temporary group are those who have some expertise about the problem area. They are some time trained to use

\(^{24}\) PDCA cycle is discussed in total quality control section. This tool is used in improvement of quality of product and is extended to improve quality of work environment under kaizen.

\(^{25}\) Discussed in chapter 3.
certain statistical and analytical tools to accomplish the task. Once the target is achieved the group is disbanded.

Group oriented kaizen is most popular because of its inherent characteristic of bringing employees together. By this activity, employees are encouraged to share and coordinate among themselves to solve problems. This builds teamwork and improves relations among themselves. Labour-management relations are greatly improved because as the management is often involved in dialogue with the groups about the improvements, a cooperative attitude is imbibed among employees.

**Individual oriented kaizen**

Individual kaizen is aimed at enhancing awareness of the individual worker, to his work. The individual is constantly in search of finding ways and means to improve his work. This allows for creativity to grow and makes the task he performs more challenging. The individual level has infinite scope for improvement and requires the individual to be alert to notice areas for improvement. Kaizen can be applied anywhere. All it requires is the will to improve upon the existing condition.

Application of kaizen by a set of canteen girls in Matsushita's plant\(^{26}\) is one such example. These girls wanted to use the concept as much as their counterparts in the shop floor. They wanted to tackle the problem of waste. They found that at the lunch break workers came to drink tea and the consumption was not uniform. After weeks of keeping account of the workers who came for tea, it was found

\(^{26}\) This example is drawn from Imai Masaki book on 'Kaizen the Key to Japan's Competitive success, Random house Division new York 1986. P20
that they usually came in groups and sat at the same table. Thus, the girls were able to identify tables that had large intake of tea and those seldom used. The canteen girls thus changed the amount of tea held in each pot according to the tables where these were placed, and eliminated the wastage of tea leaves. Here, cost reduction through kaizen was miniscule in the company balance sheet but the systematic process through which it was achieved got those girls the company award for kaizen.

The main concern in kaizen is the process through which improvement can be attained. The attitude towards work plays an important part and often the ultimate result is of little value. For instance, the example cited above in terms of result is insignificant, as the cost of tea leaves was insignificant to the company. But it was recognised and recorded because of the company's attitude towards continuous improvement. Kaizen focuses on process unlike the common practice, which gives stress on results. It is the effort that counts and it is essential for management to develop a system where workers are rewarded for their efforts. It is also of importance for management to distinguish between effort and result.

**Effect of Kaizen on employees**

Kaizen is a humanistic approach as it requires involvement of everybody towards improvement. Its philosophy is continuous improvement which helps in either cost or time reduction. It is people-oriented and directed towards effort. It often results in workers acquiring new knowledge and skill. It allows for creative
thinking and is a great motivator. Since *kaizen* is most popular as a group activity, it encourages teamwork and team building. Since workers work in groups it helps them share and coordinate their respective role better. Communication between workers and management is enhanced. As these groups become self-sustaining and solve problems that would otherwise be left to management the morale is greatly improved. At the managerial level, it necessitates a change in mind frame, providing for recognition of the workers' ability to find solutions, to work in cross-functional roles and to be open to changes during implementation of various plans. Effective implementation of *kaizen* ensures better communication at all levels, as there is continuous flow of information between the workers, supervisors and managers.

The organisational set up in this system gives paramount importance to consumer satisfaction and the focus is on integrating demand into the production process. Flow production and customer orientation requires product-focused production system and an organisation structure that supports it. Quality is best attained under small lot production. Re-engineering of the production system into cell type units with a flexible production process is essential. At the core of the organisation is a multi-tier communication channel, between employees and management, between management and subcontractors, between the lower rung of management and the top management and among employees themselves. Effective communication is possible when departmental and divisional boundaries are abolished and participatory decision-making is practiced. Thus the system encourages power to be transferred to the employee who is attending to the task.
It also gives preference to employees working in small groups under little direct supervision and each worker shares responsibility in giving quality work and strives for continuous improvement. Team working helps flow of information and effective decision-making. Establishment of long term relationship with the employees and subcontractors help in promoting quality.

While the mass production system relied on the physical dexterity of the employee, the Japanese production system requires an employee to be motivated, disciplined and conversant with a wide range of tasks. A high performing, well motivated team of individuals who believe in results and are prepared to take up challenges in the accomplishment of their tasks is, then, the prerequisite. This puts pressure on the organisation to device a human resource policy that empowers employees, eliminates waste and continuously improves all dimensions of organisational life. Quality workforce is the focus and it begins with recruitment.

FIGURE:2.4 DEVELOPMENT OF AN EMPLOYEE
Figure (2.4) shows recruiting the right kind of person who can adapt to the work environment of the company is the starting point. The next step is to make him quality conscious. This means that the performance of a given task should be done efficiently and there should also be a continuous attempt at improvement. The company is able to achieve this by synergy of an employee's knowledge and capability through training. Once trained, the employee is on the threshold of proving most productive and it is, therefore, essential to develop policies that encourage contribution and develop commitment to work. Finally, in the long run through various policies, loyalty is established so that the employee contributes to the company through not only skills acquired but also through experience gleaned by him in the organisation.

From the point of view of the employee, he gets training from the company which is mutually beneficial to both parties. The employees acquire skills that enhance their capability and reduce monotony by of getting an opportunity to work on a larger platform. In return for his contribution to the company, the employee is rewarded through various incentives. While contributing to the company's growth the employee also gains experience. The question of loyalty is of most significance because all the training after induction of an employee can prove costly if the employee leaves the company. Loyalty, in the form of long term involvement with the company, means sacrifice of better remuneration in another company. On the other hand, it means employment security. Thus long term loyalty to the employee is a trade-off situation. The company's human resource management practices are the deciding factor for long-term retention of an employee. The Japanese in the course of developing a production system also developed human resource management practices through which they were able to take care of employee's needs and prove their competitive worth.