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What is lean production?

LEAN PRODUCTION is an approach to production developed in Japan. Toyota, the Japanese car manufacturer, was the first company to adopt this approach. Its aim is to reduce the quantity of resources used up in production. Lean producers use less of everything, including factory space, materials, stocks, suppliers, labour, capital and time. As a result, lean production raises productivity and reduces costs. The number of defective products is reduced, lead times are cut and reliability improves. Lean producers are also able to design new products more quickly and can offer customers a wider range of products to choose from. Lean production involves using a range of practices designed to reduce waste and to improve productivity and quality.

Kaizen (continuous improvement)

KAIZEN is perhaps the most important concept in Japanese management. It means continuous improvement. Every aspect of life, including social life, working life and home life, is constantly improved. Everyone in the business is involved. Kaizen is said to be an 'umbrella concept'. A wide range of different production techniques and working practices must be carried out for it to be effective. Figure 1 shows examples of the techniques, principles and practices. They should result in ongoing improvements. This approach argues that a day should not pass without some kind of improvement being made

Figure 1: The kaizen umbrella



somewhere in the business.

There is a number of features of Kaizen which affect a business.

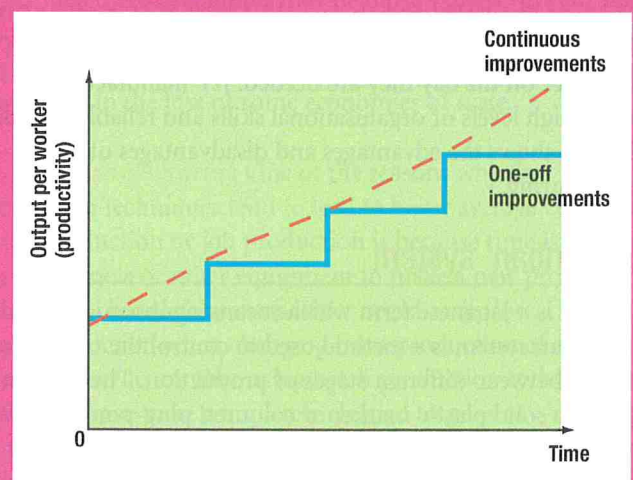
Continuous improvement Kaizen has been the main difference between the Japanese and the Western approaches to management in the past. The attempts of Western businesses to improve efficiency and quality have tended to be 'one-offs'. In Figure 2 the solid line illustrates the Western approach. Productivity remains the same for long periods of time, then suddenly rises. The increase is followed by another period of stability, before another rise. Increases in productivity may result from new working practices or new technology. The dotted line shows the Japanese approach. Improvements are continuous. They result from changes in production techniques which are introduced gradually.

Eliminating waste The elimination of waste (called muda in Japan) in business practices is an important part of Kaizen. Waste is any activity which raises costs without adding value to a product. Examples may be:

- time wasted while staff wait around before starting tasks, such as waiting for materials to arrive;
- time wasted when workers move unnecessarily in the workplace, such as walking to a central point in the factory to get tools;
- the irregular use of a machine, such as a machine which is only used once a month for a special order;
- excessive demands upon machines or workers, such as staff working overtime seven days a week which causes them to be tired and work poorly.

Firms that adopt the Kaizen approach train and reward

Figure 2: The Western and Japanese approaches to improvement



workers to continually search for waste and to suggest how it might be eliminated.

Implementing continuous improvement It is often difficult for workers in a business to look for continuous improvement all the time. Japanese businesses tried to solve this problem by introducing the PDCA (Plan, Do, Check, Action) cycle. It is a series of activities that lead to improvement.

- Plan. Businesses must identify where improvement is needed. Data must be gathered and used to develop a plan which will result in improvement.
- Do. Once the plan has been finalised it must be carried out. The plan is likely to be implemented by workers, on the production line perhaps.
- Check. The next stage in the cycle is to check whether or not there has been an improvement. This task may be carried out by inspectors.
- Action. If the plan has been successful, it must be introduced in all parts of the business.

Just-in-time manufacturing

JUST-IN-TIME (JIT) MANUFACTURING is an important part of lean production and the kaizen approach. It was developed in the Japanese shipbuilding industry in the 1950s and 1960s. The industry recognised that a great deal of money was tied up in stocks. Traditionally, one month's supply of steel was held by a shipyard. However, as the industry became more competitive, shipbuilders insisted that steel suppliers deliver orders 'just-in-time', i.e. a few hours or less before the steel was needed. This reduced the need for high levels of working capital and improved the financial performance of the business. JIT was extended to every stage of production. For example, raw materials were delivered JIT to be made into parts, parts were delivered JIT to be made into goods and goods were produced and delivered JIT to be sold.

JIT was introduced in other Japanese industries, such as the car industry, and then spread to other parts of the world, such as the USA and Europe. JCB has used JIT in its Rochester plant. When JCB excavators are manufactured, every machine on the production line has already been sold. Supplies of components, such as engines from Perkins, and raw materials, such as steel plate, arrive on the day they are needed. JIT manufacturing requires high levels of organisational skills and reliable suppliers.

Table 1 shows the advantages and disadvantages of JIT manufacturing.

The 'Kanban' system

KANBAN is a Japanese term which means signboards or cards. The Kanban system is a method used to control the transfer of materials between different stages of production. The kanban might be a solid plastic marker or coloured ping-pong ball. They might be used to:

- inform employees in the previous stage of production that a particular part must be taken from stocks and sent to a

specific destination (conveyance kanbans);

- tell employees involved in a particular operation that they can begin production and add their output to stock (production kanbans);
- instruct external suppliers to send parts to a destination (vendor kanbans).

Kanbans are used to trigger the movement or production of resources. Used properly, they will be the only means of authorising movement. Kanbans are an important part of JIT manufacturing as they prevent the build-up of stock or parts in a factory.

Time-based management

TIME-BASED MANAGEMENT involves reducing the amount of time businesses take to carry out certain tasks, such as launching new products or cutting lead times in production. Time-based management is a feature of lean production because it involves eliminating a type of waste, i.e. time. Time in business is a valuable resource. Productivity can be improved if tasks are carried out more quickly. Time-based management has a number of effects on a business.

Table 1: Advantages and disadvantages of JIT manufacturing

Advantages

- It improves cash flow since money is not tied up in stocks.
- The system reduces waste, obsolete and damaged stock.
- More factory space is made available for productive use.
- The costs of stockholding are reduced significantly.
- Links with and the control of suppliers are improved.
- The supplier base is reduced significantly.
- More scope for integration within the factory's computer system.
- The motivation of workers is improved. They are given more responsibility and encouraged to work in teams.

Disadvantages

- A lot of faith is placed in the reliability and flexibility of suppliers.
- Increased ordering and administration costs.
- Advantages of bulk buying may be lost.
- Vulnerable to a break in supply and machinery breakdowns.
- Difficult to cope with sharp increases in demand.
- Possible loss of reputation if customers are let down by late deliveries.

Focus on customer needs Customers are given a wide range of products to choose from, i.e. different models with different specifications. The same model car can be produced according to different specifications, such as different colours, engine sizes and trims. Manufacturers can achieve this by reducing the length of production runs. Shorter production runs will also allow a firm to cut customer lead times, so customers are not kept waiting.

Use other lean production methods Examples include:

- just-in-time manufacturing;
- simultaneous engineering
- Single Minute Exchange of Dies (SMED);
- flexible manufacturing.

These methods prevent delays on production lines, reduce stock levels and improve scheduling. This means employees are not waiting around for work to arrive.

Machines must be versatile They must be able to produce a variety of products and be adjusted to a range of settings. Settings must be changed quickly and easily to deal with shorter production runs.

Speed up the design process They do this by carrying out a number of design tasks simultaneously. The traditional approach to design is to carry out one task after another. However, time can be saved if design tasks can be completed at the same time. This is called SIMULTANEOUS ENGINEERING. It is a project management approach, not a method of production. Such an approach needs co-ordination and communication between each design team. This approach to speeding up the design process has been called LEAN DESIGN.

Mass producers argue that economies of scale will only be achieved and costs cut if products are standardised and production runs are long. Producing a variety of different models will lead to shorter production runs and higher average costs. Time-based management challenges this view. It may be possible to produce smaller quantities, because costs can be reduced by time savings.

There may be certain advantages for a business using a time-based management system.

- Customers will benefit. A wider range of products will be available and there will be faster delivery times. This might result in higher sales levels for the firm.
- Lean design will result in shorter lead times. This means that resources will be used more effectively and product development will be faster. This will give the business a competitive edge in the market.
- Other lean production techniques will increase efficiency, the quality of products will be improved and waste will be minimised.
- The time spent on a range of production tasks is reduced. This helps to improve productivity and reduce unit costs. As a result manufacturers may offer their products at lower prices or enjoy higher profit margins.

However, it could be argued that some costs might rise as a

Question 1.

New Balance Athletic Shoes (UK) Ltd is a US owned company producing a range of high performance athletic shoes. The business has been manufacturing in the UK since 1982 and moved to its current site in Flimby, near Workington, in 1991. New Balance had developed a five year strategic business plan to increase turnover from £70 million to £250 million. In order to achieve this, the manufacturing plant would have to triple the output of the one million pairs of shoes produced in 2005. Land was acquired adjacent to the current site to build another factory unit and the management team was looking for new ways to increase capacity and productivity.

The company employed a consultant to run a series of team workshops with process workers to introduce the basic principles of lean manufacturing. These teams were then challenged to analyse their current process, which led to the development of a new cellular layout requiring 35 per cent less space and only four operatives instead of five. The total work content was balanced between the four operatives to create product flow around the cell. Once the cell footprint had been agreed, a new future state 'ideal' factory layout was developed to convert freed up space into additional cells. The switch to lean production generated a number of benefits for the company.

- Output increased from 10 to 14 pairs of shoes per person per hour.
- Cell teams reduced from five to four people.
- Thirty five per cent reduction in space taken up by manufacturing cell.
- New cells created.
- £1.5 million positive cost variance compared to 2005 manufacturing costs.
- £1.5 million cost avoidance, as there was no longer any requirement to build an additional factory.

Source: adapted from www.mas.dti.gov.uk.

- Using this case as an example, explain what is meant by cell production.
- Explain why cell production lends itself well to teamworking.
- How did the introduction of cell production benefit New Balance Athletic Shoes Ltd?

result of using time-based management. The versatile machinery which this method requires may be more expensive. Staff may also need to be trained in a wider range of skills and tasks to cope with the flexibility in production. Shorter production runs may result in the loss of some economies of scale.

Flexible manufacturing One of the reasons why flow production techniques tend to lead to lower average costs than batch production or job production is because time is not lost changing tools or other equipment to make a new product. For example, a chocolate manufacturer could easily lose a day or two days' production when changing from production of one chocolate bar to another using batch production techniques. Machines have to be completely cleaned to prevent contamination and tooling within the machines has to be changed.

FLEXIBLE MANUFACTURING aims to reduce or even

eliminate changeover time from one product to another so that it becomes as cheap to produce 10 units of one item, 8 of another, and 12 of a third as it is to produce 30 units of the same item. On a car production line, the ideal is for every car produced to be unique. It might be the same model with different specifications. Or it might be two or more models being made at the same time. Flexible manufacturing is achieved by using equipment which can be changed from one use to another use very quickly and ideally instantaneously. It also means that workers must be flexible too, having the skills to deal with different products. Flexible manufacturing requires the back-up of other lean production techniques. For example, on a vehicle production line, if there are 14 different sets of doors

fitted during a shift, each a different colour, then there must be just-in-time production techniques used to deliver those doors to that work station at the right time. Otherwise flexible manufacturing would require huge levels of stocks. Similarly, every worker must be responsible for the quality of work done.

Just-in-time production Just-in-time (JIT) manufacturing can be seen as another example of time-based management. JIT cuts the amount of time that stocks are held by a business. In a car manufacturing company, for example, car seats may have been held on average 10 days at the factory in the 1970s before being assembled inside a car. Today, the average stock time held may be three hours because seats are being delivered three times a day to the car plant.

Empowerment

Empowerment involves giving employees the power to make decisions in a business. The aim of empowerment is to give employees more control over their own work conditions. Workers in the past have tended to follow the instructions of managers. They were rarely required to think, make decisions, solve problems or work creatively. There was often conflict between management and workers, and little co-operation and team-spirit.

In recent years many businesses have learned that efficiency will improve if workers are given the opportunity to involve themselves in decision making. Workers will be better motivated and the business may gain from the creativity of its workers. Workers may also be more flexible and adaptable. For example, a worker may speak directly to a customer about changes in an order. For empowerment to be successful, managers must have faith in their workforce. They must also trust them and work in partnership without conflict.

Empowerment is not without difficulties. Some workers may not be able to make their own decisions and training may be required to teach them such skills. Managers may resent giving up authority. Some staff may even abuse their power to make decisions.

Teamworking

A growing number of businesses are introducing teamworking into their organisations. This involves dividing the workforce into fairly small groups. Each team will focus on a particular area of production and team members will have the same common aims. Teamworking probably works best in businesses that do not have a hierarchical structure and which have an organisational culture which supports group work. Effective teamworking requires co-operation between workers and management, training for staff and decision making responsibility for workers.

Both the business and its employees might benefit from teamwork. Workers should develop relationships with colleagues and a 'team spirit' which may improve motivation and productivity. Flexibility might improve. For example, team

Question 2.

Jenx Ltd is one of the UK's longest established companies designing innovative, therapeutic and development products for children with spinal problems. The company was founded in 1982 and is still run by a Paediatric Physiotherapist and her husband. The company sells its products to over twenty countries worldwide and is committed to a continuous process of review and improvement to offer children the best products available.

After attending a lean training workshop in 2005, Mr Jenkins learned about lean production and the importance of developing an improvement plan. He could see where this could potentially help his business to improve, develop and grow. The key objective from the outset was to involve employees in an improvement programme that allowed them to learn how to make and sustain their own improvements. A team was formed in the machine shop and they were taught the fundamentals of lean manufacturing. This set the foundations for implementing a 5S improvement programme in the machine shop. It was felt that this would help to create a better working environment, improve productivity and provide the best way forward for a programme of change.

As a result of the 15 day 5S Improvement Project, the company has achieved the following.

- Noticeable change in employee commitment and contribution to business improvement.
- Gross value added has increased by £60,000, and productivity by 15 per cent, as a result of the creation of manufacturing cells.
- Distance travelled to manufacture products has reduced from 80 metres to 5 metres (93 per cent).
- Manufacturing finishing cells have been developed and lead times have reduced (60 per cent).
- Stock and WIP (work in progress) has reduced.
- Investment in a new extraction system and sawing equipment has been made.
- Work flow and space utilisation has improved by 20 per cent

Source: adapted from www.mas.dti.gov.uk.

- (a) Which lean production method may have been used to reduce stock and WIP?
- (b) What is meant by 5S?
- (c) How did the implementation of 5S help Jenx Ltd?

members might be more willing to cover for an absent colleague. Teams might plan their own work schedules, share out tasks, choose their methods of work and solve their own problems. This should lead to quicker decision making and the generation of more ideas. It is also suggested that communication and labour relations may improve as a result of teamworking. However, there may be conflict between team members and managers may resent the responsibility delegated to teams. Teamwork also results to some extent in a loss of specialisation among workers, which is often found in flow or mass production techniques.

Cellular manufacturing

Flow production involves mass producing a standard product on a production line. The product undergoes a series of operations in sequence on a continuous basis until a finished product rolls off the 'end of the line'.

CELLULAR MANUFACTURING or CELL PRODUCTION adopts a different approach and involves dividing the workplace into 'cells'. Each cell occupies an area on the factory floor and focuses on the production of a 'product family'. A 'product family' is a group of products which requires a sequence of similar operations. For example, the metal body part of a machine might require the operations cut, punch, fold, spot weld, dispatch. This could all be carried out in one cell. Inside a cell, machines are grouped together and a team of workers sees the production of a good from start to finish.

Take the example of a furniture manufacturer making parts for a kitchen range in a cell. The raw material, such as wood, would be brought into the cell. Tasks such as turning on a lathe or shaping by routing would be carried out at workstations. The part would then be assembled and passed on to stock. The cell may also be responsible for tasks such as designing, schedule planning, maintenance and problem solving, as well as the manufacturing tasks which are shared by the team.

The advantages of cellular manufacturing include:

- floor space is released because cells use less space than a linear production line;
- product flexibility is improved;
- lead times are cut;
- movement of resources and handling time is reduced;
- there is less work-in-progress;
- teamworking is encouraged;
- there may be a safer working environment and more efficient maintenance.

Benchmarking

BEST PRACTICE BENCHMARKING (BPB) is a technique used by some businesses to help them discover the 'best' methods of production available and then adopt them. BPB involves:

- finding out what makes the difference, in the customer's eyes, between an ordinary supplier and an excellent supplier;
- setting standards for business operations based on the best

practice that can be found;

- finding out how these best companies meet those standards;
- applying both competitors' standards and their own to meet the new standards and, if possible, to exceed them.

Figure 3 illustrates the five main steps in BPB. The first step is to **identify** exactly what the company intends to benchmark. Benchmarks that are important for customer satisfaction might include consistency of product, correct invoices, shorter delivery times, shorter lead times and improved after-sales service. For example, Motorola, the communications company, has benchmarked the yield and product characteristics of a range of its activities including its assembly, warehousing and purchasing performance.

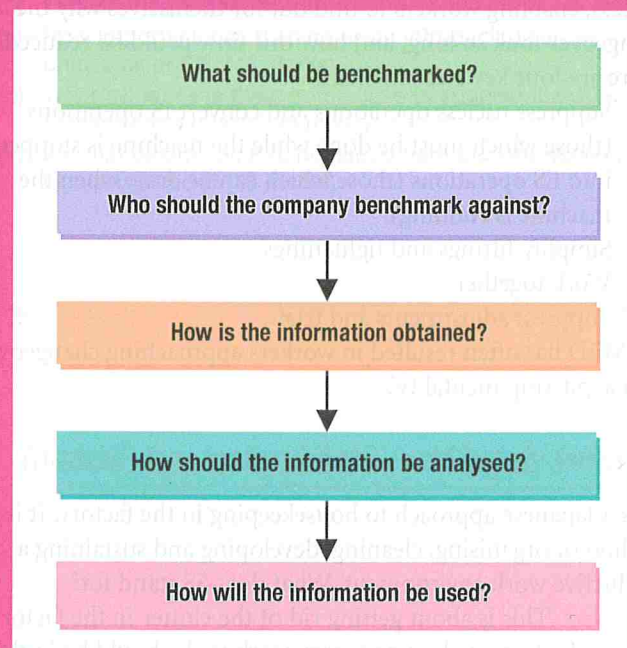
The second step involves **choosing a company** to set the benchmark against. This may be done by asking customers who they feel is the best in the field. Business analysts, journalists, stockbrokers or industrialists may also be used. Rank Xerox and Centreparc, the leisure group, have used other parts of their own organisations which have developed a reputation for excellence.

In the third step, information can be **gathered** from a number of sources, such as magazines, newspapers, trade association reports, specialist databases, customers and suppliers. Companies in the same industry often share information. An example may be businesses supplying local markets, such as garden centres. The benefits of this are that the worst performers can get advice from the best and perhaps visit their premises.

The **analysis** of information is best done with quantitative techniques. For example, a firm might compare numerical data relating to delivery times.

The final stage involves **using** the information. Once

Figure 3: A summary of the steps involved in benchmarking



standards have been found and set, they must be communicated throughout the business. Improvements must be funded, introduced and monitored. Once a company becomes the best in the field others will begin to benchmark against them. This means the company must continue to benchmark its own process.

Six Sigma

Six Sigma is a Japanese method developed by Motorola. It takes its name from the Greek letter 'sigma' used in statistics to indicate standard deviation. It is a statistical approach designed to eliminate defects in processes. A process must not produce more than 3.4 defects per million. A Six Sigma defect is defined as anything that fails to match customer specifications. Six Sigma involves collecting data on performance in processes and then evaluating it. Businesses can reduce variations in performance by using one of two Six Sigma approaches. DMAIC (define, measure, analyse, improve, control) is an improvement system for existing processes that result in too many defects. DMADV (define, measure, analyse, design, verify) is an improvement system used to develop new processes.

Single Minute Exchange of Dies (SMED)

Many manufacturers are under pressure to offer a wider variety of products. This has resulted in companies having to reduce the size of the batches they produce. So it is important to reduce changeover or set-up time. Bottling industries can spend more than 20 per cent of production time on changeovers, for example. Single Minute Exchange of Dies (SMED) is an approach to reduce output and quality losses due to changeovers. It was developed in Japan by Shigeo Shingo and has allowed companies to reduce changeover times from hours to minutes. He developed a method to analyse the changeover process, enabling workers to find out for themselves why the changeover took so long, and how this time could be reduced. There are four key steps in SMED.

- Suppress useless operations and convert IS operations (those which must be done while the machine is stopped) into ES operations (those which can be done when the machine is running).
- Simplify fittings and tightenings.
- Work together.
- Suppress adjustments and trials.

SMED has often resulted in workers approaching changeovers with a 'pit-stop mentality'.

5S (Sort, Set, Shine, Standardise and Sustain)

5S is a Japanese approach to housekeeping in the factory. It is a method of organising, cleaning, developing and sustaining a productive work environment. What does 5S stand for?

- **Sort.** This is about getting rid of the clutter in the factory. Only items such as necessary work tools should be in the factory environment. All other items, such as excess

inventory, should be removed.

- **Set in order.** The work area should be organised so that it is easy to find what is needed.
- **Shine.** This is to do with keeping the work area clean. Make it 'shine'.
- **Standardise.** Once the most effective cleaning and sorting methods have been established, they should be used as standards for the whole factory.
- **Sustain.** Mechanisms should be implemented to ensure that the standards achieved are recognised by everyone and used in the future.

This approach has helped businesses to improve efficiency because the work environment is less cluttered and more organised.

KEYTERMS

Best practice benchmarking – imitating the standards of an established leader in quality and attempting to better them.

Cellular manufacturing or cell production – involves producing a 'family of products' in a small self-contained unit (a cell) within a factory.

Flexible manufacturing – a system designed to allow a number of products and product variants to be produced using the same resources over a short space of time.

Just-in-time manufacturing – a production technique which is highly responsive to customer orders and uses very little stock holding.

Kanban – a card which acts as a signal to move or provide resources in a factory.

Kaizen – a Japanese term which means continuous improvement.

Lean design – keeping the resources and time used in the design process to a minimum.

Lean production – an approach to operations management aimed at reducing the quantity of resources used up in production.

Simultaneous engineering – an approach to project management where some, or all of the tasks involved in a project, are carried out at the same time.

Time-based-management – involves setting strict time limits in which tasks must be completed.

KNOWLEDGE

1. What are the aims of lean production?
2. What is meant by the Kaizen umbrella?
3. Explain the purpose of the PDCA cycle.
4. Describe four advantages of JIT manufacturing.
5. What is the purpose of the Kanban system?
6. Describe the three principles of time-based manufacturing.
7. What are the advantages of time-based manufacturing?
8. Give two advantages and two disadvantages of empowerment.
9. Why is teamworking a growing trend in businesses?
10. Describe how cellular manufacturing works.