

A Review of the Implementation of Lean – Comparative Case Studies and Lessons for the Rolls-Royce Manufacturing Value Chain

POMSS ZG628T Dissertation

by

Sumalatha Gude

Id No. 2016SA84012

**Dissertation work carried out at
Rolls- Royce Plc, England, United Kingdom**



**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE
PILANI (RAJASTHAN)**

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Management degree programme

Under the Supervision of

Suresh Suvisheshamuthu,
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Abstract

Companies today operate in a difficult and dynamic environment which is highly competitive. They must seek to continuously improve to ensure that they can meet their customers ever increasing demands on cost, quality, delivery and responsiveness. One of the prevalent improvement initiatives of the last 5 years has been the implementation and the drive to become Lean by removing waste from processes to perform as efficiently as possible.

This dissertation will review and discuss the contextual issues around the implementation of Lean along with a review of the standard tools and techniques. It will look at the Rolls-Royce approach to Lean implementation and education and consider whether the current methods are effective. It will review the potential behavioural issues, the impact of change and the critical success factors that can influence the pace of change and the sustainment of the improvements.

The dissertation will focus on a Rolls-Royce manufacturing project to highlight some of these contextual issues but will also discuss two other companies approach to Lean to identify areas for improvement in the Rolls-Royce process.

The outcome of this dissertation will be to identify the challenges faced when implementing Lean and how these could be overcome, identifying the key contributors to successful implementation.

The research findings revealed that the tools for implementing Lean are effective if used in an organisation that has the foundations for Lean embedded. There are a number of behavioural and cultural factors that can cause resistance to Lean which need to be carefully addressed and can take a number of years to overcome. The time required to implement Lean should not be underestimated and it is important that an organisations management team understand and support this.

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Chapter 1: Introduction

1.1 Background Organisations are operating in an ever increasing competitive environment where the focus on increasing throughput and reducing costs is essential. The general view by management is that to do this they must fully utilise both machines and people and that all improvement activity should be focused on achieving this. Lean as an improvement technique has the same aim but by focussing on the removal of waste, reduction of inventory and development of flow etc. within a product value stream. Organisations have become accustomed to optimising the silos within the value streams but what is essential to Lean is looking across the full value stream and linking the silos together to focus on the end customer.

1.2 Research Question

The focus of this dissertation is to answer the following research question: "What are the challenges to implementing Lean across a manufacturing value stream, how can these be overcome and what are the success factors for implementation?"

1.3 Research Objective The objective of this report are; a) describe the concepts of Lean along with the implementation considerations as stated in the literature; b) compare these to actual current practice identified by the study of three specific case studies and c) to analyse the findings, the outcome of which will be an understanding of the challenges faced when implementing Lean to consider for future implementations.

1.4 Research Methodology A case study methodology has been adopted to investigate a number of companies in the area of Lean implementation. Eisenhardt (1989) suggested that a case study methodology is particularly well suited to research areas for which existing theory seems inadequate. Although Lean has been around for a number of years the research on Lean implementation is limited and hence the reason for choosing a case study methodology. The initial phase of this study will review the literature on Lean and related topics such as the tools, the link with Six Sigma, the impact of Change Management and the importance of behaviours. The second phase of the study will look specifically at the case organisations by gathering data using a questionnaire as well as information from interviews and documentation.

1.5 Scope and Limitations of the Research The case study research uses three case organisations with different backgrounds but of a similar size, aiming to obtain a clear representation of the varying issues faced when implementing Lean. A questionnaire will be used to gather data to back up the findings.

1.6 Structure of the Dissertation Following this introductory chapter, chapter 2 will review the principles, application and history of relevant literature to Lean implementation such as Continuous Improvement, the theory of Lean, tools and techniques, the integration of Lean and Six Sigma, behaviours, Change Management and critical success factors. The aim of

chapter 2 is to provide a review of the thoughts and experience of key researchers in the implementation of Lean and the surrounding factors that should be considered when implementing Lean.

Chapter 3 describes the research approach adopted and chapter 4 looks at the case study organisations giving a brief background of each of the organisations, followed by a review of the Continuous Improvement approach adopted by the organisation, their approach to Lean and a brief description of specific implementations and any lessons learnt.

Chapter 2: Literature Review

2.1 Continuous Improvement Organisations are constantly striving to improve their performance and to provide a better service to their customers whilst remaining competitive in their market. In order to do this they need to be constantly seeking new opportunities to remove waste from their processes whilst at the same time maintaining high levels of quality. The external environment that organisations operate in is frequently changing and it is important that they can respond by looking at their internal performance. Ruffa (2008) argues that companies have become adept at managing crises, mobilising enormous teams and diverting whatever resources they need to quickly stabilise a disruptive situation. Whilst this is sometimes necessary this is merely creating further waste rather than fixing the root cause of the problem. Continuous improvement (CI) looks at the reasons why these failures or problems occur and aims to resolve them. This may be small, incremental improvements or large programmes of change which revolutionise the way that an organisation operates.

CI is a philosophy described by Deming as improvement initiatives that increase successes and reduce failures (Juergensen, 2000). Bozarth and Handfield (2006) see it as an organisation never being content with the status quo and always assuming there will be room for improvement no matter how well they are performing. Bhuiyan et al. (2006) define CI as a culture of sustained improvement aimed at eliminating waste in all organisational systems and processes, involving all organisational participants. Juergensen (2000) suggests that CI comes only from people – people learning things they can learn, solving problems they can solve, implementing improvements they can implement.

CI is very closely linked to Quality Management (QM) and many of the CI initiatives have stemmed from the evolution of QM. Back in the 1950's Japanese companies were embracing initiatives such as Quality Control Circles, Total Quality Control and Just in Time (JIT). Since those early days of QM a number of other initiatives have emerged such as Total Quality Management (TQM), Six Sigma, Lean, Total Production Maintenance (TPM), Business Process Re-engineering and Process Excellence. The evolution has occurred because each new initiative seems to bring something new and different, however it has now become confusing for companies to know which initiative is the best choice for them. Thawesaengskulthai and

Tannock (2008) describe how the combination of one programme with another, in an aim to produce a better solution, seems to be dominating much of the current literature. CI can otherwise be known as Kaizen which is aimed at continuously discovering and eliminating waste. CI is made up of both incremental and breakthrough improvements and then critically the maintenance of those improvements. Figure 1 shows the CI or Kaizen journey and how both incremental and breakthrough improvements are important along with the maintenance or sustainment of the improvements. Often the emphasis on sustainment is missed which can result in a decline in performance.

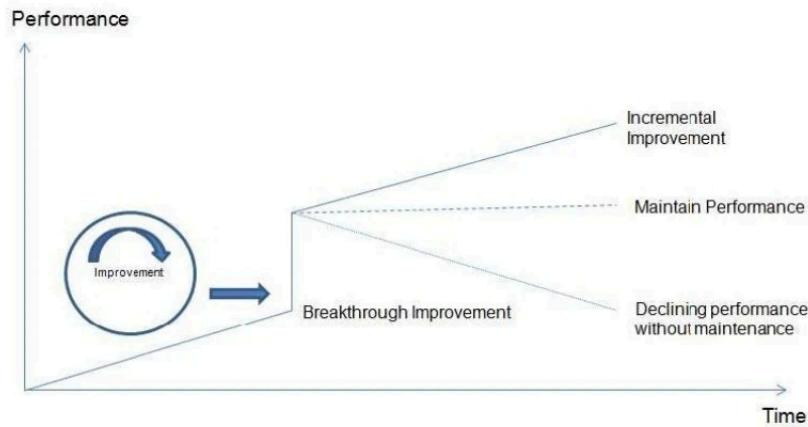


Figure 1: Continuous Improvement Journey (Source: Adapted from Imai, 1986) Of the emerging CI initiatives mentioned previously Six Sigma and Lean seem to be the most prominent and effective. Six Sigma stemmed from TQM. TQM was designed to create an organisational culture of achieving customer satisfaction through an integrated system of tools, techniques and training (Sashkin and Kiser, 1993). TQM is not a solution to the problem but an approach to manage an organisation effectively, built around CI (Kanji and Asher, 1996). Although TQM has been effectively implemented in many organisations one of the down sides to its use was that there was no clear way of prioritising projects. This was one of the reasons for the introduction of Six Sigma, which continues to have a quality focus by looking at bringing processes under statistical control but is very clear on the financial benefits that the project is expected to deliver. Six Sigma projects tend to be the breakthrough projects seen in figure 1. Although Six Sigma is extremely effective for understanding variation in processes and improving the capability of a process it may not be suitable for all improvement requirements. For example, it is not focused on the improvement of lead time or the reduction in levels of inventory, although the improvement of capability will have a secondary impact on this, this is where the methodology of Lean stands out, with the main aim being to remove waste ensuring that activities can be completed in the most efficient way. Lean improvements tend to be smaller and more incremental, building up to, in some cases, breakthrough improvements. Many companies have now realised the importance of looking at both the control of processes and the removal of waste jointly which is why a combination of Six Sigma and Lean has been established.

2.2 Lean, as described previously, is one of the most widely used CI initiatives that stemmed from the foundations and the theory of JIT. Bozarth and Handfield (2006) list the primary elements of JIT as only the required inventory when needed, zero defects, reduction of lead times by reduced set up times, queue lengths and lot sizes and the achievement of these activities at minimum cost. This ability to do more with less led many people to refer to JIT as Lean production. Sayer and Williams (2007) describe Lean as a broad catchphrase that describes a holistic and sustainable approach that uses less of everything to give you more.

The JIT philosophy made an impact in the 1980's when the likes of the Toyota motor company started to show some considerable improvements to key statistics such as assembly hours, defects and inventory levels. Toyota is one of the most successful automobile manufacturers in the world and the foundation of their ongoing strong performance is their manufacturing system. They were the founders of many of the Lean techniques and these have helped them to reach a high level of efficiency in production. Toyota called its Lean system the Toyota Production System (TPS) and has embedded its use into the culture and behaviours of its employees.

The main aim of Toyota was to produce cars as efficiently as possible with minimal inventory, cost and waste to the highest quality. One of the challenges that Toyota faced was to enable customers to choose from a variety of cars with the ability to manufacture on a mass scale. This required production flexibility and therefore during the early 1950's the Production Chief of the Toyoda Group Automotive Operations, Taiichi Ohno, experimented in ways of setting up equipment to produce items in a timely manner. Assisted by other Toyota seniors, studies of car manufacturers, such as Ford, took place. It became clear that their systems were full of inefficiencies. Ohno realized that the only way to compete with these competitors was to produce a manufacturing system free of all inefficiencies. The TPS tried to overcome the deficiencies or limitations of production and increase the efficiency by eliminating waste and lowering costs (Regani, 1990).

The TPS consists of two aspects: the techniques and the people, the latter often being overlooked by other organisations. Toyota understood that implementing Lean could potentially improve efficiency but without the acceptance and support of employees the full benefits would not be achieved or sustained. Figure 2 shows the TPS house which is a high level view of the elements of the TPS. Toyota established a number of the Lean techniques and used them to produce an integrated solution to identify waste. The house also emphasizes the importance of employee motivation.

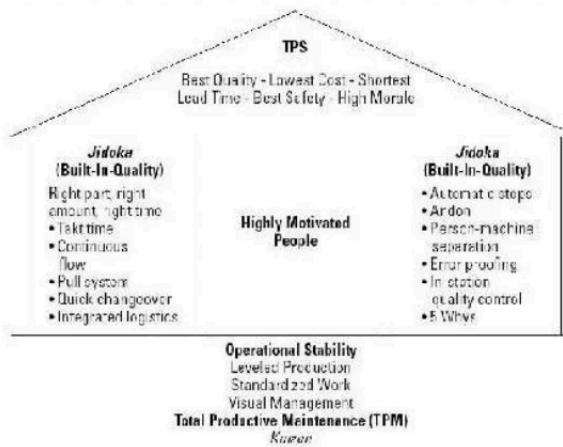


Figure 1-1: The TPS House — a high-level view of the Toyota Production System.

Figure 2: The TPS house (Source: Sayer and Williams, 2007) Womack and Jones (2003) describe 5 basic principles to Lean:

1. Value
2. Value Stream
3. Flow
4. Pull perfection

2.2.1 Value

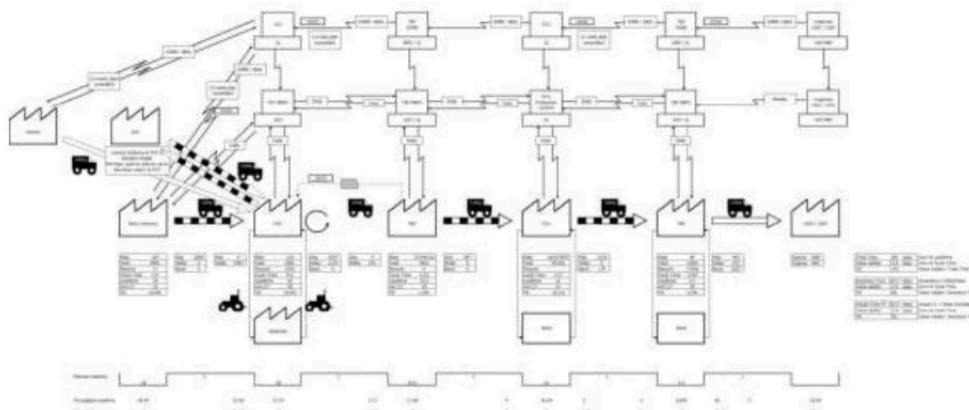
The most important starting point for a Lean project and one that is often overlooked or misunderstood is defining value. Value has to be defined by the customer and created by the producer. Womack and Jones (2003) explain that Lean thinking must start with a conscious attempt to precisely define value in terms of specific products and capabilities offered at specific prices. They also say that providing the wrong goods or service in the right way is a form of waste. Identifying what your customer sees as true value enables the elimination of waste. A classic example of when an organisation has not identified value from a customer's perspective is within the airline industry. From a customer perspective value would be getting to a chosen destination, safely, with the least hassle, at a reasonable price. However, from an airline's perspective their definition seems to be using their existing assets in the most efficient manner which may involve the customer changing flights and stopping off at locations which have no interest to them. The airlines add in entertainment packages to aim to please the customer like VIP lounges and TVs rather than thinking about what the customer really wants.

Useful Tools

a. The Voice of Customer It is important to understand the needs of the customer and often the basic needs and expectations can be overlooked. One of the tools that can be used for connecting the requirements with customer satisfaction is the Kano Model. The Kano Model, which can be seen in appendix 2, classifies three types of requirements to determine if the customer is satisfied. Firstly, the must haves, the basic needs. These are not a source of satisfaction but can cause major disappointment if they are not delivered. Referring back to the airline example this would be getting from A to B. Secondly, the performance need, which is a strong source of satisfaction, e.g. the flight being on time. Finally, the delighters, which are not expected, but are also a source of satisfaction e.g. in-flight entertainment and VIP lounges at airports. When an organisation is looking at the Kano Model it is important that the basic needs of their customer is identified and ensure that they are delivering these before focussing on the performance needs and the delighters. The delighters are not a priority until high performance of the basic needs is reached; often organisations forget this basic rule.

2.2.2 Value Stream

A key difference of Lean as a CI initiative to all others is its focus on improving the full value stream (VS). The VS is the set of activities required to make / provide a specific product / service. The visual identification of the VS starts to allow the exposure of many opportunities for waste reduction. Figure 3 shows where the VS fits within an organisation.

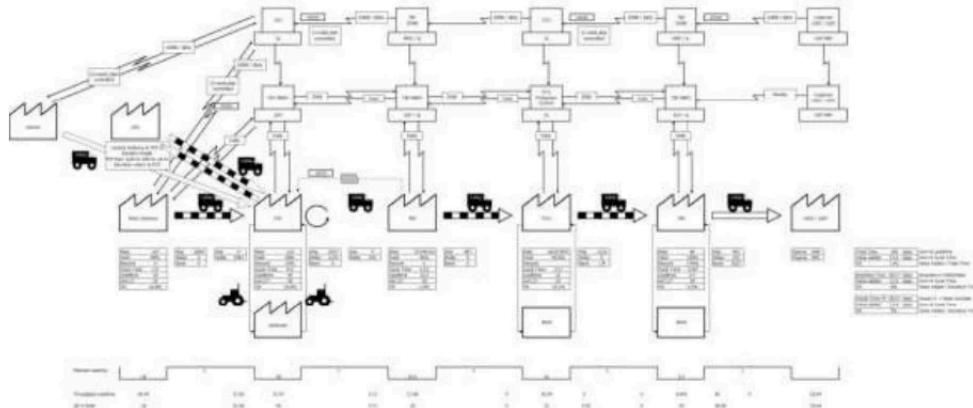


The organisation will set a strategy and a vision which will set the standard for all of its VS but the required improvements of the particular VS will be made clear. A VS is made up of a number of operational cells or areas, these are where the improvements will need to be focused. The overall intention always comes back to satisfying the customer of the VS. The VS perspective ensures that the correct activities at the operational level achieve the best outcome for the customer. Figure 3: Structure of Lean Implementation (Source: Rich et al, 2006) Useful Tools a. Value Stream Mapping A VS map is a visual representation of the individual operations and the performance of those operations within the VS. Womack and Jones (2003) state that when a VS map is created there are generally three types of activities identified; those which create value; those that do not create value but that are unavoidable with current technology and assets and finally those that do not create value that can be immediately avoidable. VS mapping is a visual flowchart; it is used to chart the existing and future process (Taghizadegan, 2006). A current state VS map will be created which will show the status of the VS at that point in time; this helps to identify the areas requiring improvement. A future state VS map will be created which is the vision that the organisation needs to drive the VS towards in order to satisfy the customer. An improvement plan will be created to take the VS from its current to the future state. Figure 4 shows an example of a VS map.

Figure 4: A Value Stream Map Example (Source: Rolls-Royce Internal Document, 2011)

b. Waste Identification when looking at a VS and identifying activities that do not create value the following 8 waste categories should be considered (Bozarth and Handfield, 2006):

- Overproduction – finished goods or work in progress with no immediate customer demand;
 - Unnecessary inventory – a result of overproduction resulting in inventory build-up waiting for an order to arrive;



- Unnecessary transportation – the movement of materials around the factory, consuming time and increasing the risk of damage to the product;
 - Inappropriate processing – a mismatch between the processes needed to make a product and the processes that are in place e.g. using sophisticated machinery to make simple products;
 - Unnecessary / excess motion – if a process is designed poorly and requires excessive manual handling by the operators, again this will increase the risk of unnecessary defects;
 - Unnecessary defects – reworking or scrap of parts which could take up valuable capacity;
 - Unnecessary delay – materials idly hanging around in an uncontrolled manner;
 - Under-utilisation of employees – not utilising the skills and decision making capabilities of employees.

By performing “go, look, see” activity and monitoring and analysing processes over a period of time it should be possible to identify if any of the eight wastes are occurring. The elimination of these wastes will result in a Leaner more efficient process.

2.2.3 Flow

Once the obvious wasteful steps have been identified and eliminated it is possible to start to address the steps which do not create value but are currently unavoidable due to certain restrictions. The main aim is to ensure that the true value creating steps line up in a steady, continuous flow with no wasted motions, no interruptions, no batches and no queues (Womack and Jones, 2003). Flow aims to link manpower and equipment so that the next process receives the inputs from the previous process JIT, without work stations having to wait, or having excess work piling up in between.

Useful Tools

- a. Kaizen Running Kaizen events is one way of encouraging flow. The benefit of running Kaizen events is that a cross functional team will form and use their knowledge and experience to suggest ways to overcome the problem. Kaizen can be used at any stage within a Lean project.
- b. Layout One of the key enablers to flow is the layout of the factory which may require some significant changes if, over a period of time, the flow has become inefficient e.g. excessive motion and transportation. Running table-top simulations can help with identifying an optimal flow.
- c. Single Piece Flow Single Piece Flow is the moving of products along the production line in small batches, ideally individually. This means that if any rework is required to an individual part then the whole batch is not held up. Single Piece Flow requires minimal waste in the production process to work. The layout needs to be arranged in sequence with minimal transport between workstations and the machines must be able to convert from one product variant to another almost instantaneously.
- d. Mistake Proofing Martin (2007) explains that mistake proofing involves a combination of techniques and methods designed to prevent errors or detect them before they can cause operational problems. Mistake-proofing techniques help standardise the process to ensure continuous flow of material and information through the system. Examples of mistake proofing include designing a part so that it can only be assembled in one particular way, tamper proofing, the use of guide pins, blinking lights, alarms, counters and checklists. Inevitably even with mistake proofing you cannot mitigate every possible situation therefore indicators of failure are important. Leading indicators include sensors placed on the machine to detect error conditions (Martin, 2007)
- e. Production Levelling Production levelling or as otherwise known level scheduling is about addressing the peaks and troughs in demand which could have a negative effect on flow. The aim of production levelling is that the future demand is analysed and a suitable schedule is produced which allows the right mix of parts to be manufactured at a constant rate minimising machine changeover and the need for capacity to be under or over utilised.
- f. Quick Changeover Quick changeover refers to the ability to change a machines tooling or fixtures as quickly as possible when the product changes. Ideally level scheduling would minimise the times that this happens by grouping products together however when this is required it is important that it can happen as quickly as possible.
- g. Total Production Maintenance (TPM) TPM is keeping all machinery functioning so that it is available for use at all times. It is also about scheduling maintenance at times when it will have the least impact on production i.e. during weekends or evenings or when the machines are not in use. There are lots of tools and techniques to help improve flow and the key to achieving flow is looking across the VS from beginning to end. It should aim to ignore all traditional boundaries and remove all impediments to the continuous flow of the product.

2.2.4 Pull

Womack and Jones (2003) believe that the implementation of flow within a VS can result in up to a 90% reduction in throughput times for physical production. If this reduction can be achieved then the result should be that an organisation can make what the customer wants when they want it without the need for huge buffers of inventory. The customer will be able to pull the product as and when they require it rather than the producer pushing it when they have completed it. This will result in an increased level of confidence from the customer which will mean that they can provide more stable demands to the producer reducing the “bullwhip” affect.

Useful Tools

a. Kanban / Control Systems A tool to help produce pull is Kanban. Bozarth and Handfield (2006) describe this as a production control approach that uses containers, cards, or visual cues to control the production and movement of goods through the supply chain. Bozarth and Handfield summarise the Kanban system in the following way:

- You have two work centres – A and B;
- Work centre A has Raw Material and Finished Material as does work centre B;
- Work centre A’s finished material becomes work centre B’s raw material when pulled;
- Move and produce cards will signal when to move material to the next step or when to produce more material at the current step, this controls the inventory levels within the VS.

Kanban systems are sometimes otherwise known as pull systems because downstream demand sets off a chain of events that pull materials through the various process steps (Bozarth and Handfield, 2006). This is in contrast to a push system where work is pushed through the system at each stage sometimes regardless of demand. The problem with push systems is that material could get held up at any point resulting in inventory build up and disruption to flow. Martin (2007) explains that Kanban are used to control the production and movement of materials by requiring that specific inventory quantities be placed in standardised containers. The way that organisations determine the number of Kanban needed to link two process steps together depends on various factors including lead times, yield, demand requirements and stability of demand.

In the theory of JIT, inventory is not only seen as a waste but also a cover up for inefficient business processes. Kanban are designed to control the level of inventory in a VS. Inventory in the supply chain is often compared to water in a river. If the water is high enough, it will cover all the rocks (quality problems, absenteeism, equipment breakdowns, etc.) and everything will appear to be running smoothly (Bozarth and Handfield, 2006). If high inventory is present

then it is necessary to lower the inventory levels gradually to expose problems and deal with them appropriately. The lowering of inventory can be uncomfortable for many managers as it is taking away their comfort blanket which is why they need to understand the concept of Lean so that they display the supporting behaviours.

2.2.5 Perfection

Womack and Jones (2003) believe that by combining an understanding of value, identifying the VS, removing non value add waste, making the value add steps flow and allowing the customer to pull, allows perfection to be within reaching distance. This is what every organisation should be striving for. This also provides clear transparency for CI activity along the VS.

2.2.6 Other Lean Tools

A number of Lean tools have already been described and below are some others which can be useful when implementing a Lean project.

a. Visual Management Visual management addresses both visual display and control. Visual display includes things such as team boards to display performance metrics, customer requirements and maintenance issues that need addressing. Visual control allows the identification of problems to be obvious, for example, machines requiring maintenance or a lack of raw material.

Another aspect of visual management which also supports instantaneous waste reduction is 5S which consists of the following steps:

- Sort – organising the workplace to remove clutter;
- Shine – keeping things clean;
- Straighten – ordering everything so that things can be easily found and are accessible;
- Standardise operations – maintaining all of the above through agreed standards that are adhered to;
- Sustain improvements – ensure that the above are sustained through the embedding of benefits into the culture of the employees.

Visual management and 5S are simple but effective enablers to Lean. Martin (2007) explains that 5S must be implemented prior to the deployment of other improvement initiatives because improvements cannot be sustained within processes lacking operational standardisation. CI is not about achieving a standard it is about improving on the standard which is why it is important that the current standard is clear.

b. Self-Inspection The idea of self-inspection is that errors are not passed onto the next step. This requires extensive training and a high level of integrity and honesty from employees. If operated correctly it will minimise rework which can affect the flow of parts by holding up batches.

c. Standardised Work working to standard processes and procedures means less variation in output and therefore achievement of predicted cycle times but also higher likelihood of achieving cost, quality and delivery metrics.

2.3 The Integration of Lean Six Sigma

Lean and Six Sigma are two of the well-established and proven CI methodologies that are adopted by organisations today and are probably the most well embedded. Some companies have adopted Six Sigma others Lean but those who are really serious about making step changes in quality, cost and delivery have adopted the joint approach known as Lean Six Sigma. Six Sigma is a disciplined and structured approach used to enhance process performance and achieve high levels of quality and low levels of variability (Salah, Rahim and Carretero, 2010). Six Sigma quality means only two defects exist per billion opportunities. Motorola were the founders of the Six Sigma quality program and they created a number of steps to achieve Six Sigma, which were later replaced by the four phases of Measure, Analyse, Improve and Control by General Electric. After that, the define phase was added before the measure phase to form the well-known Define, Measure, Analyse, Improve and Control process (DMAIC).

Salah, Rahim and Carretero (2010) explain that Lean is proven to help organisations achieve on time delivery of the right quality and quantity to satisfy customers. Lean focuses on enabling people to see the product or service across the whole VS from the customer perspective. As explained in the previous section Lean is designed to eliminate waste, variation and work imbalance, including, unnecessarily long cycle times, or waiting times between value-added activities. Waste can also include rework or scrap, which often results from excess variability in a process; this is where the link between Lean and Six Sigma becomes apparent.

Although the main aim of an improvement project may be to create a Lean VS there will be an intrinsic link to the control of processes and therefore the Six Sigma methodology. If processes are out of control then products will not flow through the VS. It would be naive to try to implement Lean without considering the impact of out of control processes.

2.4 Lean Behaviours and Critical Success Factors

Although the tools and techniques for Lean implementation are important there are also a number of behavioural changes which are required to succeed in developing and sustaining a truly Lean VS. Bhasin and Burcher (2006) suggest that one of the key reasons that organisations do not succeed in the implementation of Lean is that they see it as a process rather than a philosophy. Lean needs to be seen as a mindset that governs the way that one looks at the business. It needs to be part of a long term strategy and evident across all processes. If management think that Lean can be implemented overnight then they are misunderstanding it completely, as Turfa (2003) explains, Lean is a journey that never ends.

Achanga et al (2006) conducted a study on small to medium sized enterprises in order to identify a number of critical success factors for Lean implementation. Among those identified were leadership and management and organisational culture. It is important that companies harbour strong leadership traits capable of exhibiting excellent project management styles. One of the most critical changes that the leadership team need to make is the switch of focus from the management of short term crises to emphasise and reward more strategic improvements. They should have a clear vision of the strategic initiatives, a good level of education and a willingness to support productivity improvement initiatives. Lean requires a supportive organisational culture, one of sustainable and proactive improvement. There needs to be some degree of communication skills, a long term focus and strategic team in place. Management should have the ability to operate in a diverse environment, with easy acceptance of change and a long term focus on their roles. The Boston Consulting Group (BCG) also conducted a study on critical success factors for Lean and released a report in 2008 looking at organisations that have been successful in implementing Lean. Seven key success factors were established as described below. There is a strong similarity with those identified by Achanga et al.

- a. Choose strategic, customer centric projects. The initiatives must align to the overall organisation strategy and the need for change should be clearly evident. The focus is always on the customer and meeting the customer's requirements.
- b. Think big, but start small. The aim of Lean should be visionary and ambitious but initially small pilot projects should be chosen to gain momentum and prove the concepts. Small refers to management in scope not in terms of importance.
- c. Involve everyone from top managers to line workers. The direct involvement from everyone at all levels is critical when implementing Lean. This taps into organisational wide knowledge but also helps to create enthusiasm and obtain buy-in. It is important that Lean is not enforced on people but that it is achieved alongside them.
- d. Tailor your approach to your culture. It is important to be aware of the challenges that the culture of your particular organisation brings to the implementation of Lean. Organisations with a strong hierarchical culture with little standardisation or sharing of knowledge will need to focus on breaking down the silo's and empowering employees.
- e. Assign dedicated experienced resources. Lean projects require full time dedicated experts to send out a message that Lean is a priority. With this dedication the projects should gain traction more quickly and build momentum and enthusiasm. Over time companies should transfer the ownership of Lean to line management.
- f. Use metrics to drive progress. It is essential that any project has a clear set of metrics driving its success. The right set of metrics will help the team to focus on the right things and measure progress towards a goal. Metrics that drive time, financial impact and behaviours will drive successful implementation of Lean. On many occasions the defined Key Performance Indicators (KPIs) that are set and driven by the leadership team drive the wrong behaviours. The measuring of machine utilisation and employee utilisation and the treating of WIP as an

asset drives the wrong behaviours. Machines making unwanted parts 100% of the time and employees performing non-required tasks during every available minute are simply creating waste. Incentives should ensure that the achieving of targets such as production efficiency is not achieved through overproduction but by reinforcing the notion that production will only take place when demanded by the next process.

Some of the common Lean metrics are shown below:

- Customer on time delivery;
- Inventory investment;
- Throughput of materials;
- Quality of work;
- Value added time;
- Machine up time;
- Machine changeover.

Most of these metrics are time-based and improvements to time-based metrics will significantly reduce lead-time and increase system flexibility relative to external customer demand. Having the wrong set of KPIs or metrics can conflict with the implementation of Lean and make it more difficult to achieve and sustain.

g. Communicate having a communication plan and sticking to it is essential. It is important that the management team support this and remain visible and supportive to the initiatives. Different types of communication will be effective for different roles within the organisation. The communication should be tailored to suit the individual receiving it. It is important to be able to demonstrate progress and also allow feedback from the wider population. Not only is communication from the project team important but also within the organisation. One of the key behavioural differences of a Lean enterprise is the inclusion and engagement of all staff that work within the entire VS. In the old mass production world the thought was that the factory workforce had no need to talk to one another, they should keep their heads down and keep working. And also that the professionals rarely went near the scene of action (Womack and Jones, 2003). This is not acceptable in a Lean enterprise as in order to identify and resolve problems as they occur, the workforce need to be communicating with one another and the professionals need to be supporting them.

2.5 Change Management

A key factor that is often overlooked in any improvement activity is the impact of change. People often react to change by showing resistance which can have a negative and obstructive effect. It is important that the impact of change on people is not underestimated and that the management approach is considered as part of the overall project.

Capon (2004) describes how managers in organisations experiencing change need to be aware of both driving forces and restraining forces. The managers involved should communicate a

strong justification of the changes by offering a clear and unclouded explanation of the reasons for the changes and any advances in employee empowerment that will result. A careful balance needs to be achieved between providing too much information, which may result in questions that cannot be answered, and too little information, which makes employees feel like they are being left in the dark. Capon (2004) explains that a strong and effective change manager will disperse resistance to change by highlighting early achievements resulting from the change, which will help maintain the momentum. However recognition should be made that not everyone will accept the proposed change and certain individuals may require sensitive handling.

2.5.1 A Change Process Model

There is a vast array of literature on Change Management and a number of change models which can be followed. One of the most prevalent authors and models that organisations seem to be adopting is Kotter (2007) with his "eight steps to transforming your organisation". Kotter has studied a number of organisations over the years through implementation of change whether it is TQM, re-engineering, re-structuring or cultural change. Some of these cases have been successful, some complete failures but most falling in between. Kotter used his experience of these cases to emphasise the need to follow a change model and consider a number of critical aspects as follows:

- a. Establish a Sense of Urgency This first stage is looking at the organisation's competitive position and performance to predict potential crises or new opportunities. Commencing a transformation programme requires aggressive co-operation of many individuals and over 50% of organisations fail in this first stage. It can be difficult to drive people out of their comfort zones, which is why this stage is so important. Often senior management do not take this stage seriously because they have a lack of patience and just want to get on to see the business benefits. Another problem with this stage is that many organisations have too many managers and not enough leaders. Successful transformational change requires leaders who can inspire and make the status quo seem more dangerous than launching into the unknown. Ideally in this stage the aim is to get 75% of the organisations management team convinced that business as usual is not acceptable (Kotter, 2007).
- b. Forming a Powerful Coalition The second stage is assembling a group with enough power to lead the change effort. This group should form and develop a shared commitment to excellent performance through renewal (Kotter, 2007). The coalition needs to be made up of a number of senior managers although will not be all senior managers.
- c. Creating a Vision This stage is creating a vision to help direct the change effort and develop the strategy for achieving that vision. The guiding coalition should create a vision of what the

future looks like that is easily communicable. The coalition will develop the vision over a relatively substantial amount of time to ensure it is robust. Without a sensible vision a transformational effort can dissolve into a list of confusing and incompatible projects (Kotter, 2007). Without a clear vision employees will be confused and in some cases feel alienated. If you cannot communicate the vision in five minutes then it is not a sound and communicable vision and needs more work.

d. Communicating the Vision This stage is using all opportunities to communicate the vision and ensuring that the leaders communicating the vision are showing the correct behaviours to motivate others to understand and support the vision. Employees will not make sacrifices, even if they are unhappy with the status quo, unless they believe that useful change is possible (Kotter, 2007). Leaders who communicate well send the messages as part of their day to day activities; they link it to employee behaviour or business performance. Communication is not just about what is said but also the action that is taken and often a vision is understood more through the actions and behaviours displayed.

e. Empowering Others to Act on the Vision This stage is looking at the reasons why the vision may not be achieved and the potential blockers. Often an employee will understand the vision and want to take actions to help achieve it but there are blockers in the way. In some cases the organisation structure can be a blocker in that it may not allow people the time to think outside the box, the reward systems may encourage the wrong behaviours or management may not display the correct supporting behaviours by making demands inconsistent with the vision.

f. Planning for and Creating Short-Term Wins This stage is transforming the vision into activity and planning and creating the required improvements to achieve the vision. Achieving a vision will be long term and therefore it is important to show that improvements are being made by setting short term goals. When these goals are achieved they should be celebrated and rewarded which will motivate employees and encourage the continuation of the improvement efforts. It is important to create short term wins rather than hoping that they will happen and they also help to maintain the sense of urgency (Kotter, 2007).

g. Consolidating Improvements and Producing Still More Change This stage is using the success of the short term wins to help to drive the vision. It is important not to declare victory too early or the improvements will not be sustained and the vision will not be achieved. Successful leaders use the credibility afforded by short-term wins to tackle even bigger problems (Kotter, 2007). It is also important to pay attention to the employees who have been supporting the vision and those that have been obstructive and consider this when making promotions and development.

h. Institutionalising New Approaches Finally, make a connection between the performance of the organisation and the success of the improvements made. When people are left on their own to make the connections, they create inaccurate links (Kotter, 2007). This comes back to having effective communication. Also succession decisions and leadership appointments must take into account the new behaviours as a result of the change. Bad decisions on recruitment could undermine all the improvements that have been made.

2.6 Literature Summary

Since the early 1950's CI has evolved and many different initiatives have emerged which has given companies the dilemma of establishing the most effective ones. At the same time it has built up a perception that CI initiatives are destined to fail because companies never stick with one. This makes it all the more difficult to drive and sustain CI in an organisation. Of the CI initiatives currently available Lean and Six Sigma stand out as two of the most effective and widely used and the combination of these seems to be what many companies are now using to drive CI in their organisation.

Both Lean and Six Sigma have very clear methodologies and tools which can be used to understand the root cause of problems and in many cases improve the performance of the business. However implementation of Lean is more complex than just implementation of the tools. One of the most important aspects is the understanding of the behavioural and Change Management issues and building them into the project plan. Lean requires a cultural change in employees at every level of the organisation and the ability to make this happen should not be underestimated. Change Management is a difficult and lengthy process that directly shows no tangible benefit to the organisation but without it improvement projects are destined to fail.

Chapter 3: Methodology

3.1 Research Context The specific area of research for this dissertation is on the challenges involved to implement Lean across manufacturing VS within the Rolls-Royce organisation with a comparison to two other organisations.

3.2 Selected Research Methodology A combination of research methodology approaches has been used in this project. This comprises of a review of literature along with case study research using semi-structured interviews, observation and the collection of organisation data, including both qualitative and quantitative data.

3.3 Data Collection The data collection process involved the selection of three large global organisations. These organisations were chosen firstly because they were available to the author and willing to participate in the study, but also because they have been involved in specific Lean implementations and therefore it was felt they could provide valuable data for comparison providing an informal benchmark. Interviews were conducted with key improvement personnel within the organisations who were experienced and familiar with Lean manufacturing implementation.

3.4 Primary and Secondary Data The primary data was captured through the semi-structured interviews. Each organisation had one pre-arranged interview with further discussion taking place afterwards, where required, for clarification purposes. The secondary data was captured through the gathering of supporting material such as corporate presentations and author notes made during shop floor observations.

3.5 Data Collection Method A questionnaire was created and used during the semi-structured interviews, see appendix 3. Interviewees were on some occasions, asked to expand on their answers in order to gain a thorough understanding of Lean within their organisation. Interviewees were also asked, in some cases, to provide data to support their answers and where possible to show specific examples of the Lean implementations.

3.6 Data Analysis The responses to the questionnaire plus key gathered data was reviewed and compared using a matrix report to look for similarities and differences that could be drawn from the data see appendix 4. The data was also compared to the theory captured as part of the literature review.

3.7 Limitations of Research The information gathered was limited to the responses received from the questions asked during the interviews. In some cases the answers were expanded on by further questioning. Some key areas may have been overlooked due to the specific questions asked. The understanding of the Rolls-Royce case was more thorough due to the author working for the organisation. The data could have been improved had the author spent significant periods of time in the other two case study organisations.

Chapter 4: Case Studies

4.1 Rolls-Royce

4.1.1 Organisation Overview

Rolls-Royce (RR) is a world-leading provider of power systems. It operates in five global markets – civil aerospace, defence, marine, energy and nuclear. Since its return to the London Stock exchange as a listed organisation the transformation has been remarkable. It has changed from a UK based niche supplier into a global business with a significant market presence.

Although RR has a balanced portfolio it is not immune to the threat of competition. Levitt (1983) stated that there are two vectors which shape the world, namely technology and globalisation. This is of particular relevance to RR as it operates in a high technology market where high barriers to entry will be slowly overcome as markets become more competitive. With the organisation becoming more global it now needs to ensure it has a supply chain that gives it a competitive advantage. In order to do this RR needs a commitment to CI. RR sees CI as a way of life where every employee continually seeks to improve the processes we operate to generate greater value for the business and our customers (Rolls-Royce, 2010).

4.1.2 Continuous Improvement Approach

In the same way that Toyota produced an integrated system for ensuring efficient and effective processes, the TPS, RR have created a similar framework. The Improvement Journey to Process Excellence (IJTPE), the Lean model of business production has been applied through the RR Production System (RRPS) for a number of years with outstanding results. RR, like many organisations, has seen the introduction and the passing of a number of CI initiatives over the last 2 decades finally settling for the IJTPE, see figure 5.

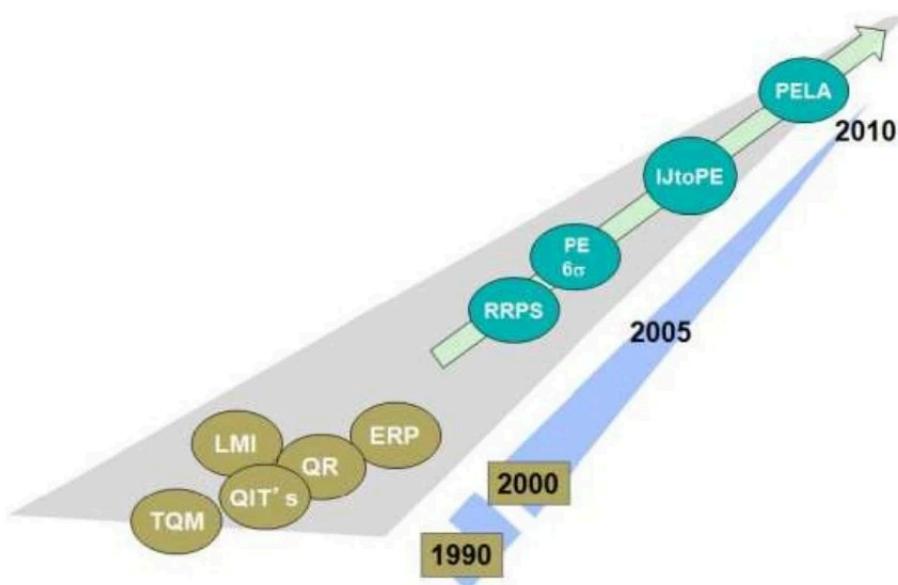
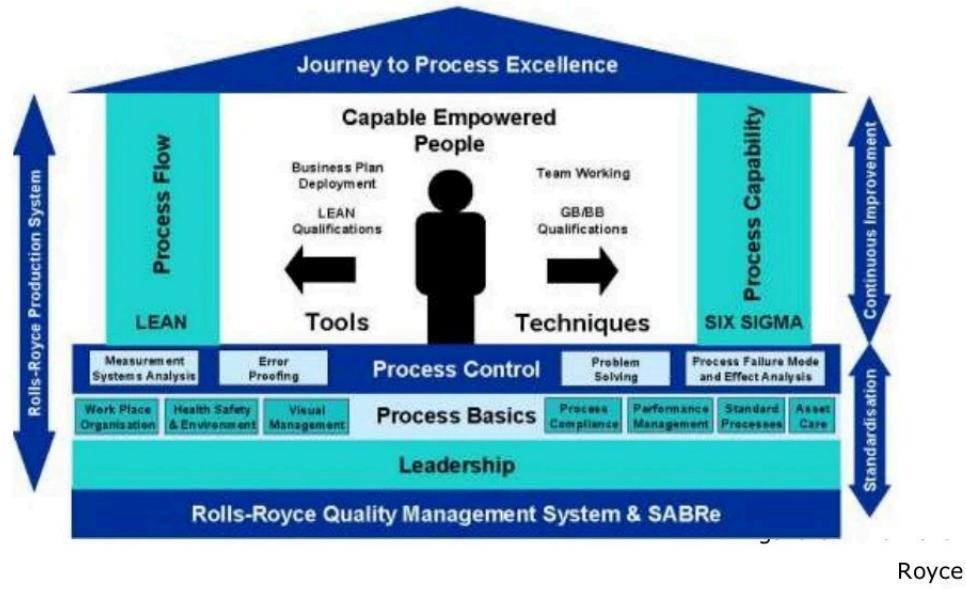


Figure 5: The Rolls-Royce CI Evolution (Source: Rolls-Royce Internal Document, 2011)

The IJTPE is the organisation strategy for embedding a customer first, CI and compliance culture through a structured framework of process basics, control, flow and capability (Rolls-Royce, 2010). The IJTPE incorporates Six Sigma and Lean to give a complete, holistic approach to business improvement. Figure 6 shows the house of the IJTPE for RR. There are strong similarities with the Toyota TPS and also the Achieving Competitive Excellence methodology that Pratt and Whitney have established and implemented. The importance of people, the tools and techniques, standardisation and process flow are evident in the different approaches. One of the interesting points about the IJTPE house is the foundation layer of leadership. When reviewing the assessment criteria and the literature that explains the IJTPE this is one area that is completely underestimated.



Improvement Journey to Process Excellence House (Source: Rolls-Royce Internal Document, 2011)

The IJTPE is made up of 4 stages which represent the level of maturity along the journey.

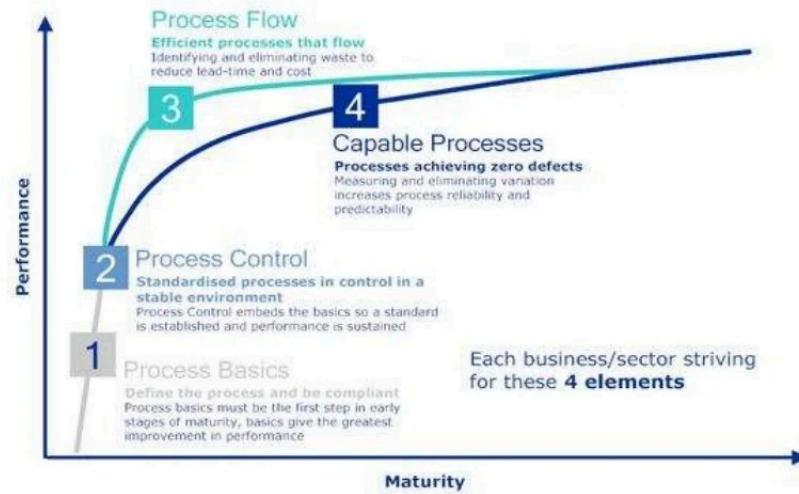


Figure 7 shows these four stages:

Figure 7: The Rolls-Royce Improvement Journey to Process Excellence Stages (Source: Rolls-Royce Internal Document, 2011). The first stage is *Process Basics* and is designed to ensure that the foundations of Lean are in place. Figure 8 shows the building blocks that make up each of the stages in the journey. Process Basics are about understanding what processes exist, whether there is compliance to these processes and how visual this is. The Basics are

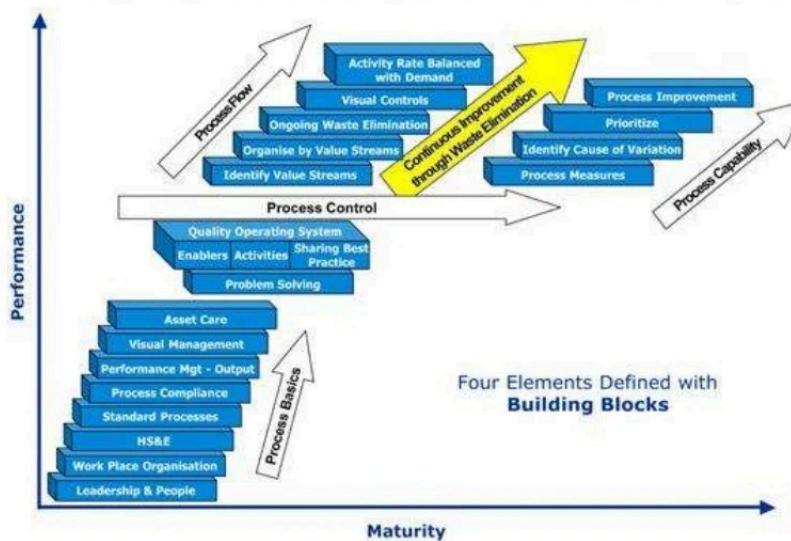
probably the most important stage in the journey as it is difficult to implement and sustain improvements without these. This coincides with Martin (2007) when he said that 5S should be implemented prior to the deployment of other improvement initiatives because improvements cannot be sustained within processes lacking operational standardisation.

The second stage is called Process Control and is designed to embed the Basics so that a standard is established and performance is maintained. In simple terms this means everyone complying with a process standard consistently, which then allows the process performance measures to be meaningful and action to be taken to resolve any problems, hence improving its effectiveness. Referring back to figure 1 this is the important aspect of sustaining improvements. Each time a standard is improved it must be controlled and therefore sustained. Process Control is also the foundation for Flow and Capability as it is difficult to improve a process that is not stable and in control.

The third stage is called Process Flow and is designed to encourage the identification and elimination of waste to reduce lead time and cost. This is when the Lean techniques described earlier in this report are used. It is about the arrangement of people, equipment, materials and methods creating products and / or services in a continuous flow, achieving short lead times, low inventory and flexibility, as appropriate, to maximise customer and other stakeholder satisfaction and minimising waste. Although this stage is called "Flow" it incorporates most elements of the Womack and Jones (2003) Lean model.

The final stage, Process Capability, is designed to provide a framework for measuring how well the outputs of a process (quality, cost and delivery) meet the requirements placed on it by customers and stakeholders. It is also the understanding of key process output measures that reflect the needs of all stakeholders, measuring process capabilities and identify root causes of poor capability whilst prioritising the improvement of these processes to meet capability requirements. Often Six Sigma projects are used to improve process capability at RR.

Figure 8: The Rolls-Royce Improvement Journey to Process Excellence Building Blocks (Source:



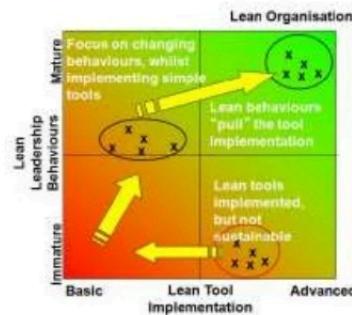
Rolls-Royce Internal Document, 2011)

The tools used as part of the delivery of the IJTPE can be found within the RRPS. The RRPS is a comprehensive framework of Lean principles, behaviours and methodologies for designing, operating and improving our total value chain at minimum total cost to the extended enterprise (Rolls-Royce, 2010).

The IJTPE is well known within Roll-Royce, with each business unit and function having a set of targets. Because these targets have been flowed down to an individual objective level progress being made on the journey is evident. The IJTPE has been an excellent mechanism for allowing organisation wide awareness of Lean and CI and to show that it is not just about improving the manufacturing space (as it is applicable to the functions too). One issue with the IJTPE is the sustainment of the improvements made as a result of meeting the criteria. Because the IJTPE is an assessment process some areas see it as a tick box exercise, therefore only making improvements in preparation for an audit and not embedding the improvements. The IJTPE is a clear structure for implementation of the tools and techniques but the people aspects of behaviours and Change Management are still critical and are not addressed. The tools associated with Lean manufacturing are relatively simple in concept and in some cases in implementation. The common mistake is to implement the tools in a physical state only. When the tools are not supported by the essential leadership behaviours they will not deliver the expected performance improvement and when performance improvements are not seen faith in the tools is lost. Generally in RR implementation has been tool based and not behaviourally led as the view is that if the tools are implemented then quick wins will be gained. Often the leadership want to understand the complex tools before they understand the simple tools. What needs to happen is the understanding of the behaviours followed by the application of the simple tools.

The behaviours will sustain improvements from the simple tools, this mind set will then develop the thinking to improve the tools in a sustainable manner and it will then be possible to understand the more complex issues and develop the more complex tools as they are needed. Without the behaviours the tools will never deliver their capability, short term wins will degrade and performance will not sustain. Figure 9 shows this pictorially. Figure 9: Lean Tools Vs Behaviours (Source: Rolls-Royce Internal Document, 2011)

To address this gap RR has introduced a basic recognised improvement role called a Yellow Belt (YB). The YB role is focussed on understanding and implementing improvements on the IJTPE Process Basics. The reason for introducing this role was to try to engage the whole organisation in CI and to achieve a more proactive approach to identifying and implementing improvements. Another action that RR has taken is to look at the role of the leadership in the IJTPE. Leadership is the foundation for the IJTPE and without leadership support the IJTPE will not be embedded and sustained. RR, working with an external training organisation has created a course called Process Excellence Learning Academy (PELA) designed to create an organisational culture that harnesses the implementation of CI through leaders who exhibit the required behaviours. The training is designed for senior and middle management to allow them



to think about their leadership styles and behaviours and the actions that they should be taking to build a CI culture. PELA is in its early stages of implementation and

has so far delivered limited benefits but it is addressing a gap within the IJTPE implementation.

4.1.3 Lean and Six Sigma

The RR IJTPE integrates both Six Sigma and Lean to give a complete, holistic approach to CI. In order to effectively embed elements of Six Sigma and Lean into the organisation at pace there is a need to have the right level of talent within key CI roles. To achieve this there is a need to have consistent, standardised improvement roles, talent selection / resourcing, professional development and engagement programme. These factors aim to ensure the appropriate resources are in place and engaged to consistently deliver high levels of benefits to the business. RR has 4 standard CI roles which drive the implementation of Lean and Six Sigma at different levels:

- a. Yellow Belt As discussed the YB is the foundation level process excellence role established to achieve a base level of improvement skill across all of RR. The expectation is that the YBs will

regularly complete small „just do it“ projects. The YB training equips employees with the knowledge and skills to be able to deliver improvements to their business processes and understand the Process Excellence programme. The creation of the YB role has substantially helped with engagement of the workforce on the IJTPE and CI.

- b. Green Belt The Green Belt (GB) role is designed to deliver agreed significant benefits to the business through the leadership of projects on a full or usually part time basis. They will work with business leaders and Black Belts (BB) to identify and quantify opportunities for process improvement, lead improvement projects to deliver and maintain process improvements, provide leadership and direction to cross functional teams coach and mentor other people in the organisation to help them become involved in CI activities and champion and share improvement learning and best practice within and beyond their own business.
- c. Black Belt The BB is an expert in Lean and Six Sigma and a full time improvement role. As with the GB the BB will deliver agreed significant benefits to the business through the leadership of improvement activities sponsored by the business leadership team. They will deliver improvement projects / programmes with highly effective and appropriate leading edge tool sets and implement the identified changes in behaviour required to ensure that the business can be best placed to cope with the challenges of growth. They will work with the Improvement Managers and teams to deploy the necessary behaviours to achieve success. They will also support local process owners and users to drive CI and coach, train and mentor Green and Yellow Belts through accreditation / recognition. Finally, they will lead the improvement strategy in-line with the IJTPE.
- d. Master Black Belt The role of the Master Black Belt (MBB) is to support Business Leadership in developing the improvement strategy in order to help deliver the business objectives. The MBB is a full time role and would be undertaken by an experienced BB with a history of coaching others. The MBB should identify best external / internal improvement practice and champion its deployment across the businesses and its partners. They should lead, coach and mentor improvement across the business, providing leadership in the selection, scoping, structuring and delivery of complex / strategic programmes. They should also lead behavioural change to inject true business pace and apply advanced change management skills focused on the need to develop a simplified, scalable and standardised organisation. As with the BB they will analyse and monitor financial and customer benefits throughout the life of improvement projects. They will also ensure that project gate reviews are robust through structured governance and support organisation process owners and users to drive for CI. They will coach, train and mentor designated Master, Black and Green Belts through accreditation and manage the capability development process. Finally, they will define, develop and lead improvement strategy in line with the IJTPE.

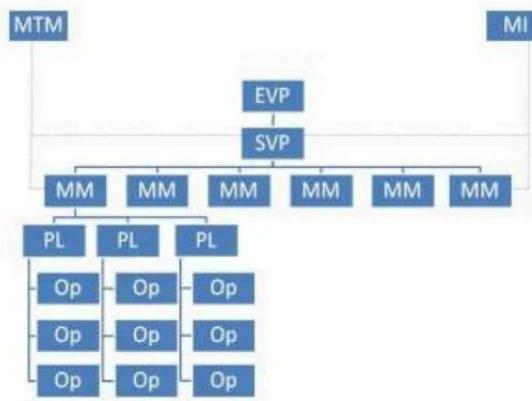
4.1.4 Organisation Structure

The Gas Turbine Supply Chain at RR consists of seven Supply Chain Units (SCUs) and a number of supporting Functions. The Turbines SCU is responsible for the Turbine subsystem of the gas turbine engine therefore the design, manufacture and delivery of Turbine components and has around 2,200 employees. The standard organisation structure for manufacturing within a RR SCU can be seen in figure 10. Heading up the SCU is the Executive Vice President (EVP) who is accountable for the overall performance of the SCU, both domestic manufacture and the external supply chain, plus all of the supporting functions. Working for the EVP is the Senior Vice President (SVP) who is specifically accountable for domestic manufacture. Turbines have six manufacturing plants and the SVP is accountable for the performance of all of those plants. Each of the plants has a Manufacturing Manager (MM) who is accountable for the performance of their respective plant. Each plant operates independently and is measured on its individual performance made up of a number of manufacturing cells which a product travels during the manufacturing process. Each of these cells is led by a Production Leader (PL). The PL is accountable for the performance of their specific cell. Each cell has a number of operators who are involved in the manufacture of the product. On average a PL can have around 60 operators working for them across shifts however the PL does not work shifts. The MM and PLs are supported by a shared maintenance team (MTM). Requests are submitted to the MTM and problems are addressed on a priority basis. The way that CI fits into this structure is that each SCU has a Business Improvement (BI) and a Manufacturing Improvement (MI) department. These are made up of a number of BBs who are dedicated to full time improvement activity. Within Turbines the MI and BI departments are made up of a total of twenty two full time BBs, which is just 1% of the Turbines population. The MI team are dedicated to manufacturing process improvements whilst the BI team address problems with supporting transactional processes.

Figure 10: The Rolls-Royce Supply Chain Unit Organisation Structure (Source: Created by the Author, 2011)

4.1.5 Lean Implementation

The BI and MI departments within the Turbines SCU have been driving the use of Lean techniques for the last couple of years and have been working with external consultants to understand how they can be used more effectively to improve business performance. The IJTPE is also aimed at introducing and embedding Lean. In order to utilise the full benefits of Lean, at the end of 2009, Turbines chose to pilot a project looking at the implementation of Lean across one of their key VS, the HP Blade VS. This particular VS was chosen as it is one of Turbines highest volume VS with a requirement to output up to 2,500 blades to its customers per week. The HP Blade VS is made up of 2 external suppliers, 2 subcontractors and 2 internal



domestic plants. At the start of the VS the raw material is supplied by the two external suppliers to the Derby casting plant.

As part of the casting process the blades go out to a specialist sub-contractor based on site. After being cast the parts then go to the Derby machining plant, which is based on the same site as the casting plant, and as part of the machining process go out to a specialist sub-contractor for coating. Each of the 6 elements that make up the VS is managed independently by different MMs who will be driving the performance of their individual business. It was evident that there has been substantial improvement activity taking place along the VS. It was however in the individual silo's (the suppliers and the plants) thus optimising the silos rather than improving the overall VS and delivery to the customer. This was resulting in a disjointed and underperforming VS. For example, the Trent 700 HP Blade had a yield of just 60% therefore 3 sets of blades were being manufactured to get only 2 sets out to the customer which was having a huge impact on the cost of scrap. As well as scrap the flow through the VS was poor, it was taking over a hundred days to get a blade from the beginning to end which was resulting in a Work in Progress (WIP) turn of just 3.6.

Identifying Value The HP Blade VS project was established due to poor customer delivery. The value to the customer was defined as on time delivery with high quality at the lowest cost. This definition of customer value is standard across all of the SCUs at RR. The Value Stream The flow stage of the IJTPE drives RR to identify the VS across its businesses, both manufacturing and transactional. Turbines have identified its manufacturing VS and the HP Blade VS is one of the highest volume VS. At the start of the project a Kaizen workshop took

place with a cross functional set of individuals who work within the VS to share their knowledge and experience. The VS was mapped out as shown in figure 11 and it became clear that there were a number of issues, shown by the red and orange markers.

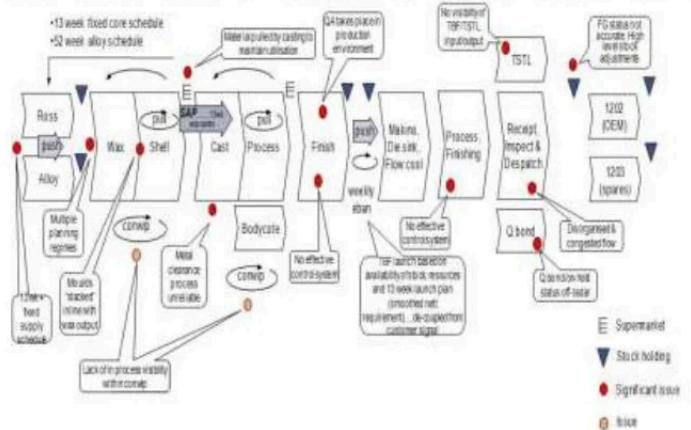


Figure 11: The Turbines HP Blade Value Stream (Source: Rolls-Royce Internal Document, 2011)

By mapping out the current state it became apparent that there was lots of opportunity for improvement, both quick wins and larger more complex problems. The output of the workshop formed the initial list of improvement actions. Following the workshop members of the project team also conducted "go, look, see" and waste walks to better understand the VS and to see if there were any further opportunities for improvement. The project was split into three work streams: Flow, Yield and Organisation. The flow work stream would focus on the flow of parts and the removal of non-value-add activities, with an aim of reducing WIP and lead time. The yield work stream would focus on increasing the yield in the problematic areas of the VS, either part or process specific, by improving the capability which also allows an improvement to flow. The organisation work stream would focus on the metrics, communication, training and the organisation design of the VS. This was a key work stream as it was aimed at changing the behaviours and the culture to encourage everyone to think about improvement and why integration across the VS is important. Flow As part of the project several improvements to layout have been made. There has been one significant re-layout project where the entire area has been completely altered in order to optimise the flow of parts through the area but also to improve the operating environment and replace some of the machines therefore improving capability. There have also been improvements in individual cells where the cell teams found ways to help parts to flow better. It can be difficult to optimise flow across a VS where there are several separate factories involved and also when the factories in some cases are old and have evolved over a number of years. It is important to have a vision for what the optimal flow would be if starting from scratch and to make small improvements to achieve the vision. This is the approach that was taken on the HP Blade VS

Project. During the initial stages of the project the planning and control team investigated the stability of the demand signal. They found that it could be improved as it was having a detrimental impact on the performance of the VS due to the regularity of changes that the plants were seeing. The forward schedule was analysed and the conclusion was made that a level schedule would be created to remove the peaks and troughs in demand. By doing this, the plant have a more robust plan to work to which minimises the interruption caused to production when the product mix changes.

Pull Prior to the HP Blade VS project there had already been changes to improve the flow of parts within the Derby casting process. At the start of the casting process a control system had been implemented to control the launch of work into the factory. After lengthy coaching of the employees on the shop floor to understand the control system it was accepted and is being used successfully. In order to control parts and integrate the full VS, the vision was to have control systems throughout. During the project, the team successfully implemented control systems across the remaining areas within the Derby casting process. A problem that often arises when using control systems is the evident behaviours when there are no requirements for parts to launch. Historically, the view by management has been that they must fully utilise both man and machines and that all improvement activity should be focused on achieving this. When control systems result in under-utilisation they panic. Instead of looking at the reason why parts are not moving through the VS and resolving the bottleneck, they break the control system by asking people to work on parts with no customer requirement. Coaching and driving the right behaviours across the VS has taken significant time by the project team over the last year.

Perfection The HP Blade VS is a long way from perfection. There have been some key improvements made during the last year but it is only the beginning of integrating the VS. The management teams within the elements of the VS still manage their business independently. There has been progress made on the use of the Lean tools and techniques but there is still a long way to go on the behaviours and the culture requirements. The project team made the mistake of presuming that the plant teams would continue to drive the IJTPE basics and therefore things like 5S, visual management and standardised work would be a given. However this was not the case and the IJTPE basics scores actually deteriorated. The learning point was that the requirements of the IJTPE need to be incorporated into Lean implementation at RR and should not be seen as separate. By following the IJTPE and using the RRPS tools and techniques the expectations of Lean should be achieved. The sustainment of improvements and the role of the leadership to support and drive the IJTPE are also critical.

Benefits Although the HP Blade VS project did not run smoothly and had a number of obstacles to overcome there were significant benefits achieved during the year:

- £1.4m WIP reduction;
- Increased WIP turns from 3.6 to 7;

- Reduction in lead time by 50%;
- Increased yield on the highest volume HP Blade by 20%.

4.1.6 Rolls-Royce Summary

From reviewing the RR case it is clear that they are making good progress on the implementation of CI and in particular of Lean and Six Sigma. By using a structured improvement methodology and standard roles set at the corporate level the knowledge and understanding of the IJTPE is successfully cascading. However what the case is also showing is that the implementation of Lean is as difficult as the theory suggests and that if you do not consider the critical success factors then the tools will not deliver the benefits alone. It shows that identifying value and the value streams is essential in order to identify where the improvements need to be and that the tools can help to identify and resolve issues. It also emphasises the importance of considering the behavioural and cultural issues and prioritising actions to tackle these alongside looking at the removal of waste and creating flow and pull.

The organisation structure within the RR SCUs does not effectively support the implementation of Lean firstly because of the ratio of improvement resource to employees but secondly because of the ratio of operators to PLs. Ideally the improvement resource would work with the production leaders to train and embed the behaviours, but the PLs have too much responsibility to enable them to take on this role. The effectiveness of the response by maintenance due to the structure is also an issue. MTM is shared and the result of this is that it is hard to identify the priorities and often machines can be down for excessive time waiting in the queue to be fixed.

The measurement and the governance of the elements of the VS need to change. They are currently measured individually with improvements identified individually. In order to support the work of the project the metrics and governance should look across the VS rather than at the individual elements. This would be a huge change but would encourage the correct behaviours and aid the decision making of improvement activity to ensure the optimal performance to customer is achieved.

4.2 BMW Hams Hall

4.2.1 Organisation Overview

With three brands, BMW, MINI and Rolls-Royce Motor Cars, the BMW Group has its sights set firmly on the premium sector of the international automobile market. BMW Plant Hams Hall plays a crucial role in BMW Groups international production network as the centre of competence for the production of all four-cylinder petrol engines for both BMW and MINI (BMW, 2011). Around 700 people are employed at the plant which supplies engines to the MINI production plant at Oxford and to multiple BMW plants around the world. Machining, assembly, logistics and quality operations all take place at Hams Hall.

4.2.2 Continuous Improvement Approach

In September 2006, BMW introduced the Value-Added Production System (VPS). The VPS was created after a group of around 60 BMW employees visited Japan to look at a selection of leading Japanese companies and the practices they use. BMW saw an opportunity and recruited experts in Lean manufacturing to establish a central CI function to create the VPS and the awareness material to be rolled out across BMW. The key difference of the VPS to other CI approaches previously tried at BMW was that the VPS is a philosophy, not an initiative, and this required a cultural mind-set shift. Figure 12 shows the key elements of the VPS and similar to the RR IJTPE there are a number of layers. These layers represent the journey which BMW are progressing along. The outer layer, or circle, represents the basics and the enablers to Lean in place and sustained to the next layer. This elements – Zero Standards, Continuous Transparency and On-Responsibility. These incremental which will help embed the workforce. The the larger inner circle, elements – Pull, One- and Zero Defects. The this level would be

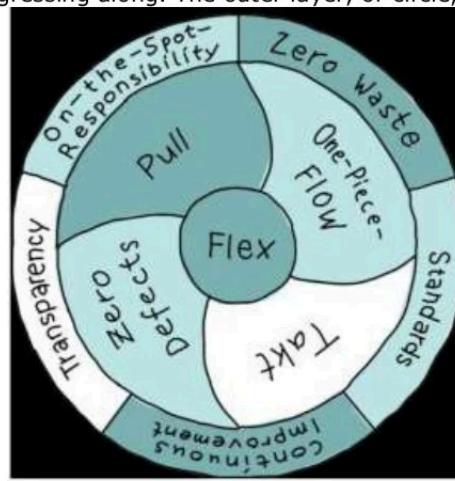


Figure 12: The BMW Value Added Production System
(Source: BMW Internal Document, 2011)

which should be before moving on is made up of 5 Waste, Improvement, the-Spot-are the smaller improvements CI and Lean into second layer, or is made up of 4 Piece-Flow, Takt improvements at more complex

and should only be considered once the foundations are in place. The final layer or the central circle is Flex and this is the ultimate aim of the VPS, a completely flexible VS which is free from non-value added waste and defects and is continuously improving. Similarities can be drawn between the VPS and Womack and Jones (2003) 5 principles of Lean. The outer circle is about identifying value and value streams and starting to look at the waste. The larger inner circle is looking at the flow and pull and the centre circle is achieving perfection.

Figure 12: The BMW Value Added Production System (Source: BMW Internal Document, 2011)

4.2.3 Lean and Six Sigma

Unlike RR, BMW Hams Hall does not have formally trained Lean Six Sigma Black, Green or Yellow Belts but they do have a dedicated improvement team who are trained in elements of the Lean and Six Sigma toolset. These are full time improvement specialists called VPS integrators who concentrate on driving and embedding the VPS by working with people across the VS. One of the critical approaches that BMW have taken is to take members of the shopfloor away from their day job and to seconde them onto improvements, full time, enabling

the sharing of the Lean tools and techniques whilst involving them in the improvement. BMW Hams Hall have found that 90% of the issues that arise do not require Six Sigma skills but rather basic problem solving skills and the aim is to equip all of BMW Hams Hall employees with the skills to solve these types of problems on a daily basis.

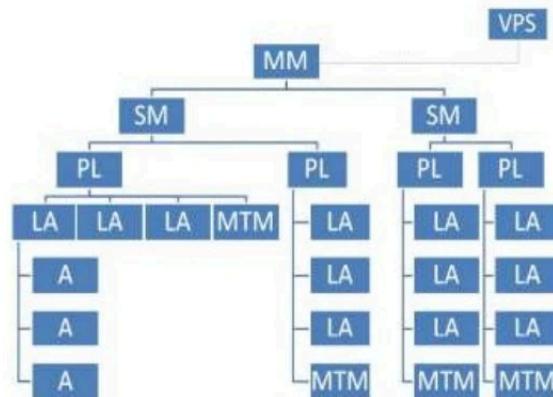
4.2.4 Organisation Structure

BMW Hams Hall has around 700 employees. The standard organisation structure for manufacturing within a BMW engine plant can be seen in figure 13. Heading up the plant is the Manufacturing Manager (MM) who is accountable for the overall performance of the plant. The Hams Hall engine plant is made up of two factories, the machining factory and the assembly factory. The MM is accountable for the performance of both of these factories. The MM has Shift Managers (SM) dedicated to both the machining and assembly factories. The SM is responsible for the production performance on their shift. The SM has a number of Process Leaders (PL) managing the cells and the PLs have Lead Associates (LA), Technicians (MTM) and Associates working for them. Only the Associates are on assigned work the other roles are supporting roles to ensure the Associates can complete their assigned work. Ratios are; 1 SM to 4 PLs; 1 PL to 3 or 4 LAs and 1 LA to 12 Associates. The LAs move around cells every shift in order to build relationships with all Associates and to establish any potential issues along the line. This encourages team work as identified issues should not be passed on to the next stage in the VS purely to make life easier for the LA as they might pick up the issue when they move along the line. The SM is ultimately responsible for all Quality, Cost and Delivery measures on their shift. The MM ensures that the SMs are aligned so that customer satisfaction is achieved. The way that CI fits into the structure is through the VPS Team. Each plant at BMW has a VPS team made up of full time CI specialists called VPS integrators. At Hams Hall the team consists of 4 VPS integrators and a Lean Manufacturing Manager which is less than 1% of the Hams Hall population. As mentioned previously, to support the VPS team when projects are selected, individuals are taken off the shop floor full time to support the team. This means that there is full engagement of the shop floor and also allows the employees to gain improvement skills to share with their colleagues. Because the ratio of LAs to Associates is low it makes it easier for the VPS team to engage with the Associates and encourage them to deliver improvements. The LAs take accountability for driving the VPS behaviours with the Associates.

Figure 13: The BMW Hams Hall Manufacturing Organisation Structure (Source: Created by the Author, 2011)

4.2.5 Lean Implementation

From 2006 through to 2010 BMW Hams Hall has been progressing along the VPS journey. Figure 14 shows the stages involved in implementing the VPS. The diagram shows that VPS is a journey and it is important to move through it one stage at a time ensuring that control is gained and maintained before moving onto the improvement stage. Figure 14: The BMW Value Added Production System Stages (Source: BMW Internal Document, 2011)



Initially, BMW focused on the enablers, for example, 5S, Daily Management Boards and Organising the Workplace. They used a systematic approach which meant that it was relatively simple, albeit time consuming. BMW Hams Hall worked their way through the VS, one stage at a time, ensuring that the basics were in place and fully embedded. At the same time they were engaging the people, thinking about how they could make small improvements to how their cell operated. One of the key implementations has been the daily management board. This is the main communication mechanism for identifying and driving improvements.



Each cell has a daily management board which consists of the following:

- Team Photos;
- T Cards;
- Hourly Counts;
- KPIs (Max 4);
- Audit Sheets;
- Daily Issues;
- Complex Problems.

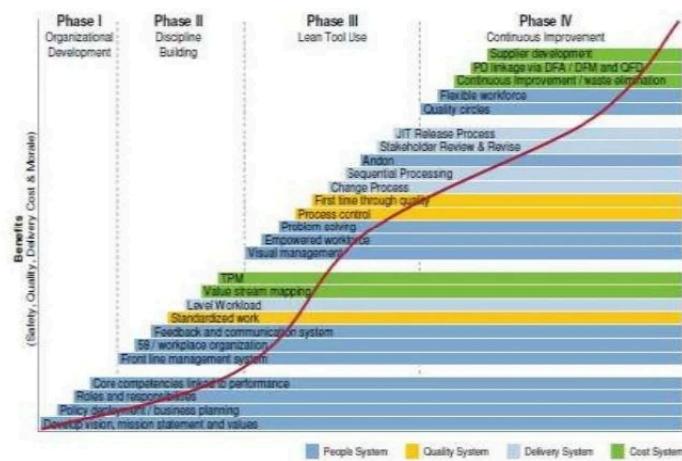
By establishing the daily management boards the VPS team are allowing the cells to investigate their performance and identify the reasons why they may not be hitting their targets. The teams are encouraged to capture and resolve the daily issues themselves. The daily walks will review the data on the board and ensure it is kept up to date. For issues that are agreed as complex, they would be moved to the complex problem board for investigation by the VPS team and the engineers. The structure for resolving these problems is similar to the DMAIC structure. In some cases members of the shop floor will be seconded to work on these projects full time.

Figure 15 shows a diagram from a Harbour Report by Oliver Wyman. BMW Hams Hall used this to guide them through the implementation of VPS at a more detailed level as they felt that it visualised the phased approach that they were taking. People are often impatient and want to introduce things which should come in later years. There is almost a sequence in which activities should be completed and the first stage is putting the standards in place and achieving a robust and sustainable foundation. Phases I and II align to the "Get Control" and "Keep Control" phases of the VPS and Phases III and IV align to the "Improve" phase of the VPS. Figure 15: The Lean Curve (Source: http://www.oliverwyman.com/ow/pdf_files/LeanCurve.pdf, 2011) BMW Hams Hall's current position on the VPS journey is that the foundation for Lean is in place and embedded. They are in a strong position to move forward and implement Lean to its full potential, however, are not yet in a position to say they have formally followed the Womack and Jones (2003) stages for Lean implementation. From the investigation BMW Hams Hall are aware of their customer, and the value they provide to the customer and the VS they are part of. Through the implementation of the VPS, opportunities for waste reduction and improvements to flow have already been identified. This is where BMW Hams Hall will next be focussing their efforts. The key thing is that BMW Hams Hall has taken everyone on the Lean journey and the next stages should be much easier because everyone is joined up and the behaviours and culture support the implementation.

Benefits Although BMW have focussed on the enablers to Lean, by ensuring that these are systematically implemented and sustained along with engaging their employees in CI they have seen significant benefits over the last four years:

- 76% improvement in rework;
- 35% improvement in hours per engine;
- 35% improvement in PPM;
- 33% improvement in throughput time.

The key to achieving the improvements involved the visualisation of performance and problems affecting performance and then the ownership of the resolution of the problems.



4.2.6 BMW Hams Hall Summary

The review of BMW Hams Hall shows that significant progress on the implementation of Lean has been achieved but that they are still in the early stages. They have taken their time to embed the foundations and ensure they have the required management support. They have made it clear that Lean is a lengthy process and that the expectation should not be that results are seen immediately. They have emphasised the importance of ensuring the foundation and the enablers are in place before jumping ahead to where some of the key opportunities for performance improvement can be achieved i.e. pull. BMW Hams Hall has successfully achieved the implementation of the foundations and is now in a position to move along the journey to look at flow and pull opportunities. Rather than seeing VPS as a CI initiative, BMW Hams Hall has used it to underpin the organisation strategy and to completely change the culture so that improvement becomes part of everybody's role. This is a key success factor which will enable BMW Hams Hall to continue to meet the benefits of Lean. Although the VPS is a corporate CI programme at BMW the way that this is implemented has been left to the localised businesses so that they can tailor their approach to their specific culture.

4.3 BAE Systems Samlesbury

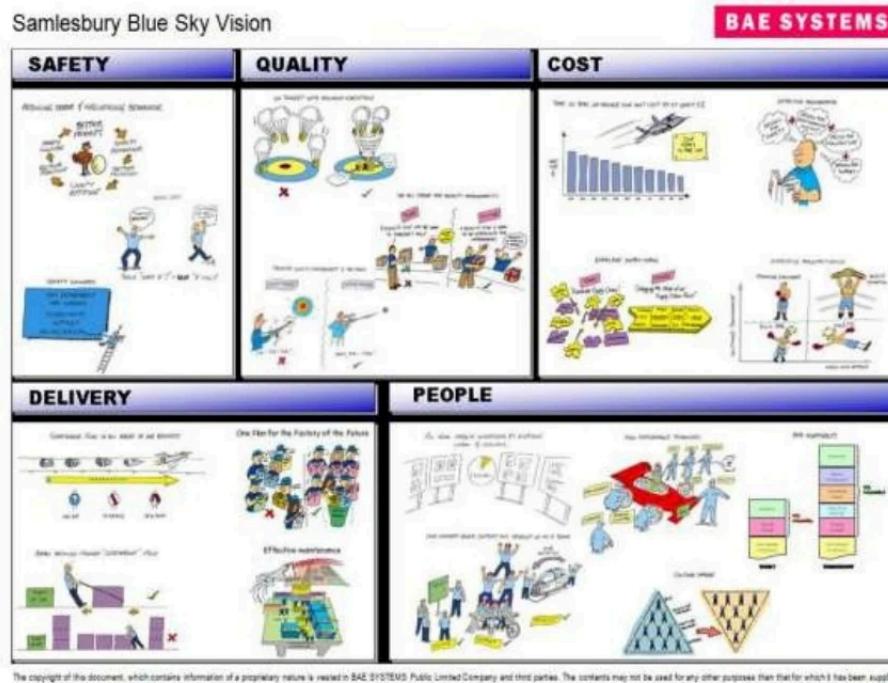
4.3.1 Organisation Overview

BAE Systems is a global defence and security organisation with approximately 100,000 employees worldwide. The organisation delivers a full range of products and services for air, land and naval forces, as well as advanced electronics, security, information technology solutions and support services. BAE Systems at Samlesbury provides manufacturing and support capabilities to a number of internationally important aircraft programmes, both

military and civilian, including the Eurofighter Typhoon, with over 4,500 staff based at the site (BAE Systems, 2011).

4.3.2 Continuous Improvement Approach

In the years preceding 2003 the perception of the BAE Systems Samlesbury site was one of under achievement in relation to its performance. As a result of this, and in the light of the significant business challenges faced, the site formally signalled its intent to embark on an improvement programme. A small team was formulated to lead the change programme and initially the CI work consisted of small localised projects which were excluded from the overall vision. Alongside these improvements initial training for a small percentage of employees was launched in order to obtain a base knowledge of Lean and Six Sigma. In 2004 the Samlesbury Blue Sky Vision (BSV) was created to give a visual representation of the aspiration for the Samlesbury site. The BSV was created by a number of stakeholders including the site



leadership team. The vision consisted of five categories: Safety, Quality, Cost, Delivery and People (SQCDP). See figure 16 for the Samlesbury BSV.

Figure 16: BAE Samlesbury BSV (Source: BAE Samlesbury Internal Document, 2011)

The BSV along with the supporting statements for SQCDP formed the framework for implementing Lean at BAE Samlesbury. The supporting statements are as follow:

- Safety: Reducing error and influencing behaviour;
- Quality: On target with minimum variation;
- Cost: Year on year we reduce our unit cost by 5%;

- Delivery: Continuous flow in all areas of our business;
- People: High performance team.

The BSV and the SQCDP was communicated across the organisation at Samlesbury in order to create a sense of urgency and to introduce people to the need for involvement in CI.

4.3.3 Lean and Six Sigma

Initially, during 2003 the CI team, consisting of four employees, plus a selection of change agents were taken through Six Sigma Green Belt training along with a 13 week course on Lean manufacturing. Since 2003 this training has been replaced by a more generic Lean Learning Academy (LLA). As a result, BAE Samlesbury does not have a CI structure of Black, Green and Yellow belt roles. However, over the last seven years there has consistently been a full time team in place to drive the CI approach which is now known as the System Design Team (SDT) consisting of four individuals. All engineers are trained in Six Sigma however the use of this training is not always seen as effective. During 2010 the SDT identified the need for more significant support from the shop floor for CI and so a group of local leaders and trainers were developed to become focal points for CI in their respective businesses, these are known as CI Champions or Leaders.

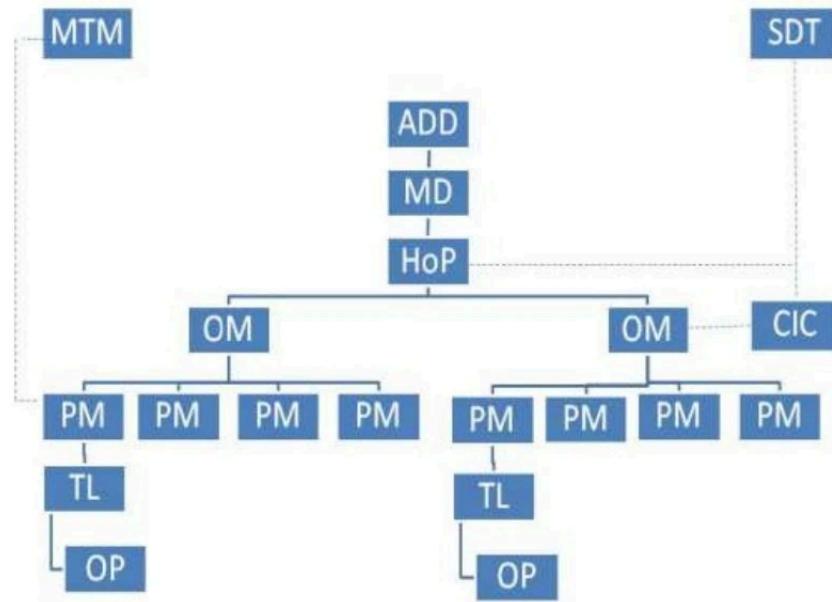
4.3.4 Organisation Structure

BAE Samlesbury has around 4,500 employees, some part of the manufacturing process; others part of the supporting functions. The standard organisation structure for manufacturing at BAE Samlesbury can be seen in figure 17. Heading up the Typhoon programme is the Airframe Delivery Director (ADD) who is accountable for the delivery of the Typhoon airframe to the Typhoon Managing Director. The ADD will lead both the manufacturing and the functions related to the delivery of the Typhoon airframe, this individual sits at a programme level. Working for the ADD is the Manufacturing Director (MD) who is accountable for all manufacturing activity across the site, not just the Typhoon. Working for the MD with a specific focus on the Typhoon programme is the Head of Typhoon Production (HoP). The HoP is responsible for the delivery performance of the specific manufacturing plants delivering Typhoon parts. Working for the HoP is two Operations Managers (OM) who are responsible for the delivery of specific elements of the Typhoon programme. Working for the OM is the Product Managers (PM) who manage individual cells within the manufacturing process and there are also team leaders (TL) who support the PMs to manage the operators. The organisation structure at BAE Samlesbury is extremely hierarchical, with a number of layers which can be quite confusing. The structure towards the bottom does however mean that the ratio of operators to first line manager is around 8 to 1 which does make the job of the SDT easier as the CI champions (CIC) can communicate directly with the TLs to engage with the operators and involve them in CI. Figure 17: The BAE Samlesbury Manufacturing Organisation Structure (Source: Created by the Author, 2011)

The maintenance team (MTM) provide a supporting role and attend the morning meetings to pick up on any issues for resolution.

4.3.5 Lean Implementation

As part of achieving the BSV and the SQCDP framework BAE Samlesbury realised the need to improve through the use of Lean. To prove the concept of Lean, BAE Samlesbury decided to pilot the approach on a model line. This enabled a significant quick-win as the improvements



had a particular resonance at BAE board level due to previous concerning levels of performance on the model line. Two initial steps were taken to address the problems; VS mapping and Process Control.

VS mapping helped Samlesbury to understand the process as a whole rather than the perceptions that existed at that time. A team was created, consisting of personnel from across the VS. The implementation plan was created with actions identified and owned by the appropriate people. This plan was then reviewed on a weekly basis by the action owners and led by the PM. Alongside the VS mapping, key process features were charted at varying frequencies. Local visual boards were set up to track the information gathered by the process operators who log the readings and note any process variables. The approach was designed to address the amount of variation in the processes and to improve the performance. The use of DMAIC improvement projects helped to address any problems.

Alongside these specific improvements on the model line some more general changes were introduced across the manufacturing plants at BAE Samlesbury. Firstly, the introduction of Policy Deployment, which took the images from the BSV and translated them into a site

scorecard. This scorecard consisted of a series of key business measures grouped under the SQCDP headings. For each measure an owner, a performance trend graph and an action plan to improve was displayed. The site scorecard has been deployed further down the business to major business areas and also across the supporting functions. This deployment is encouraging the cascade of the BAE Samlesbury strategy down to individual objective level so that individuals can see how their performance can contribute to the overall performance of the site.

Daily start up meetings allowed monitoring of policy deployment at a local level. This is where the front line employees are connected to the overall process. These meetings provide a forum whereby leaders can engage with their team members to set expectations, identify support requirements and review team performance against the Samlesbury site themes of SQCDP.

The implementation of a comprehensive training programme has also been important for the success of Lean at BAE Samlesbury. It was recognised at the outset that the apprentices would be part of a transforming organisation. It was essential to introduce the Lean concepts from day one before entering the shop floor, working with individuals who were resisting change. The changes made to the apprentice training were aimed at encouraging them to create their own environment through identifying opportunities to apply Lean principles. It was important not to enforce Lean but to help them to see the benefit of applying it. As well as introducing the new employees to Lean it was also a priority to develop the leadership capability and behaviours to ensure that Lean transformation was appropriately owned and led. The LLA was established at the Samlesbury site in September 2005 and is a three week intensive course aimed at developing the leadership and CI population in understanding the Lean principles and allowing them to understand the practical application of the associated tools and techniques. There is a particular emphasis on the role of the leadership in realising the benefits of Lean. The delegates get the opportunity to tackle a known business problem resulting in a benefit to the business whilst showing the wider population the support of the leadership, by leading by example. 2008 saw the Samlesbury site benchmarked by the Shingo prize within the context of "Operational Excellence". This assesses the organisation on its deployment of business improvement using Lean as the guiding principle. BAE Samlesbury became the first organisation outside North America to win the prestigious Shingo prize Bronze medallion. Although the Shingo prize highlighted the improvements that BAE Samlesbury achieved through the implementation of Lean the real benefit was the feedback received in how they could improve. Figure 18 shows a SWOT diagram that was formulated as part of the Shingo assessment. This could be used to form improvement action plans.

Figure 18: The BAE Samlesbury SHINGO SWOT (Source: BAE Samlesbury Internal Document, 2011) As a result of SHINGO more emphasis has been put on the need for as many people as possible to go through the LLA, the need for the CI champions in order to run more Kaizen events and a working practice change for shop floor. This change was agreed with the Trade Union and meant that employees would be paid a percentage in addition to their salary to participate in CI activity. In the first year of the scheme employees were expected to participate in CI activities which would be led by local or SDT leaders. They encouraged

<u>Shingo SWOT</u>	
Strengths	Opportunities
Visual management of Policy Deployment Balanced Scorecard Commitment to LLA process Commitment of NVQ (BIT) for workforce Service Excellence training Improved Safety culture - Safety and Environmental kaizens Process strength (CSR, LCM) Movement away from absorption costs	To clearly define Lean Vision Formal system for sharing best practice To relate to business (Cross functional) call to action Cross training to enrich flexibility and learning Lean best practice areas in each building Run formal improvement events Mandated & Disciplined 5s programme Use MRP for material scheduling of production Scheduling Focus on vital few (3 – 5) metrics that will make a difference Lean application in Admin areas Measurement for involvement in improvement events – How many / How often Simplified Lean accounting
Weaknesses	Threats
Lean metric not clearly defined in the Business No system for sharing best practice Middle management lack of involvement in lean Insufficient focus on all types of wastes Lean Coaching Very little evidence of flow – serious omission Formal kaizen events not run Effectiveness of CIB Widening engagement inconsistent Blue Sky vision not clear at all levels - influence by individuals? Modest environmental targets No evidence of Customer satisfaction survey Best practice not being shared Implementation of the tools appears to be discretionary and optional whereas foundations (E. G. 5s) should be mandatory Lean principles appear optional Admin areas not measured for effectiveness Focus on too many measures No first time yield measure Long lead times with lack of focus on reduction	Ad hoc lean implementation - sporadic use of Lean tools No system for sharing best practice Middle management lack of involvement in lean Functional Silos resulting in lost opportunities - DFMA Use of MRP inhibits flow Direct/ Indirect headcount ratio

employees to think about improvements in their local working area to actively seek and drive improvements without the push from the SDT.

Identifying Value The basis for implementing Lean at BAE Samlesbury was to help to achieve the BSV and the SQCDP. These strategies are very much aligned to improving the performance internally and to ensure that there is no waste within BAE Samlesbury. Like RR the SQCDP metrics are aligned to the needs of their customers to include on time delivery with high quality at the lowest cost. The pilot on the model line was chosen because the performance to customer was not acceptable. The Value Stream BAE Samlesbury identified their VS and the model line was chosen as a pilot. One of the initial steps was to map the VS to identify opportunities for improvement. A cross functional group was involved in this exercise and a number of opportunities were identified and subsequently projects were launched and delivered.

Flow Due to the size of the components being produced at BAE Samlesbury the only option is single piece flow. This means that they do not face batching problems which interrupt flow. One of the newer factories was designed with flow in mind and the parts therefore flow well. As a result of SHINGO the cells within the model line factory were encouraged to think about the eight wastes and how they could remove waste. As a result layout changes in the cell were made and components and tools were never out of hands reach. All items required to make

the components were delivered to the line so that operators did not need to travel around the factory unnecessarily. Shadow-boards were used to ensure that tools did not go missing causing unnecessary time searching.

Pull BAE Samlesbury found it relatively simple to implement pull due to the size of the components produced. The factory was educated on the theory of Kanban and this has been embraced well. There are still occasions when parts are prioritised ahead of others and often for the wrong reasons. This shows that there is still a learning gap in some of the leaders at BAE Samlesbury. Perfection A number of steps have been taken at BAE Samlesbury towards achieving perfection but there is still room for improvement. The key for BAE Samlesbury is to get everyone engaged in CI so they can continuously identify waste and opportunities for improvement. This is why BAE Samlesbury is putting focus on the LLA to ensure that the culture is one that drives CI. If behaviours and culture can be changed to support Lean then the implementation of the tools will be much easier.

Benefits Performance improvement has been achieved through the leadership understanding of Lean principles driven by the deployment of Lean tools. This has been prioritised through Policy Deployment and the SQCDP framework. Since 2004 the benefits have been in excess of £19m whilst ensuring the ability to meet the customer demand increases. The benefits can be broken down as follow:

- 45% reduction in incidents;
- 30% improvement in scrap and concessions;
- 14% reduction in non-labour costs;
- 22% improvement in customer delivery.

4.3.6 BAE Systems Samlesbury Summary

BAE Samlesbury has been successful in implementing Lean despite the lack of a clear framework for implementation. An important aspect of the Lean implementation was that they had a vision and some clear metrics to drive the improvements. BAE Samlesbury had taken the implementation one step at a time focussing on the behaviours and culture of the organisation and ensuring they could provide effective training to engage and encourage the organisation to think about Lean and CI. BAE Samlesbury have actively tried to improve the implementation of Lean by undertaking external benchmarking and have taken the last seven years' lessons into account, building a clearer model and framework for future deployment.

4.4 Case Study Summary Each of the case organisations has taken a different approach to the implementation of Lean. RR has a very clear framework at the corporate level which is heavily mandated with targets set at all business levels. BMW Hams Hall has a corporate vision with the local implementation left to the plants. BAE Samlesbury has no corporate vision for

Lean and the approach taken is very much localised to the Samlesbury site. Each of these approaches has been successful and in every case significant benefits have been achieved. The focus for RR has been the implementation of the tools and progression at pace along the journey. This has meant that in some cases, the improvements have not been sustained. The focus for BMW Hams Hall has been on the implementation of enablers for Lean and involving everyone in the journey so improvements can be identified and owned by all employees and sustained. The focus at BAE Samlesbury has been on the behaviours and culture for Lean through a structured training programme. The three organisations can take learning points from one another in that a structured framework with targets forms a clear vision and plan. By focusing on the enabler's any improvements implemented are sustained. Taking time to address the behaviours and culture ensures that Lean can be part of the day job rather than something that an elective set of experts has to drive continuously.

Chapter 5: Findings and Discussion

5.1 Introduction This chapter covers the findings from the three case study organisations using the semi-structured interviews and documentation gathered. The goal of the analysis is to answer the research question: "What are the challenges to implementing Lean across manufacturing VS, how can these be overcome and what are the key success factors for implementation?" with recommendations of how RR can improve their current process.

The semi-structured interviews took place separately over a period of 2 months and covered three interviewees. A tour of the shop floor was also provided by all organisations to show specific examples of improvements that had been made. Documentation was reviewed in the form of project presentations, benefits cases, frameworks, training material and performance reports. When analysing the case organisations the data has been compared to the Boston Consulting Groups study on the critical success factors for Lean along with the Kotter (2007) model for Change Management.

5.2 Rolls-Royce Challenges and Critical Success Factors

a. Choose strategic, customer centric projects and create a sense of urgency The HP Blade VS project was identified as a key project on the RR Turbines Business Plan for 2010 in order to improve the delivery performance to the customer whilst reducing WIP and lead time and improving the yield. The project was communicated as part of the Business Plan Deployment cascade but the sense of urgency could have been much greater. People did not understand how important the project was and as a consequence the support for the project varied across the business. The same can be said for the implementation of the IJTPE. People do not understand why it is so important and how it can help to improve the performance of the business which is why the sustainment of the improvements made is poor.

b. Think big, but start small The overall aim of the project was to create a Leaner HP Blade VS however to prove the concepts of Lean a pilot approach was taken on the Trent 700 HP blade. This enabled the delivery of a number of quick improvements in order to bring people on board which worked well. One lesson learnt was the expectation that the areas along the VS would ensure that the Process Basics were in place. This was not the case and the result was that some of the improvements made were not sustained.

c. Involve everyone from top managers to line workers and create a guiding coalition From day one, a number of people from both the shop floor and the supporting functions were involved in a three day workshop to discuss the aim of the project and to map out the VS. This was essential and helped to build relationships and involve those that worked the processes so that they were part of the improvements rather than becoming victims. Throughout the project the involvement of people from across the VS was a priority, however the willingness to be involved, at times was difficult. Each of the project work streams was sponsored by a member

of the Turbines leadership team in order to act as the point of escalation. This was essential and also useful as they drove pace on the project but also supported the team when issues arose. One area for improvement in the leadership support was when a number of leaders from the VS were involved in the PELA training and had the opportunity to deliver a number of small improvements. In most cases, this did not happen which was disappointing for the project team as the leadership had the opportunity to set the standard for everyone else. This was de-motivating for the areas involved and showed that, although there were senior sponsors on the project, there was not a guiding coalition. They would talk the talk but were not willing to walk the talk.

d. Tailor your approach to your culture RR has a hierarchical culture but employees have a strong influence over improvement programmes due to the unionised nature and the fairly flat structure towards the bottom of the hierarchy. The VS at RR are silo driven and Lean programmes need to focus on integrating the silo's and encouraging employees to work together. The strength of the RR culture was not considered strongly enough prior to the launch of the project and this is one of the key learning's from the HP Blade VS project. Unless the employees and their direct managers are on board, the improvements will not be sustained. The leadership team were sponsoring the project but the issue was that the middle managers did not see the need for, or the benefit of the project. This was a gap in the stakeholder management throughout the project and also there was not a powerful enough guiding coalition in place to drive the vision and remove the barriers. RR also has a fire-fighting culture which means that improvement is often not considered a priority which again does not drive the right behaviours.

e. Assign dedicated, experienced resources Initially, Turbines had six external consultants supporting and programme managing the project. The internal Turbines team consisted of six full and six part time members. The team was sufficient in number to establish quick definition of the required improvements and the delivery of some of the opportunities. After six months the consultants were withdrawn from the project and a number of the full time, and part time team drifted back to their day job. This required a complete re-structure of the remaining team and also a re-scope of the project due to the limited remaining resource. The impact on the project was significant resulting in projects being postponed which did not give a good impression to the workforce about the priority that the leadership team were giving to Lean. It also meant that many commitments made were now unachievable, for example the organisation work stream gradually diminished. This resulted in a gap on the support side of the project, the communication levels reduced and the metrics that the team had been driving forward were not embedded. This limited the overall impact of the project during 2010.

f. Use metrics to drive progress The HP Blade VS project was aimed at reducing WIP and lead time and increasing yield. Data was captured in order to baseline these metrics however during

the project the data was not regularly monitored which proved difficult to understand if the progress was delivering the required benefits. The metrics should drive the improvements therefore the data should be dynamic. Again this was a key learning point from the project and sets the standard for a Lean project moving forward. The metrics need to drive the improvements. The management team changed some of the business KPIs during 2010 and changed the name of their metric review to be called the "Lean KPI review". However metrics such as lead time and WIP are still not monitored and there are too many KPIs causing a conflict of focus. This was a result of the organisation work stream diminishing.

g. Communicate The communication in the initial stage of the project was adequate. The kick-off workshop involved a cross functional group from the VS. The project team also delivered two storyboards in the early part of the year to the wider VS community. The first was to define the reason for the project and the second to share progress. As the team reduced in size the level of communication could not be sustained, this had an impact on the engagement with the project team. Many people thought the project had failed, like so many other of the CI initiatives, in the past. Towards the end of the year engagement and communication was re-prioritised to ensure plans for 2011 could be shared. As per the Boston Consulting Group's findings along with Capon (2004) and Kotter (2007) communication is one of the most important aspects of running improvement projects and should never be given a low priority.

5.3 BMW Hams Hall Challenges and Critical Success Factors

a. Choose strategic, customer centric projects and create a sense of urgency BMWs strategy is to be number one and the VPS is a key driver for achieving and maintaining that strategy. The VPS has been the strategy for CI since 2006 and employees understand it and can see the benefits it is delivering. BMW Hams Hall did not see the need to create a sense of urgency because the need to continuously improve was enough for the employees to embrace the VPS.

b. Think big, but start small BMW Hams Hall purposefully started with the enablers such as 5S and visual management to start to get people thinking about Lean but without specifically labelling it Lean. By getting people involved and thinking about improving their own area employees started to identify and resolve problems and remove waste resulting in a Leaner VS. BMW Hams Hall has a strategy and a plan with the VPS but they are taking it step by step so that people do not get burdened by the enormity and complexity of some of the changes. They want their employees to conclude the need for the improvements themselves so that they will be embedded and sustained. BMW Hams Hall ensured that the leadership were aware that progress takes time and results will not be immediate. Quite often the management want to jump ahead to the tangible benefits of Lean before putting the enablers and foundations in place. When this happens the improvements will not be sustained.

c. Involve everyone from top managers to line workers and create a guiding coalition There is a variation in the success of the VPS implementation across the different plants within BMW, mainly down to the management focus or lack of. The resource has to be in place and the management must be seen to be taking a genuine interest and to be leading by example. BMW Hams Hall focused on ensuring that they had leadership support from day one and created a clear plan to allow constancy of purpose and to set the expectations. One of the key aspects is it should take as long as it takes, to ensure sustainment and this requires a management of expectations. The programme is a 10 year activity, requiring a fundamental change of culture. BMW Hams Hall have spent 5 years putting the enablers in place and ensuring sustainability and are now in a position to move on to optimising the workplace by focusing on training the workforce to be more effective in problem solving. The leadership show employees that the VPS is a priority to them by allowing shop floor employees to be seconded onto improvement projects full time and also attend training courses on Lean followed by the delivery of projects. BMW Hams Hall has created a strong guiding coalition in their leadership team who walk the talk as well as talking the talk, critical for a success in Lean.

d. Tailor your approach to your culture Hams Hall is a fairly new plant (around ten years old) and CI has been embedded from day one. VPS has also been the only CI initiative that the staff has seen therefore they do not have the perception that it is just another fad. The organisation structure at BMW Hams Hall is supportive of Lean because the ratio of associates to lead associates makes it easier for the VPS team to engage and work with the associates on improvement. BMW Hams Hall is not afraid of the consequence of becoming Leaner, they actively use bank days for peaks and troughs in demand. This means that if the plant runs ahead of schedule and does not have work for employees they will close the plant for the day. They also clearly state that if the plant completes its week's production by the end of Thursday, which Friday will be used to complete things such as 5S and workplace organisation or, working on opportunities for improvement. This shows the right behaviour taking away the concern of the management team about the achievement of standard hours to show that capacity is fully utilised.

e. Assign dedicated experienced resources The VPS team are full time dedicated to implementing the VPS and supporting the shop floor on identified improvements. These are the experts in the tools required to implement the VPS. The dedication of management to seconded employees to improvement projects shows strong support for the implementation of CI and the VPS. This allows the multi skilling of the shop floor employees and the creation of a plant wide CI culture.

f. Use metrics to drive progress BMW insist on having a maximum of just four KPIs, per area. This means that the area is very clear on what they are trying to achieve. The KPIs are displayed on the daily management board and reviewed by employees and management

regularly. Over the last five years BMW has focused more on the Lean measures such as value-added ratio and cycle time.

g. Communicate the daily management board and walks are well embedded at BMW Hams Hall and seen as a priority over everything else. The daily management board review is diaried and no other meetings can take place at the same time. Again, this shows the right behaviours for the employees of BMW Hams Hall in prioritising the VPS.

5.4 BAE Systems Samlesbury Challenges and Critical Success Factors

a. Choose strategic, customer centric projects and create a sense of urgency BAE Samlesbury chose the model line as the pilot project for Lean as the performance was poor and it was essential to improve this to achieve customer satisfaction. The focus has now moved to another area where it is critical that the cost of the product is reduced. This requires a significant reduction in the lead time for manufacture of the component. BAE Samlesbury has been successful at creating a sense of urgency, and this is visible in the results being seen.

b. Think big, but start small BAE Samlesbury chose the model line as a pilot in order to show people the benefits which are achievable through the implementation of Lean, starting with small improvements, e.g. implementing visual management, so that problems could be identified and then encouraging everyone to get involved in solving problems.

c. Involve everyone from top managers to line workers and create a guiding coalition BAE Samlesbury strongly believed that in order for Lean to be effective, everyone needs to be involved in the Lean journey. This was the reason for the creation of the LLA which started with introducing Lean to the management teams. They believed that if they could convince management and show employees that the leadership team believed in and supported it, then it would go a long way to encouraging every one of its importance. BAE Samlesbury received strong leadership support during the initial stages of Lean implementation as there was one member of the leadership team who believed in Lean. This member left the company after a couple of years which had a huge impact on the progress and the support that was subsequently received. The SDT found this particularly challenging and realised the importance to have strong senior stakeholders supporting the change initiative (a guiding coalition). BAE Samlesbury is now using the LLA to create a strong guiding coalition.

d. Tailor your approach to your culture the perception at BAE Samlesbury was that Lean was not suited to the BAE environment, hence why, once the supporting stakeholder left the company, it became more challenging to implement. The SDT needed to convince the leadership team, along with the workforce, that Lean is applicable to any organisation and how it would work at BAE Samlesbury. They used the LLA to do this. The working practice change

was also designed to show the wider workforce how important Lean and CI is to the organisation and confirm that BAE were prepared to pay the employees extra to work in a different way and to consider Lean and CI in their day jobs.

e. Assign dedicated, experienced resources The SDT are a dedicated full time team supporting the implementation of Lean. What they have found over the years is that full time support needs to be in the plants and cells. The SDT is too small to make the changes required at pace. The decision has been made to create a new role called a CI champion. One benefit of this is that people chosen for the role are people from the shop floor who have taken an interest in improvement. This means that they have developed a relationship with staff on the shop floor and should find it easier to engage and encourage them to become involved in CI and Lean implementations.

f. Use metrics to drive progress BAE Samlesbury has been focused on the achievement of the SQCDP metrics and improvements have been identified to improve the performance of these metrics ultimately helping to achieve the BSV. An opportunity of improvement, as identified by SHINGO, was the high number of KPIs which could be confusing. It was also apparent that there was no clear plan in place for the implementation of Lean and as such, not possible to measure if they were achieving the requirements. This could have had an impact on the pace of change that was seen at BAE Samlesbury.

g. Communicate In the initial stages the communication was not as effective as it could have been. This is one of the reasons for the LLA. The idea is that if all leaders are trained and then implement a project, this engages the wider population and starts to involve them in the Lean journey. BAE Samlesbury decided not to brand the Lean improvements as "Lean" as they didn't want to create the perception of another improvement initiative. They have kept the language very simplistic and encouraged the employees to think about waste in their processes and how they can be improved.

5.5 Summary of Findings After reviewing all three organisational case studies there are clear pros and cons to the approaches taken by all three organisations. There are also some very clear lessons learnt:

- 1 Lean implementation should be considered as a change project and therefore a change model, such as Kotter, should be followed and embedded into the implementation plan.
- 2 It is important to have a clear vision and a plan for achieving the vision. It should be simple to communicate, with a simple set of targets in order to achieve the plan, linked to business performance.
- 3 Leadership support is essential at all levels and the key stakeholders should be identified along with their level of influence.

4 An effective communication strategy should be implemented so that all stakeholders can understand the vision, the plan and their role in achieving it, allowing feedback of issues as early as possible.

5 Do not get hung up on branding, i.e. the use of the Japanese words for Lean and even the use of the word "Lean". Focus on waste identification and elimination. Sometimes branding can put people off or cause unnecessary negative perceptions.

6 Break the implementation of Lean down into achievable chunks starting with the enablers. Do not try and jump ahead before the foundations are in place. Lean is a journey which takes considerable time and resource, and leadership team need to understand and support this.

7 Use the shop floor to deliver improvements. Both BMW and BAE have successfully used staff from the shop floor to deliver improvements and RR is now seeing the benefit of this.

8 Consider the organisational structure. Lean is more achievable with a flatter structure at the bottom where the ratio of operators to the first line manager is low. This means that the first line manager can encourage CI as they have fewer other activities to concentrate on and not as many people to manage.

9 Do not focus solely on the implementation of the tools as this is the easy part. It is the changing of the behaviours and culture to sustain the improvements which is the difficult thing. It is important to ensure that the Lean implementation plan considers the behaviours and culture changes required. Consider a LLA which all three example organisations are now seeing the benefits of. This should incorporate both training and the delivery of projects.

Chapter 6: Conclusion and Recommendation

6.1 Conclusion The focus of this report seeks to understand the challenges of implementing Lean across manufacturing VS. First a literature review was completed to review relevant aspects of Lean, including the tools and techniques, along with the critical success factors and the influence of Change Management. This provides the foundation for the research on three case organisations in their implementation of Lean. An overview of the organisation's background, their approach to CI and specific Lean implementation was covered to provide an understanding of the challenges.

The research data and findings support the fact that Lean can be particularly challenging to implement if the behaviours and cultural aspects are not addressed from the outset. All interviewees recognised that leadership support for Lean implementation is critical and without it improvements would not be sustained. All three organisations have been successful at implementing Lean within a manufacturing environment. Each organisation has taken a different approach but all have faced similar challenges. These challenges are consistent with those found by the Boston Consulting Group and Kotter.

6.2 Recommendations for Improvements to the Rolls-Royce Approach From the review of the three case studies and the identification of lessons learnt there are a number of recommendations for improvements to the RR approach to Lean implementation.

6.2.1 Organisation Structure

The organisational structure within the manufacturing plants at RR is too flat at the bottom. The ratio of operators to first line management is too high meaning that the leadership cannot drive improvements because they spend too much time managing people, attending meetings, fire-fighting issues that arise on a daily basis and reporting on performance. A recommendation is that a new role is created, "Team Leader" whom answers to the PL. The PL can have a number of Team Leaders depending on the size of the team, ensuring that a ratio of, at the most, ten to one is achieved. This will mean that the team leader can focus on encouraging the operators to think about improvements within their area and take ownership for ensuring the Process Basics are implemented and sustained. The current process for maintenance support is also ineffective and creates a further burden on the PL. The current method of a shared service does not support Lean because it results in interruptions to flow as maintenance is reactive rather than proactive. The BMW Hams Hall model, where maintenance are allocated to a cell ensuring that they work closely with the team leaders within the cell to keep all machines running, seems to be more effective.

6.2.2 Use of Shop Floor personnel to deliver full time improvements

BMW Hams Hall and BAE Samlesbury have both successfully encouraged shop floor personnel to deliver improvements on a full-time basis for a period of time. This involved changes to the Terms and Conditions of those employees. RR introduced a change of contract to shop floor personnel around three years ago, "Modern Working Practices", resulting in a pay increase for employees. One of the conditions of this was that shop floor personnel would become involved in improvements. Since the introduction of "Modern Working Practices" little has changed and resistance to CI on the shop floor remains. RR has failed to enforce the conditions of the agreement and this is something which is essential in moving forward. The recommendation is that the agreement is reviewed and enforced on shop floor staff to allow them to be more involved in CI which, over a period of time, will change the perception of CI.

6.2.3 Focus on the Enablers

The IJTPE is a very clear and structured framework for implementing Lean. The first stage is the Basics, the foundation and the enablers to Lean. This is the most difficult and most important stage of the IJTPE. RR have not allowed enough time for the enablers to be implemented and sustained before driving the implementation of Control, Flow and Capability. Without the Basics the improvements made as part of the other stages will not be sustained. Targets set at the corporate level are based on an assessment matrix, which drives the wrong behaviours as people only make improvements to get a tick in the box rather than because they see a benefit to implementation and therefore are not sustained. The recommendation is that RR does not set targets against the IJTPE but they should clearly articulate the benefits to business performance for implementing the IJTPE and allow the businesses to implement at their own pace with a caveat on using the IJTPE to ensure continued improvements to business performance.

6.2.4 IJTPE as Support Framework

The IJTPE is an excellent framework for guiding people along the journey to achieving Lean. The RRPS, sitting alongside it, details how to implement the tools and techniques. Each business unit at RR is at a different level of maturity and has different cultures. This will have an impact on how the IJTPE is implemented. The business unit needs to tailor the implementation approach to its culture. The recommendation is that the IJTPE is less mandated in the business units. There should be recommendations and guidelines for implementation but the exact method and timescales should be down to the business unit.

6.2.5 Comprehensive Leadership Training Programme

The training around the IJTPE at RR is focussed on the implementation of the tools and techniques. The gap seems to be in displaying the required behaviours in the leadership to support and encourage CI. If the leadership do not lead by example and show that CI is important in creating a sense of urgency then employees will not see the need to change. The recommendation is that a comprehensive training programme for leadership is created involving an understanding of their role, the important characteristics and the display of these behaviours by implementing improvements on the shop floor. The PELA programme is the first step to achieving this but this needs to be fully embedded and rolled out across Turbines leadership from executives down to first line managers.

6.3 Recommendations for Further Research

The case studies that were chosen were mainly due to the availability of the organisations to the author but also because they had been involved in Lean implementation for a number of years. Further research could involve other organisations to understand if the challenges faced by the chosen three could be considered generic. All organisations involved were large global organisations which allowed a suitable comparison however it may be interesting to look at more diverse organisations in both size and product.

It would be interesting to continue to study the three case organisations for a number of years to see if further progress is made on Lean and to learn if changes are made to overcome some of the identified challenges.

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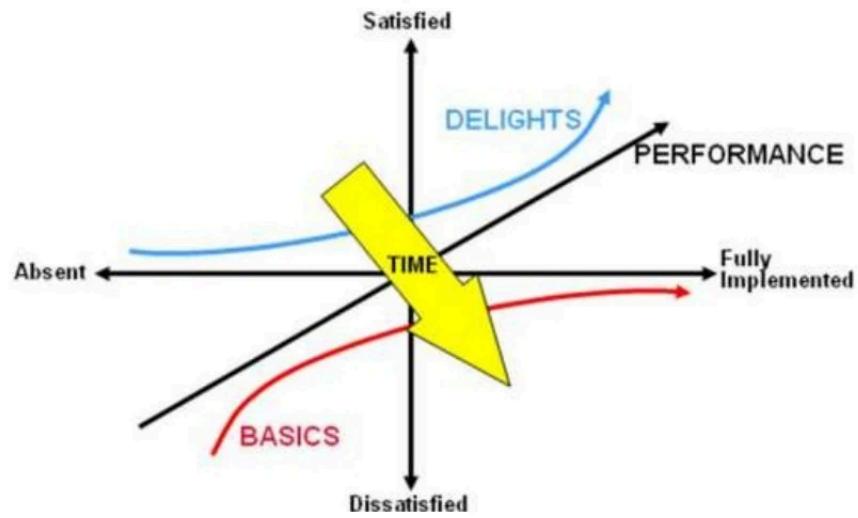
Appendices

Appendix 1 – Acronyms

BB	Black Belt
BSV	Blue Sky Vision
CI	Continuous Improvement
DMAIC	Design, Measure, Analyse, Improve, Control
GB	Green Belt
IJTPE	Improvement Journey to Process Excellence
JIT	Just In Time
KPI	Key Performance Indicators
LA	Lead Associate
LLA	Lean Learning Academy
MBB	Master Black Belt
MM	Manufacturing Manager
PL (RR)	Production Leader
PL (BMW)	Process Lead
QM	Quality Management
RR	Rolls-Royce
RRPS	Rolls-Royce Production System
SCU	Supply Chain Unit
SDT	Systems Design Team
SM	Shift Manager
SQCDP	Safety, Quality, Cost, Delivery, People
TPS	Toyota Production System
TPM	Total Production Maintenance
TQM	Total Quality Management
VPS	Value-Added Production System
VS	Value Stream
YB	Yellow Belt

Appendix 2: Kano Model

Appendix 2: Kano Model (Source: Prof. Noriaki Kano, 1984)



Appendix 3: Case Study Questionnaire

1. What is the name of the organisation in which you work?
2. What is your role within that organisation?
3. How long have you worked for that organisation?
4. Do you have a corporate initiative for continuous improvement?
5. Do you have a department / role specifically focussed on continuous improvement?
6. Is lean well understood and adopted in your organisation?
7. Is six sigma well understood and adopted in your organisation?
8. Do you use yellow, green and black belts to drive CI?
9. How well do employees understand the concept of lean?

10. Do you find the lean methodology and tools effective?
11. Have you implemented any specific lean projects?
12. If yes, have these been successful and what are the challenges you have faced and how were these challenges overcome?
13. Have you had any external help to implement lean e.g. consultants, professional bodies or academics?
14. If yes, how effective were they?
15. Did you get the required leadership support to implement and sustain lean?
16. Have you identified the value streams in your organisation?
17. Have you integrated lean across a full value stream?
18. What lean tools were used?
19. How well have the lean improvements been sustained?
20. How have you sustained the improvements from lean?
21. Have you changed your performance measures / KPIs as a result of implementing lean?
22. How could you improve the implementation of lean in your company?
23. What do you think are the most important factors to consider in order implementing lean successfully?
24. What do you think are the most challenging factors to overcome when implementing lean?

Appendix 4: Case Study Comparative Matrix

	Rolls-Royce	BMW Hams Hall	BAE Samlesbury
Corporate Initiatives for CI	The Journey to Process Excellence (JTPE)	Value Added Production System (VAPS)	No specific framework but driving towards the achievement of the Blue Sky Vision and the SQCDP metrics
Dept / Role specifically focused on CI	Continuous Improvement Organisation (Manufacturing Improvement and Business Improvement) 20 or so Black Belts	VAPS Team made up of VAPS integrators or methodologists are full time improvement. Also take people off the shop floor full time for periods of time to complete specific projects.	Systems Design Team and CI champions
Is lean well understood	Yes by the CI organization and by some key members of the leadership team. The concept of lean is starting to be trained out to the wider HR through VIPS training	Basic principles are understood and adopted. Informal training has been taking place for the last few years and in the last year more formal training has been put in place.	At the leadership level yes as they have all gone through the lean learning academy. CI champion roles the basics are understood but it's not been labelled as lean as they wouldn't make the link.
Is six sigma well understood	No only by those trained as black belts who have used the six sigma skills to deliver a project. Probably a handful of people in Turbines	No. A handful of people at hams hall with the skills who will be used for specific projects as and when they arise. 90% of the issues that arise do not require sigma skills just basic problem solving issues.	All engineers at BAE Samlesbury are Six Sigma trained but the skills are not used effectively. There are no Black Belts at BAE Samlesbury.
Do you use the below roles YB, GB & BB?	Yes, HR use all belief roles - YB, GB and BBs	No but do have specific individuals focused on improvements (as above).	No but do have specific individuals focussed on improvements (as above).
Who is responsible for lean	The JTPE is about ensuring that our businesses are lean and the responsibility of the JTPE within an SCU is the quality exec. However every manager has targets for the JTPE therefore the responsibility lies in all.	Everybody in the organisation. Most senior people in the organisation need to embrace and take ownership for the delivery of lean.	Everyone but the driving force is the Systems Design Team and the leadership.
Do employees understand lean	They understand it at the very basic level.	They will understand the basic principles e.g. 5S inc. workplace organisation. People who are taken off the shop floor for improvement projects will understand lean and understanding but will always discuss with the other people on the shop floor to allow them to have an input.	As previous employees have been involved in making small improvements to their areas but they do not understand these as lean.
Do you find lean tools effective	Yes, they have helped deliver a number of improvements within turbines	Yes definitely. Has shown some considerable improvements in results.	Yes, # taken seriously can show business benefits but needs the support of the leadership.
Have you implemented any specific lean projects	Yes, the HP blade value Stream project looking at one of Turbines highest volume value streams	There have been some specific projects but the majority of the effort has been on putting the discipline in place.	The model line was a pilot implementation for lean. The model line represents the concept for the wider enterprise.
If you have been successful	Yes. This project delivered £1.8m reduction in WIP, doubled the WIP turn, halved the leadtime and increased the yield by 20% on one of the HP blades	Yes definitely, Has shown some considerable improvements in results.	Yes. There has been improved delivery performance and quality.
What are the challenges you faced	Lots of challenges: resistance from the workforce, staff not understanding why they should be involved, scope creep	Not faced too many problems due to the culture of the workforce. Clear understanding of what the aim is.	Need for consistent leadership support. A clear direction or plan.
How were they overcome	As much involvement of workforce as early as possible. Gentle coaching of staff and escalation of problems where necessary. Clear programme management to avoid scope creep.	Training and communication has been key. Commitment from the senior team to show the importance of this, use of agency staff to provide flexibility for peaks and troughs, this has the added benefit that permanent staff do not feel threatened by the improvements that are being made.	They weren't and these have had an impact on the progression of lean at samlesbury.
Have you had any external help with lean	Yes we had some lean consultants in for 6 months	Started about 5 years ago when 60+ BMW people went over to Japan to look at the leading Japanese companies and the way they work. They used prime recruited senior experts in lean to facilitate training in a number of areas. They created the awareness material etc. Also use of external trainers (management courses like our PELA), production specialist courses, Business Improvement techniques (COPIKES).	An external trainer runs the lean learning academy.
If you how effective were they	They helped to form the project and get it on the right tracks. I don't think they had any expertise that we didn't have in house and they did a big favour when they left. The project has been completely re-formed which has been more trouble than the benefit of them being there in the first place. You have to do these things yourself.	Training has been effective. Wouldn't use consultants as it is important to learn and do yourself. Better to recruit an expert in.	Very effective. It is embedding a basic level understanding of lean and the behaviours required to support lean in all of the Naderi at BAE Samlesbury. Also brings experience of other companies that worked with.
Did you get the required leadership support to implement and sustain lean	The project was identified by the leadership team and sponsored by them. There is an executive steering group in place to drive the project. The support at the exec level is fine the problem is at middle management where they do not believe in the project at all. Change management, they work and potential new ideas that the current structure does not allow them to may need to staff their improvements to ensure the value stream improves. This is a completely new concept to them.	Yes, the sustenance is clear. Have had required leadership support and they have been willing to drive and deliver projects. It is important to set the level of expectation with the leadership. This is a journey and can take years before you see real benefits. Need ongoing support.	Not consistently. Lean was best implemented when the site director was an advocate of lean and was willing to drive the implementation. When he left the efforts that had been made diminished and the support from the leadership lacked momentum. There was a perception that lean worked in the car industry but not at BAE Samlesbury.
Have you identified the value streams in your organisation	Yes. There are 4 value streams within Turbines. The HP blade, The IP blade, The LP blade and the NGV.	Yes in other parts of BMW but not as much at Hams Hall.	Yes. And the model line value stream was mapped out at the start of the project.
Have you mapped lean across a full value stream	The project on the HP blade value stream is aimed at doing this. The project is one year in but there is still a long way to go.	Have looked at how material is delivered and the amount of WIP and redesigned the layout to minimise WIP and put in 5S (5S/5R/Kaizen).	Yes. The model line.
What lean tools were used	Value Stream Maps, Kaizen, 5S, waste walks, layout, control systems, visual management, production leveling and standardized work. Plus a number of six sigma projects were delivered for specific yield problems.	5S, Visual Management, TPM, Standardized work	Value Stream Mapping, Kaizen, Standardized Work, Workplace Organization
How well have the lean improvements been sustained	In some cases well and in others not so well. We have learnt that for those were we didn't involve the area management in the improvements it has not been sustained. In others it is also about identifying the key supporting personnel and utilising them on the projects to drive the other team members to sustain the improvements.	They have been well sustained which can be seen when walking around. Also have a wheel that can spin against any area to focus on anything at any time. Drives the behaviour that always need to be up to date etc.	Fairly well but could be better. Which is why there is a need for the CI champions in the areas. At the moment the Systems Design Team cannot sustainment in all areas.
How have you sustained the improvements	Lots of support and governance.	Frequent audits / audit hierarchy. Process leader and the VAPS team do audits. Project line team spinning the wheel to audits. These audits are taken away from the output and reviewing the output to ensure actions are taken. Accountability for certain things i.e. the photographs on the team boards. The continuous relentless focus and support. Once hitting a top standard continuously need to change that standard to improve further. Very disciplined approach e.g. meetings to review data - nobody will put time in the diary when these are on.	By spending a lot of time in the areas and actually enforcing the use of the start up sheets and the visual management boards. Encouraging them to identify the bottlenecks and then helping them to deliver the improvements. Unless the full time support is there it will not happen.
Have you changed your performance measures / KPIs as a result of implementing lean	A lean KPI review has been put in place but I do not feel this includes all lean metrics and there are still some metrics in this review which I do not believe should be such as standard hours. As a project team we are very focused on leadtime, WIP, WIP turns, delivery performance to customer and yield and this is what we will be driving the plants and the teams to do. We are not yet fully aligned to the plant.	Yes. New measure things like direct run - how many cars straight through the system. Throughput time. Value added percentage.	All KPIs are aligned to the achievement of the SQCDP measure. Areas can decide what KPIs are relevant to them. Difficult to standardise KPIs because they may not be meaningful to all areas and then are priorities as will not drive the right improvements.
How could you improve the implementation of lean in your company	Metric need to be the right ones. Stop driving the optimisation of performance within the plants and drive all governance along the value stream. More support from the shop floor and middle management. The organisation structure within an SCU doesn't support lean.	No obvious changes to the approach.	Better sponsorship and drive from the leadership team. The CI champion roles should improve the pace.
What do you think are the most important factors to consider for successful implementation of lean	Communication and involvement of everyone along the value stream. The driving of the correct metrics. All leadership on the same page driving the same thing.	Management support (genuine). A systematic approach to create a solid foundation.	Leadership support and a clear plan and vision of what you are trying to achieve and how you will get there.
What do you think are the most challenging factors to overcome when implementing lean	Resistance to change	Get people to understand what lean manufacturing is about and the long term benefits. Convert it into a language they understand - job security.	Lack of leadership support or saying one thing but doing another.

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**WORK-INTEGRATED LEARNING PROGRAMMES DIVISION****First Semester 2018-2019**

POMSS ZG628T: Dissertation - Pre-Final Evaluation Sheet

Upload Softcopy of Final Dissertation Report, Pre-Final Evaluation Sheet, and Final Presentation October 15, 2018

ID No. : _____ 2016SA84012 _____

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DISSERTATION TITLE : _____ A Review of the Implementation of Lean – Comparative Case Studies and Lessons for the Rolls-Royce Manufacturing Value Chain _____

Dissertation Final Evaluation (Please put a tick (✓) mark in the appropriate box)

S No.	Evaluation Component	Excellent	Good	Fair	Poor
1.	Final Dissertation Report	✓			
2.	Final Seminar and Viva-Voce				

S.No.	Evaluation Criteria	Excellent	Good	Fair	Poor
1	Technical/Professional Competence	✓			
2	Work Progress and Achievements		✓		
3	Documentation and expression	✓			
4	Initiative and Originality	✓			
5	Research & Innovation	✓			
6	Relevance to the work environment	✓			

Please ENCIRCLE the Recommended Final Grade: Excellent / Good / Fair / Poor

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Place & Date	Derby & 15/10/2018	

Checklist of items for the Final Dissertation Report

This checklist is to be attached as the last page of the report.

This checklist is to be duly completed, verified and signed by the student.

1.	Is the final report neatly formatted with all the elements required for a technical Report?	Yes / No
2.	Is the Cover page in proper format as given in Annexure A?	Yes / No
3.	Is the Title page (Inner cover page) in proper format?	Yes / No
4.	(a) Is the Certificate from the Supervisor in proper format? (b) Has it been signed by the Supervisor?	Yes / No Yes / No
5.	Is the Abstract included in the report properly written within one page? Have the technical keywords been specified properly?	Yes / No
6.	Is the title of your report appropriate? The title should be adequately descriptive, precise and must reflect scope of the actual work done. Uncommon abbreviations / Acronyms should not be used in the title	Yes / No
7.	Have you included the List of abbreviations / Acronyms?	Yes / No
8.	Does the Report contain a summary of the literature survey?	Yes / No
9.	Does the Table of Contents include page numbers? (i). Are the Pages numbered properly? (Ch. 1 should start on Page # 1) (ii). Are the Figures numbered properly? (Figure Numbers and Figure Titles should be at the bottom of the figures) (iii). Are the Tables numbered properly? (Table Numbers and Table Titles should be at the top of the tables) (iv). Are the Captions for the Figures and Tables proper? (v). Are the Appendices numbered properly? Are their titles appropriate	Yes / No Yes / No Yes / No Yes / No Yes / No Yes / No
10.	Is the conclusion of the Report based on discussion of the work?	Yes / No
11.	Are References or Bibliography given at the end of the Report? Have the References been cited properly inside the text of the Report? Are all the references cited in the body of the report	Yes / No Yes / No Yes / No
12.	Is the report format and content according to the guidelines? The report should not be a mere printout of a Power Point Presentation, or a user manual. Source code of software need not be included in the report.	Yes / No

Declaration by Student:

I certify that I have properly verified all the items in this checklist and ensure that the report is in proper format as specified in the course handout.



Place: _____ **Chennai** _____

Signature of the Student

Date: _____ **15/06/2018** _____

Name: Sumalatha Gude _____

ID No.: _____ **2016SA84012** _____