LEAN AND AGILE SUPPLY CHAIN

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Changing customer and technological requirements, volatile markets and global sourcing have created fresh challenges to supply chain management, and the traditional forecast-driven longer and slower logistic pipelines are becoming non-competitive and therefore unsustainable. As the first in a series of articles on various aspects of lean and agile supply chain application, this article discusses the most important basic principles of how to respond to this challenge by lean production and a lean and agile supply chain.

With real time access through the internet and with increased global competition, customers have high expectations. They demand greater speed, more product variety, dependable performance and quality at a best in class and at a competitive price. And they expect fulfilment of demand almost instantly. The risk attached to traditional forecast-driven long supply lines has become untenable for consumer products.

A Google search shows that *lean supply chain* is not unknown in the brewing industry. In recent years, Coors in South Africa, Carlsberg in Denmark, Guinness (Diageo) in Ireland, and brewers in Australia, New Zealand and the Netherlands have installed supply chain software, including ERP systems for forecasting, 'improved visibility' of resources, aggregation of data to generate performance metrics and so on. For example, in 2009, South African Breweries Ltd are reported to have committed to a Supply Chain Management system to be deployed throughout their operations including 70 warehouses and 12 production plants. It is claimed that this will improve accuracy of forecasting, visibility of resources, on-time delivery performance and will reduce inventory holdings.

In their 'pure' form, the two models of supply chain are 'Push' and 'Pull' (See Figure 1).

Push represents the traditional supply chain model.
Characteristics are:

- Protection of market, and aims for market leadership
- Is forecast-driven
- Has a higher emphasis on customer service than cost, and
- Inventory is held to buffer fluctuations in demand and lead times

Pull aims for a lean and agile supply chain.
Characteristics are:

- Integration upstream with suppliers
- Integration downstream with customers
- High emphasis on efficiency
- Aims for reduced stock holding
- Achieves flexibility and speed in reacting to unpredictable demand

With *lean and agile*, the aim is to be demand-driven in scheduling production rather than relying on long-term forecasts, but, obviously, some broad-based forecasts will be necessary. In this paper, we will consider two stages in achieving a lean and agile supply chain. The first stage is getting our own house in order, the second stage considers upstream and downstream integration to achieve a lean and agile supply chain.

LEAN PRODUCTION

With a true just in time *Lean* operation, materials flow 'like water' from the supplier through the production process and onto the customer with little, if any, stock of raw materials in warehouses, with no buffer stocks of materials and part-finished goods between stages of the manufacturing process,

and no output stock of finished goods. This *just in time* approach requires that materials arrive from dedicated suppliers to production at the right stage of the process just when required, and when the production process is completed that the finished product is shipped directly to the next stage in the supply chain. With no spare or safety stock in the system, there is no room for error. Scheduling of activities and resource has to be exact, communication with suppliers must be precise, and suppliers need to be reliable. Materials have to arrive on time, in the correct quantity and meet specification. The plant has to be maintained so that there is no downtime. Workers have to be well-trained and cannot make mistakes; there is no allowance for waste, mistakes, and idle time. Finally, the finished product has to be delivered to specification (quality and quantity) on time.

A lean approach reduces the number of supervisors and quality inspectors. The workers are trained to know the production standards required and are authorised to take corrective action; in short, they become their own inspectors/supervisors. Maintenance of plant is planned to be preventative and to minimise downtime. As a result, the equipment becomes more reliable and each worker develops pride of 'ownership' of 'their' plant and equipment.

Until recently, supply chains were understood primarily in terms of planning demand forecasts, upstream collaboration with suppliers and planning and scheduling resources to meet demand. Cost reduction is often the key driver for Lean, but it is also about speed of delivery and quality of products and service to the customer. Note that the customer need not be the end user, but the next stage in the supply chain. The competition for gaining and retaining customers and market share is between supply chains rather than against a competing brand. Each stage of a supply chain therefore has to be lean with four interrelated key characteristics or objectives:

1. Elimination of waste
2. Smooth operation flow
3. High level of efficiency
4. Quality assurance

Elimination of waste

One obvious area of waste is in holding excess inventory. Inventory reduction efforts include use of *Enterprise Resource Planning*, *Just-In-Time* and integrated supply chain management, but there is still plenty of room for improvement. It has been found that most manufacturers carry at least 25 per cent more inventory than they really require.

Before anything can be eliminated it first has to be identified. The Toyota approach was to identify areas of waste classified into seven 'mudas'. Figure 2, drawing on Toyotas original seven mudas, identifies eight types of waste. Note inventory is only one of the wastes. Having identified where waste occurs the next step is to identify the cause. Once the cause has been eliminated, the effect will not re-occur.

Cycle time or lead time reduction is an area for waste reduction. The cycle time required to process a customer order might start with the customer phone call and end with the order being shipped. The overall process is made up of many sub-processes such as order entry, assembly, inspection, packaging, and shipping. Reducing cycle time requires eliminating or reducing non-value-added activity. An example of non-value-added activity is plant downtime and includes time taken for change-over, set-up, inspection, and waiting for approval. One method for cycle time reduction is Quick Response Manufacturing (QRM). QRM is underpinned by →

THE PUSH PULL SUPPLY CHAIN

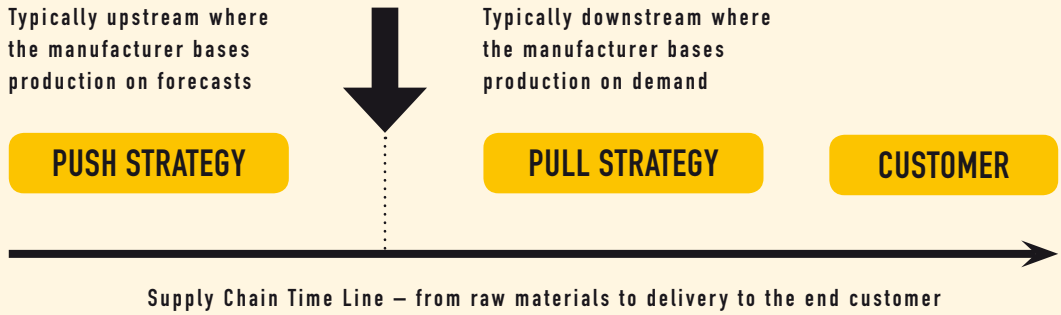

FIGURE 1

Source: AUT University

PROBLEMS OF NON-VALUE ADDED ACTIVITIES – EIGHT TYPES OF WASTE

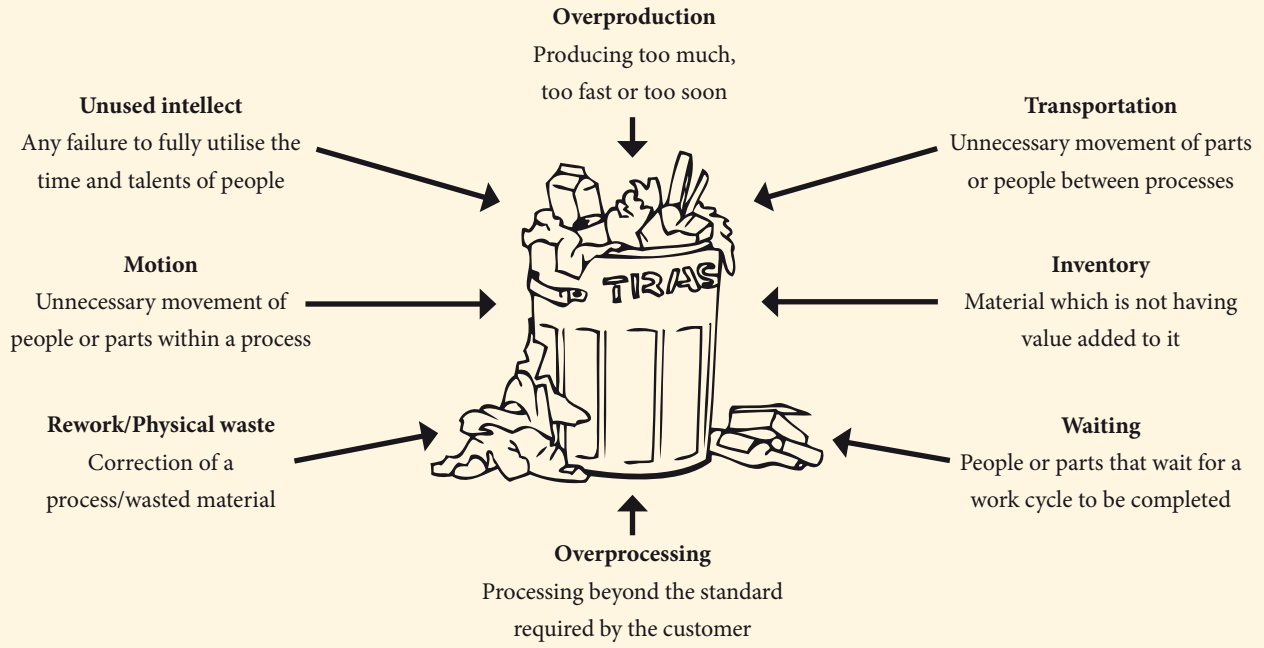

FIGURE 2

two key principles. First, plan to operate at 80 per cent or no less than 70 per cent capacity of key resources. Second, measure lead times and treat as a key performance measure.

The reduction of cycle time has become an important feature of lean thinking beyond manufacturing industries; in call centres, for example, there is extensive application of value analysis around process mapping charts. Through the development of multi-skilled workers, the aim is to overlap activities, reduce activity durations through cycle time studies and to reduce work-in-process.

Smooth operational flow

To achieve smooth flow in a process, bottlenecks are eliminated, process times of work stations are balanced, and there is little buffer of inventories between operations. Smooth operation flow requires the applications of appropriate approaches. When demand is predictable and there is low product variety with high volume, an optimum batch size is calculated starting with the most critical work stations and the largest inventory carrying costs. Action is taken for improvement at each work station. *The theory of constraints* (TOC), developed by Goldratt in 1992, is an approach to achieve a smooth flow of production. With TOC, the objective is to identify and eliminate bottlenecks. For companies that employ skilled workers and for many service organisations, the constraint is often the time required by one or a few key employees to complete a step in the overall process. The key steps with TOC are:

1. Identify the area of constraint (the work station that is the bottleneck for following stages in the supply chain)
2. Determine the throughput per unit of the area of constraint
3. Reduce resources at a non-constrained workstation (one with spare capacity) so that there is no idle time or build-up of material at that work stage
4. Find ways to increase capacity of the constraint area. This does not have to include capital expenditure. For example, continuous production with relief workers during normal meal break periods, and perhaps extra shifts etc., will increase throughput.
5. Go back to step 1. Once a constraint has been eliminated, it is likely that new areas of constraint will emerge.

The smooth operation flow of materials and products requires sufficient machine and resource availability. Experience shows that for many companies plant uptime cannot be assumed. In order to make lean concepts work, the old approach of measuring labour efficiency (e.g. the ratio of standard hours and hours worked) has now shifted to the efficiency of machines and plant and the control of work station bottlenecks.

> REDUCING CYCLE TIME REQUIRES ELIMINATING OR REDUCING NON-VALUE-ADDED ACTIVITY. AN EXAMPLE OF NON-VALUE-ADDED ACTIVITY IS PLANT DOWNTIME AND INCLUDES TIME TAKEN FOR CHANGE-OVER, SET-UP, INSPECTION, AND WAITING FOR APPROVAL.

High efficiency level

Total productive maintenance (TPM) is a proven Japanese approach to maximising overall equipment effectiveness and utilisation, and relies on attention to detail in all aspects of manufacturing. TPM includes operators looking after their own maintenance and thus encourages empowerment. TPM includes more than maintenance, it addresses all aspects of manufacturing. The two primary goals of TPM are to develop optimum conditions for the factory through a self-help people/machine system culture and to improve the overall quality of the workplace. It involves every employee in the factory. Success relies on sustained management commitment. In TPM 'six big losses' have been identified. These are (i) breakdown, (ii) set-up and adjustment, (iii) minor stoppages, (iv) reduced speed, (v) quality defects and (vi) start-up and shut-down.

The process of autonomous maintenance is to encourage operators to care for their equipment by performing daily checks, cleaning, lubrication, adjustments, size changes, simple repairs and the early detection of abnormalities. It is a step-by-step approach to bring the equipment to its original condition. However, not all maintenance can be done by operators. Planned maintenance with specialist staff is essential. Nevertheless, if the skill and education levels of operators are high, then a good proportion of planned maintenance activities can be executed by operators after proper training. Cleaning, lubrication and minor adjustments together with an ability to recognise when a machine is not functioning correctly should be the minimum required of operators.

Whilst great progress can be made in reducing breakdowns with autonomous maintenance and planned maintenance, 'zero breakdowns' can only be achieved by the specification of parts and equipment which are designed to give full functionality and not to fail. All engineers and designers of the user company should work with the suppliers of equipment to achieve a system of maintenance prevention.

Five S is a tool for improving the housekeeping of an operation, developed in Japan, where the 5S's represent five Japanese words all beginning with 's':

- Seiri (Sort): Separate what is essential from what is not
- Seiton (Set in order): Arrange items in an orderly manner and in a clearly marked space
- Seiso (Shine): Keep the work station and the surrounding area clean and tidy
- Seiketson (Standardisation): Maintain equipment to laid down standards
- Shitsuke (Sustain): Follow established procedures

With the Five S approach, quality is improved by better organisation, and productivity is increased due to the decreased time spent in searching for the right tool or material at the workstation. Benefits are also found in environmental and safety factors due to reduced clutter. The exact number of S's is less important than observing the simple doctrine of achieving the elimination of waste.

Quality assurance

The ideal of *Total Quality Management* (TQM) is to systematically and continuously remove the root causes of poor quality from the production processes so that the organisation as a whole and its products are moving towards perfection. This relentless pursuit of the perfect is key attitude of an organisation that is 'going for lean'. Quality assurance focuses on the prevention of failures or defects in a process by analysing the root causes and sustaining the improved process by documenting the standard operating procedure and continuous training. TQM is quality assurance of all processes across the organisation involving a culture embracing everyone from the top manager to a trainee.

The Toyota production system is frequently modelled as a house with two pillars. One pillar represents *just-in-time* (JIT), and the other pillar the concept of *jidoka*. Jidoka is 'automation with a human touch'. An example is a machine that will detect a problem and stop production automatically rather than continue producing poor output.

The principle was first used by Toyoda at the beginning of the 20th century when he invented a loom which stopped when the thread broke. Jidoka comprises a four-step process of:

1. Detect the abnormality
2. Stop
3. Fix or correct the immediate condition
4. Investigate the root cause and install a counter measure

The first two steps can be mechanised or automated. Ultimately, it is about transferring human intelligence to machines to eradicate the problem.

THE LEAN AND AGILE SUPPLY CHAIN

Up to now, we have discussed getting our own house in order. We now consider the supply chain as a whole. A lean and agile supply chain is characterised by a rapid response on a global scale to constantly changing markets. Rapid response needs to cover changes in demand for both volume and variety. A further dimension is lead times and how long it takes to replenish goods in order to satisfy demand. Buffer capacity and buffer stocks are required in order to satisfy the fluctuation of demand.

A lean supply chain has the following key characteristics:

1. Flexibility
2. Market sensitivity
3. A virtual network
4. Postponement
5. Selected lean supply chain principles

Flexibility is the ability to respond to the variations of requirements in volume and variety. The variability in volume is the result of product launching, seasonal demand and promotional activities. The variations in the supply chain result from variability of lead times of both suppliers and customers, increased service level, change in order size, etc. In order to improve flexibility in a supply chain, it is crucial to reduce complexity in product specifications to maximise mass customisation, reduce complexity in processes by standardising them and enhance organisation flexibility by multi-skilling and seamless working practices.

Market sensitivity means that the supply chain is capable of responding to actual demand. This requires demand planning not to be driven by periodically adjusted annual forecast but

by actual customer requirements. The scheduling of operations will be a 'pull' system for scheduling based on customer orders rather than a push system of forward-scheduling based on forecasts. In addition to actual customer order, the use of information technology and ECR (efficient consumer response) and CRM (customer relationship management) systems are utilised to capture data directly from point of sales and consumer buying habits.

Virtual network is the use of the internet and information technology for real time sharing of data between customers, buyers, suppliers, planners, manufacturers and distributors in a virtual network. The visibility of demand and CPFR (collaborative planning forecasting and replenishment) systems in a virtual network are important tools to respond to the real needs of customers in a global market. The concept of competitive advantage through world class manufacturing in individual sites has now shifted to network excellence. The supply chain where a group of partners can be linked together in a virtual network and communicate on line and on time.

Postponement is based on the principle that semi-finished products are kept in generic form and the final assembly or customisation does not take place until actual customer or market requirements are known. The point in the supply chain where the semi-finished product is stocked is known as 'de-coupling' point. This point should be as close to the market place as possible in the downstream of the supply chain. In addition to responding quickly to specific customer demand, the concept of postponement offers some operational, economic and marketing advantages. As the inventory is kept at a generic level, this makes easier forecasting and reduces inventory levels in total. Additionally, as the inventory is kept at an earlier stage stock, value is also likely to be less than the value of finished product inventory. A higher level of variety can be offered at a lower cost and marketing can promote apparent exclusivity to customers.

> "QUALITY ASSURANCE FOCUSES ON THE PREVENTION OF FAILURES OR DEFECTS IN A PROCESS BY ANALYSING THE ROOT CAUSES AND SUSTAINING THE IMPROVED PROCESS BY DOCUMENTING THE STANDARD OPERATING PROCEDURE AND CONTINUOUS TRAINING. TQM IS QUALITY ASSURANCE OF ALL PROCESSES ACROSS THE ORGANISATION INVOLVING A CULTURE EMBRACING EVERYONE FROM THE TOP MANAGER TO A TRAINEE."

The enhanced responsiveness of an agile supply chain is, in addition to the high level of efficiency, quality assurance and smooth operation flow which are the key characteristics of a lean production. An agile supply chain also focuses on the elimination of waste or mudas as in a lean process, but with a different strategy for buffer capacity and inventory required for postponement. However, a pure lean strategy can also be applied up to the de-coupling point and then an agile strategy can be applied beyond that point. It should be possible to achieve volume-oriented economies of scale up to the decoupling point.

This article is derived from:

Basu, R., and Wright J N (2008). Total Supply Chain Management, Chapter 13: Butterworth and Heinemann