

Pearson BTEC Level 5 Higher Nationals in Engineering (RQF)

Unit 49: Lean Manufacturing

Unit Workbook 1

in a series of 4 for this unit

Learning Outcome 1

Common Principles of Lean Manufacturing

1.1 Lean Manufacturing

Lean manufacturing is a term that has been brought out using a philosophy adopted by Toyota, their well-planned and organised philosophies when it comes to the production line have put them in a prime position to become the largest automobile manufacturer in terms of sales.

1.1.1 What is Lean Manufacturing?

Lean manufacturing is the continuous optimisation of the manufacturing process to minimise the amount of waste produced, without any compromise to the productivity of the production line. Waste, from a manufacturing perspective, is any activity that does not add value from the customer's perspective.

A study conducted by the Lean Enterprise Research Centre has concluded that roughly 60% of production activities add no value to the product for the customer. Considering this value, production lines are able to shave off a lot of waste, and develop higher quality products at a significantly lower cost. Which will improve the business across a number of areas.

1.1.2 Origins of Lean Manufacturing

One of the biggest steps in the manufacturing process was the mass production line introduced by Henry Ford in 1913. Ford took the idea of interchangeable parts, along with creating a linear production line with special purpose machines to assemble individual components within a matter of minutes. Ford's production lines produced an incredible output, and could turn over a full inventory of materials within a matter of days.

The Model T, shown in Fig.1.1 was the manufactured product of Ford's production lines. Before the Model T, cars were a luxury item owned by the rich, the goal of the Model T was to bridge the gap across the classes, and make cars available for everyone. The Model T initially cost \$850 in 1909 (around £13,400 today) and available in a range of colours. Henry Ford's biography tells of his vision for the Model T...

"I will build a motor car for the great multitude. It will be large enough for the family but small enough for the individual to run and care for. It will be constructed of the best materials, by the best men to be hired, after the simplest designs that modern engineering can devise. But it will be so low in price that no man making a good salary will be unable to own one – and enjoy with his family the blessing of hours of pleasure in God's great open spaces."

Ford had incredible faith in his product to revolutionise the automotive sector, and shockingly announced in 1909 that the company will build one model, the Model T, the production process was to be as simple with as little variance as possible with his famous remark:

"Any customer can have a car painted any colour that he wants so long as it is black."



Figure 1.1: The 1909 Ford Model T

Ford's mass production philosophies were hugely successful at increasing the production rate, at the introduction in 1913, the production numbers were greater than the total from the past four years. By 1914, the production lines were able to produce thousands of the Model T every week and in 1924 the River Rouge Plant in Michigan could produce 10,000 engine blocks for the Model T every day. The total number of Model T's purchased is around 15 million over a 19-year period with the cost reaching as low as \$300, and accounted for roughly 40% of cars on the roads in the United States. Fig.1.2 shows the annual production output for the Model T, and a comparison of its price customers paid.

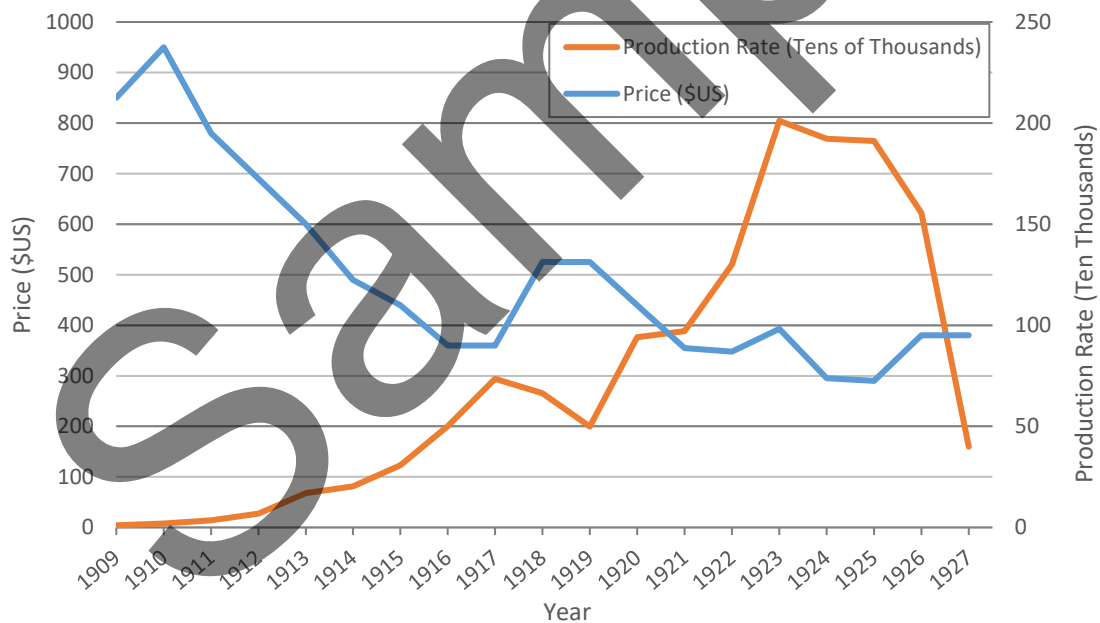


Figure 1.2: Production rate and price of the Model T by year

The trend of the production rate takes an unexpected dip after 1916, and the cost jumps up, why would this be the case?

The Model T for all its success, had one problem, it was inflexible; Ford stood by the idea of any car as long as its black, and that was the only colour available off the production lines after 1913. As machining techniques advanced, other companies were able to compete with production rates and Henry Ford was not

willing to move with the times. The Ford production line was dependent on labour force that was desperate for money and ready to do whatever it takes for a wage. The formation of labour unions and the prosperity that came about during the “Roaring 20s” conflicted with the exploitation of workers that Ford relied on. Some elements of Ford’s production line were adopted by other companies, including General Motors, and with their wider variety of models and colours, became the dominant force in the market in the 1930s.

Years of market dominance from Ford was no accident, but the crucial flaw was the inflexibility of the production lines, a 19-year cycle life of the Model T, with no updates to the design, was too long. It occurred to some at Toyota, however, that through a series of innovations in the production process, it could be possible to provide continuity in the production (the reason that the Model T could be sold so cheaply) and also incorporate a wide variety of products. Revisiting Ford’s concepts, they developed the “Toyota Production System”, which will be discussed in more detail in Work book 2.

1.1.3 Principles of Lean Management

The principles of lean management is not a point-to-point process, it is a continuous cycle of development and improvement. The cycle can be broken down into five principles, shown in Fig.1.3.

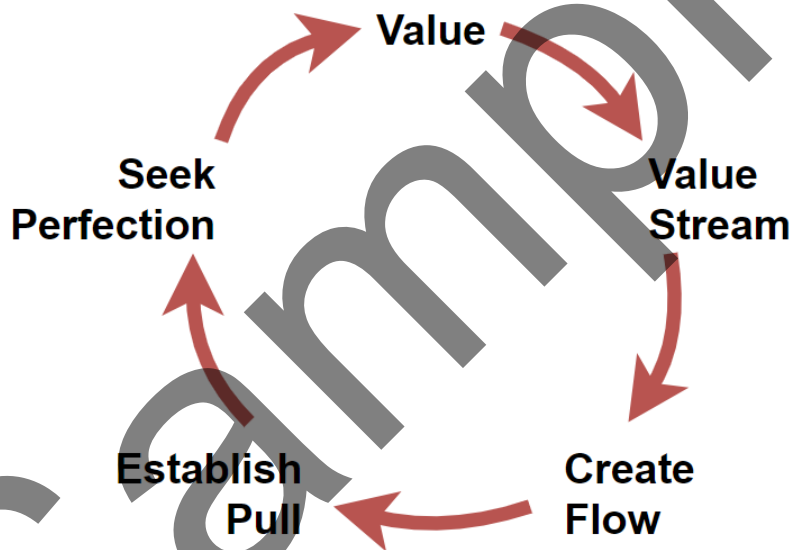


Figure 1.3: Five principles of lean manufacturing

- 1. Value:** Value is always defined as the customer’s need. Obviously, this can change depending on the market or sector, but determining the value should answer questions such as:
 - What is the timeline between manufacturing and delivery?
 - What Price?
 - What are important requirements or expectations of the product?
- 2. Value Stream:** *Other works may refer to this step as “process re-engineering”.* With the end goal defined (from the value stage) the route to achieve this goal should be plotted. It is important to break down each step across each department, whether it is design, procurement, delivery, customer service, production, or even HR and administration. By mapping out the entire process of the product, it is then possible to spot the waste (the processes that do not add value to the product) and develop

If customers are satisfied with the purchased product, they are more than happy to keep coming back and purchasing more from the company due to their reputation. Which of course means that the company will earn more and more from sales, which will boost the company value, an increase in the company value will translate into higher share prices or higher dividends per share.

This is only considering customer sales. Remembering lean manufacturing will remove all waste from the manufacturing process, there will also be a reduction in the production costs, providing a further boost in profits.

1.2.4 Cycle of Prosperity

If lean manufacturing is done correctly, there is no end to the benefits. Fig.1.4 shows a simple graphic of the cycle of prosperity.

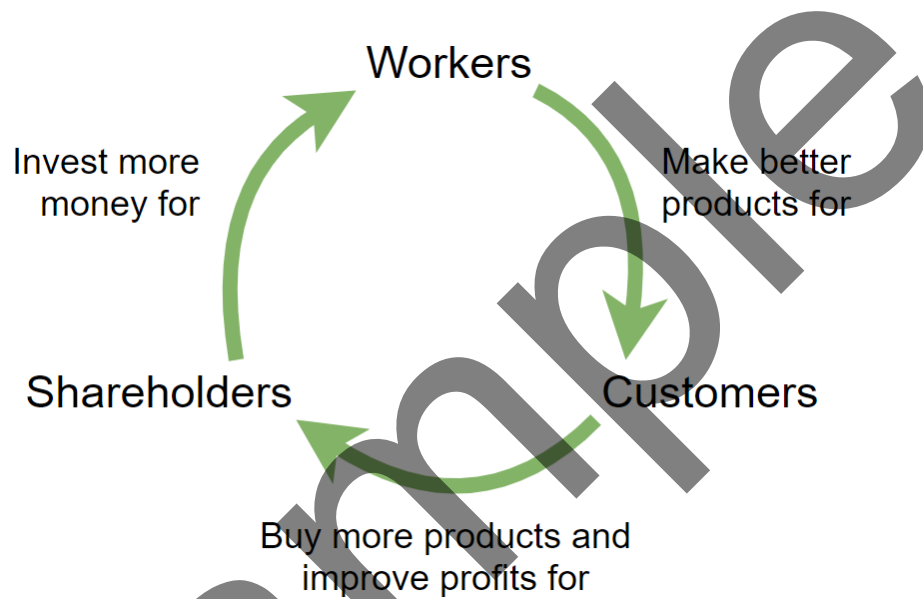


Figure 1.4: The cycle of prosperity

(It's also worth noting that there are more factors that drive customer sales, such as competitor's actions, new marketing techniques, etc. Businesses will most likely need to complete several analytical techniques such as a SWOT or a PESTLE analysis)

Fig.1.4 explains that if the quality of the products from the production lines improves, more customers are going to purchase products; as sales go up, the company earns more money; as the company earns more money, the production lines will be improved with better equipment, more workers, or happier workers; which will then further improve the quality of products; and so on...

This cycle only looks at the prosperity of one company selling their products, what if Fig.1.4 was expanded to include the supply chain. The supply chain has four major players: the customers, retailers, manufacturers and suppliers *(this can vary in certain circumstances, as the manufacturer could also be the retailer, or sometimes even the supplier)*.

A similar principle applies:

- Customers purchase more products from the retailer;
- Retailers place larger orders to the manufacturer to meet the demand;

- Manufacturers place larger orders to the suppliers to meet the demand.

Fig.1.5 shows a diagram for an expanded cycle for the supply chain.

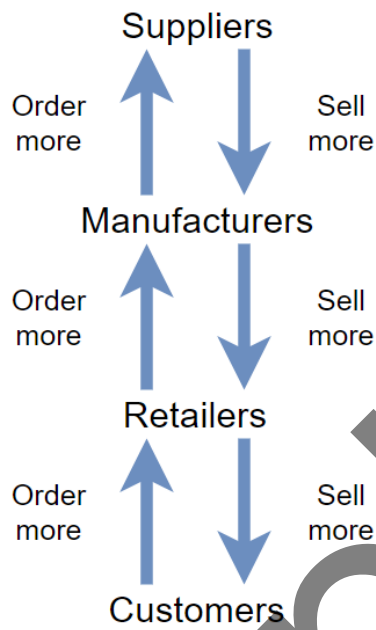


Figure 1.5: The supply chain cycle of prosperity

1.3 Lean Manufacturing Challenges

The benefits of lean manufacturing sound as though every company should adopt this policy for their manufacturing processes. Lean manufacturing is a difficult culture to instil into a company, and the philosophy itself is a long and difficult process.

1.3.1 Change

Everyone has been there, whether it is a New Year's resolution, a promise for Lent or just the desire for improvement; making a big change is difficult, whether it is a new diet, committing to the gym or giving up a bad habit. According to a study in the US, 80% of new years resolutions fail by February, this is just changing the mindset of one person, it is going to be much more difficult to change the entire culture of a company. If a company is going to change, then change management will need to be administered.

1.3.2 The “Burning Platform”

Introducing lean management is a radical change in the organisation, and to start driving a radical change, there needs to be an urgency, which brings onto the idea of the “burning platform”. The burning platform is a simple idea, if someone is on a burning platform, they are going to act quickly to try and survive. While this is a grim metaphor, one of the most effective motivation techniques is to send a “pain message”. The burning platform metaphor is applied in situations where:

- There is a real and immediate crisis
- There is a limited number of difficult and challenging choices
- Each choice is irreversible
- Each choice has a high risk of failure

The metaphor is from a real situation, the Piper Alpha oil rig disaster on July 6th, 1988. At the time, Piper Alpha was Britain's biggest oil and gas producing platform, producing over 300,000 barrels of crude oil every day off the coast of Aberdeen. Unfortunately, a lack of communication between different shifts meant that an unsafe gas pipe was used, which triggered an explosion. With reports saying that the blaze from the platform reached 90 metres and could be seen from 100 km away.

The disaster cost the lives of 167 out of the 228 workers either on the rig or in the standby safety vessels. But the analogy in particular looks at three of the workers, who trapped themselves in a room to wait for the fire to be extinguished, once they realised that the fire would not be extinguished in time for them to survive in the room, they ran to the platforms edge, and they were faced with two difficult choices.

1. Do nothing, stay on the platform, risk the heat from the flames and wait for help by air.
2. Jump into the water, risk hypothermia from the freezing North Sea and wait for help by sea.

Both options were dangerous, and there was no guarantee that either option would save their lives. Two of the workers jumped into the sea, whilst the third stayed on the platform. The two that jumped were rescued with terrible injuries, thanks to the rescue operations on the sea. The third worker did not survive as helicopters could not arrive in time.

The tragic story does have some lessons about the need to respond positively and proactively to serious challenges. It brings an idea of an unacceptable option of staying the same