

# PLANNING LEAN MANUFACTURING IMPLEMENTATION: A CASE STUDY IN A SCOTTISH ENGINEERING COMPANY

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*Lean Manufacturing is famous worldwide for being a modern and efficient manufacture philosophy and has been widely discussed in the literature. However, although it is possible to find some studies regarding critical success factors and difficulties SMEs find during implementation, little has been said about its implementation in SMEs. After entering into a Long Term Agreement involving the supply of aerospace components, a medium sized Scottish company decided to create its very first Lean Manufacturing production cell. In order to produce the components faster, better and cheaper than its competitors, the company spent approximately 8 months carefully planning all of the structure involved in the project. This article aims to expose the cell's planning phase, highlighting the presence or absence of critical success factors found in literature.*

*Palavras-chave: lean manufacturing, critical success factors, lean manufacturing planning.*

## 1. Introduction

The concept of lean manufacturing has been thoroughly discussed by several different authors. However, “there appears to be little empirical evidence in publications on the implementation of lean practices and the factors that might influence them in SMEs” (Bruun and Mefford apud Achanga et al, 2006, p.462). Moreover, the planning phase of Lean initiatives has also not been a focus of researches. This is particularly important, as these enterprises are numerous and usually the backbone of the economy (Matt and Rauch, 2013). Other than that, although the aerospace industry is 10-15 years behind the automotive sector in implementing Lean, there are major Lean initiatives in companies from this sector in the UK (Crute et al, 2003).

In 2011 a medium sized Scottish company, which will be identified in this article as “A”, started a project that consisted of the installation and leaning out of its biggest client (identified in this article as “B”) Aerospace production cell. Said project was conceived after the latter and A made a Long Term Agreement (LTA) involving the supply of five engine components. The agreement is ten years long, which motivated company A’s managers to carefully plan the structure involved in manufacturing the components.

The aim of this paper is to explain how the cell was planned, highlighting the presence or absence of critical success factors found in literature. Therefore, the first section of the essay tackles the concept of Lean Manufacturing, critical success factors for its implementation and challenges commonly faced by SMEs when implementing Lean. Following that is the case study per se and, finally, a comparison between what was done by the company and what literature recommends.

## 2. Methodology

The methodology applied in this article was case study. The authors were in the company for four months, during the planning phase described in the case study section. During this period of time the authors collected data through direct and participant observation.

## 3. Theory

Lean Manufacturing rose in Japan just after World War II, in a conjecture that no longer allowed for a mass production of cars. Womack et al (2008) described this scenario in four

factors: “the domestic market was tiny and demanded a wide range of vehicles”; “the war-ravaged Japanese economy was starved for capital and for foreign exchange”; “the native Japanese workforce was no longer willing to be treated as a variable cost or as interchangeable parts”; and “the outside world was full of huge motor-vehicle producers who were anxious to establish operations in Japan and ready to defend their established markets against Japanese exports”. In this context, mechanical engineer Taiichi Ohno introduced a new perspective in Toyota that was later to be known as Lean Manufacturing. Lean is aimed at reducing waste and adding value to production systems so that systems performance is significantly improved and a company “does more with less” (Achanga et al, 2006).

Since then the “Lean” concept has often successfully allowed companies to deliver bottom-line savings in production through the improvement of process efficiency. Hayes (2000, apud Achanga et al, 2006) discussed that successful corporate initiatives like Lean Manufacturing should be properly planned prior to implementation. In order for the implementation of Lean to be successful, however, it is essential that some factors are taken into consideration.

According to Achanga et al (2006) these critical factors include leadership and management, finance, skills and expertise, and culture of the recipient organisation. It is also highly desirable to have some degree of communication skills, long-term focus and strategic team. The authors also make the hypothesis that leadership and management commitment are the most critical ones, since great leadership enables excellent project management styles, permeates a vision and strategy for generating, while permitting a flexible organisational structure, and fosters effective skills and knowledge enhancement amongst its workforce. Furthermore, Holland and Light (1999) asserted that in attempting to implement any productivity improvement drive in any organisation, a business should have a clear vision and strategy in forecasting a project’s likely costs and duration.

In addition, recently Bortolli et al (2015) showed that soft Lean practices are indeed essential for a successful Lean Implementation. These practices include high institutional collectivism, future orientation and humane orientation, and low assertiveness. Thus, the article demonstrates that having an organisational culture that perceives individuals as a valuable resource for the firm, as well as encourages teamwork, promotes collaborative relations between employees and reinforces the importance of long-range planning. Besides that, using communication as a tool to seek consensus and solve conflict among individuals from different functions or divisions is relevant.

Besides the critical factors mentioned by these different authors, there are studies that focus on the main challenges faced by SME companies when attempting to implement lean manufacturing. Dorota Rymaszewska (2014) claimed that these difficulties were the need for long-term orientation; becoming a learning organisation, levelling out workflow; employee empowerment and standardization of procedures; and the importance of supplier-buyer relations and JIT.

On the other hand, Achanga et al (2004, 2005a, b, apud Achanga et al, 2006) bring to light some constraints that SMEs, by virtue of their size, find when implementing improvement initiatives. These include the lack of adequate funding and leadership deficiencies. Also, Prasanna, Vinodh (2013) display the working nature of SMEs and, although they vary in different countries, the article shows some of the deficient characteristics that are recurring in literature, such as poor management skills, inadequate training offered to the employees and poor infrastructure.

Other traits that were listed by the authors constituted of deficient management commitment; low degree of standardisation and formalization; poor communication, skills and experience; and inadequate leadership. Thus, it is easy to notice that some of these characteristics are hindering for the adoption of lean manufacturing.

Moreover, Thomas et al (2009) mention some of the traditional “excuses” cited by SMEs regarding difficulties in implementing lean and Six Sigma: high costs and complexity of implementation.

The table 1 below summarizes the critical success factors that were previously mentioned.

Table 1 - Success Critical Factors found in literature

Critical Success Factor	Definition	Source
Leadership and management	A strong leadership enables excellent project management, permeates a vision and strategy, while permitting a flexible organisational structure, and fosters effective skills and knowledge enhancement amongst its workforce.	Achanga et al (2006).
Finance	Finance, as in every other project, ought to be carefully considered during the implementation of lean, as it is necessary to invest in training and other provisions.	Achanga et al (2006)

Skills and expertise	As an improvement strategy, it is crucial that the companies and their staff invest in skill enhancements constantly.	Achanga et al (2006).
Organisational culture	Organisational culture that perceives individuals as a valuable resource for the firm, as well as encourages teamwork, promotes collaborative relations between employees and reinforces the importance of long-range planning. Sustainable culture and proactive improvement.	Achanga et al (2006), Bortolli et al (2015).
Communication skills	Similarly, to any other project, the exchange of information between individuals is pivotal for the triumph of the enterprise.	Achanga et al (2006).
Clear vision and project strategy	Forecasting a project's likely costs, duration and goals.	Holland and Light (1999).
Long-term focus/future orientation	When implementing Lean Manufacturing the enterprise's purpose should be to reap its benefits in a distant future, rather than concentrating on instant results. Thus, engaging in behaviours such as planning should be encouraged.	Achanga et al (2006), Bortolli et al (2015).
Strategic team	Having a team assigned specifically for the implementation of lean.	Achanga et al (2006).
High institutional collectivism	Encouraging and rewarding collective action and distribution of resources.	Bortolli et al (2015).
Humane orientation	Promoting and remunerating individuals for being fair, altruistic and friendly to others.	Bortolli et al (2015).
Low assertiveness	Companies that are assertive in relationships (instead of aggressive or confrontational) tend to be more successful in the implementation of Lean. This is due to the fact that the project requires people of different functions to work together, and it is important for these relationships to be harmonious.	Bortolli et al (2015).
Planning prior to implementation	Preparation in advance.	Hayes (2000, apud Achanga et

al, 2006).

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Source: The authors

## 4. Case Study

### 4.1. Introduction

Company A is an engineering family business which was founded in 1951 that operates in many different sectors, such as Aerospace, Defense, Electronic, Petrochemical, Energy and Automotive. The company has approximately 170 employees and has won many awards in Scotland, where it is based. Its production scheme is the traditional 'push system' and the factory's layout is organised into production sectors, gathering similar machines close to each other.

However, after entering into a Long Term Agreement involving the supply of five similar aerospace components for a big customer for ten years, the company decided to invest in a different manufacturing scheme: a Lean Manufacturing cell devoted, exclusively, for the manufacturing of these components.

In this article, the implementation of Lean Manufacturing at company A will be explained according to the critical success factors identified in the company's practices.

### 4.2. Leadership and management commitment

The leadership was strong and participated intensely in this project through the Operations Director. His presence in every weekly meeting was an important factor, and a fair representation of his wide participation and leadership role in the project.

He was responsible for guiding the meetings and the team's discussions, sharing the project's vision and was the biggest advocate for the benefits of Lean's implementation. In fact, his extensive knowledge of Lean Manufacturing was essential for the project's success, since he had the technical knowledge required to establish goals and a vision for the project, as well as to guide the other employees.

Furthermore, his ability to manage people was remarkable. He would allow people to think for themselves when solving a problem, help them in finding solutions, and recognize them

for good ideas proposed. Ergo the leader was clearly attempting to make people feel like they were an important part of the project in order to increase their motivation and dedication to it.

The director faced an important conflict regarding different generations of workers. He was a young leader, since he was substituting his father in the company management, and there were many employees, such as production managers, who were older than him, with decades of experience in the firm. These employees were resistant to the implementation of Lean, and the director constantly had to expose arguments sustaining the idea of the project.

On the other hand, younger employees, such as some engineers and the quality director, heartily supported Lean. And, although the conflict existed, the people who opposed to the changes gradually got comfortable with it, and the project was not delayed or impaired because of it.

### **4.3. Finance**

Many investments were required for the project, such as new equipment, tools and others. They were discussed in the beginning of the project and their purchase was carefully planned according to the company's financial planning and budget. Consequently, all the required investments were made, contributing to the project's success.

Smaller investments, such as cranes, workbenches, measuring tools and spacecases (containers used to safely transport the parts), were also planned. The team tried as hard as possible to reduce costs by producing some of the products themselves and searching for the lowest prices.

Although A already had established manufacturing processes for the five parts, the project required the development of new and improved manufacturing processes for the components, in order to reduce the cost through the use of modern new equipment. This included four machining equipment, one quality inspection machine, one pre-setter (used for aligning machines before operations) and one part marker.

With the installation of the cell, the company expected to reduce the manufacturing cost of the components and, at the same time, to achieve the payback of the said investment.

### **4.4. Skills and expertise**

Because the project's team included people from different areas, there were different skills and expertise involved. Moreover, if, at any moment, someone else's opinion was needed, this person was called to take part in the meeting or in conversations during the week. By doing so, the company tried to gather all the skills and expertise required for the cell's planning.

Regarding the execution, trainings were planned in order to prepare operators for working in the cell. They were supposed to know how to operate all machines in the cell. Although there was some planning of this topic in particular, more efforts could have been made.

In particular, there was a lack of preparation regarding to the change in the employee's obligations. Because the company A, until then, had a very taylorist-like production, the new cell would represent a completely different approach to the worker's responsibilities, requiring their participation for its continuous improvement.

#### **4.5. Communication Skills**

Targeting the success of the project, the manner in which the workers would be informed of the new implementations was carefully thought out. From the start, the team determined that the announcement would be made through a workshop that would involve all of the employees that would work in the cell.

Moreover, with the purpose of promoting good communication inside the cell, the team decided that the employees would have a daily meeting and that there would be a board that would assist in its visual management. Thus, there was a delineation of the design of a board that would be placed in the cell. It should contain relevant information for various audiences such as managers, clients and the workforce as a whole

#### **4.6. Clear vision and strategy, long-term focus/future orientation**

Considering the external scenario, the main goal of the project was to produce the components faster, better and cheaper than the firm's competitors. Additionally, there were five visions, developed by the Operations Director, which included the development of the company's own concept of Lean and the enterprise's growth and innovation, (including the increase of its market share). Apart from that, the initiative could instigate and support future similar applications inside company A.

Targets were established in order to inspire the team to achieve the desired results and measure them. These included weekly production hours, number of operators, running, set-up and final inspection times, carbide costs, batch lead times, shift pattern, scrap and load x capacity.

Regarding future orientation, throughout the project the leaders of company A expressed that the focus was to reap the benefits in a distant future, rather than fixating only in the present. The reason why the project was created is the biggest evidence of it: the Long Term Agreement with a client. The term consisted of a ten-year supply, which required excellence in manufacturing the components throughout the ten years, not only in the present. Besides, the company's intention of developing other Lean initiatives shows a long-term focus.

#### **4.7. Project Management and strategic team**

In order to guarantee the implementation of the said cell, its planning was treated as a project: a schedule was established, the team defined and periodic meetings were set. The team was composed by people from different functions and departments, such as production, quality, maintenance, engineering and high management. Furthermore, weekly meetings were held, which allowed the participants to come up with new ideas and make the important decisions.

The use of a Gantt chart was key for the success of the project, as it made it possible for the team to keep track of the arrival of all the items and training of the workers for the cell.

Despite the use of said tool, there were some delays that could not be helped, such as the wait for the delivery of the machines due to the sinking of the supplier's ship and the need to move some of the machines only after the arrival of the new ones (this was done because of the position of the machines and the space required for moving them). However, the Gantt chart was useful when rearranging the deadlines and for keeping the schedule up to date.

#### **4.8. Institutional collectivism, humane orientation and assertiveness**

Although the project required a lot of teamwork, collective action was encouraged but not rewarded in company A. Also, humane orientation was not a concern for the firm, and there was no remuneration for altruistic or friendly behaviour.

In regards to the relationships in the firm, they were predominantly assertive, which proved to be pivotal for the implementation of Lean. In fact, it was noticeable that even though many times the team members did not agree, they were very respectful to each other and got along well.

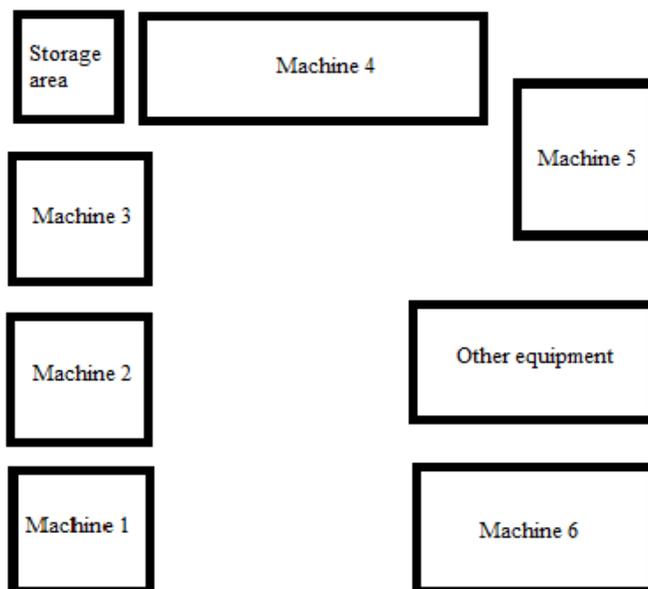
#### **4.9. Planning prior to implementation**

In order to prepare for the implementation of Lean Manufacturing company A spent approximately eight months planning it. Different aspects of the project were thoroughly analysed, such as the cell's layout, the material handling and the products' flow inside the factory.

Different tools were used during the planning phase. Spaghetti diagrams and flowcharts were two of these tools, used to facilitate the understanding of the current manufacturing process and product flow, as well as comparing possible future flows when analysing possible layouts for the cell. For instance, the travelled distance for each part, since the raw material were received until the final product reaches the despatch area, was calculated in two layout options, and the team noticed a relevant difference between them. In one of the final versions, the total distance travelled (considering all of the five parts) was 306 meters, while in the other one, it was 201 meters.

Throughout the project fifteen different layout design versions were considered and narrowed down until a final decision was made, represented at Figure 1. The rationale of this choice included different reasons, such as the flow inside the cell, the position of the quality inspection machine, the aesthetics aspect and the sufficient space for storage.

Figure 1 - Cell final layout



Source: the authors

When it comes to material handling, initially the team decided to use trolleys to transport the parts inside the cell, from one machine to another, and to the company's despatch area whenever necessary. The preference for this equipment was justified by the ease to transport the parts, since they do not require neither a forklift nor a pallet truck. In addition, they are more flexible than pallets regarding the use of cranes, as it is possible to adjust the position of the trolley.

On the other hand, these trolleys were designed to fit the weekly production, which means that, for the heaviest part, each trolley would end up carrying more than one hundred kilograms. An engineer proposed a different solution. Considering that a cellular layout should work in a one-piece flow instead of batches, there is no need to transport the whole batch from one machine to another. Consequently, the trolley should hold only one part at a time. However, the long distance between these places and the considerable weight to be transported were still a concern.

A different idea, then, emerged using the spacecases inside the cell. Until this moment, the cases would be placed in the company's despatch area, waiting for the components to be taken out of the individual trolleys and put inside them, and then despatched to subcontractors.

Considering the fact that the cases are a great solution protecting the parts, due to its internal foam partitions, they should be used to store the parts as soon as possible, once the parts are

finish machined. Therefore the cases should be stored and loaded with parts inside the cell, and only then transported to the despatch area.

Although the cases are able to be transported by forklifts and pallet trucks, the team also proposed a simple platform trolley, in order to make it easier for the operators to transport it. This platform should be able to hold the case and provide it with the flexibility of a trolley.

## 5. Conclusion

Overall, most of the critical success factors found in literature were present, even if not completely, in the case studied, and A considered the project a success. The factors least present were: skills and expertise (when it comes to preparing the operators for their new obligations and responsibilities, such as participating in continuous improvement), institutional collectivism and humane orientation (since collective action was encouraged but not rewarded, and humane orientation was not a concern and there was no remuneration for altruistic or friendly behaviour). Therefore, we can conclude that the soft aspects of Lean Manufacturing were taken for granted by company A, which deemed the hard aspects as more important.

On the other hand, the most noticeable and effective factors were: leadership and management commitment, finance, strategic team and planning prior to implementation, which are all proved by the fact that a project was set eight months before the implementation deadline, besides all that have been mentioned in the previous sections. It is remarkable that some of the most effective factors are directly related to common constraints SMEs face when implementing Lean, such as lack of funding and leadership commitment.

It is also interesting to note that, in this case, the planning phase had a high level of uncertainty. Although every planning phase is prone to have uncertainties, because this project relied in a new manufacturing process, the high level of uncertainty was something to be considered on every step.

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