Evaluating and improving Lean Six Sigma by integrating leadership and communication

Literature study and case study of a Lean Six Sigma production improvement project at Stork Fokker AESP

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Master Thesis
Delft, University of Technology
Faculty of Technical Policy Management
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Préface

After finishing my courses of my study Systems Engineering, Policy Analysis and Management at Delft University of Technology, I had to find myself a company to write my thesis at. I especially wanted to write my thesis at a company, because enjoy working with people, experience the work environment and culture of commercial companies and I wanted to be useful for people or a company. And then, at a day in October, I saw the internship description of a Lean Six Sigma project at Stork Fokker AESP. It was unfortunately in Hoogeveen, but I really liked the project (at least the description of it). After having an appointment at Stork, I was invited to join a Lean Six Sigma project team.

I started writing my thesis proposal in January 2009. The starting was Lean Six Sigma and the internship/case study at Stork Fokker AESP. After a month I had my thesis proposal, which has been my guideline during this thesis, finished.

Besides writing my thesis I took part of a Lean Six Sigma project team at Stork Fokker AESP. Right at the beginning people gave me a very comforting feeling and adopted my immediately. This increased my ‘feeling’ with the organization, which made me very quick ‘useful’ for the project team. Right at the beginning I got my own responsibilities and tasks and I helped the other team members whenever possible. This meant that I had to talk to many different people, particularly from the working floor. Talking to them on a frequent basis, helped me gaining good insight in all of the working processes and also gaining their trust. This was very important, because they had many ideas about the way things were going. So I acquired information for myself as well as for the project team.

Taking part at such a project team provided me the best opportunity to see how Lean Six Sigma really works. Of course I read many articles and books about it, but actually experiencing it makes it more lively and understandable. And, as long as you can be objective, you can all of the advantages and disadvantages of the way Lean Six Sigma is enrolled in the company. Being objective is easy in the first months and my supervisor at Stork Fokker AESP Maarten Heere asked me to report any point of attention I might encounter. This helped me being objective and helped me looking critically at the things I saw. In this way a participative field research is a very useful addition to literature research, but you have to be aware of subjectivity. I noticed after a while that I started to take things/processes for granted, instead of questioning them. At least twice per month I forced myself to think objectively about what I had seen and wrote that done, to use it while finishing my thesis. And it worked pretty well for me. I would encourage every student to do a participative field research, because you learn so much more from comparing what happens in reality to literature instead of only reading and learning from literature.

Writing this thesis has been a bit of a difficult challenge for me because it was sometimes hard finding the right balance between working on this thesis and working on the project. Besides that I found it difficult shaping the project in a satisfying (for everybody involved) way, but I was lucky with the support I got from Maarten Heere (supervisor at Stork Fokker AESP), Marcel Ludema (1st supervisor DUT) and Willemijn Dicke (2nd supervisor DUT). The motivated me whenever I needed it, provided me with new ideas and they helped me structuring this thesis. I hereby would like to thank them for their continuous support and their trust in my work.

Although I struggled a bit with this thesis, I would like to think of the last 8 months as a very pleasant time in which I have learned a lot on personal as well as on professional level.
Summary

Lean Six Sigma is a combination of Lean and Six Sigma and combines the best of both worlds. The method has been very well thought-out, but according to literature, leadership and communication have not been taken into account. Especially leadership (and with that communication) is a very important and critical success factor. Leadership helps to increase the acceptance of solutions and helps therefore increasing the effect of Lean Six Sigma projects (effect of solution is the quality of the solution times the acceptance of it → \( E = Q \times A \)).

The goal of this research is to increase the effect of Lean Six Sigma projects, for companies willing to implement or already implementing Lean Six Sigma, by integrating leadership and communication, by learning from its strengths and weaknesses and by comparing and learning from other quality improvement methods. The research question is:

“How to improve Lean Six Sigma to make it more effective for the industry and by integrating leadership and communication and by learning from its strengths and weaknesses, compared with alternatives?”

In order to be able to answer this question literature research has been done on Lean Six Sigma itself, on other quality improvement methods and on leadership and communication. Furthermore a case study has been performed, for which the author did a participative field research, to compare the findings of the literature research with reality. This participative field research has been a very valuable addition to the ‘normal’ literature research. It provided great insight in a real Lean Six Sigma project implementation with all of its difficulties and hurdles to overcome and to cope with. It showed how Stork Fokker AESP coped with the conclusion of the literature research. In this way it has been a very valuable addition to this thesis. The findings of the literature research are also evaluated with Lean Six Sigma experts to come to decent conclusions and recommendations.

According to literature research on Lean Six Sigma and other quality improvement methods, it is very important to create the right expectations of the method used. A table has been created to provide insight in the most important characteristics of those methods. This is about creating the right expectations before starting a project. Also during a project it is important to manage the expectations of the employees. If they know what to expect and if they are getting involved into the project, they are more willing to think about and accept improvement solutions. One of the experts who are interviewed thinks that every employee should get some sort of training about Lean Six Sigma to increase the involvement of the employees.

In the chapter about leadership and communication one of the most important conclusions is that the right environment for change programs has to be created to increase the effect of those change programs. Although the realization might differ per company, the next points of focus are important for any kind of company willing to improve its quality (ranked in order of importance):

1. Having the right leaders. A combination of transformational and transactional leadership style. Those leaders should be very persistent and persuasive about Lean Six Sigma to be successful (Mr. Adriaans). The leaders are setting an example for the employees and therefore have to be “prepared to question their paradigms” and have the willingness to learn, listen and change (Mr. Verhoeven). The transformational leadership style therefore is the most important one, because the leaders have to inspire, motivate en guide their employees into Lean Six Sigma. If a leader believes in this method and if he continuously supports that method, his employees will follow eventually. This leader should be able to switch to transactional leadership whenever necessary, because this style is sometimes necessary in Lean Six Sigma projects.

2. Supporting Lean Six Sigma through the whole company by the highest management for at least a few years (top-down implementation). The CEO of Stork is doing it since 2006 and this has been very important for the acceptance of Lean Six
Sigma. Also Mr. Adriaans and Mr. Verhoeven told about the importance of management support at the highest level. The management has to make Lean Six Sigma happen!

3. Having the right combination of organizational cultures (group, rational and developmental cultures are the most important ones for change programs). In those cultures you combine empowerment (group), with the drive for new product/processes (developmental) and right and clear focus/goals (rational). There is a desired behavioral change (employees should think about improvements continuously) required and the leaders have to set an example. The employees will follow their leader(s). Which culture is the most important one, depends on the existing organizational culture and on the DMAIC phase the project is in (see figure 25 and last part of this section before the recommendations).

4. Giving the employees the right incentives to let them be actively involved in the improvement (thinking) process. But be aware of perverse behavior! Celebrate successes and create an environment to let the employees think together for improvements with the ‘improvement board’ for example (Mr. Adriaans). Both of the experts think that group incentives are more desired than individual incentives, since that stimulates group thinking processes (that is desired in a change culture). During the participative field research it became clear that talking frequently with the employees about the Lean Six Sigma project stimulates them to get them more actively involved in the project. Simple things like giving a production team special t-shirt as a token of appreciation and giving the production team that lives up the best with 5S a diner check. Does a standard ‘right’ incentive exist? The answer is no, because it depends on the already existing reward structure in the organization. But it is important, according to De Bruijn (2007), to realize that people tend to show perverse behavior when there is very much at stake. Examples of incentives are; a bonus linked to the production figure; naming and shaming of the better and much worse than average producing teams and administrative and managerial intervention.

5. Clear (well-thought-out) communication to (and between) all of the involved personnel (before and during the project). This is important because communication helps to create the willingness to change, to accept solutions and to create the right expectations. Communication also helps to let the employees be more involved, by keeping them up-to-date. This can be done in several ways (mail, news bulletins, speeches, meetings etc.). Employees are really interested in getting informed and they appreciate getting involved.

6. Making arrangements about the responsibilities of the involved people for the project (when selected the right people for the project). This bullet is important during individual Lean Six Sigma project, but not relevant for creating a Lean Six Sigma organization. If everyone on a team gets a leading role on a certain subject, they all have more responsibility and that enhances the progress, because you cannot transfer the responsibility to another team member. Furthermore time management is very important for those team members, because in many cases they struggle to combine their ‘normal’ activities with their Lean Six Sigma obligations.

All of the above bullets help to enhance the effect of Lean Six Sigma projects and they have to be established by good leadership (see the first bullet). Those points help to make Lean Six Sigma more effective.

The proposal is to change the Lean Six Sigma implementation steps (as provided by literature). The proposal for improving the implementation steps for realizing a successful Lean Six Sigma project is, according to conclusions of this thesis, going to be (Figure 1):
In the first steps you have to establish all of the before mentioned bullets. For the second step you can use the comparison framework to have better insight in the different quality improvement methods to ensure that the expectations of the chosen method are not too high. The rest of the steps stay the same as described in literature. In those steps, and especially in the fifth step, is communication to the employees to involve them into the project very important. Within this fifth step Figure 25 could be useful. This figure shows which leadership style and which organizational culture should be dominant in each DMAIC phase. The most dominant leadership style and organizational culture vary over the phases, which means that the leader (of the project team) has to be able to switch between transactional (making decisions, regulating tasks, clarifying roles and managing) and transformational (coaching, motivating and inspiring employees with vision and charisma) leadership to let the employees and team members work in a ‘different’ stimulating culture. A short summary of the required dominant leadership style and organizational culture of each phase:

- Define: Transactional leadership (achievement-type leader) style and rational culture
- Measure: Transformational leadership style (facilitator-type leader) and group culture
- Analyze: Transformational leadership style (entrepreneurship-type leader) and developmental culture
- Improve: Transformational leadership style (entrepreneurship-type leader) and developmental culture
- Control: Transactional leadership (achievement-type leader) style and rational culture

One important thing to keep in mind; emphasis of function over form! This is only a guideline and not a path to follow strictly. It should be adjusted as fits, the company using it, the best.

Recommendations
Besides the conclusions on how to make Lean Six Sigma more effective, some recommendations can be made for further research.

- How to make change last?
  ISO 9000 provides a template to document processes which might be suitable to use ensuring lasting solutions of Lean Six Sigma projects.
- Keep all the important people (from directors to the laborers) for a project in the information loop
  This depends on the type of company how you want to communicate and to who. But a research could make things clearer about this subject and maybe even create some sort of a framework on how to communicate (when, to whom, in which way etc.)
- Select the right leaders
  Since leaders have to create the right environment for Lean Six Sigma and also have to make sure Lean Six Sigma is successful, it is important that you have the right leaders. What are the characteristics of the right leader? Does the right leader exist? The leader should combine transformational and transactional leadership, as concluded in chapter 4. How do you measure those characteristics to be desired or not? Therefore a more detailed description of the characteristics of such a leader is desirable.
- Create the right culture/environment for change programs
  How did other companies make it through such a creation process (and perhaps radical transformation of its organizational culture). How long does it take to actually achieve the right environment? How can you speed this up? Are there any practical tips & tricks to enhance this process? This subject could be the subject for another Master Thesis, since it is a very important part of Lean Six Sigma success.
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1. Introduction

This chapter starts with the introduction to the research problem. After the problem is made clear, the research goal is presented. The main research question and its sub questions are formulated in such a way the goal can be reached. Furthermore a short explanation of the outline of the report is given as well as introduction in the research methods used for this thesis.

1.1 Problem introduction

Since in September 2008 the worldwide financial system began to collapse, starting with the bankruptcy of the private bank Lehman Brothers, many organizations are facing big financial problems. Banks don’t trust each other anymore, which means that they do not provide loans for companies together. That is why it is harder for organizations to get a loan. Due to this financial crisis, many companies have adopted quality improvement methods to make their processes more efficient (Fontelera, 2008). By adopting quality improvement methods, companies want to save money and satisfy their customers in order to be as guaranteed of product orders as possible.

Lean Six Sigma is one of the most popular methods in the quality improvement method sector. It is a customer focused method, which reduce production process variances by statistical analysis and by eliminating waste (non-value-adding processes).

Although the method is very popular and much used, two of the most important critical success factors have not been paid much attention to. In different literature studies on the performances of Lean Six Sigma is mentioned that, although there are many and very well documented Lean Six Sigma trainings, scientific articles and books available, hardly any leadership and communication is taken into account (Loethen, 2007) (Anthony, 2008). While these are very important for an effective and successful Lean Six Sigma project (Antony & Banuelas Coronado, 2002) (Wyper & Harrison, 2000) (Van Solingen, 2007) (Snee, 2005) (van Daalen, 2009), as well for any kind of project. This has to do with the formula provided by Van Solingen (Van Solingen, 2007): E = Q x A. The effect of the solution is the product of its quality and its acceptance (by the employees). Leadership and communication influence the acceptance of a solution. So to make Lean Six Sigma even more effective, than it already is, it has to deal with leadership and communication. The key to acquiring and maintaining a successful organization in the 21st century is leadership, according to John P. Kotter (1996). Paragraph 4.3 gives a more detailed description of the importance of leadership and communication.

Lean Six Sigma is mainly suitable for organizations with repetitive processes, because of its statistical character. Organizations operating in the production industry, healthcare, financial- and business services (with focus on logistics) represent the users of Lean Six Sigma (IBIS UvA, 2009). This research is meant for those kind of organizations in The Netherlands implementing Lean Six Sigma.

It is important to know which quality improvement method to select for what kind of project. Therefore popular other quality improvement methods, like TQM (total quality management), BPR (business process re-engineering), ISO 9000 and Theory of Constraints, are elaborated on. Lean Six Sigma could learn from those methods as well, to make it more effective. This is the first part of this thesis, done by literature research. The second and most important part has to do with how leadership and communication can and should be implemented/integrated in Lean Six Sigma projects. This will be done by literature study and by a case study. The case study is performed at Stork Fokker AESP, which is implementing an improvement project according to the already adopted Lean Six Sigma method.
In its Composites plant in Hoogeveen Stork Fokker AESP produces the so-called J-Nose (fixed leading edge), which consists of skins and sub spars for the wings, for both the A380 and A340 (see Figure 2). Compared to other produced products in this plant, the J-Noses production process shows many deviations from specifications. Lean Six Sigma has to help reducing those deviations. The project at Stork Fokker is a good and representative case study, because this company has adopted Lean Six Sigma throughout the whole organization and has much experience with the method.

1.2 Research goal
Lean Six Sigma is the subject of research. It is a combination of Lean Thinking and Six Sigma and it has been developed for years. It has become a very popular method all over the world. The goal of this research is to improve this method even further for Dutch companies implementing Lean Six Sigma, by learning from literature studies and by the case study at Stork Fokker AESP. By improve Lean Six Sigma, the increase of the acceptance of the employees of an organization is meant, because the effect of a proposed change is the quality of the solution times the acceptance of the solution. Therefore leadership and communication are very important. The main research question is formulated as follows:

“How to improve Lean Six Sigma to make it more effective for the industry and by integrating leadership and communication and by learning from its strengths and weaknesses, compared with alternatives?”

The goal of this thesis is improving Lean Six Sigma by:
1. increasing the acceptation of solutions, provided by Lean Six Sigma, by integrating leadership and communication into Lean Six Sigma and....
2. ..... by providing insight in how Lean Six Sigma can learn from other quality improvement methods and what method is suitable for what kind of processes.

This is mainly interesting for companies that are willing to implement Lean Six Sigma, but companies that already have implemented Lean Six Sigma may also find the conclusions interesting and valuable. This research is Dutch companies oriented, but the outcome(s) may be generic (for companies in other countries) as well.

The main research question covers the whole project, but off course this question is too generic to answer without specifying and subdividing it. The answer lies in sub questions, which can be found in the next paragraph.

1.3 Sub questions
The following sub questions are formulated to be able to answer the main research question:

1. What is Lean Six Sigma?
   - What is Six Sigma?
   - What is Lean Management?
   - Why are these two methods combined?
• What are its strengths and weaknesses?
• On which topics is research needed to improve Lean Six Sigma?
This question will be answered by literature research.

2. What can Lean Six Sigma learn from other quality improvement methods?
• What are other important and popular quality improvement methods?
• For what kind of processes these methods are applicable?
• What are the strengths and weaknesses of the other quality improvement methods?
• What can be learned from other quality improvement methods?
• What can be concluded from this literature research/how can Lean Six Sigma improve by implementing/learning from other quality improvement methods?
This question will be answered by literature research.

3. What can Lean Six Sigma learn from Leadership and Communication literature?
• What is leadership and communication?
• Why is it so important?
• Do cultural differences between different countries/organizations have a clear influence on leadership and communication?
• What has been written in literature about those factors in (Lean) Six Sigma?
• At what organizational levels is it important?
• How is dealt with those factors at best practices?
• What can be concluded about leadership and communication with regard to Lean Six Sigma?
This question will be answered by literature research

4. What are the important conclusions of the literature research?
• What can be learned from Lean Six Sigma literature?
• What can Lean Six Sigma learn from other quality improvement methods?
• What can Lean Six Sigma learn from Leadership and Communication?
• What are the conclusions of the previous chapters combined?
This question will be answered by using the conclusions of the previous chapters.

5. How is Lean Six Sigma implemented and executed at Stork Fokker AESP?
• How does Stork Fokker AESP ensure quality?
• How did this project started (from which initiative)?
• How did it go through the phases Define, Measure, Analyze and Improve?
• How is dealt with leadership and communication during this project?
• Does Stork deals with the conclusions from literature?
• What can be learned from those phases?
• What can be concluded from this project?
This question will be answered by participative field research, by talking to Stork employees and by reviewing internal documents.

6. Can the literature conclusions be validated by experts in the field?
• How do Lean Six Sigma experts look at the results?
• How did they deal with those potential pitfalls
• What can be concluded from the opinions of the experts?
This question will be answered by interviewing Lean Six Sigma experts of Dutch companies who have already implemented Lean Six Sigma.

7. What are the conclusions and recommendations for this research about Lean Six Sigma?
This question will be answered by using the conclusions of the previous chapters combined.

Those questions will be answered in this thesis. Every sub question will be discussed in its own chapter. The sub question will finally result in conclusions and recommendation on how to improve Lean Six Sigma. Figure 3 provides a schematic overview of how the various sub questions relate to each other and represent the chapters of this thesis as well.

Figure 3: Thesis/research flow chart

First of all the chapter about Lean Six Sigma provides input for the literature studies about the other quality improvement methods and about leadership and communication and it is also input for the conclusions about how to improve Lean Six Sigma according to literature. The chapters about leadership and communication and about other quality improvement methods also provide input about how to make Lean Six Sigma more effective on these fields. The conclusions of those individual chapters are melted together in the overall literature research conclusions. Those overall conclusions of the literature research are compared with reality at Stork Fokker AESP (case study) and with Lean Six Sigma experts (interview) to see if those conclusions make sense in real life. The final conclusions to improve the effect of Lean Six Sigma are based on literature and on reality, ranked by impact and importance.

This sequence has been chosen to validate the conclusions of the literature research by both the case study and the expert interviews. In this way it is possible to make conclusions and recommendations that are supported by both a theoretical as well as a practical study.

1.4 Research methods

This report is based on a short literature review that showed that Lean Six Sigma needed some research on leadership and communication. For this report a more extensive literature research is performed on Lean Six Sigma itself, on other important quality methods and on leadership and communication. The literature research is in fact a summary and combination of different ideas and views on Lean Six Sigma, change programs in general and leadership and communication. The outcome of this literature research has to be a set of conclusions recommendations on how to improve/enhance the rate of successful Lean Six Sigma
projects. The outcome is, of course, one of a theoretical nature, but it is based on experiences of experts on these topics.

To verify the real importance of the outcome in real companies and in real projects, a participative field research is performed at Stork Fokker AESP in Hoogeveen. Is the set of recommendations from the literature research valuable in real life, do the findings of the literature exist in real life and, if present, how is dealt with them. This participative field research provides the opportunity to spot more practical solutions for some issues regarding Lean Six Sigma and that is a big advantage over literature research only.

The conclusions of the literature research are also input for expert interviews to see if they recognize those conclusions and how they dealt with them. The benefit of interviewing those experts is that they can provide real-life examples of the conclusions and they can support my conclusions to make them more valid.

1.5 Report outline
The outline of this report follows the sub questions, since every sub question has its own chapter. Chapter 2 deals provides an overview of Lean Six Sigma, than chapter 3 elaborates on the other important and popular quality improvement methods. The literature research on leadership and communication are discussed in chapter 4, while chapter 5 deals with the conclusions/findings of the previous 3 chapters.

The case study at Stork Fokker AESP is discussed in chapter 6. This chapter also discusses if and how the conclusions from the literature research exist, occur and are valid in real life (and what Stork Fokker AESP has done about it). In the seventh chapter the conclusions of the literature research are discussed and validated by Lean Six Sigma experts. The final conclusions and recommendations, based on the literature research, case study and expert interviews, are presented in the eight chapter.

At the beginning of every chapter, a figure like Figure 3 will be presented and the part the chapter covers will be highlighted to have clear insight in what the chapter is about and how it relates to the other chapter.
2. Overview of Lean Six Sigma
Six Sigma is the leading method in Lean Six Sigma, with Lean methods adapted (Arnheiter & Maleyeff, 2005). Therefore the Six Sigma part of this chapter is more extensive than the Lean part. Both methods are being described in the first two paragraphs. The third paragraph elaborates on the integration of both methods. This chapter ends with critical notes on Lean Six Sigma.

2.1 Lean Thinking
The history, basics and way of implementation of Lean Thinking are described in this paragraph. The last part of this paragraph elaborates on the advantages and disadvantages of Lean Thinking.

2.1.1 History of Lean Thinking
The concept of Lean Thinking (often simply known as Lean) can be traced to the Toyota Production System (TPS), which is a manufacturing philosophy (Inman, 1999). The Just-In-Time (JIT) principle is originated from TPS as well (Arnheiter & Maleyeff, 2005). Toyota grew very fast from a relatively small car manufacturer, to the world’s largest car manufacturer (Reuters, 2008). This caused growing interest in the “Lean” concept.

2.1.2 What is Lean Thinking?
Lean Thinking is a way of thinking. Its purpose is providing a template to improvement activities in organizations with the intention of increasing effectiveness of the complete organization. This means that this way of thinking stimulates a continuous search for ways of making the organization function faster, cheaper and better.

Five main organizing principles for creating a Lean production system are (Womack & Jones, 1996) (Howell & Ballard, 1998):
1. Specify value by product
2. Identify the value stream for each product
3. Make value flow without interruptions
4. Let customer pull value from the producer
5. Pursue perfection
Others say that the Lean Thinking approach is being recognized by (FME-CWM, 2007) (Arnheiter & Maleyeff, 2005):
1. Look through the eyes of the customer
2. Remove waste (non-value adding processes)
3. Involve every employee into changes and Lean activities
4. Action focused: Implement changes as quick as possible

Implementing Lean Thinking results mostly into:
- Shorter lead times
- Minimal stock inventory
- Minimal changeover times
- Clean and conveniently arranged work environments

The main idea is to create value for the customer, and therefore the total value chain is important for Lean Thinking and not only the production of the product. That means that Lean is a challenge for production, sales, engineering and supporting departments.

The production goal of Lean Thinking is to eliminate non-value adding processes in such a way that every remaining process creates value (Arnheiter & Maleyeff, 2005).

Quality management practices in Lean Thinking focus on zero quality control: fool proof (Poka-Yoke), operators inspecting each others’ work, ensuring setup quality, automated stopping of operations at the time a mistake has been made etc.

2.1.3 Implementation of Lean Thinking
Professor Peter Hines and Professor David Taylor worked at the Lean Enterprise Research Centre from 1997 until 2000, extending Lean Thinking. In that time they were frequently asked different question about the application of Lean Thinking like (Hines & Taylor, 2000):
- Where do I start?
- Is there a road to follow?
- What does Lean Thinking involve?
- Who do I have to involve?
- Etc.

Those two professors decided to build a simple step by step introductory guide to ‘lean’. A schematic overview is given in Figure 5.

Figure 5: Introductory to Lean (Hines & Taylor, 2000)
This introductory helps to select the right scope for Lean implementation. If Lean needs to be implemented into an organization, to following steps have to be made (Womack & Jones, 1996):

**Getting Started**
In first instance a change agent is required who takes personal responsibility for the Lean transformation. Knowledge about Lean techniques and tools and how to implement those into a system is required for the change agent. Then a sense of urgency (a crisis) is needed to begin the transformation. The 'real thing' starts by mapping value streams, beginning with the current state of how material and information flow now, then drawing a leaner future of how they should flow and crating an implementation plan. The agent needs to begin as soon as possible with visible activity to involve the employees and he has to demand immediate results.

**Creating an Organization to Channel Your Value Streams**
Reorganize the organization by product family and value stream and create a lean promotion function. The change agent should deal with excess people at the outset and create/set up a growth strategy. Another very important thing to do is to remove the so-called anchor-draggers. These people are against changes and will do anything to prevent the proposed changes. Keep improving processes/things in the value stream, do not stop looking at it when you have fixed/improved it once.

**Install Business Systems to Encourage Lean Thinking**
Since the idea of Lean Thinking is that everybody in the organization has to ‘think lean’, it is important to give them incentives to do so. This can be done by letting the employees work on a partly commission basis, by making performance measures transparent and teach Lean Thinking and skills to everyone.

**Completing the Transformation**
The final phase of the transformation to a Lean organization consists of convincing the suppliers and customers to take the previous steps (as described) and convert from top-down leadership to bottom-up initiatives.

To achieve Lean Thinking/production in an organization, the following methods (amongst others) can be used:
- **Kaizen:** Japanese for “improvement”. Kaizen deals with continuous improvements within an organization, by eliminating waste, just-in-time deliverances and standardizing production
- **VSM:** Value Stream Mapping is a technique to analyze the flow of materials and information which is required to bring a product or service to a customer
- **5S:** Standardized way of cleaning an organization
- **Poka-Yoke:** Mistake proof production, which means that everybody can produce
- **Just-in-time (JIT):** Hardly any stock, product is finished just-in-time
- **Pull production:** Nothing is made until it is needed by the downstream customer

These methods are used in many companies and they have proven to be successful in many different countries and organizational cultures.

### 2.1.4 Advantages and disadvantages
Different literature studies elaborating on Lean Thinking, provide many advantages as well as many disadvantages (FME-CWM, 2007) (Arnheiter & Maleyeff, 2005) (Howell & Ballard, 1998) (Womack & Jones, 1996):
Advantages
- Encourage the employees to think about process quality
- Lean focuses on the total value chain, rather than on production only
- Lean focuses on eliminating non-value adding processes, with result that every remaining process creates value
- Fool proof processes to ensure the quality
- Reduced lead times enhance competitiveness by achieving faster deliveries or by meeting promised due dates (for companies producing to order)
- Lean emphasizes on small batch sizes (pull principle)
- A common side effect of implementing and improving processes is the enhancement of safety, hygienic and ergonomics

Disadvantages
- Hard to find the right change agent with the right scope
- Resistance to decentralized decision making
- A common misconception of Lean is that people think Lean means lay-offs. It is not the intention of Lean to lay-off employees, but employees are encouraged to think about getting rid of non-value adding processes without losing their job over it
- Implementing a successful and lasting system requires a extensive preparation, while results are not noticeable on the short term.
- Solutions are not data-driven or based on a scientific approach
- Lean focuses on pass/fail individual attribute inspections, while keeping processes on target might be more interesting and important

Lean has proven to be a successful method, but it lacks data-driven solutions. That is the specialty of Six Sigma.

2.2 Six Sigma
This paragraph elaborates on the quality improvement Six Sigma by describing its history, basics, implementation & tools, team and advantages & disadvantages.

2.2.1 History of Six Sigma
Six Sigma originates from Motorola Inc. in 1985. It was developed to solve problems with the product quality and customer satisfaction and to improve processes by eliminating defects. Motorola had to improve their production because they were facing the threat of Japanese competition (Harry & Schroeder, 2000). With the adaptation by General Electric (in the mid 90s), which saved the company billions of dollars over a period of a couple of years (Henderson & Evans, 2000), Six Sigma became a significant and popular method. Other companies also recognized the strengths and the potentials of Six Sigma and Six Sigma grew even more in popularity.

2.2.2 What is Six Sigma?
Six Sigma can be seen as a quality management method that offers a framework to ‘manage’ quality. It is mainly based on Statistical Process Control (SPC). To understand the processes you have to know the processes. The understanding of the processes is achieved by measuring all the important ones in a company.

“Six Sigma is an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates.” (Linderman, Schroeder, Zaheer, & Choo, 2003)
Six Sigma is based on five basic principles (Van Solingen, 2007):
1. Customer and his needs are important
2. Speed, quality and low costs determine customer satisfaction and therefore also the operating results of a company
3. Reliable deliverance of speed, quality and low costs only succeeds if all the processes are being controlled and variance and failures are being reduced to the extreme
4. Facts, data and measurements are the basic conditions to make the right decisions and to realize improvements
5. Motivation and involvement of the employees and management are essential for success (empowerment). Leadership is vital to implement a Six Sigma organization

Six Sigma derives its name from the lower case Greek letter $\sigma$. This letter is used to represent the standard deviation of a statistical population. A defect rate of $6\sigma$ means only 2 failures will occur per billion steps. In practice however, disturbances cause a shift of $1.5\sigma$ off target (Montgomery, 2001). This means that $6\sigma$ indicates a failure rate of 3.4 defects per million opportunities (DPMO) in practice. This is a huge improvement compared to the 35000 to 50000 DPMO most companies produce (Conlin, 1998). In Table 1 on the next page the defect rate per sigma level is presented, with the $1.5\sigma$ disturbance shift taken into account.

Table 1: Defects per Process Sigma

<table>
<thead>
<tr>
<th>Process Sigma</th>
<th>Percentage of good products</th>
<th>DPMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30.2%</td>
<td>697.672</td>
</tr>
<tr>
<td>2</td>
<td>69.1%</td>
<td>308.770</td>
</tr>
<tr>
<td>3</td>
<td>93.32%</td>
<td>66.810</td>
</tr>
<tr>
<td>4</td>
<td>99.379%</td>
<td>6.210</td>
</tr>
<tr>
<td>5</td>
<td>99.9767%</td>
<td>233</td>
</tr>
<tr>
<td>6</td>
<td>99.99967%</td>
<td>3.4</td>
</tr>
</tbody>
</table>

As can be seen in the table above, the improvements possible from the lower Sigma levels to Six Sigma is enormous. The graph in Figure 6 shows the numbers presented in Table 1 in a schematic way. Although it sounds nice, not all processes should operate at a Six Sigma level. This depends on the strategic importance of the process. If a process operates at Sigma level 3, it might be quite easy to adjust that to level 4. But to reach level 5 and 6, much more effort and money is needed.

Figure 6: Graph of defects per Sigma level
2.2.3 Implementation of Six Sigma

The strength of Six Sigma can be found in many things, of which these three are the most important ones (Goh, 2002):

1. Six Sigma contributes to the trading results. According to Six Sigma quality is not a goal in itself, but it is a means to an end.
2. Focus on the customer is really important: meeting the customer demand and enhancing the customer satisfaction.
3. Six Sigma provides a powerful base for quality improvement by training employees. In this way they can measure the processes themselves. A very popular method to do this is DMAIC(R) (Define, Measure, Analyze, Improve, Control (Report)).

The first point can be realized by lower costs which can be traced back to quality improvements, but also by enlarging the market, by improving and extending the products and by strengthen the position amongst the competitors.

The second point has everything to do with identifying the different customers and their needs/demands. If the customers are better known by the company, the company can jump onto the needs of the customers in a more easy way.

The third and last point is considered to be the most important strength of Six Sigma. DMAIC(R) (one of the most used methods) provides a framework to implement Six Sigma. In the beginning DMAIC existed without the R, but many companies were really interested in the R (Reporting) and therefore the R is added in most cases (Senapati, 2004). The DMAIC(R) method stands for: Define, Measure, Analyze, Improve, Control and Report. Figure 7 shows the DMAICR method in a schematic way.

---

1 Stork Fokker AESP uses DMAIC without the Report phase, since they report throughout the whole project.
The different steps are covering the following aspects (Senapati, 2004) (SixSigma.nl, 2009) (Cynax, 2006) (Henderson & Evans, 2000) (Raisinghani M., Ette, Pierce, Cannon, & Daripaly, 2005):

Define (D)
The define phase starts with the selection of an appropriate project (a selection matrix is provided in Appendix A (Van Solingen, 2007)) and a team to handle the project. If a project is selected, the customers (customer can both be external and internal (George, Rowland, & Kastle, 2004)) are identified in order to understand the problem and to know what the customers’ needs are. Those needs are translated into critical to quality (CTQ) of the process. Furthermore a team charters is developed and a process map is created.

To get to know the CTQ’s, the customers need to be interviewed. The results of those interviews are called the Voice Of the Customer (VOC). All of the identified needs of customers are brought together to form a CTQ-statement, which can be seen as the project goal. Then a team charter is made to give insight in what can be expected from the team and to help maintaining the right focus. Important elements of the team charter are:
- Business case (explanation of the need for this project)
- Problem and goal statement (elaborates on the problem, little bit on scope and on the goal)
- Project scope (clarifies what the project will handle)
- Tollgates (time schedule of finishing the different phases
- Roles of the team members

Now that the CTQ’s and scope is clear, a process map needs to be made. This map gives a clear overview of what is done in the different processes which are in scope.

Measure (M)
In this phase the CTQ’s are quantified and operationalized, which means the CTQ’s can be measured. The performance standards are defined and the requirements of the customers are translated/formulated into a clear and measurable characteristic. At last a plan is made to gather data and evaluate the measurement system.

The identification/selection of the right CTQ’s that have to be improved, has proven to be less straightforward as it seems. There does not always exist a relationship between what the customer wants and how he wants it to be accomplished, although this might seems that way. In most cases the relations are interrelated and complex. After figuring out what the right CTQ’s are, performance standards can be set. Those standards give a good representation of what the customers want and what they think is a good process and/or product. With those standards specification limits for the output signal Y are established.

The output signal should be measured on a (to be determined) regular basis. To make those measurements valid, a Measurement System Analysis (MSA) has to be made. This analysis tests the repeatability and reproducibility of the measurement system by using a tool called Gage R&R (or a similar tool).

Analyze (A)
This phase is used to determine the process capability and the project goals and to identify the sources of variances influencing the process(es).

Process data needs to be gathered and statistically analyzed to determine the baseline (starting point for improvement) and process entitlement (to know what is possible with current technologies). This leads to greater awareness and understanding of the current situation and process capability. If the current situation is known, the project goal can be set by using statistical tools and benchmarking.

The last part of this phase deals with generating statistically significant factors influencing the process(es). This generation will be done on basis of historical data. From this list of significant factors, a selection is made of which factors are to be analyzed more
extensively in the Improve phase. This selection will be done with the aid of various statistical tools and hypothesis testing.

**Improve (I)**

The objective of this phase is to determine a solution and to plan and execute an implementation of the improvements. The selected factors (potential causes of disturbance in the process) in the previous phase are being analyzed further, to be able to identify the essential factors influencing the output signal Y. The relationship between those essential factors and Y are determined, optimized and tolerances are specified.

The essential factors and their relationship with Y are identified by performing optimization experiments. At last the tolerances are determined (based on product specifications).

**Control (C)**

Of all the phases this is often seen as most important, because this phase has to ensure that the changes last. Therefore the main objective of this phase is to ensure that the process stays in control and that deviations are quickly detected.

To be able to do this, a Measurement System Analysis needs to be done on the control factors. In this way the new and, hopefully, improved process capability can be determined to see whether or not the goals are met. At last a, newly developed, process control plan needs to be implemented. For those matters Six Sigma provides tools like Control Charts, Flow Diagrams, Pareto Charts (to compare results before and after change) and Quality Control Process Charts.

**Report (R)**

This final phase of the DMAICR method deal with the report of the results of the re-engineered process.

### 2.2.4 Team

The framework is provided, but who is going to carry this out? In other words; who is responsible for what and how do we call those people? According the Grand Master Black Belt (the kind of belt indicates the degree of the person) James M. Lucas and others as well (Linderman, Schroeder, Zaheer, & Choo, 2003) the following structure is used (Lucas, 2002):

The Six Sigma implementation is top-down. This means that the management (usually the CEO) is the driving force and the executive management team provides a Champion for each project. The Champions are responsible for active support and promotion of the Six Sigma program and they also directly report to the management of the company.

Master Black Belts are mainly external consultants who train Black Belts and support and coach the Six Sigma project. Master Black Belts are often experienced Black Belts and they have often worked on Six Sigma projects. Black Belts are the project leaders of the company for the Six Sigma projects. The experienced Black Belts (trained on the fast track) train the Green Belts. Those employees help the Black Belts to carry out the projects successfully. The difference between them and Black Belts is that the Green Belts don’t spend all their time on the project(s) and they receive a more basic training compared to that of the Black Belts.


**Champion/Master Black Belt**

The Champion is a strong leader with a high position (executive management function) in the organization. The Master Black Belt is most of the times an external consultant who is an experienced Black Belt. In this role he can assist the Champion and the Black Belt. The Champion and the Master Black Belt have the following roles/responsibilities:
- Select strategic important projects
- Coach Black Belts
- Enforce new ways of working
- Support operational leadership
- Ask for as-is data which support actions and improvements
- Select Black Belts for the projects
- Remove roadblocks to project success
- Report project activity to executive team

**Black Belt**
The Black Belt is an improvement manager who has great management and leadership potential and social skills. He is the leader of the Six Sigma project team and has the following roles/responsibilities:
- Executes X-functional projects
- Mobilizes commitment for change
- Supports project selections
- Stimulate ‘out-of-the-box’ thinking
- Applies Six Sigma

**Green Belt**
A Green Belt supports the Black Belt in the project and works on a more practical basis on the project. The roles/responsibilities of a Green Belt is:
- Helps Black Belt
- Local advocates
- Accelerates deployment

### 2.2.5 Advantages and disadvantages
Different literature studies elaborating on Six Sigma, provide many advantages as well as many disadvantages (Goh, 2002) (Antony, 2004) (van Daalen, 2009).

**Advantages**
- DMAIC(R) integrates techniques such as SPC (Statistical Process Control), QFD (Quality Function Deployment), FMEA (Failure Mode and Effect Analysis) and DOE (Design Of Experiment) in a logical flow.
- Implementation is ‘top-down’ instead of from the HRM department, quality insurance people or from the working floor to the top.
- Six Sigma emphasizes the importance of data and decision making based on facts instead of on assumptions. Measurements are of great importance to the method.
- The Six Sigma method is not limited to operations in manufacturing, although one would think otherwise because it has a substantial number of statistical techniques.
- Six Sigma focuses more on customers than other methods. CTQ (Critical To Quality) is used to make improvements. Due to the strong focus on customers, Six Sigma is very sensitive to requirements for customer satisfaction compared to inward-looking efforts like ISO or QS certification.
- The project-by-project feature is very important for Six Sigma. Every project has a clear beginning and an end, this instead of other method which try to improve the quality throughout a whole company.
- The outcomes of a Six Sigma project are almost always required to be expressed in financial term. In this way it is possible to measure the direct effect in a way anybody can understand it. Some other methods have outcomes that are strictly black or white (success or failure).
- The different level of certificates (Belts) stimulates people to be more involved in the process and the project can use their experience.

Those features contribute to the effectiveness of Six Sigma. The features can be summarized in: Framework, Approach, Data, Application, Focus, Organization, Result and Personnel.

Disadvantages
- “Successful Six Sigma implementation efforts are driven by committed leaders with edge.” (Raisinghani, Ette, Pierce, Cannon, & Daripaly, 2005). This might be a hard to meet precondition in many cases.
- The 3.4 DPMO measures all defects, but it is illogical that all defects are equally bad. Or: it is naïve to think that all non-defects are equally good or desirable. A non-defect in an operating theatre is much more desirable than a non-defect in the process of making a pen for example.
- It is not guaranteed that the Champions and Black Belts use the right scope for the problem and only work on problems only related to their surrounding instead of keeping the whole picture in mind. This is also a case of prioritization, which is very subjective. The right prioritization is a critical success factor for Six Sigma.
- Due to the dynamic market demands it is not always the case the CTQ that is important today, is also important the day after. Therefore the CTQ’s should be refined when necessary.
- The 1.5σ shift does not make much sense for all processes. More research is needed on this topic, since a small shift in sigma can lead to enormous change in defect calculations.
- Implementing Six Sigma needs a significant investment (time and money), which discourages many companies to implement Six Sigma.
- Six Sigma can easily fall into training the Black Belts etc. instead of working towards the desired goal.
- There are very many consulting firms which try to sell Six Sigma, although a lot of those companies do not even have that much experience.
- Six Sigma tends to be preoccupied with internal objectives and does not have a social mission or responsibility.
- People should be aware of the capabilities of Six Sigma, too high expectations can lead to misunderstandings later on in the project and it might even lead to putting off Six Sigma as a good quality improvement method.

There are many more disadvantages (same counts for the advantages), but the above mentioned are the most important ones.

2.3 Integration of Lean Thinking and Six Sigma
Lean Thinking and Six Sigma were derived from two different point of views. Lean focused on the increase of product flow speed by eliminating non-value adding processes, while Six Sigma focused on product quality by identifying and dealing with variances in production processes. Even shorter: Lean Six Sigma leads to a process which is logistical efficient (Lean) and of high quality (Six Sigma).

Lean Six Sigma is based four basic principles, which are (George, Rowland, & Kastle, 2004):
1. Keep your customers satisfied with speed and quality
   Know what satisfies your customer, how they define quality and defect and how fast they want your products/services
2. Improve your processes
   What are the variance factors in the process and how do they influence the process, by understanding the process you can improve the process
3. Work together for maximal result
   Put a group of people together to work on a Lean Six Sigma project. To have them
   working together effectively, training on skills like listening, brainstorming and
   decision making can be very useful.

4. Decide on data and facts
   If a decision is based on facts, it is undisputable for any involved person.

Those four basic principles are shown in Figure 8 (derived from George, Rowland & Kastle,
2004) which shows the ‘Lean Six Sigma house’.

![Lean Six Sigma House](image)

**Figure 8: Lean Six Sigma House (George, Rowland, & Kastle, 2004)**

Typical operating fields for Lean Six Sigma projects are (IBIS UvA, 2009):

- Production industry
- Product and process development
- Healthcare
- Financial services
- Business services

DMAIC is the leading tool to implement the Lean Six Sigma project. Tools like 5S, Poka-
Yoke are to be implemented throughout the whole organization to encourage ‘lean thinking’
by the employees.

According to Arnheiter and Maleyeff (2005), a Lean Six Sigma organization would include the
following tenets of lean management:

1. It would incorporate an overriding philosophy that seeks to maximize the value-added
   content of all operations.
2. It would constantly evaluate all incentive systems in place to ensure that they result in
   global optimization instead of local optimization.
3. It would incorporate a management decision-making process that bases every
   decision on its relative impact on the customer.

And it would include the following tenets of Six Sigma:

1. It would stress data-driven methodologies in all decision making, so that changes are
   based on scientific rather than ad hoc studies.
2. It would promote methodologies that strive to minimize variation of quality characteristics.
3. It would design and implement a company-wide and highly structured education and training regimen.

Figure 9 (Arnheiter & Maleyeff, 2005) shows the benefits of integrating Six Sigma and Lean Management, compared to if only one of those methods is implemented. It is clear that Six Sigma results in low costs for the producer, but average value for the customer. Lean results in average costs for the producer, but high value for the customer. Combining those methods results in both low costs for producer and high value for customer.

![Figure 9: Strength of Lean and Six Sigma combined (Arnheiter & Maleyeff, 2005)](image)

Van Solingen (2007) and George, Rowland & Kastle (2004) are providing a few steps to follow to realize a successful Lean Six Sigma project:
1. Select the right project
2. Select the right people for this project
3. Train those people
4. Follow the method and validate earnings
5. Secure results

2.4 Conclusions
What are important points of attention for Lean Six Sigma, as described in literature about the method? As described in the introduction, leadership and communication are two very important factors for a successful Lean Six Sigma project (van Daalen, 2009) (Van Solingen, 2007). This is one of the most important elements not enough attention is being paid to (Loethen, 2007).

Other points of attention (van Daalen, 2009) (Anthony, 2008):
- Right project selection is critical for the success of a Lean Six Sigma project. The project should have a potential high financial impact, high impact on customer satisfaction, a lead time of maximal +/- 9 months, it should not be too complex and should have possible spin-off projects.
- Six Sigma 3,4 DPMO does not make much sense for all processes, since 3,4 DPMO is not desirable for all processes (because of the costs of reaching this defect rate).
- Too high expectations might endanger the project (if the expectations are not met, the support for Lean Six Sigma could decrease). The previous bullet might enhance the too high expectations.
- Trainings for leaders (Black Belts and Green Belts) are not standardized throughout the world, what results in variances in quality of the leaders.
- Hard to implement Lean Six Sigma throughout a whole organization.
- Time management is very important for team members. In many cases team members are struggling to combine their ‘normal’ activities with their Lean Six Sigma obligations.

With those points in mind, I will look at the Lean Six Sigma project at Stork Fokker AESP. Are those points of attentions really an issue during the implementation of a Lean Six Sigma project? If yes, when and where do they occur, how severe are they and how is coped with them?
3. What can be learned from other quality methods?

This chapter provides in the first paragraph a short introduction in the other existing important quality methods (alternatives for Lean Six Sigma). Four major quality improvement methods are identified as being possible alternatives for Lean Six Sigma (Antony, 2004) (Kedar, Lahke, Deshpande, Washimkar, & Wakhare, 2008) (Van Solingen, 2007): Total Quality Management (TQM), ISO 9000 (International Organization for Standardization), Business Process Re-engineering and Theory Of Constraints (TOC).

The next two paragraphs deal with the applicability and the advantages and disadvantages of those methods. In the fourth paragraph a schematic overview is provided to have all the important characteristics clearly arranged. This overview is very useful for managers/leaders in making the right choice for which quality method to choose given characteristics of the problem and demands of the problem owners. Finally recommendations are made about how to improve Lean Six Sigma and about which pitfalls one should be aware.

![Figure 10: Thesis/research flow chart; Chapter 3](image)

3.1 Four important quality methods

**Total Quality Management (TQM)**

TQM started in the early 1980s in the USA when Hewlett-Packard criticized US chip manufactures for poor quality compared to Japanese competitors (Talha & Lama, 2004).

The method refers to a broad set of management and control processes designed to focus to an entire organization and all of its employees by providing tools to satisfy the customer (Talha & Lama, 2004). TQM means that throughout a whole organization a culture is created, by supporting means like tools, infrastructure, techniques and training, to maximize the customers satisfaction. Therefore TQM uses tools like Kaizen, Risk Management, training and also ISO 9000.

TQM focuses on continuous improvement within an organization to ensure superior value to customers. The central theme of TQM stresses a few elements (Li, Markowski, Xu, & Markowski, 2008) (Sharma & Kodali, 2008):

- Customer satisfaction
- Continuous improvement
- Leadership
- People/change management
- Employee involvement and empowerment
- Process involvement
TQM initiatives not only put customer satisfaction at the centre of organizational enterprise, but also prefer a flattened organization structure. An organization with many levels of supervision suffers from reduced communication speed and agility (Li, Markowski, Xu, & Markowski, 2008).

Commitment from senior leadership is a requirement for TQM. Top management supports continuous quality improvement by guiding and freeing funds. Senior management should be involved by visible activities like planning, coordinating, reviewing and coaching. Those activities are important for the success of TQM (Li, Markowski, Xu, & Markowski, 2008).

ISO 9000
The ISO 9000 standard is a generic code of management practice that can improve the product development process (Krause, 1996). It is applicable for many types of organizations, and is implemented by over a million organizations in 175 countries (ISO, 2008). Organizations can acquire ISO-certification if they execute processes according to ISO standards. Those standards provide guidelines on how to ensure the organization’s ability to satisfy its customer(s). ISO 9000 is the family name for a range of standards for quality management systems, which contains (ISO, 2008):

1. ISO 9000:2005 – Fundamentals and vocabulary
   This is a guidance document, which is not for certification purpose but for understanding the vocabulary related to quality management systems. It covers the basics of quality management systems and it contains the core language of the ISO 9000 family.
2. ISO 9001:2008 – Requirements
   This standard provides a set of standardized requirements for a quality management system. It is applicable for any kind of organization, no matter what the size, sector or ownership is.
   This standard deals with how to enhance a mature system (not for implementation of a new system).

ISO 9000 is based on eight management principles (ISO, 2008):
1. Customer focus
2. Leadership
3. Involvement of people
4. Process approach
5. System approach to management
6. Continual improvement
7. Factual approach to decision making
8. Mutually beneficial supplier relationships

Furthermore ISO 9000 is based on the operating principle of Deming’s Plan – Do – Check – Act cycle (ISO, 2008).

Business Process Re-engineering (BPR)
BPR is defined as the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed (Hammer & Champy, 1993) and to satisfy customer requirements much better than before. This method is often promoted as the radical answer to quality improvement methods which “don’t change too much”, because they are bound to policies and narrow focuses (Cross, Feather, & Lynch, 1994).

Steps and labels might differ slightly in the early models of BPR, but almost every existing BPR model shares the same basic principles and elements (Grant, 2002). A short
overview of such a model is provided, which is developed in 1993 (Guha, William, & Teng, 1993):

1. Envision new processes
2. Initiate change
3. Process diagnosis
4. Process redesign
5. Reconstruction
6. Process Monitoring

Davenport and Hammer define three rules (Biazzo, 1998):

1. The organization is a combination of processes which can be reorganized in an empirical scientific and systematic way.
2. The nature of the change is revolutionary and exists of a transition of functional oriented business units to multi disciplinary teams. The whole organizational structure needs to be reorganized to achieve this, with customer satisfaction as basic thought.
3. Change starts at the higher management and they need to act as an example. The changes are not unique, but it is a continuous process of adjustments.

Theory Of Constraints (TOC)
The Theory of Constraints (TOC) is developed from logistics management and is a concept that can be applied to a wide range of things such as production, operations, finance and measures, project, marketing, sales (Blackstone, 2001), supply chain etc. It focuses on eliminating bottlenecks in logistical chains. TOC can be summarized as (Rahman, 1998):

1. Every system must at least have one constraint
   If there are no constraints, an organization would make unlimited profit. “A constraint is anything that limits an organization from achieving a higher performance versus its goal” (Goldratt, 1988).
2. The existence of constraints represent opportunities for improvement
   Constraints are seen as positive, not negative. Because they determine the organization’s performance, the elevation of a constraint improves the performance of the organization.

TOC works by a five steps cycle principle of continuous improvement. Those steps are summarized below (Goldratt, 1990) (Blackstone, 2001):

1. Identify the system’s constraint(s)
2. Decide how to exploit the system’s constraint(s)
3. Subordinate everything else to the above decision
4. Elevate the system’s constraint(s)
5. If in any of the previous steps a constraint is broken, go back to step 1. Do not let inertia become the next constraint

Similarities of those methods are that they are all customer(cost)- driven and they all are mapping the problem. Ways of how they do this are different and Lean Six Sigma may learn from those different approaches (see paragraph 3). Another similarity is that all of those methods have been used many times, by many different types of companies in many different countries. Therefore it is useful to look at those methods so that Lean Six Sigma can learn from them to become more effective.

In the coming paragraphs Lean Six Sigma will be compared with those four methods with the goal of providing insight and guidance in which method to choose for what kind of project. Besides that, strengths and weaknesses of all of the methods will be discussed in order to identify elements on which Lean Six Sigma can be improved or can learn from the other methods.
3.2 Application field of Lean Six Sigma and other methods

If you want to select the right method to solve a certain problem, you must know which methods are suitable for which kind of problems and/or processes. This paragraph provides insight in the applicability of the, in chapter 3, identified methods.

**Lean Six Sigma**

Lean Six Sigma is, as mentioned in paragraph 2.3, typically used in (IBIS UvA, 2009):
- Production industry
- Product and process development
- Healthcare
- Financial and Business services

The project, for which Lean Six Sigma is applicable, needs to have iterative processes. This is because Lean Six Sigma is statistically based and it needs data to be able to do analyses. Lean Six Sigma can be used as the tool throughout the whole organization, where Lean helps to improve the flow and Six Sigma helps to eliminate variances in existing processes.

**Total Quality Management (TQM)**

It is not specified for what specific kind of organizations TQM is applicable, since TQM is about total quality throughout a whole organization (Prajogo, 1999). How that is done, depends on the implementers of TQM within a organization.

**ISO 9000**

For any company wanting to have:
- ISO-certificate(s) for work processes
- Standardized work processes
- Audits for checking consistency of work processes

ISO does not really establish quality improvement, but it is meant for ensuring constant quality. By measuring CPIs (Critical Performance Indicators) an organization can detect problems in processes and react to it.

**Business Process Re-engineering (BPR)**

BPR is mainly implemented in the banking and insurance industry, where information technology plays a very important role. Besides the financial sector, BPR is applicable in the manufacturing and services sector.

**Theory of Constraints (TOC)**

Applicable for organizations valuing a systems approach and separation between worker and management. It has to be understood by a few people with the power to change. That is all what is needed (Nave, 2002). TOC can be used for processes which operate in a chain. A constraint is the weakest link in the chain and needs to be improved to the chains’ performance. TOC is used in:
- Manufacturing
- Project Management
- Supply Chain/Distributions

3.3 Advantages and disadvantages of the different methods

There are a few pitfalls which are the same for each method. These are (Malhotra, 1998) (Van Daalen, 2009):
- Lack of sustained management commitment and leadership
- Unrealistic scope and expectations
- Resistance to change
Besides those ‘standard’ pitfalls each method has its own more specific disadvantages, but they also have their own advantages. Those advantages and disadvantages are summarized in the following 4. The most important advantages and disadvantages are presented in an overall overview presented in paragraph 4.3. The information as presented in the different tables come from different sources. Those source are referenced below each table.

**Total Quality Management (TQM)**
Information as presented in Table 2 is gathered from different sources.

**Table 2: Advantages and disadvantages of TQM** (Li, Markowski, Xu, & Markowski, 2008)(Sharma & Kodali, 2008)(Talha & Lama, 2004)

<table>
<thead>
<tr>
<th>Advantages (possibilities)</th>
<th>Disadvantages (limitations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural change towards improvement in organization</td>
<td>Not appropriate for all organizations in all circumstances</td>
</tr>
<tr>
<td>Empowerment (higher productivity due to greater involvement)</td>
<td>Empowerment (may obstruct radical changes)</td>
</tr>
<tr>
<td>Continuous improvement</td>
<td>Lack of focus and goals</td>
</tr>
<tr>
<td>Reduction of defects</td>
<td>Emphasis of form over function</td>
</tr>
<tr>
<td>Quality products → customer satisfaction</td>
<td></td>
</tr>
<tr>
<td>Cost reductions</td>
<td></td>
</tr>
</tbody>
</table>

**ISO 9000**
Information as presented in Table 3 is gathered from different sources.


<table>
<thead>
<tr>
<th>Advantages (possibilities)</th>
<th>Disadvantages (limitations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process improvements</td>
<td>Certification above quality</td>
</tr>
<tr>
<td>Increased quality awareness</td>
<td>Certification is not equal to better quality</td>
</tr>
<tr>
<td>Consistency in operations</td>
<td>Lots of money, time and paperwork required for certification</td>
</tr>
<tr>
<td>Market (competitive) advantages</td>
<td>Does not really improve</td>
</tr>
<tr>
<td>Improved employee motivation and morale</td>
<td></td>
</tr>
</tbody>
</table>

**Business Process Re-engineering (BPR)**
Information as presented in Table 4 is gathered from different sources.


<table>
<thead>
<tr>
<th>Advantages (possibilities)</th>
<th>Disadvantages (limitations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radical redesign</td>
<td>Heavy reliance on IT-based Technology</td>
</tr>
<tr>
<td>Customer focus</td>
<td>No means of validating the limiting factor(s)</td>
</tr>
<tr>
<td>The steps are performed in a natural order</td>
<td>Disregards status quo</td>
</tr>
<tr>
<td>Reduction of costs</td>
<td>No increase of revenues/sales</td>
</tr>
<tr>
<td>Select but broad business processes</td>
<td>Select but broad business processes</td>
</tr>
</tbody>
</table>

**Theory of Constraints (TOC)**
Information as presented in Table 5 is gathered from different sources.

**Table 5: Advantages and disadvantages of TOC** (Blackstone, 2001) (Goldratt, 1990) (Rahman, 1998)

<table>
<thead>
<tr>
<th>Advantages (possibilities)</th>
<th>Disadvantages (limitations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast throughput</td>
<td>Minimal worker input</td>
</tr>
<tr>
<td>Less inventory/waste</td>
<td>Data analysis not valued</td>
</tr>
<tr>
<td>Improved quality</td>
<td>Is not part of mainstream business education</td>
</tr>
<tr>
<td>Removal of bottlenecks</td>
<td></td>
</tr>
</tbody>
</table>
3.4 Schematic overview

Applicability and advantages and disadvantages of Lean Six Sigma and other methods are important to know when starting a quality program within an organization. But there are more characteristics that are important to be aware of. They are presented in Table 6 and should provide a relatively simple and clear overview of the important characteristics of Lean Six Sigma and the other methods. Lean and Six Sigma are presented separated in the overview. That is done because, although you might have a Lean Six Sigma organization, you use Lean and Six Sigma for different purposes. Of course they are used besides each other in Lean Six Sigma, but they aim at different goals. The information, used to fill the overview, is gathered from different sources (Li, Markowski, Xu, & Markowski, 2008)(Sharma & Kodali, 2008)(Talha & Lama, 2004) (ISO, 2008)(Krause, 1996) (Biazzo, 1998) (Cross, Feather, & Lynch, 1994)(Hammer & Champy, 1993) (Blackstone, 2001) (Goldratt, 1990) (Rahman, 1998) (Goh, 2002) (Antony, 2004) (van Daalen, 2009)  (Raisinghani, Ette, Pierce, Cannon, & Daripaly, 2005).

Table 6: Overview of compared improvement methods

<table>
<thead>
<tr>
<th>Program</th>
<th>Lean Six Sigma</th>
<th>Six Sigma</th>
<th>Lean</th>
<th>TQM</th>
<th>ISO 9000</th>
<th>BPR</th>
<th>TOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory</td>
<td>Reduce variation</td>
<td>Remove waste</td>
<td>Continuous improvement</td>
<td>Standardize quality</td>
<td>Re-design processes</td>
<td>Manage constraints</td>
<td></td>
</tr>
<tr>
<td>Application guidelines</td>
<td>1. Define</td>
<td>1. Identify value</td>
<td>1. Plan</td>
<td>1. Plan</td>
<td>1. Envision</td>
<td>1. Identify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Measure</td>
<td>2. Identify value stream</td>
<td>2. Do</td>
<td>2. Do</td>
<td>2. Initiate change</td>
<td>2. Exploit</td>
<td></td>
</tr>
<tr>
<td>Focus</td>
<td>Problem focused</td>
<td>Flow focused</td>
<td>Customer focused</td>
<td>Secure quality</td>
<td>Select, but broad</td>
<td>Systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>business processes</td>
<td>constraints</td>
<td></td>
</tr>
<tr>
<td>Primary effect</td>
<td>Uniform process output</td>
<td>Reduced waste</td>
<td>Continuous improvement</td>
<td>Standard work processes</td>
<td>Improved critical process performances</td>
<td>Fast throughput</td>
<td></td>
</tr>
<tr>
<td>Customer orientation</td>
<td>Customer focused</td>
<td>Customer focused</td>
<td>Customer focused</td>
<td>Customer focused</td>
<td>Customer focused</td>
<td>Internal focused</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium-High</td>
<td>High</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Ease</td>
<td>Low</td>
<td>Medium-High</td>
<td>Medium</td>
<td>Low-Medium</td>
<td>Low-Medium</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Leadership importance</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>High to medium</td>
<td>Medium to low</td>
<td>Medium</td>
<td>Depends on project size</td>
<td>High to medium</td>
<td>Medium to low</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>High</td>
<td>Depends on project size</td>
<td>Project sizes are moderate</td>
<td>Depends on project size</td>
<td>High</td>
<td>Project sizes are moderate</td>
<td></td>
</tr>
<tr>
<td>Executive role</td>
<td>Top-down</td>
<td>Bottom-up (empowerment)</td>
<td>Top-down</td>
<td>Top-down</td>
<td>Top-down</td>
<td>Top-down</td>
<td></td>
</tr>
<tr>
<td>Criticisms</td>
<td>- System interaction not considered - Processes improved independently</td>
<td>- Statistical or system analysis not valued</td>
<td>- Unclear goals - Leadership apathy - Departmentalized focus</td>
<td>- Does not focus on solutions - No tools for analysis and evaluation - Certification above quality</td>
<td>- Heavy reliance on IT-technology - Broad scope - Disregards status quo - No increase in revenues/sales</td>
<td>- Minimal worker input - Data analysis not valued</td>
<td></td>
</tr>
</tbody>
</table>

3.5 Conclusions

What can Lean Six Sigma learn from the other quality improvement methods? It can mainly learn from the disadvantages/pitfalls of the other methods and of projects in general. Many of the advantages of the other methods do already apply to Lean Six Sigma. I have spotted one thing Lean Six Sigma could really learn from another method.
Lean Six Sigma could learn from:
- Standardization and documentation of work processes (ISO)
  After improving a process with a Lean Six Sigma project, it is very important to make
  the changes last. ISO provides nice templates for process documentation and many
  companies have proven that those templates work (ISO, 2008). This could be useful
  for Lean Six Sigma project teams to have a look at.

People implementing Lean Six Sigma should be aware of:
- Lack of sustained management commitment and leadership (general)
  This is a very important success factor identified by literature on all of the methods.
  Without good management commitment and leadership, most projects are doomed to
  fail.
- Unrealistic scope and expectations (general)
  If the scope and expectations are unrealistic, people may get dissatisfied by the
  results. This may cause a whole project to fail.
- Natural resistance to change (general)
  A very well know pitfall is the resistance to change of the employees. Although this is
  a familiar disadvantage of all improvement projects, you should be aware of it all the
  time.
- Importance of focus and goals (TQM)
  A very well defined problem is a solid base to start a project on. This should be done
  in the Define phase of Lean Six Sigma and it is important throughout the whole
  project.
- Emphasis of form over function (TQM)
  Sometimes a methods is carried out exactly as described in books. In many of those
  case you might see that the project is unsuccessful. You should use those books as
  guidelines for your project and use what is applicable in your case. What is good for
  one organization does not have to be necessarily good for your organization as well.

Table 6 provides an overview of the most important characteristics of Lean & Six Sigma and
the other discussed quality improvement methods. This table should give clear insight in
quality improvement methods for people interesting in starting a quality improvement
program or project.

So Lean Six Sigma is a method combining best of both worlds of Lean and Six Sigma. Every
organization is free to choose what to pick from Lean and what to pick from Six Sigma.
4. The importance of leadership and communication

As concluded in the previous chapters, literature research on Lean Six Sigma and on other quality improvement methods and the case study at Stork Fokker AESP showed that commitment is a very serious and important success factor. Increased commitment can be achieved by good leadership and communication. This chapter deals with those factors to improve the commitment and acceptance and therefore the effectiveness of Lean Six Sigma projects.

4.1 What is Leadership?

There are many different definitions for leadership, but providing a single definition clarifies what is meant by it and covers most elements of it:

“Leadership is not only about being the boss, but also about pointing out directions, changing and controlling. Leadership does not only apply to someone who is in charge, but also for someone who takes charge. Leadership needs decisiveness, persistence, vision and the willingness to change.” (translated from Dutch) (Van Solingen, 2007)

There is a significant difference between leadership and management, although these two sometimes cause confusion. Management aims at planning, organizing, controlling and problem solving, while leadership focuses on constructive and adaptive changes (Den Hartog, Koopman, & Muijen, 1997). Leadership is needed for realizing changes.

In the 1990’s a new paradigm about leadership started to exist. In this new way of thinking leaders are charismatic, transformational, inspirational and visionary. The differences between this new and old paradigm are described by Trist and Beyer (Makin, Cooper, & Cox, 1996) and are provided in Table 7.

<table>
<thead>
<tr>
<th>“Old” leadership</th>
<th>“New” leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-charismatic</td>
<td>Charismatic</td>
</tr>
<tr>
<td>Transactional</td>
<td>Transformational</td>
</tr>
<tr>
<td>Management</td>
<td>Leaders</td>
</tr>
<tr>
<td>No Vision</td>
<td>Vision</td>
</tr>
<tr>
<td>Non-magical</td>
<td>Magical</td>
</tr>
</tbody>
</table>
“New” leadership focuses on vision and mission instead of on planning, and on motivating and inspiring instead of inspecting.

The new leadership approach consists of two kinds of leadership: Transformational and charismatic leadership. Both of those kinds of leadership have different important elements (Den Hartog, Koopman, & Muijen, 1997):

Transformational leadership:
1. Charism (to create pride, trust and respect)
2. Inspiration (communication of vision, role model of the leader)
3. Intellectual stimulation (stimulation of thinking critically about employees themselves and processes)
4. Individual attention (coaching, guiding and supporting of employees)

Charismatic leadership:
1. Exceptional leader (extraordinary and skilled)
2. Crisis situation or social disorder
3. Appealing vision/mission, which provides a solution for the crisis
4. ‘Follower’ appealed by the leader and his mission
5. Proved quality of leader by repeated successes

Both types give insight in what a leader should be and what type/element of leadership is needed to achieve a certain goal.

Although transactional leadership is part of the “old” leadership as presented in Table 7, current leadership research recommends a combination of transformational and transactional leadership styles (Bass, Avolio, Jung, & Berson, 2003).

Transformational leadership is based on the idea of motivating others to do more than they originally intended or thought possible. Transactional leadership is based on transactions between leaders and followers. It clarifies the role and task requirements of employees, initiates structure, and provides appropriate rewards” (Ozorovskaja, Voordijk, & Wilderom, 2007).

4.2 What is Communication?

Just like for leadership, many definitions are available for communication. The following definition covers most elements of communication and clarifies what is meant by it:

“Communication is the intentional production of messages in an informational, relational and situational context, reception and interpretation are the effects. The relation between senders and receivers are shaped this way” (Van Putte, 1998)

Without communication, there cannot be interaction, contact and information exchange. Without communication an organization cannot exist and there cannot be leadership.

In projects internal communication is utmost important and is all about organizational transparency (Van Putte, 1998). Employees need, in order to function properly, the necessary information to execute their work. They also need to be able to communicate with others in a way that they can adjust their work on other processes. Management should be careful not to provide too much information, because this could lead to information overload.

Communication is mostly used as a direct or as an indirect instrument (Van Putte, 1998). The management wants to achieve three effects by direct communication: enlarging involvement, willingness to change and acceptation of organizational policy. Indirect communication serves to achieve: clear and uniform organizational culture, influence on behavior of employees and informal organizing.

How should an organization communicate during a Lean Six Sigma project, who should communicate and to whom? How should employees be able to respond (and should
they be able to respond) and on what basis should they be informed? Those are questions leaders of a Lean Six Sigma project should think about to create good conditions for the employees in which they are more committed, more willing to change and more willing to accept solutions.

4.3 Why are Leadership and Communication important?

In the previous paragraphs short introductions are given on the subjects leadership and communication. Why are those two factors important for this research? A few citations about these subjects, to confirm their importance, as found in literature:

“The not (completely) implementation of a change, is not due to the Belt, but more to poor leadership and the lack of decisiveness. The management has to show its commitment and it has to "walk the talk." (translated from Dutch)
(Van Daalen, 2009)

“As leadership is important to the overall success of the Six Sigma projects and thus, the overall initiative, it is important to know if Six Sigma Black Belts have adequate leadership skills to facilitate Six Sigma project teams.”
(Loethen, 2007)

“Alleen leiderschap kan verandering doen beklijvend door haar te verankeren in de cultuur van een organisatie.”
(Kotter, 1996)

“I think very little research has been carried out to demonstrate the impact of leadership style and culture on the successful deployment of a Six Sigma initiative.”
(Anthony, 2008)

“Leadership is the basis of a Six Sigma program. The management has to be the engine for creating commitment throughout the complete organization. When good leadership is lacking, Six Sigma is due to fail." (translated from Dutch)
(Van Solingen, 2007)

“Active leadership by management and others involved is integral to the method and critical to its success.”
(Snee, 2005)

“...... But, above all, that successful implementation of Six Sigma depends on leadership.”
&
“Leadership skills are needed to improve processes and organizations.”
(Wyper & Harrison, 2000)

“A communication plan is important in order to involve the personnel with the Six Sigma initiative by showing them how it works, how it is related to their jobs and the benefits from it.”
(Antony & Banuelas Coronado, 2002)

“You communicate, communicate, communicate!”
(George, Rowland, & Kastle, 2004)

As written in the introduction of this thesis, various authors have been arguing for some time now that Six Sigma is lacking leadership and communication (Loethen, 2007) (Anthony, 2008). Those two factors are very important for a successful Six Sigma project, just as they are very important for any kind of project. There are more factors which are critical for a
successful implementation of a Lean Six Sigma project, such as: selection and prioritization of projects, gathering of the right data, have the right scope (Antony, 2004), behavioral insight, technical understanding (Linderman, Schroeder, Zaheer, & Choo, 2003), involvement of the directors, understanding the customer needs (Eckes, 2000), focus on processes and therefore on customers, clear vision values and objectives of management and management by fact (Caulcutt, 2001). For this research leadership and communication are chosen to integrate in Lean Six Sigma, because those factors are being seen as very important the last few years and because the interest of the author of this research in those factors. Besides that, those two factors cover parts of many of the other critical success factors.

“Real leaders” believe that the effect of a change is the outcome of the quality of the solution times the acceptance of it, which is formulated in the formula: \( E = Q \times A \) (Van Solingen, 2007). Leadership can influence the acceptance of a change and is therefore a very important factor in projects. This formula is the leading thought behind how to achieve effectiveness.

The problem is that leadership is not explicitly taken into account in Lean Six Sigma training courses. Black Belts are the project leaders and for them good leadership and communication is utmost important for a successful implementation of a Lean Six Sigma project. Those elements are not only important for the Black Belts, but for the champions (a champion is the sponsor of a Lean Six Sigma project, who is part of the top management of the company) and process owners as well. For the champions it is important because they have to support the project in the right way and for the process owners it is important because they have to make sure the employees will help to make the project successful.

Communication is a central theme in the leadership literature (Tourish & Robson, 2006), because communication involves the personnel, can help reducing the resistance to changes (Antony & Banuelas Coronado, 2002) (Van Solingen, 2007) and helps the leaders to guide their employees (Terry, 1998).

Furthermore, according to Breyfogle (2006), companies that have successfully implemented Lean Six Sigma share a view basic characteristics, which are: Committed leadership, supporting infrastructure and use of top talent. Those characteristics all involve leadership and communication.

Leadership and communication are not solely important for Lean Six Sigma as explained in this paragraph and concluded in chapter 2. Those two factors are also very important factors for the identified other quality programs/methods. In every project Leadership and communication, at whichever level, are two of the most important success factors. Besides proof of importance in literature, the case study at Stork Fokker AESP also shows how important leadership and communication are within a (Lean Six Sigma) project.

All of these findings validate the importance of leadership and communication and therefore the research about how to integrate or how to deal with those two factors in Lean Six Sigma.

**4.4 How to achieve effectiveness?**

Now we understand the importance of leadership and communication within Lean Six Sigma, what has to be done to achieve effective leadership and communication within projects? What should we know? A few things have to be figured out and those are:

- Do cultural differences play a significant role? How to deal with those differences? (paragraph 4.5)
- What has been written about leadership and communication in literature about Lean Six Sigma? (paragraph 4.6)
- How is dealt with those factors within best practices? (paragraph 4.7)
- What can be learned from the case study at Stork Fokker AESP? (paragraph 6.8)

This paragraph discusses additional information about leadership retrieved from literature.
Given $E = Q \times A$, how can effectiveness be achieved with leadership according to science? Stefan Covey speaks about the "seven habits of highly effective people" (Covey, 1999):

1. Be pro-active
2. Begin with a clear goal
3. Begin at the beginning
4. Think in terms of win/win
5. Try to understand first, then try to be understood
6. Work synergetic
7. Keep yourself fit and sharp

This is a very well known list by Stefan Covey, but it is nevertheless a very important list for leaders to keep in mind and very well applicable for Lean Six Sigma projects as well.

Another way of achieving effectiveness is publishing production figures. Lean Six Sigma uses production figures to keep the involved people up-to-date of the project's results. Those figures can also stimulate organizations or departments to improve their production. But does the publishing of the figures only stimulate enough or are consequences needed? The impact of the publication of the figures has low impact when there are no direct consequences, on the other hand will the impact be high if there are (severe) consequences (de Bruijn, 2007). Those consequences can be called, in a more positive way, incentives. Those consequences/incentives with a high impact are (de Bruijn, 2007):

- **Financial sanctions**: A positive or negative financial sanction is linked to the production figure. An underperforming organization receives a punishment, whereas one that over performs is rewarded with a bonus. The impact of such sanctions is high because future budget largely determine an organization's opportunities.
- **Naming and shaming**: An organization's production figures may be published alongside those of other organizations in the form of a ranking, declaring publicly which organization performs best and which worst. The impact of this method is high because low ranking may influence the choice made by customers, not to mention future personnel, who would prefer to work for an organization with a high ranking.
- **Administrative and managerial interventions**: Production figures that differ from average are likely to attract attention of managers. Below average results can result in tighter supervision and so on, while above average results can lead to new higher targets (which can be experienced as an undesired effect). Therefore this sanction has a high impact.

Then there are two respects in which a low-impact performance measurement may be appreciated according to De Bruijn. This first one is that "it probably has few incentives for improving an organization’s performance. From the professional’s perspective, the system is innocuous: the production figures have hardly any function". The second is that "a low impact is sufficient for effective performance measurement. Suppose a professional organization is able to exhibit only mediocre production figures. Professionals who observe this state of affairs may feel that it is a matter of professional honour to improve the organization’s performance. By appealing to professional honour, the figures have a self-healing effect".

This self-healing effect may not manifest itself, therefore an organization can increase the impact since the idea is that whenever the potential impact increases, the positive effects of performance measurement increase accordingly (de Bruijn, 2007).

One major point of attention and weakness of increasing the impact, is that it may stimulate perverse behavior. If too much is depended on the performance measurement, people tend to provide only the desired and, sometimes, wrong information. This effect is called ‘The Law of Decreasing Effectiveness’: “If performance measurement has a high impact, the effectiveness of performance measurement declines, because strong incentives for perverse behavior arise” (see Figure 12).
Companies should look into ways of stimulating their employees to work on (and think about) improvements of work processes. How this should be stimulated differs per company and depends on the culture and policy of that company. However, people who are trying to build-in those incentives, should be aware of the advantages and disadvantages of positive or negative incentives regarding the “Law of Decreasing Effectiveness”.

### 4.5 Cultural differences

The focus of this research is on Dutch companies implementing or wanting to implement Lean Six Sigma, as mentioned in the introduction of this research. This focus has been chosen, because cultural difference might come into play when you make a generic model for Lean Six Sigma. This model may not be even effective in all countries, due to these potential important cultural differences. Most of the articles about Lean Six Sigma and leadership and communication are written in an American context. Leadership and communication might need a different approach in the Netherlands compared to the USA. But there are also similarities to be identified between companies in the Netherlands and the USA. There exist four major cultures in companies (Cameron & Freeman, 1991) (Denison & Spreitzer, 1991): Group, Developmental, Hierarchical and Rational Culture (see Appendix F). Those different cultures are characterized as presented in Figure 13.

![The competing values framework of organizational culture](image)

**Figure 13: The competing values framework of organizational culture (Cameron & Freeman, 1991) (Denison & Spreitzer, 1991)**

The research of Zu, Fredendall and Robbins (2006) was about which culture is needed for which quality practice? Those practices are (see Appendix F):
Group culture appears to be the most important cultural orientation for implementing quality practices in Six Sigma (except for Six Sigma role structure) in US manufacturing companies, according to the research of Zu, Fredendall & Robbins. Group culture is about participation, trust, and a concern for human resources. By creating a group culture, an organization is likely to develop a supportive environment where employees are encouraged to participate in continuous improvement teams and are rewarded for their contribution to better quality (Zu, Fredendall, & Robbins, 2006). This also sounds like a perfect culture for a Lean organization, since lean is about empowerment of the employees and encourages continuous improvements initiated by the employees.

The second most important cultural orientation for quality management orientation is: the rational culture. This culture focuses on control and goal achievement. The results of the research indicate that the rational focus has a combined effect on many quality practices with both group and developmental culture. Shea and Howell (1998) suggest that if a company wants to have a successful quality management implementation, it has “to provide employees with the freedom, autonomy and range of skills to engage in creative and effective continuous improvement activities, while encouraging the use of a systematic problem-solving approach to use quality tools to control its systems and processes”.

The results further indicate that a hierarchical culture is not related to any of the quality practices and therefore this culture can only contribute to a successful Lean Six Sigma implementation when combined with other cultural orientations (Appendix F provides insights in which cultures are important for which quality practices).

Zu, Fredendall & Robbins are concluding that “to achieve the full benefits of implementing Six Sigma, companies should put emphases on at least three cultural orientations, i.e., group culture, developmental culture, and rational culture, in order to support the full implementation of Six Sigma’. They furthermore conclude that “in order to receive the full benefits of a quality management implementation, managers may find that it is important to assess their company’s cultural orientations and to develop necessary plans and policies to create a supportive environment in which all quality practices thrive”.

This means that the basis of the organization, the culture, should be arranged in such a way that Lean Six Sigma has the most chance to succeed. It has to be a balance between group, developmental and rational culture.

Because the research of Zu, Fredendall and Robbins (2006) is based on a survey amongst American, but worldwide based, companies, it is very well applicable for Dutch companies as well since the investigated cultures can be found in companies in The Netherlands too. Those investigated cultures are used in literature researches all over the world and the research of Zu, Fredendall and Robbins is based on American worldwide based companies, so one can say that the conclusions of Zu, Fredendall and Robbins are also valuable and important for companies all over the world.
4.6 Leadership and Communication in Lean Six Sigma

What has been written about leadership and communication in Lean Six Sigma literature?

Leadership model: top-down implementation
The leadership model is characterized by commitment and involvement of the highest management (Van Solingen, 2007). The highest management consists of ‘Champions’ and is responsible for implementing Lean Six Sigma throughout the whole organization. The management is being judged on the levels of success of Lean Six Sigma. The big advantage of this model is that it sort of guarantees the continuity of Lean Six Sigma due to the permanent support of the management. Commitment, involvement, prioritization and financial means are not an issue since the management is the sponsor itself.

Most important thing to achieve in the leadership model, is to get everybody Lean Six Sigma minded. This requires a change of the organization’s culture. Disadvantages are:
- Potential resistance to change
- Takes long to have visible change due to the required cultural change
- Management has to act as one; if one or a few manager(s) act differently, everything collapses

But to summarize; the leadership model is a model with a high rate of success.

Expert model: bottom-up implementation
The opposite of the leadership model is the expert model. Within this model experts are implementing quality improvement projects using Lean Six Sigma on their own initiative (Van Solingen, 2007). Experience is one of the major success factors, alongside visible advantages on the work floor and real process improvements. This gives Lean Six Sigma a positive image. The expert model is characterized by process experts having the drive to improve their own processes. With this initiative Lean Six Sigma has been brought to the company bottom-up and ‘sold’ to the management.

It is sold to the management because this small group of experts is incapable of implementing Lean Six Sigma throughout the whole organization, due to insufficient knowledge and/or power to do so. Therefore it should be handed over to the leadership model.

To summarize: The expert model can be used as example project (how it should be done), but if you want Lean Six Sigma throughout the whole organization you should use the leadership model.

RACI model
The RACI model, as described in What is Lean Six Sigma? (George, Rowland, & Kastle, 2004), shows how to spread power and responsibility during a Lean Six Sigma project. RACI stands for:
- **Responsibility**: People who are expected to be actively involved and motivated to do their best
- **Accountability**: People having final responsibility for the results
- **Consultation**: People who have either a special expertise which is important for taking decisions or whose opinion have to be asked before decisions can be made
- **Inform**: People who will be influenced by the project, but who are not working on the project

The RACI model is not a standard model and can be applied according to the wishes, culture and possibilities within an organization. Before constructing a RACI model for your own organization, one of the most important decisions to be made is the role of the Black Belt. Black Belt are in a special position since they have experience to make the project successful, but the risk is that the team(s) might think or get the impression that they have to do it the Black Belt’s way. This is not desired and therefore a guiding and supporting role is
the ideal role for a Black Belt. They should not be in a position of someone making decisions since they don’t have the expertise nor the responsibility of the process (George, Rowland, & Kastle, 2004). Table 8 provides an example of organizing responsibilities in a RACI-overview.

Table 8: RACI model example

<table>
<thead>
<tr>
<th>Activity --&gt; Task</th>
<th>Ownership</th>
<th>Identify projects</th>
<th>Select projects</th>
<th>Project results</th>
<th>Project execution</th>
<th>Team support</th>
<th>Make change last</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exec team</td>
<td>Lss</td>
<td>A</td>
<td>R</td>
<td>A</td>
<td>R</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Champion/sponsor</td>
<td>I/C</td>
<td>R</td>
<td>A</td>
<td>R</td>
<td>R</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Process owner</td>
<td>C</td>
<td>R</td>
<td>A</td>
<td>R</td>
<td>R</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Black Belt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Belt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Etcetera</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Three way communication
Leaders within Lean Six Sigma project have many different responsibilities and tasks, like: selecting introducing projects, starting trainings, supporting employees etc. Besides that they should be aware of what happens with the employees who are not directly involved in the project. The leaders have to put effort and time in creating a good communication network between different departments of the organization. This communication network has three levels (George, Rowland, & Kastle, 2004):

- **Communication with other leaders**: Communication between leaders is very important to remove potential burdens and to solve conflicts between different departments
- **Communication with project team members**: Make sure that the team members understand the leader’s goals, scope and expectations of the project. Stimulate the team to communicate to the leader and to ask questions to get more clarity
- **Communication with and by employees amongst themselves**: The more people in an organization are aware and up-to-date with the project, the bigger the chance that Lean Six Sigma is successful

Selection of Team members
A very important part of Lean Six Sigma is that decisions are based on data and thus facts. In the past decisions were often based on intuition. The team member selection is still based on intuition, while this is a essential part of the success of Lean Six Sigma projects (George, Rowland, & Kastle, 2004). How team members should be selection are beyond the scope of this research, but nevertheless an important subject to be aware of. A team should consist of the right combination of people and their skills, knowledge and personality (depending on the complexity of the problem, the environment and goal setting).

The fundamental decision to be made for example is to let projects be performed by people in their own work environment or in other environments. The advantage of people operating in their own environment is that they have specific knowledge and that they are committed. The disadvantage is a more narrow focus and a lack of new ideas due to the lack of fresh insights. If those kind of processes are performed in a new environment, another type of person is needed. Due to the lack of specific knowledge, personal competences like persuasiveness, natural drive and leadership are much more important (Van Solingen, 2007) (van Daalen, 2009).
For who important?
For who are leadership and communication important within a Lean Six Sigma project? This summary for who and why those factors are important are concluded from literature research and participative field research:

- **Black Belt**: The Black Belt is the most important person in the project, since he is responsible for the communication between Champion, Sponsor, Process Owner and team members. The Black Belt has to make sure and facilitate that the project can be executed in a good way.

- **Champion/Sponsor**: The Champion and Sponsor have to make sure that the project team has all the required resources like money, time and access to expertise. They also have to carry out the Lean Six Sigma structure throughout their organization(s) in order to make it accepted by the employees.

- **Process Owner**: The Process Owner is responsible for the process and has therefore final responsibility for the success of the project.

- **Green Belt**: Green Belts have a more operative role and are responsible for the tasks of the project to be carried out. They also have more contact with the employees who are not directly involved in the project. Therefore it is important that the Green Belts have a clear vision of the project and they know how to inform the other employees about it.

Because those people are very important for the success of a Lean Six Sigma project, they should receive the right training to function as good as possible within the Lean Six Sigma method.

### 4.7 Leadership and Communication at best practice General Electric

How are those two elements integrated at best practice General Electric? GE is the company which has made Six Sigma a significant and popular quality improvement method. Lean Six Sigma is nowadays the basis within GE.

**General Electric (GE)**

GE is, by saving billions of dollars, the company that made Six Sigma popular and is seen as a best-practice (Henderson & Evans, 2000). The former CEO of GE, Jack Welch, has written much about leadership. He judges his managers/leaders on values which are important for GE. In his opinion, a ‘real’ leader operate according to four values: 4 E’s & 1 P (Van Solingen, 2007);

- **Energy**: What the leader radiates.
- **Energize**: What the leader does with a group of people, how he influences them.
- **Edge**: Leader knows his limitations, seeks them continuously and tries to move them.
- **Execute**: ‘Walk the talk’.
- **Passion**: Passion can be felt, tasted and experienced. Passion excites others.

Jack Welch thinks leaders should be judged on these values, because these are more important than gaining targets. The leaders can work on these values during workshops with other leaders. In such an ‘open’ environment they can easily discuss those values and learn from each other.

Lean Six Sigma is the basis for all personnel at GE and almost every manager at GE gets a ‘Leadership’ training course to train the managers to create a supportive environment for the employees of GE to stimulate them to think about how to improve processes (General Electric, 2009). GE provides two levels of trainings: “Entry-level Leadership Program” and “Experienced Leadership Program”. The first program is for people who are recently enrolled in the company and are seen as talents for the future and they get a broad leadership
program. The second program is, also for talents, for people who have more experience in
the company and they get a more in-depth training.

Agnes van Driel (2007) wrote in her Master Thesis report that the success factors of GE
were:
- Very strong commitment from the top
- Regular evaluation of all projects
- Measuring and monitoring of results
- Change efforts linked to rewards

The Quality Director Europe of GE Plastics said, during an interview done by Agnes van
Driel, that “a culture has to be established were change is not seen as a threat but as an
opportunity”. This matches with what is the conclusion about which organizational cultures
are desired to have the right preconditions for quality improvement programs (in 5.5).

4.8 Conclusions about leadership and communication regarding Lean Six Sigma

The first two paragraphs discuss leadership and communication and what it is in literature. A
trend in leadership is that leaders are becoming more and more charismatic and motivating
for their employees (transformational leadership), while the transactional leadership style is
becoming less used. A combination of leadership styles is preferred to motivate employees
and to shape the right preconditions on the work floor. Communication is very important to
create a willingness to change and a willingness to accept solutions by the employees. It also
creates more involvement of the employees

Those two elements are very important because they are proven to be success
factors not only in Lean Six Sigma projects, but in other change programs as well. And since
the goal of this thesis is to increase the effect of Lean Six Sigma, which is a product of the
quality and the acceptation of the solution, leadership and communication play a very
important role in doing so.

So how to achieve effectiveness? Leaders could look at the seven habits by Stefan
Covey, a theory very well known amongst leaders. Incentives can play a very important role
in really achieving effectiveness. Those incentives (to be determined per company
depending on complexity of problem and organizational culture) can stimulate the employees
to work on actual improvements. When composing those incentives, one should take the
effect, known as the “Law of Decreasing Effectiveness”, into account.

Those previous things are important at the moment the right preconditions have been
met. First of all a right organizational culture has to be established, a culture in which quality
improvement methods have a chance to succeed. According to research, in the right culture,
employees have the freedom, autonomy and range of skills to engage in creative and
effective continuous improvement activities. The organizational culture should be supportive
towards employees to let them work on such activities. A combination of group,
developmental and rational culture is proven to be the best mix of cultures for quality
improvement methods, where group culture is the most important one. If this precondition is
not met and you try to implement Lean Six Sigma in a hierarchical culture, the project will
most likely fail. Therefore this is the most important step before a company is going to select
the right project (which is the first step in literature).

So what should a company know, according to literature, about how to implement Lean Six
Sigma successfully?
- Top-down implementation (the leadership model) is the way to implement Lean Six
  Sigma throughout the whole company. Bottom-up implementation (expert model) can
  only be used as a first project to act as example;
- A way of organizing responsibilities is provided by the RACI-model, which has to be
  filled-in upfront the project by the Black Belt, Champion and process owner;
- Those people also needs to think about how communication between the different leaders, between team members, between employees and between all of them should be arranged. This is very important for the involvement and thus acceptation of the project;
- The selection of the team members should be very well considered, since the team should have the right combination of skills, knowledge and personality to make the project successful;
- Those people, with different roles like Champion, Black Belt, process owner and Green Belts, should receive the right training to make a successful project possible.

‘Best practice’ General Electric provides some insight in how to train and evaluate leaders what is the most desired environment/culture a company should create to enhance the chance of a successful change program. GE states that it is important that leaders create/establish a supportive environment for employees in which “change is not seen as a threat but as an opportunity”. Leaders should stimulate employees to think about possible improvements and to actually implement improved processes.

The main conclusion of this chapter is that leaders should create and shape the right environment for their employees by giving them the opportunity, freedom and drive to think about improvements and let them feel appreciated in their way of thinking (in order to let Lean Six Sigma be more effective). This could be achieved by:
- Having the right leaders. A combination of transformational and transactional leadership style. Transformational is the most important one, because the leaders have to inspire, motivate and guide their employees into Lean Six Sigma. If a leader believes in this method and if he continuously supports that method, his employees will follow eventually.
- Having the right combination of organizational cultures (group, rational and developmental cultures are the most important ones for change programs). Which culture is the most important one, depends on the existing organizational culture and on the DMAIC phase the project is in.
- Giving the employees the right incentives to let them be actively involved in the improvement (thinking) process. So what is a right incentive? This depends on the already existing reward structure in the organization. But it is important, according to De Bruijn (2007), to realize that people tend to show perverse behavior when there is very much at stake. Examples of incentives are; a bonus linked to the production figure; naming and shaming of the better and much worse than average producing teams and administrative and managerial intervention.
- Supporting Lean Six Sigma throughout the whole company by the highest management for at least a few years (top-down implementation). This will help Lean Six Sigma to settle itself in an organization.
- Making arrangements about the responsibilities of the involved people for the project.
- Clear (well-thought-out) communication to (and between) all of the involved personnel, because communication helps to create the willingness to change, and to accept solutions. Communication also helps to let the employees be more involved, by keeping them up-to-date.
5. Conclusions of literature research

So what can be learned from the literature studies and case study? What are the most important things to keep in mind when starting a Lean Six Sigma project?

5.1 Combination of previous conclusions

The conclusions of the different parts of literature research have a few common points of focus and attention. It seems that a big part of the success of Lean Six Sigma projects lies before implementing a project, even before selecting a project. Leaders play a very important role in this pre stage of Lean Six Sigma.

The current common steps to take when implementing a Lean Six Sigma project are described in many books and papers, but differ only slightly. The core (basic thought) of all those different steps to take are summarized in the following steps:

- Select the right project
- Select the right people for this project
- Train these people
- Follow the method and validate earnings
- Secure results

There is no doubt about the importance of those steps and many companies have proven that those steps are the ones to follow. But there is more, because there are also companies who have followed those steps and did not succeed. Are there other steps to be taken, to ensure the success and effect of Lean Six Sigma?

According to literature about Lean Six Sigma and other quality improvement methods, one should be aware of the possible over-expectation of the method. Therefore it is important that all of the involved people know what to and what not expect from Lean Six Sigma and what other methods are about. If you can envision (with help of my framework) what kind of method is most suitable and most desirable for a certain kind of problem, you decrease the chance of over expectations. Furthermore it is important to communicate to the employees what to expect from Lean Six Sigma in what time frame (or achieve this by train them). This is an add-on for the right project selection.

But even before that, the right preconditions have to be met for implementing a successful change program. To achieve that, leaders should create and shape the right environment for their employees by giving them the opportunity, freedom and drive to think about improvements and let them feel appreciated in their way of thinking (in order to let Lean Six Sigma be more effective). This could be achieved by:
- Having the right leaders. A combination of transformational and transactional leadership style. Transformational is the most important one, because the leaders have to inspire, motivate and guide their employees into Lean Six Sigma. If a leader believes in this method and if he continuously supports that method, his employees will follow eventually.

- Having the right combination of organizational cultures (group, rational and developmental cultures are the most important ones for change programs). Which culture is the most important one, depends on the existing organizational culture and on the DMAIC phase the project is in.

- Giving the employees the right incentives to let them be actively involved in the improvement (thinking) process. So what is a right incentive? This depends on the already existing reward structure in the organization. But it is important, according to De Bruijn (2007), to realize that people tend to show perverse behavior when there is very much at stake. Examples of incentives are; a bonus linked to the production figure; naming and shaming of the better and much worse than average producing teams and administrative and managerial intervention.

- Supporting Lean Six Sigma throughout the whole company by the highest management for at least a few years (top-down implementation). This will help Lean Six Sigma to settle itself in an organization. This support is very important since it is hard to become a full Lean Six Sigma organization (see 2.4).

- Clear (well-thought-out) communication to (and between) all of the involved personnel (before and during the project). This is important because communication helps to create the willingness to change, and to accept solutions. Communication also helps to let the employees be more involved, by keeping them up-to-date.

- Making arrangements about the responsibilities of the involved people for the project (when selected the right people for the project). Time management is very important for those team members, because in many cases they struggle to combine their ‘normal’ activities with their Lean Six Sigma obligations.

All of those above mentioned points will have to be differently fulfilled per organization, depending on its culture and policy.

### 5.2 How to proceed?

The previous paragraph represent the combination of the most important conclusions from the literature research. Those conclusions can best be seen as recommendations for people, leaders, who are implementing (or wanting to implement) a Lean Six Sigma project to increase the chance of a successful project.

Do those conclusions also occur in real life, in the case study? How does Stork Fokker AESP deals with those things? Are those conclusions really points of attention and how do they exist/occur? Those kind of questions will be answered throughout the following chapter.

After comparing the conclusions with the reality at Stork Fokker AESP, they will be checked with experts in the Lean Six Sigma field. What do they think of them? Do/did they see the same kind of problems or points of attention? How do/did they deal with them? And do they concur with the conclusions about those aspects? This evaluation of the conclusions will be discussed in chapter 7. In chapter 8 the final conclusions, based on the literature research and on the case study and expert interviews, will be presented.
6. Case study at Stork Fokker AESP: “Facelift”

To verify the importance of the results of the literature research and to obtain possible additions, a participative field research (case study) is performed at Stork Fokker AESP in Hoogeveen. At first this chapter discusses the reason of this project together with the steps Stork Fokker has taken to become a Lean Six Sigma company. The next paragraph deal with the question; “Are the steps taken sufficient according to literature?”. The biggest part of this chapter provides a summary of the DMAIC steps of the case study. At the end of the chapter points of attention (and how to deal with them) are given, followed by the conclusions.

This case study is a participative field research for the author of the thesis, which will be described in more detail in the last paragraph of this chapter.

![Figure 15: Thesis/research flow chart; Chapter 6](Image)

6.1 Reason of this project

In 2006 Stork Fokker AESP (part of Stork B.V. see Figure 16 and Appendix I) started research on the biggest problems such as non-quality costs, (un)reliability of processes and stock turns.

![Figure 16: Stork B.V. since May 2008](Image)

A part of the findings, which focused on reducing the non-quality costs by increasing the first time yield, showed that 1/3 of the non-conformance costs were caused by the composite part of the factory. In 2007 the Lean Six Sigma project First Time Right (FTR) started in order to reduce the amount of NC’s. After this project a big reduction in NC’s was achieved, except for the Airbus part of the factory. Therefore the recommendation was to implement a Lean
Six Sigma project for the production process of the J-Noses of the Airbus A380 and A340 (see Figure 2 and Figure 17). This production process takes place at the location in Hoogeveen.

Stork Fokker AESP deals with high non quality (=non conformance=NC) costs for the production of the J-Nose for the Airbus A380 and A340 (which are composed of thermoplastics). In 2008 420 NC reports were written, mainly due to wrinkles, buckles, deviations in thickness and other visual deviations. 420 NC’s means that more than 50% of the produced products had an NC, and that costs a lot of money. Those NC’s cause high lead times what could prevent the realization of the planned ramp-up of 30 ship sets (one ship set consists of 16 skins and 16 sub spars) per year after 2009.

The goal of the project is reducing the costs. This has to be obtained by a robust J-Nose production process with tolerances which are simply and clearly formulated. This will lead to a higher first time yield, lower non-quality costs, lower lead times and lower costs due to work in progress. This project will focus on the production processes of the A380 & A340 skins and the A380 sub spars.

### 6.2 Lean Six Sigma throughout Stork

So what is done at Stork Fokker AESP to make Lean Six Sigma a successful method?

**Standardized improvement method (WCP@Stork2010)**

In 2006 the World Class Performance program (WCP@Stork2010) started at Stork, in this program Lean Six Sigma is the leading method in becoming a World Class Performance company. This program was launched to make Stork a World Class Performance company in 2010 and with that goal, Stork attached itself to Lean Six Sigma for at least the first 4 years, but very likely for much longer. That means a continuous support for Lean Six Sigma by the highest management of Stork and therefore by every management at the local plants.

To become the company Stork wants to become, changes have to come into place and therefore the WCP@Stork2010 framework is made (see Figure 18). For this thesis mainly the pillars “Leadership”, “People” and “Tools, methodology” are interesting. The pillar “Tools, methodology” does not only contain Lean Six Sigma, but a collection of tools like: 5S, Kaizen, Lean, Six Sigma, Just do it, Change acceleration etc.

Not each tool is applicable for any kind of situation. Figure 19 shows when which tool to use.
### Leadership
- Stork leaders behave as the technical and emotional owners of their business.
- Stork leaders are results-driven with stretched ambition levels.
- Stork leaders change their business, on an ongoing base.

### People
- Stork applies a decentralized management style giving talented people their own responsibility.
- Stork has highly effective people & teams.

### Stretched and aligned targets
- Stork has longer term financial incentives designed to encourage continued change and growth of the business.
- Stork delivers beyond stretched expectations.

### Tools, methodology
- Stork’s lean six sigma approach provides a relentless organizational focus upon eliminating any non-value-added consumption of resources.
- Stork’s tools and methodology are aimed at growth, market leadership and installed base championship.

### WCP@Stork2010 pillars
- **Customer intimacy;**
  - Stork perceives customers’ real needs and provides products and services to meet or exceed them.
- **Operational perfection;**
  - Stork provides better products and services than competitors.
- **Fact driven;**
  - Stork knows the significant numbers to rely their business on.

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**Figure 18: WCP@Stork2010 pillars**

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**Figure 19: Tools and Methodology of WCP@Stork2010**

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Figure 19 shows which tool to use if you have a certain amount of time. The project at Stork Fokker AESP used as case study has a duration of about 9 months and is about process capability. It is not a process which is new to designed and thus not a DFSS (Design For Six Sigma), but a DMAIC project. This program is the basis for the case study project and this adopted philosophy ensures the continuous support for Lean Six Sigma projects by the highest management.

**Standardized improvement method (Change Acceleration Process (CAP))**

To be ready for Lean Six Sigma projects, the prerequisites had to be met in order to be able to implement Lean Six Sigma successfully. Stork Fokker AESP uses a model which is constructed at General Electric. This model combines the most important prerequisites (Van Solingen, 2007) and is known as the CAP-model (Change Acceleration Process). It deals with seven points of attention to make Lean Six Sigma projects successful:

1. **Leading Change**
   Having a Champion who sponsors the change, who has visible, active public commitment and support of change.

2. **Creating a Shared Need**
   The reason to change, whether driven by threat of opportunity, is instilled within the organization and widely shared through data, demonstrated or demand. The need for change must exceed its resistance.

3. **Shaping a Vision**
   The desired outcome of change is clear, legitimate, widely understood and shared. The vision is shaped in behavioral terms.

4. **Mobilizing Commitment**
   There is a strong commitment from constituents to invest in the change, make it work, and demand and receive management attention. Constituents agree to change their own actions and behaviors to support the change.

5. **Making Change Last**
   Once the change is started, it endures, and learning is transferred throughout the organization. Change is integrated with other key initiatives; early wins are encouraged to build momentum for the change.

6. **Monitoring Progress**
   Progress is real, benchmarks set and realized, indicators established to guarantee accountability.

7. **Changing Systems and Structures**
   Making sure that the management practices (Staffing, Development, Rewards, Measures, Communication, Organizational Design and Information Technology Systems) are used to complement and reinforce change.

A schematic overview is given in Figure 20. If one of the elements of CAP is missing, it will endanger the whole Lean Six Sigma project. CAP is part of the Black Belt training for Stork.
Continuous support of management
One of the point of attention and way of implementing Lean Six Sigma, is a continuous support for Lean Six Sigma by the highest Management. The CEO of Stork, Sjoerd Vollebregt, is supporting Lean Six Sigma continuously for a few years now. This made it possible to implement several Lean Six Sigma projects and it stimulates higher management to implement even more sort-a-like projects. The case study can be seen as a ‘sequel’ and was a recommendation from a former Lean Six Sigma project. In this way, the CEO helps to create and shape the right preconditions for Lean Six Sigma projects. He ensures that Lean Six Sigma is being paid enough attention to by:
- Visiting factories and ask about change programs at that factory
- Taking part of Kaizen sessions at local factories
- Arranging a special part of the Monitor (communiqué of Stork, see 6.7) for change programs only
- Making press releases for internal and external use about importance of change programs
- Discussing about change programs with board of commissioners

Visibility of change program
Everybody has to be involved in the company’s policy and everybody should see it and should be aware of it. At the location in Hoogeveen, the Lean Six Sigma thought is made visible by the company’s rules (“huisregels” as shown in Appendix G). Those rules hang on every wall in the factory and every employee is aware of it.

To make the employees even more involved with those rules and especially the 5S’s (5S is a Lean tool mentioned in 2.1.3), every quarter the “golden thumb” is awarded to the team who lives best up to the 5S’s. This award is really alive amongst they employees, because it is a way to compete with each other, but the winning team also gets a diner sponsored by Stork. This is a real good way in my opinion, as long as this award keeps motivating the people, to keep the employees occupied with organizing, cleaning, standardizing and stimulating their work environment. Even at the office where I was working in, we had a 5S meeting every month in order to live up to the 5S’s as good as possible to win the golden thumb. Everybody at this office was really keeping an eye on each other to be as organized as possible, but unfortunately we have won the silver thumb twice in a row. This 5S program is up and running for 3 years now and since September 2008 it really began to work. It took 2 years before it really became alive. Now is the time that the person who actually runs this program can take his hands of it slowly, because it is almost ‘self-sustaining’. The Director Operations Hoogeveen is the person who ordered and supported this program.
Organizational structure/culture
Everybody can walk into each office and talk to anyone on a first-name basis. This makes it easy for everybody to talk to anyone they would like to talk to. There exists a flat structure instead of a hierarchical structure.

At Stork Fokker AESP in Hoogeveen both a strong group and developmental culture exists. There is a lot of empowerment, employees are stimulated to come up with new ideas (they get a reward when their idea is actually implemented) and teamwork is encouraged. Stork Fokker AESP is specialized in special product for a highly demanding high-tech industry. Therefore the company needs to be (and is) innovative and aiming at new markets. That makes Stork Fokker AESP a suitable company for Lean Six Sigma projects.

Stork Fokker AESP is, at least in Hoogeveen, very well prepared for Lean Six Sigma projects. The existence of continuous management support, a World Class Program, as well as the visibility of change programs and the existence of the (for the major part) desired culture enable Stork Fokker AESP to achieve Lean Six Sigma success (according to literature). The coming paragraphs describe the progress of the project.

6.3 Define: Start of project ‘Facelift’
As described in the first paragraph of this chapter, the Airbus A340 and A380 J-Nose production is subjected to a Lean Six Sigma project. This was the recommendation of a research on the biggest problems, such as non-quality costs, (un)reliability of processes and stock turns, at Stork Fokker AESP. The J-Nose production process is showing too many deviations over the last year, which causes high non-conformance costs. Some of the products showing deviations can still be sold, but only after writing a detailed non-conformance report. The writing of such a report costs money, but it is more desirable than a produced product that is scrap and can be thrown away.

The team that has been brought together to implement this Lean Six Sigma project, and thus to improve the J-Nose production process, can be found in Appendix B. The team is very important for the success of the project and it needed to be balanced, that is why the team consists of people of (almost) every involved department (planning, operation, design, control, management). This team configuration should lead to maximum involvement and willingness to help at every department.

The first thing the team did was to identify the customers (in this case internal customers) of the J-Nose production process. After interviewing those customers (Voice of the Customer = VOC) and summarizing their demand and wishes, the following CTQ-statement was formulated:

“A predictable and stable J-Nose production process, which is executed within boundaries which are formulated in a simple, clear and understandable way.”

This is what the customers like to see as result of the Lean Six Sigma project. Of course there are boundary conditions for the outcome like that the process has to be efficient and that the production has to be within present lead times. This leads to the business case, problem & goal statement and scope as presented in Appendix C.

With a clear business case, problem and goal statement as well as a well defined scope, the process can be mapped. A flow chart of the process is provided in Appendix D along with a description of every process step.

Although this tool is most of the time used in the measure phase, the fishbone diagram was already used in the define phase at Stork Fokker. This was done, because we already knew there was little historical data to use for this project. Therefore the team wanted to know in an early stage which kind of data/information we needed to gather and it succeed in finding what kind of data was important. This was achieved by brainstorm sessions with experts on practical and theoretical field and with generalistic thinkers. These brainstorm
sessions, results of them presented in fishbone diagrams (the one in Appendix E is one of the 6 diagrams made), were actually great ways of improving our insight in the problems. This proofs also that the Black Belt of our team does not emphasis on form, but on function. The other way around has been identified as a possible pitfall in chapter 3.

This phase was officially finished with a toll-gate presentation (February 11th) of the project team for the sponsor and champion of the project. They gave the team a ‘go’ and approved the Define phase. The toll-gate presentation can best be seen as a half-way or quarter-way presentation to keep the champion and sponsor officially up-to-date with the project.

6.4 Measure

The first and most important thing to do in the Measure phase is to know how the CTQ is going to be measured. The part “predictable and stable J-Nose production process” of the CTQ is the main signal that was to be measured to be able to see improvements. This main signal is the first time yield of all the products in scope. The yield is the percentage of products that is fabricated without any non-conformities (NC’s). This formula is presented below:

\[
Y = 100 - \left(\frac{\# \text{ Orders hit by NC}}{\# \text{ Order through Autoclave}}\right) \times 100\%
\]

This formula is the main signal, but there are also sub-signals. Those signals have the same kind of formula, but are specific for one kind of NC only. An example is the yield for buckles in skins. The outcome is the percentage of products that has no NC’s due to buckles. Those signals are updated every week to be able to see improvements. The signal is presented as can be seen in Figure 21.

The second part of the CTQ - “… which is executed within boundaries which are formulated in a simple, clear and understandable way” - is not to be measured. Instead a new team has been set up to make sure all of the reports, memo’s and specs are arranged in a systematic way. There are many different kind of documents in use on the production floor, but it is unclear if they are still valid or not. This means that there is a risk that in practice “old” working processes are executed due to invalid documents. The special new team has to ensure that all of the documents are valid and clearly arranged and become part of the official Technical Procedures. In this way this project can meet up to the second part of the CTQ.
Another important thing is to ensure that the NC’s that are written, are written correctly and that they are written objectively. This means that it is important to know if every employee sees the same kind of deviation of specifications as an NC. Gage R&R (Repeatability & Reproducibility) is a tool that helps to identify problems with the measurement system. If the Gage R&R tests shows positive results, then you can trust the obtained data.

Gage R&R tests are used on the identification of:
- Buckles in skins
- Imprints in sub spars
- Wrinkles in sub spars

The Measure phase was, like the Define phase finished with a toll-gate presentation. This together with the toll-gate presentation of the Analyze phase. This was done, because we had to re-schedule the Measure toll-gate presentation. Considering the date of the Analyze phase toll-gate presentation, we decided to combine the two presentations (May 7th). Looking back at this decision, it might have been better if we would have given a short review of what we had done until that time. I got the feeling that the Champion and Sponsor are not good enough involved, for which our team can partly be blamed. It is important that there are a few more contact moments with the Champion and Sponsor. Some of them could be informal, because that releases some of the pressure of such a moment.

### 6.5 Analyze

In the Analyze phase, the current process capability is determined. In first instance the yield signal over 2008 was calculated and is presented in Figure 22.
The average yield of 40% means that only 40% of the products were produced without any deviations from specification. The other 60% showed non-conformities, which could be used as-is, had to be repaired or were scrap and had to be disposed of. This is of course a non-desirable process.

Another tool, the probability plot (Figure 23), shows us in how many cases the yield (four weekly moving average) in 2008 has a certain percentage. Because this plot is a four weekly moving average, it differs (45% – 40%) from the yield as presented in previous figure. The probability plot shows that in 75% of the cases, the yield is 52% or lower.

Figure 22: Yield graph Facelift 2008

Figure 23: Probability plot Facelift 2008
This third quartile (75%) is normally the goal for a Lean Six Sigma project, but since this is such a low percentage the team wanted to set a more challenging and a more desirable goal. The overall production goal of Stork Fokker AESP is a yield of 95%, but that was not a realistic goal for this project since the team had to come from a 40% – 45% yield. Therefore stretched targets were set at. Those are shown in Figure 24.

![Figure 24: Probability plot Facelift 2008 + Goal of Facelift](image)

The stretched targets are:
- Yearly average of at least 70%
- Four weekly average of at least 60%
- Weekly average of at least 50%

So how should those targets be reached? The results of the fishbone analyses (completed in the Define phase) suggested that many problems could be caused by the employees and the work methods of the employees. The problem is that Stork Fokker does not know what the critical elements in the methods are (regarding welding, laminating and wrapping up the products) that cause the buckles, wrinkles and other deviations. Therefore an observation is needed. All of the employees actually producing the products in scope, are observed (while making the product from start to finish) in the same way. By observing them uniformly, the project team can analyze those differences, compare them with the results and find out if any of those differences can be a cause of a deviation from specification. This is done in the Improve phase.

But there were also many quick-wins to be found in the fishbone analyses, like constructing a wall around the work space (to prevent dust from falling on the products), directives for template maintenance and many more.

Other important data the team needed, is collected by a “routing form”. This document ‘travels’ with the product through all of the different stages.

As explained in the previous paragraph, the Analyze phase was officially finished after a combined tollgate (with Measure). The Champion and Sponsor were pleased to see the results of both of the phases and gave the team a GO for the next phase: Improve.
6.6 Improve

In this phase the team experienced the first real problems due to prioritization. The sub spars were all having the same kind of problem, that was never really notified by anyone (neither Stork, nor the customer Airbus). This was such an important problem (because due to this problem, Stork couldn’t sell the products to Airbus), that 3 team members had to spend most of their time fixing that problem. This was the cause that our project slowed down significantly. After a few weeks our team, under the leadership of our Black Belt, agreed on:

- Acquiring a new team member to support. The first one coming to support our team is a sustaining engineer and the second one will be a grad student.
- Having more formal and quicker meetings. Our weekly meeting of Thursday morning has been changed from 8.30-12.00h to 10.30-12.00h. To compensate that, we have also agreed on meeting an extra time every week on Monday (for 15 to 30 minutes), to arrange and discuss our tasks for that coming week.
- Giving team members responsibility for a focus point. Every team member is made responsible for a part of the project, which means that he is the one making that part happen/work. This gives more insight in who has to do what.
- Restoring visional management (like planning tasks on tasks board).
- The Black Belt talked to the Champion and Sponsor and they agreed on working on a more ‘visible leadership’. That means in this case that they will let the team and employees know how important this project is, by going to them and asking them serious and problem-related questions instead of small-talk.

The tasks we have performed as a team were:

- Observations: Analyze the observations and draw conclusions about the working methods.
- Thickness measurements: Information gathering about how thickness is measured and how thick the products are, analyze that and draw conclusions
- Routing document: The routing document ‘travels’ with the product from the moment the plies (layers of product) are made, to the place where the product is actually made. The employees answers a few questions posed on the document, which have to do with possible causes for the problems (extracted from the fishbone diagrams).
- ‘Quick wins’: Making plans for the ‘quick wins’ which were extracted from the fishbone diagrams. Simple quick wins were implemented straight away (like company clothing, separate storage of materials), for others implementation plans were made.
- Analyzing NC’s: NC’s are analyzed; are there differences in the amount of NC’s the employees produce? What are the differences and what can be concluded from that.

At the time of handing in this report, no real improvements has been made and there are no real results from the various tasks done by the team members. This is caused by the delay of the project, due to the prioritization of the sub spar problem.

6.7 Leadership and Communication during ‘Facelift’

Leadership and communication are the two leading success factors in chapter 4. Therefore it is interesting and important to summarize what was done about this subject within the project at Stork Fokker AESP. How was being dealt with leadership and with communication? What means were used to influence and inform the employees? Were the right preconditions met to have a successful Lean Six Sigma project?
Leadership
- Experienced Black Belt who knows how to motivate and stimulate people in the project team. He also removes burdens (whenever present), like work prioritization of team members at the time that the commitment of the team members was low due to other tasks.
- Champion and sponsor allocate resources for the project team like money, time and prioritization.
- Vision created upfront by Champion, Sponsor, Black Belt en Process Owner. Those are the people who have initiated this project and gave this project its first shape.
- Certified Green Belts and Black Belt. Stork has its own educational program to train people for becoming certified Green or Black Belts. This training consists of theory (a virtual training program called Siggy, which I have completed as well), a few day at ‘school’ and an exam. But before becoming a certified Green Belt, you have to complete one Lean Six Sigma project. Black Belts have to complete two projects to become certified.
- WCP@Stork2010: This program is carried out throughout the whole organization by the highest management. In this way the highest management stimulate the use, the aceptation and the continuity of Lean Six Sigma.

Communication
- Facelift bulletin: Communication of project progress through a poster with three subjects on it, with text and photo’s of the subjects. This poster is distributed among every employee who is attached to or interested in the project. The meaning of the poster is to keep everybody informed and, by doing so, also involved. (Communication by the team). See Appendix H
- Quarterly presentation: During a quarterly presentation, the Director of Operations (the Champion) informs the employees on the company’s achievements. During this presentation he also gives a short introduction about the project and explains why this project is so important. (Communication by the Champion)
- Weekly yield signal: The yield signal is weekly updated and is mailed to customers and employees to keep them informed
- Monitor: This is a way of communication towards all the employees of Stork. Every year 22 Monitor’s are distributed/mailed and their purpose is to keep the employees informed of the most important Stork-wide things, but also provides information about projects (such as this Lean Six Sigma project) in local plants.
- Flyer: The equivalent of “Monitor” but only for Stork Aerospace employees. It is distributed around 25 times per year and deals with all the recent happenings/projects of this part of Stork.

6.8 Lessons learned during DMAI-phases at Stork Fokker AESP

I have tried to write about the case study as neutral as possible to get a clear view on reality. Of course I have spotted a few things, about which I think they could be improved or that those are points of attention for other Lean Six Sigma projects. Many of those things were consistent with findings in previous chapters (as summarized in chapter 5). I have arranged those findings in a few more general subjects.

Commitment
- Commitment of project team members is also very important. We as a team experienced that the project slowed down due to other priorities (highest priority is the current sub spar problem). A more dedicated team would be a possible solution, just like giving Lean Six Sigma projects the highest priority.
- In first instance employees are skeptical about changes, since they have “all” the expertise (that is their perception). When putting more time and effort in it, employees
are very interested in project progress and they are eager and waiting for changes to happen. If they get the feeling that people are listening to them, they are more willing to help and accept possible changes.

- Commitment of employees is very important. A trip/visit to a parts supplier created insight in the suppliers' problems and created a better mutual understanding.

(Visible) leadership / culture

- Leaders should be more on the working floor (perception of employees). Is important for the acceptance of solutions, since employees say that they do not automatically agree to solutions of people who are spending hardly any time on the work floor. This is a very important point of attention, since leaders should behave the way they want their employees to behave.

- Team leader (on work floor) was kept busy with a lot of things, but not really with his people. While, in my opinion, the management of the people is one of the key elements in change projects. If the employees are with you, it is much easier to implement changes and change programs.

- The project team could use some more supervision and stricter deadlines sometimes, because in my opinion that partly of the cause the project slowed down.

In chapter 4 the different leadership styles (transactional and transformational) and different organizational cultures are discussed. That chapter is concludes that the right preconditions have to be met to increase the effect of Lean Six Sigma. There was no connection made between the different leadership styles, cultures and DMAIC-phases. During my case study I found out that leadership styles should vary during the DMAIC-phases and also the cultures are flexible. Figure 25 shows the most important leadership style (and type of leader) and culture for every DMAIC-phase, the way I have experienced to be the best.

![Figure 25: leadership styles and organizational cultures during DMAIC](image)

In this context transformational leadership is about vision, charisma, coaching, inspiring and motivating people, while transactional tends to managing, decision-making and clarifying roles of the involved employees. A short explanation of Figure 25:

**Define:** The define phase is very important for setting the right goals for the project, and therefore it is necessary to come up with the right ones. Decisions have to
be made, based on ratio and there are not a lot of employees necessary to accomplish that.

**Measure:** The target of this phase is to acquire the right things to measure. To be sure to measure the right things, the involved employees should be consulted and committed to the project. The leaders should coach and facilitate the employees and project team members to work together in order to come up with the right things to measure.

**Analyze:** In the analyze phase the data is to be analyzed, to find the bottleneck(s) of the process(es). The project team leader should support and coach its team members while they are analyzing. This requires a more developmental culture, because connections have to be made between bottlenecks/failures and the available data. This requires creativity of the team members and employees.

**Improve:** The same characteristics as during the analyze phase.

**Control:** The changes/improvements should last for a long time and have to be regulated in some sort of way. This requires a more rational culture and a more transactional leadership style (requires more managing).

For the lean aspect in an organization transformational leadership is desired in combination with a group culture. Lean is about empowerment, which is the best in group cultures with a leader who stimulates group thinking processes, who has a vision and gets people to do more than they originally thought was possible.

**Managing expectations**
- Goal setting of project suddenly not entirely clear (during tollgate M&A). The Champion and Sponsor were expecting more of our project in first instance. Our Black Belt spoke to them afterwards and convinced them of our goals. The standard 95% yield goal of other Lean Six Sigma project throughout the company are far from realistic for our project, since we have to come from a 40% yield. This problem could be tackled by having the champion and sponsor every once in a while in a team meeting.
- The employees became a little bit impatient, because it costs so much time to actually improve something. The reason for their impatience was that they did not really know what to expect from the project in what period of time. This could be prevented by giving a explanation/presentation (by the project team) of the Lean Six Sigma project to them at the beginning of the project.

**Work processes**
- Two team members were responsible for finding out which work process descriptions were in use and which ones were valid. A lot of different reports, memo’s and procedures were found and it was not clear of some of them if they were still valid or not. It was not and still is not clear who is responsible for keeping the work process descriptions up-to-date. This is not good for the clarity towards its employees. Maybe Stork Fokker AESP could learn from ISO regarding to process ownership and responsibilities?
- Adjustment between different departments of the factory could be way better. Lead times are occasionally pretty high and thus very undesirable.
- Lean can be implemented better with regard to 5S. Although 5S is working pretty good at many departments, some of them are not really preoccupied with the 5S thought. Those departments should get some more attention of the 5S team en some more pressure from their leaders.

**Communication**
- Double tollgate (Measure + Analyze) may not have been the best solution, since that meant sacrificing one contact moment of the team with the Champion and Sponsor.
This is part of the reason the Champion and Sponsor were surprised about the fact that we as a team were striving to a 70% yield, instead of the 95% standard goal throughout the whole company.

- During the fishbone diagram analysis meetings we, as a team, have spoken to many different involved people. Those meetings were very useful in two ways. In the first place we were able to gain much (different) information on the problems in very short time and, very important for the commitment, we created an opportunity to inform the involved people about our project and commit them to it.
- The observations were also very useful for us as a team to gain information, but again also to provide information about the project to the employees. By keeping them up-to-date, they were very willing to think about any kind of improvements. This showed me how important communication to the employees is and how important the employees are in an improvement program.

DMAIC phases
- The decision on what to measure is made based on an opinion of team members supported by fishbone diagrams. This is in contradiction to the basic philosophy of Six Sigma that all the actions should be based on facts. In this case study there was no data available and therefore we had to make the decision based on intuition.
- The fishbone diagram analysis was done in the define phase while it is actually a tool normally used in the measure phase. It gave us greater insight in an earlier stage of the project in many possible causes. Although it was a necessity to use this tool earlier, it proved to be a very valuable decision to use it in the define phase. Therefore it is good to sometimes deviate a little from the original DMAIC structure.

6.9 Conclusions
This project acted as a case study for this research. It gave an excellent impression about how Lean Six Sigma can be integrated in an organization.

Participative field research
The so-called “participative field research” has a very big advantage over literature research only and that is that you can see if the ideas and (dis-)advantages derived from literature exist or occur in reality. Because I was full team member, I got to see every aspect of a Lean Six Sigma project. I have talked to the director of the composites plant, with the employees actually making the product and everyone in between. By talking to many people, I was able to get a good picture of the Lean Six Sigma organization, the project, the leaders (on different levels) and the willingness of the employees to accept and to help with the project.

I quickly realized that we had to involve the employees a bit more, because they are the ones implementing the projects’ solution. In the very beginning I noticed that they were unhappy with the current situation, but they were also a bit skeptical about the project. Later on it became clear why. In the past year(s) there were many small changes in their work processes without them being asked for advice. Since they have the practical knowledge and since they have to accept the changes, it is utmost important to involve them in every change in their work processes. Every day I have talked to those employees and they became more and more interested and enthusiast about the project, they even came with own ideas about how to improve the processes. They told me anything I wanted to know about the work processes and everything closely related to them and I told them everything about the progress of the project. I would like to think that I played a very important role in getting the employees really involved in the project.

Besides that I have tried to support any team member whenever possible in order to have a smooth project progress. The other team members really appreciated this and they started to tell me about how they experienced the project, what they liked and what they did
not liked. This of course is very subjective, but it indicates how people are experiencing Lean Six Sigma and thus gives insight in what could be improved.

A potential pitfall of a participative field research is that you lose your objectivity due to your adjustment to the organization. To prevent this from happen, I forced myself at least twice per month to think about all the things I had seen in an objective way and to write those things down. Furthermore I talked with my supervisor (also the Lean Six Sigma project team leader) about those things, he actually asked me to look around with an open-minded view and report anything I found questionable.

I was able to create my own vision on the situation at Stork Fokker AESP and with that I am able to judge if they shaped the right preconditions (as described in chapter 5).

**Does Stork meet the right preconditions?**

In chapter 6 a few preconditions are mentioned which have to be met before starting a Lean Six Sigma project. Does Stork Fokker AESP keep those preconditions in mind, what have they done about it and is it working? Conclusions are derived from chapter 7 and 8.

- **Supporting management**
  The CEO, Sjoerd Vollebregt, is supporting Lean Six Sigma continuously since the end of 2006 and is still supporting it. The World Class Organization program of Stork (WCP@Stork2010) uses Lean Six Sigma as standard tool and is aiming at a world class company in 2010. Lean Six Sigma is to be supported at least until 2010, but most likely much longer according to Black Belt Maarten Heere.

- **Right culture**
  Everybody talks to each other on a first-name basis, which makes it easier for anybody to go to a superior and talk about issues/problems on the work floor. There does not really exist a hierarchical culture. Stork Fokker AESP is a very innovative company in which empowerment is very important. The cultures which do exists are group culture, developmental culture and, although less, a rational culture. These cultures are the perfect bases for implementing a Lean Six Sigma project (see chapter 4).

- **Right leaders**
  In Hoogeveen Stork Fokker AESP has some very good and involved leaders. Our Champion for example knows the names of most of the employees on the working floor and he knows what they are doing. Besides that he is very approachable and those characteristics make him a leader who can motivate people and persuade people to help with Lean Six Sigma for example. On the other hand it would be nice if he sometimes asks specific questions about our project to show his involvement. People are tend to ‘walk faster’ if they feel that the director is very keen on a project and thus involved.

  The Black Belt of our team knows exactly how he can make people feel comfortable in different situations, which is useful for the effort these people are willing to put in the project.

  At last the process owner is very busy with a lot of different things (probably due to a very busy agenda), but has very little time for our project due to that. I think it is very important that especially the process owner is putting much time in such a project, since he is responsible for the production at the end.

- **Incentives**
  Stork Fokker AESP has initiated some incentives to encourage employees to think about improvements and be preoccupied with quality. The so-called Golden Thumb which is awarded every quarter year is a very nice and good example of that. If your team wins this thumb, you’ll get a free dinner with your team (on Stork Fokker AESP’s expenses) and all the other teams will know that your team is working very good and
conform the highest standards. This price encourages a lot of teams to stick to the 5S way of working which helps to have a very orderly work environment. Furthermore employees get a financial reward if they come up with a good practical solution for a problem.

- **Clear communication**
  Stork Fokker AESP uses many means of communicating to its employees. It happens through the information papers "Monitor" and "Flyer", speeches of directors (like at the quarterly presentations), and project related communication ways like the “Facelift” bulletin and yield signal distribution list. But there is a catch. In my opinion there is too much information distributed which possibly causes information overload. That can result in not reading the distributed information and if that happens, then there is something wrong and ready for a change.

- **Right expectations**
  Stork Fokker AESP has already implemented a few Lean Six Sigma projects and the management knows, for the most important part, what to expect from this method. True, there was a small disagreement and discussion about the goal of our project, but overall is the management very well aware of the capabilities of Lean Six Sigma. The employees on the work floor can be more informed about the capabilities and goals of Lean Six Sigma, since they do not have any training/education on this matter. If the employees can get somehow more insight in Lean Six Sigma, it could enlarge the involvement and willingness to help Lean Six Sigma project teams.

To summarize: Stork Fokker AESP has created (and already possessed) a good environment for implementing Lean Six Sigma projects. Of course there are things that could done better (see 6.8), but in general it is pretty good arranged.

**What can be learned from the case study?**
Stork Fokker AESP meets the preconditions, as described in chapter 5, pretty good. And since this company has implemented Lean Six Sigma a few times already, we can learn a few things to keep in mind when implementing Lean Six Sigma projects.

The experience at Stork Fokker AESP and the knowledge of the literature research combined, made clear that there are different leadership styles as well as different organizational cultures necessary during the different DMAIC phases to benefit the most from Lean Six Sigma. This is presented in Figure 25. Although it is very important to meet the right preconditions as described, it is also very important to have leaders who can switch their leadership style. In the define and control phase the leader should be more transactional, while during the other phases, in which group and developmental cultures play important roles, a more transformational style leader is needed. In those phases it is important that the leader guides, coaches and shares his vision amongst his employees, instead of making quick decisions by his own.

Besides that, I have encountered some points of attention as well, which are potential pitfalls for any kind of company:

- **Emphasis of function over form**
  Our Black Belt focused on the function of the method instead of on the form. An example was the Fishbone diagram analysis which we performed in an earlier phase that prescribed. This was necessary due to the lack of available data and therefore the need for early data gathering. The Fishbone diagram analysis pointed out which data to collect.
- **Importance of communication**

Communication is not only important for creating the right expectations of a method, it is also very important for the willingness of the employees to accept solutions. There are many ways to communicate with people and by communicating to them, you can involve them in the project. If you can achieve that the employees feel involved, then they will be much more committed to the problem and method and willing to help and to accept solutions.

- **Involve employees in improvement processes**

For this point of attention, communication is very important. The employees told me that their work process methods have been changed many times by the "production preparer" without consulting the people actually working on those processes. The employees do not really care anymore if new changes are made, because they are not involved in it. On the other hand I noticed that, after involving the employees in the project, they were thinking about improvements by themselves and came with ideas to me. That is the situation everyone would like to have I suppose.

- **Divide responsibilities**

In June 2009 we divided the responsibilities within the team. Every team member was appointed to a certain subject and since that time he was responsible for that. It did not mean that he had to do everything on that subject by himself, but it meant having a leading role on that subject. In this way it is easier to keep an overview who is responsible for what and in this way we hope to speed up the project. In the last few weeks it seems like it is working.
7. Expert opinion of literature conclusions

The conclusions, as presented in chapters 2, 3, 4 and 5, conducted from literature research have been compared with the findings of the case study. But that is only one ‘real’ experience. What do Lean Six Sigma experts have to say about the conclusions from the literature research? Do they recognize the disadvantages and possible pitfalls? How did they experienced them and what did they do about it to conquer them? The conclusions are presented to and discussed with two Lean Six Sigma experts. The presentation sheets can be found in Appendix J.

7.1 Interview 1: Hubert Adriaans (Stork Fokker AESP, DAF)

Hubert Adriaans (Business Improvement Manager at Stork Fokker AESP, former Black Belt at DAF Trucks NV and Lean Consultant at Blom Consultancy)

Mr. Adriaans was willing to discuss the findings and conclusions of the literature research. This paragraph is a summary of the most important things he told and shared. He agreed with the conclusions as presented in chapter 5. He thinks that shaping the right environment for change programs for employees is utmost important and should be done before starting a Lean Six Sigma project. Having the right expectations of a project are also important for both the higher management and the ‘normal’ employees.

The discussed aspects are summed up and represent the way Mr. Adriaans thinks about Lean Six Sigma (in organizations).

Perfect organization

Mr. Adriaans wants to have a ‘perfect’ organization, realizing that perfect does not exists. With the word perfect he means no losses and in his perfect organization he wants this losses to be eliminated. How is that done:

1. Involvement / commitment
2. No acceptation of losses
   a. Map those losses (measurement, 5S, VSM)
   b. Work in teams (two men know more than one, acceptation of changes)
   c. Work process-oriented
   d. Standardize / secure
   e. Celebrate successes
How to implement Lean Six Sigma throughout a whole organization?

In the ‘90s the parent company of DAF, PACCAR, demanded DAF to use Six Sigma to improve their processes. In that time stocks and shares of companies using Six Sigma went up. Six Sigma was thus supported by the highest management and that caused the management of DAF to support it. Champions received Six Sigma training and Six Sigma expert from the USA came to guide and support them. The was a very important and necessary drive to open the eyes of employees of DAF, according to Mr. Adriaans.

The first thing Mr. Adriaans did, when he was asked to be in charge of the quality department of DAF, was sending his employees on a Green Belt course. This course made his people aware of the benefits and ideas of this program. With this awareness it was easier to implement the method.

Slow start of Lean Six Sigma

The first Lean Six Sigma project at a company is also hard. People are not very willing to adapt the method, but after a while (with training everybody as Green Belt and sustained management commitment) the first successes are achieved. This is very important for further implementation. When the so-called ‘low-hanging-fruits’ are taken care of, then a difficult phase starts. Will the company continue to use Lean Six Sigma for the more difficult problems? Who is going to lead this?

Commitment/incentives

Commitment can be obtained by:
- Celebrating successes
  With the celebration of a success, people become proud of what they did and all the other employees can see it. This can be an incentive for the other employees.
- Secure management support/involvement
  Constant management support and involvement is very important, since they have the power and money to make the project successful. Involvement is very important for the employees to notice, because they tend to work a little bit better if the management shows its involvement.

You can motivate employees (give them incentives) by:
- Providing the employees freedom to think about solutions for problems. This can be done by having a ‘idea-box’ and/or improvement board. Although they ‘idea-box’ might create perverse behavior: People keep ideas to themselves, because they might be afraid that somebody else will ‘steal’ their idea and earns the reward (money) for the improvement.
- Promise a reward if they have do something very well (or according to what was planned) and celebrate successes.

Managing expectations/communication

The management of expectations is also important according to Mr. Adriaans. At first the expectations at the highest level has to be arranged by:
- Clearly defining the scope/goal/focus
- Pick projects with the right size (duration should be 6 months at most, because otherwise the commitment will decrease) and split up projects if they are too big. This has to be done by the Black Belt, Champion and process owner
- The project has to be realistic as well as ambitious (to challenge people)

Then the employees have to know what is going on and what they can expect. The ‘improvement board’ is a very good tool to establish that. Communication of the project should be, for an important part, through this board. This board is divided three layers as presented in Table 9.
Table 9: Improvement board by Mr. Adriaans

<table>
<thead>
<tr>
<th>Goals</th>
<th>At the top layer the goals of the organization are mentioned (e.g. quality, lead-times etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects</td>
<td>At this layer the current projects, to reach the goals in the top layer, are presented with up-to-date information. With this information you can keep the employees involved and up-to-date with the project's progress</td>
</tr>
<tr>
<td>Ideas of employees</td>
<td>At this layer employees can file and share their ideas with others. In this way you stimulate employees to think about improvement ideas of others and help each other developing such an idea</td>
</tr>
</tbody>
</table>

7.2 Interview 2: Christiaan Verhoeven (Nedtrain, Stork Fokker AESP)

Christiaan Verhoeven (Program Director Refurbishment & Overhaul at Nedtrain, former Director Lean Manufacturing at Stork Fokker AESP)

Mr. Verhoeven agrees with the conclusions as stated in chapter 5, but he reckons it could be less abstract. Creating the right environment and right expectations are important for the success of Lean Six Sigma deployment and implementation, but it is subjected to the willingness to change of the highest leaders in the organization. Every leader should be “prepared to question his own paradigm” in order to learn from others and to change his behavior. Because Lean Six Sigma organizations require behavioral changes throughout the whole organization, according to Mr. Verhoeven. That means that also “leaders have to change, otherwise Lean Six Sigma would not be necessary”.

How to implement Lean Six Sigma throughout a whole organization?
The most important thing is that the leaders have the willingness to learn and listen. Those leaders should be modest, interested in the processes and employees and should be able to coach the employees. Employees always look at their boss the way he acts. If their boss sets the right example, the employees will follow.

Thus some aspects of the organization have to change according to Mr. Verhoeven to create the right environment for Lean Six Sigma:
- Change goals
- Change measurement systems
- Change behavior (document what the desired behavior is and make that common knowledge in the organization)

Commitment/incentives
So how to achieve commitment? It all starts with the commitment of the leaders and the willingness of them to question their own paradigms. Leaders should act the way they want their employees to act. A few points of creating more commitment:
- Leaders act the same as they want their employees to act (since employees tend to copy and follow the behavior of their boss)
- Leaders have to show trust in people actually implementing Lean Six Sigma
- Leaders have to be on the work floor frequently to ask questions and show their involvement, also in times that everything goes very well

The above mentioned points are also a sort of incentives for the employees to be more focused on quality. Other possibilities of incentives are:
- Stimulating the ‘first believers’. The people who see the importance and possibilities of Lean Six Sigma before others, should be stimulated by the management in every kind of way. Those enthusiastic people are needed to create more involvement and commitment throughout the whole organization.
- Reward good behavior of a group rather than reward an individual. In this way you stimulate group processes and stimulate employees to help each other and learn from each other.

Managing expectations/communication
The management of expectations is important, but once again Mr. Verhoeven emphasizes on the importance of commitment and involvement of the highest management. If they are very involved, they will know what to and what not to expect from Lean Six Sigma. Communicating with and between the different organization layers is very important for the expectation throughout the whole organization. The focus and goal of projects have to be very clear, but also ambitious to stimulate people to do more that they originally thought they could do.

7.3 Conclusions of expert evaluation
From both of the expert interviews can be concluded that the conclusions drawn in chapter 6 are valid and relevant in ‘real life’. But there is a ranking of importance possible.

1. The most important factor for making Lean Six Sigma successful is the continuous commitment and involvement of the highest management. If this is very well in order/arranged, the rest of the employees and managers will follow eventually. According to both experts, the highest management should know the capabilities of Lean Six Sigma and should have had some training on the subject. Mr. Verhoeven adds to these requirements that the ‘leaders’ have to be prepared to question their own paradigms and therefore have to be able to learn and listen. The leaders have to act accordingly that how they expect their employees to act. If the leaders do this, the employees will follow much more easily and almost automatically.

2. This desired behavioral change relates immediately to a cultural change within the organization. It helps to document the desired behavior and to distribute this document amongst the employees so they know what is expected from them. Once again, if the leaders do not change accordingly the employees will not either.

3. Incentives are also found really important by both the experts. They both choose for group incentives rather than individual incentives, because by giving group incentives you stimulate group thinking processes and that is what you want to establish. The behavior of leaders is also a very important incentives for the employees and should not be underestimated!

4. As long as the goal, focus and scope of a project are clear for all the involved people, the project should be a bit ambitious to trigger people to work more motivated on the project.
8. Conclusions & Recommendations

So how to make Lean Six Sigma more effective? That is the most important part of the research question of this thesis. In this final chapter the conclusions of the literature, case study and expert interviews are combined. With regard to these conclusions recommendations for further research and implementation of Lean Six Sigma are made in 8.2.

8.1 Conclusions

The research question of this thesis was:

“How to improve Lean Six Sigma to make it more effective for the industry and by integrating leadership and communication and by learning from its strengths and weaknesses, compared with alternatives?”

How do the results help to make Lean Six Sigma more effective? This paragraph provides the combined conclusions of literature research, participative field research and expert interviews.

In chapter 2 the following steps are given to implement a successful Lean Six Sigma project:
1. Select the right project
2. Select the right people for this project
3. Train those people
4. Follow the method and validate earnings
5. Secure results

The conclusions of chapter 3 however, show that all the involved people should have the right expectations of a quality improvement method. This is not taken into account in the above mentioned steps. Van Solingen (2007) provides a matrix (see Appendix A) to select the right project for Lean Six Sigma. But still you do neither have the main goal nor the advantages and disadvantages of the method clear. Besides that you do not have a clear overview of other popular methods which can improve quality. If this overview is clear to you, you still can choose for Lean Six Sigma, but then at least you have had a look at an overview of quality improvement methods and by then you know what is the right method for your project. This overview of popular methods can be found in chapter 3, paragraph 4 (see Table 6). Therefore I propose to change the first step into “Select the right project & method”. This step covers an important pitfall of creating too high expectations of Lean Six Sigma. During
the Lean Six Sigma project, the team members have to ensure that the employees also have
the right expectations of the project, since they are the ones who are going to work with the
(to be) improved working methods. Training all the involved people in Lean Six Sigma is a
very good solution according Mr. Adriaans.

Creating the right expectations is only a small part of realizing even more effective
Lean Six Sigma project. The most important part lies even before the first step of the
implementation steps: You have to create the right environment for change programs. This is
the conclusion of the literature research on leadership and communication and the experts
agree with this conclusion. During the case study at Stork Fokker AESP I have seen the
importance of the right environment. The willingness of the employees to change and to help
changing depends heavily on the environment. If they are involved into the project, they tend
to think much more about improvements and they accept solutions much easier. So how to
create the right environment? Although the realization might differ per company, the next
points of focus are important for any kind of company willing to improve its quality (ranked in
order of importance):

- Having the right leaders. A combination of transformational and transactional
  leadership style. Those leaders should be very persistent and persuasive about Lean
  Six Sigma to be successful (Mr. Adriaans). The leaders are setting an example for the
  employees and therefore have to be “prepared to question their paradigms” and have
  the willingness to learn, listen and change (Mr. Verhoeven). The transformational
  leadership style therefore is the most important one, because the leaders have to
  inspire, motivate en guide their employees into Lean Six Sigma. If a leader believes in
  this method and if he continuously supports that method, his employees will follow
  eventually. This leader should be able to switch to transactional leadership whenever
  necessary, because this style is sometimes necessary in Lean Six Sigma projects.

- Supporting Lean Six Sigma throughout the whole company by the highest
  management for at least a few years (top-down implementation). The CEO of Stork is
doing it since 2006 and this has been very important for the acceptance of Lean Six
  Sigma. Also Mr. Adriaans and Mr. Verhoeven told about the importance of
  management support at the highest level. The management has to make Lean Six
  Sigma happen!

- Having the right combination of organizational cultures (group, rational and
developmental cultures are the most important ones for change programs). In those
cultures you combine empowerment (group), with the drive for new product/processes (developmental) and right and clear focus/goals (rational). There is
a desired behavioral change (employees should think about improvements
continuously) required and the leaders have to set an example. The employees will
follow their leader(s). Which culture is the most important one, depends on the
existing organizational culture and on the DMAIC phase the project is in (see figure
25 and at the end of this paragraph).

- Giving the employees the right incentives to let them be actively involved in the
  improvement (thinking) process. But be aware of perverse behavior! Celebrate
  successes and create an environment to let the employees think together for
  improvements with the ‘improvement board’ for example (Mr. Adriaans). Both of the
  experts think that group incentives are more desired than individual incentives, since
  that stimulates group thinking processes (that is desired in a change culture). During
  the participative field research it became clear that talking frequently with the
  employees about the Lean Six Sigma project stimulates them to get them more
  actively involved in the project. Simple things like giving a production team special t-
  shirt as a token of appreciation and giving the production team that lives up the best
  with 5S a diner check. Does a standard ‘right’ incentive exist? The answer is no,
because it depends on the already existing reward structure in the organization. But it
is important, according to De Bruijn (2007), to realize that people tend to show
perverse behavior when there is very much at stake. Examples of incentives are; a
bonus linked to the production figure; naming and shaming of the better and much worse than average producing teams and administrative and managerial intervention.

- Clear (well-thought-out) communication to (and between) all of the involved personnel (before and during the project). This is important because communication helps to create the willingness to change, to accept solutions and to create the right expectations. Communication also helps to let the employees be more involved, by keeping them up-to-date. This can be done in several ways (mail, news bulletins, speeches, meetings etc.). Employees are really interested in getting informed and they appreciate getting involved.

- Making arrangements about the responsibilities of the involved people for the project (when selected the right people for the project). This bullet is important during individual Lean Six Sigma project, but not relevant for creating a Lean Six Sigma organization. If everyone on a team gets a leading role on a certain subject, they all have more responsibility and that enhances the progress, because you cannot transfer the responsibility to another team member. Furthermore time management is very important for those team members, because in many cases they struggle to combine their ‘normal’ activities with their Lean Six Sigma obligations.

All of the above bullets help to enhance the effect of Lean Six Sigma projects and they have to be established by good leadership (see the first bullet). Those points help to make Lean Six Sigma more effective.

The proposal is to change the Lean Six Sigma implementation steps as presented at the beginning of this paragraph. The proposal for improving the implementation steps for realizing a successful Lean Six Sigma project is, according to conclusions of this thesis, going to be (Figure 28):

![Figure 28: Improved Lean Six Sigma implementation steps](image)

In the first steps you have to establish all of the before mentioned bullets. For the second step you can use the comparison framework to have better insight in the different quality improvement methods to ensure that the expectations of the chosen method are not too high. The rest of the steps stay the same as described in literature. In those steps, and especially in the fifth step, is communication to the employees to involve them into the project very important. Within this fifth step Figure 25 could be useful. This figure shows which leadership style and which organizational culture should be dominant in each DMAIC phase. The most dominant leadership style and organizational culture vary over the phases, which means that the leader (of the project team) has to be able to switch between transactional (making decisions, regulating tasks, clarifying roles and managing) and transformational (coaching, motivating and inspiring employees with vision and charisma) leadership to let the employees and team members work in a ‘different’ stimulating culture. A short summary of the required dominant leadership style and organizational culture of each phase:

- Define: Transactional leadership (achievement-type leader) style and rational culture
- Measure: Transformational leadership style (facilitator-type leader) and group culture
- Analyze: Transformational leadership style (entrepreneurship-type leader) and developmental culture
- Improve: Transformational leadership style (entrepreneurship-type leader) and developmental culture
- Control: Transactional leadership (achievement-type leader) style and rational culture

One important thing to keep in mind; emphasis of function over form! This is only a guideline and not a path to follow strictly. It should be adjusted as fits, the company using it, the best.
8.2 Recommendations
Besides the conclusions on how to make Lean Six Sigma more effective, some recommendations can be made for further research.

- How to make change last?
  ISO 9000 provides a template to document processes which might be suitable to use ensuring lasting solutions of Lean Six Sigma projects.

- Keep all the important people (from directors to the laborers) for a project in the information loop
  This depends on the type of company how you want to communicate and to who. But a research could make things clearer about this subject and maybe even create some sort of a framework on how to communicate (when, to whom, in which way etc.)

- Select the right leaders
  Since leaders have to create the right environment for Lean Six Sigma and also have to make sure Lean Six Sigma is successful, it is important that you have the right leaders. What are the characteristics of the right leader? Does the right leader exist? The leader should combine transformational and transactional leadership, as concluded in chapter 4. How do you measure those characteristics to be desired or not? Therefore a more detailed description of the characteristics of such a leader is desirable.

- Create the right culture/environment for change programs
  How did other companies make it through such a creation process (and perhaps radical transformation of its organizational culture). How long does it take to actually achieve the right environment? How can you speed this up? Are there any practical tips & tricks to enhance this process? This subject could be the subject for another Master Thesis, since it is a very important part of Lean Six Sigma success.
References


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</tr>
</tbody>
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Scientific Article

“Increasing the effect of Lean Six Sigma by creating the right environment by good leadership”
Appendix A – Project Selection

This table helps selecting improvement project. Every project proposal receives a score of 1, 3 or 9 for a low, average or high impact. The five aspects to score on are: financial impact, impact on customer satisfaction, lead time, possibilities for replication and complexity.

The scores are summed up for each project proposal, which can be ranked afterwards. To conclude: preferred projects are simple, have a short lead time, with high impact on customer satisfaction and make lots of money. Besides that it is preferred that the project can be repeated many times in the organization.

Table 10: Project evaluation matrix for improvement projects

<table>
<thead>
<tr>
<th>Financial impact</th>
<th>High (9) &gt;150 000€</th>
<th>Medium (3) 100 000 – 150 000€</th>
<th>Low (1) &lt;100 000€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on customer satisfaction</td>
<td>High (9) Customer has direct contact with process and results are visible</td>
<td>Medium (3) Internal process, results not directly visible to customer</td>
<td>Low (1) Not essential for customer satisfaction</td>
</tr>
<tr>
<td>Project lead time</td>
<td>Short (9) &lt;4 months</td>
<td>Medium (3) 4-6 months</td>
<td>Long (1) &gt;6 months</td>
</tr>
<tr>
<td>Possibilities for spin-off projects</td>
<td>High (9) Can be applied to 5 or more other processes or locations</td>
<td>Medium (3) Can be applied to 1 to 4 other processes or locations</td>
<td>Low (1) Can be applied to 1 other process or location</td>
</tr>
<tr>
<td>Complexity</td>
<td>Low (9) All data present</td>
<td>Medium (3)</td>
<td>High (1) Data missing</td>
</tr>
</tbody>
</table>

(Van Solingen, 2007)
Appendix B – The team members of the case study project

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Work background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roel Hessen</td>
<td>Champion</td>
<td>Director Operations Hoogeveen</td>
</tr>
<tr>
<td>Renze Kuiken</td>
<td>Sponsor</td>
<td>Program Director Airbus</td>
</tr>
<tr>
<td>Peter van der Linden</td>
<td>Process Owner</td>
<td>Manager Composite Parts Production</td>
</tr>
<tr>
<td>Maarten Heere</td>
<td>Black Belt</td>
<td>Change Office</td>
</tr>
<tr>
<td>Bart Boom</td>
<td>Green Belt</td>
<td>TU Delft Graduate</td>
</tr>
<tr>
<td>Bert Bron</td>
<td>Green Belt</td>
<td>Sr. Process Specialist</td>
</tr>
<tr>
<td>Erik Bruins</td>
<td>Green Belt</td>
<td>Process Specialist</td>
</tr>
<tr>
<td>Jan-Henk Centen</td>
<td>Green belt</td>
<td>Team leader J-Nose production</td>
</tr>
<tr>
<td>Jaques van Muijen</td>
<td>Green Belt</td>
<td>Sr. Process Specialist</td>
</tr>
<tr>
<td>Peter Alting</td>
<td>Green Belt</td>
<td>Production Preparer J-Nose production</td>
</tr>
<tr>
<td>Rob Ormeling</td>
<td>Green Belt</td>
<td>Design Lead A380 J-Noses</td>
</tr>
</tbody>
</table>

The project team consists of people with different functions within the organization, but they are all involved in the production process that is to be improved.
Appendix C – Business case and scope of project

Business Case
Sinds de introductie van thermoplast aanmaakdelen hebben we jaarlijks met hoge non-quality kosten te maken. Uit het First Time Right project is gebleken dat bij de skins (A380 & A340) en sub sparren (A380) de hoogste non-conformance kosten werden gemaakt. Om deze kosten omlaag te brengen is besloten om met behulp van de Six Sigma DMAIC methode deze problemen op te lossen. Tevens kan, als dit probleem niet aangepakt wordt, niet aan de geplande tempo verhoging voldaan worden.

Problem Statement
In 2008 werden 420 NC’s geschreven op skins (A380 & A340) en sub sparren (A380). (48,5 % van gemaakte delen). Dit is een oplopende trend. De hoofdredenen hiervoor zijn plooiens, dikte afwijkingen en andere visuele afwijkingen. (zie pareto grafiek). De kosten om deze NC’s te schrijven plus de kosten van reparatie en scrap, waren over 2008 *** EURO (confidential information). NC’s veroorzaken een hogere doorlooptijd (DLT) wat de geplande ramp-up tot 30 shipsets per jaar voor A380 na 2009 in de weg staat.

Project Goal
Het doel van dit project is het reduceren van de kosten. Dit moet bereikt worden door een robuust J-Nose productieproces en door toleranties die eenvoudig, helder en duidelijk geformuleerd zijn. Dit zal leiden tot een hogere yield (FTY), lagere non-quality costs, kortere doorlooptijden (DLT) en minder kosten door werk onder handen.
Dit project zal zich concentreren op de productie processen bij de aanmaak van A380 & A340 skins en A380 subsparren.
Appendix D – Flow chart and high level process map

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Input</th>
<th>Process</th>
<th>Output</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ten Cate &amp; Spörl KG</td>
<td>Semipreg &amp; Astrostrike</td>
<td>CoC controle</td>
<td>Vrijgegeven materialen</td>
<td>Intern transport</td>
</tr>
<tr>
<td>Intern transport</td>
<td>Vrijgegeven materialen</td>
<td>Opslag</td>
<td>Vrijgegeven materialen</td>
<td>Voorsnij afdeling</td>
</tr>
<tr>
<td>Opslag</td>
<td>Vrijgegeven materialen &amp; voorsnij programma</td>
<td>Voorsnijden</td>
<td>Voorgesneden laminaten</td>
<td>Tussenopslag</td>
</tr>
<tr>
<td>Voorsnijder</td>
<td>Voorgesneden laminaten</td>
<td>Opslag</td>
<td>Voorgesneden laminaten</td>
<td>Lamineer afdeling</td>
</tr>
<tr>
<td>Tussen opslag &amp; Magazijn</td>
<td>Voorgesneden laminaten en hulpmaterialen</td>
<td>Lamineren en inpakken</td>
<td>Producten onder vacuum</td>
<td>Autoclaf</td>
</tr>
<tr>
<td>Lamineer afdeling</td>
<td>Producten onder vacuum</td>
<td>Tussen opslag</td>
<td>Opgeslagen producten onder vacuum</td>
<td>Autoclaf</td>
</tr>
<tr>
<td>Autoclaf</td>
<td>Producten onder vacuum</td>
<td>Consolideren</td>
<td>Geconsolideerde producten op mal</td>
<td>Lossen</td>
</tr>
<tr>
<td>Autoclaf</td>
<td>Geconsolideerde producten op mal</td>
<td>Lossen en nummeren</td>
<td>Genummerde producten en malien</td>
<td>Verspaning (subsparren) en NDO (skins)</td>
</tr>
<tr>
<td>Lossen</td>
<td>Genummerde subsparren</td>
<td>Verspanen en afbramen</td>
<td>Netto subparren</td>
<td>NDO</td>
</tr>
<tr>
<td>Lossen en Verspaning</td>
<td>Genummerde producten</td>
<td>NDO-en</td>
<td>Gecontroleerde producten</td>
<td>Eindcontrole</td>
</tr>
<tr>
<td>NDO</td>
<td>Gecontroleerde producten</td>
<td>Eindcontrole (visueel)</td>
<td>Vrijgegeven producten</td>
<td>Samenbouw</td>
</tr>
</tbody>
</table>
Appendix E – Fishbone diagram

A fishbone diagram is a tool to get greater insight in potential causes of a problem. The head of the fish is the problem, which is the result of the bones (causes). There are 6 types of bones/causes: Man, Material, Machine, Method, Means and Environment. The idea is that the selected people have a different angle of view towards the problem, which should result in as many potential causes as possible. The participants get about 15 minutes time to think about potential causes for the problem. With their input, the fishbone is made. A example of a fishbone if shown below:

A brainstorm session with a fishbone as tool, is setup as follows:
1. Select the right people (people actually experiencing the problem, people with practical/theoretical knowledge)
2. Have a clear problem definition
3. Have the right space, tools and time (quiet room with table, flip-over, post-its, pencils and 2 hours of time planned in)
4. Begin of the brainstorm session:
   a. Begin with a short discussion about the problem definition to make sure everybody has the same problem in mind (5-10min)
   b. Explain method
   c. Rules (there are no stupid or wrong questions and no discussion possible about people’s ideas)
   d. Provide enough post-its to everyone (1 cause for the problem per post-it)
   e. Paste post-its on flip-over
   f. Are all of the M’s treated?
   g. Round-up, finish session
5. Elaborate the ideas and send it to the participants
Appendix F – Organizational cultures and effect on LSS quality practices

The research of Zu, Fredendall and Robbins (2006) provides insight in which kind of organizational cultures are necessary for a successful Lean Six Sigma implementation. They identify the following organizational cultures:

- The **group culture** focuses on flexibility and internal integration. Organizations emphasizing a group culture tend to value belongingness, trust and participation. The strategies used in these organizations concentrate on the development of human relations and member commitment. The leaders encourage teamwork, empowerment and concerns for employee ideas.

- The **developmental culture** emphasizes flexibility and external orientation. Organizations with emphasis on this cultural orientation tend to focus on growth, resource acquisition, creativity, and adaptation to the external environment. The strategies used to manage business include innovation, resource acquisition, and the development of new market. Leadership styles in such organizations are entrepreneur- and innovator-type.

- The **rational culture** is focused on the external environment and control. Organizations with emphasis on a rational culture encourage competition and the successful achievement of well-defined goals. The strategies are oriented toward efficient planning and control of production to achieve competitive advantages and high productivity. The leaders tend to be directive, goal-oriented, and functional.

- The **hierarchical culture** emphasizes stability and internal integration. It stresses centralization and regulations. The strategies emphasize clear rules, close control, and routinization. The leaders are conservative and cautious.

The quality practices they identify are:

- **Top management support**
  Senior managers’ support for Six Sigma determines the degree to which other quality practices are implemented. During the process of adopting a Six Sigma program, new rules need to be set up, new procedures need to be followed, and new tools need to be learned. Companies often encounter instability, confusion, and resistance in this process. Managers’ consistent involvement in Six Sigma activities enables the restructuring of business processes and facilitates changing employees’ attitudes toward continuous improvement through the unstable transformation period. Some companies link managers’ compensation to their efforts and performance in Six Sigma implementation, which helps to reduce the risk of managers’ having a temporary but quickly fading zeal for quality improvement and to ensure a consistent and high level of top management support for Six Sigma.

- **Customer relationship**
  To achieve quality, it is critical to understand what customers want and to provide products or services that meet their needs and expectations. Factors important to customers' perception of quality are taken into consideration when companies select, design, and execute a Six Sigma improvement project. A formal evaluation system of customer requirements is needed as a platform for customers to input their voices, using techniques such as customer survey, meetings with customers, and customer visits to the plant. Critical-to-customer characteristics can be translated into metrics which are then used to define the goal of a project, to monitor its progress, and to evaluate its outcomes. Customer relationship is strengthened if top management takes time to visit the major customers and employees have access to the customers’ voice in order to understand the importance of customers and to integrate customer requirements into their daily jobs.

- **Supplier relationship**
  Suppliers’ involvement in Six Sigma helps to provide a high quality of products and services to the ultimate customers. Companies put emphasis on obtaining significant
benefits from Six Sigma projects, which requires them to explore more avenues for improving quality, including those related to their suppliers. A supplier selection system is set up based on quality considerations and whether suppliers are willing to cooperate, which helps to establish a long-term working relationship between the company and a small number of its suppliers. In addition, Six Sigma encourages companies to engage their suppliers at the early stage of improvement projects, i.e., early supplier involvement (ESI). ESI allows parallel development of product and service design in an iterative interaction with the suppliers.

- **Workforce management**
  The Six Sigma implementation needs a competent and supportive workforce who is willing to participate in the organization-wide improvement efforts. In Six Sigma, management policies are taken to strengthen job security, to motivate employees to speak out with ideas, and to provide employees technical and psychological supports. For example, a policy that links employees’ performance in Six Sigma projects with their compensation and promotion motivates them to participate in and contribute to Six Sigma. Also, continual education and training to management and employees assist companies to develop knowledge and skills of its employees for effective quality improvement. It is important that companies manage the workforce in conjunction with a Six Sigma green and black belt system, which is a role structure unique to Six Sigma, in the areas of employee deployment and training. The Six Sigma role structure is discussed later.

- **Quality information**
  Six Sigma relies on using extensive data and information to detect and solve problems. Information and data are collected relating to customer needs and expectations, business processes, and products and services, which are then analyzed to generate improvement ideas, examine improvement activities, and evaluate and maintain improvement outcomes. Effective use of quality information in Six Sigma is connected with the metrics used in Six Sigma, which is discussed later. Six Sigma emphasizes linking quality improvement with bottom-line benefits and thus the metrics incorporate bottom-line performance measures with the measures of quality defects. To provide appropriate data for evaluating those metrics, the content of quality information must include both operational and financial data.

- **Product/service design**
  To achieve improved quality, it is important to design products for manufacturability and design quality into products and services. Cross-functional teams, consisting of design, manufacturing, and marketing functions, are formed to reduce the number of parts per product, to standardize the parts, and to focus on improving manufacturing processes. Moreover, Six Sigma applies Design for Six Sigma (DFSS) in the design process. A feature of DFSS is to use a structured, standardized product development procedure, e.g., Plan-Identify-Design-Optimize-Verify (PIDOV). Also, DFSS emphasizes satisfying customer needs with a product/service design that utilizes materials, technologies, and manufacturing processes that are also financially beneficial for the organization. A comprehensive set of tools are used in DFSS, such as phase-gate project reviews, benchmarking, measurement system analysis, voice of the customer, Quality Function Deployment (QFD), Pugh concept selection technique, design failure modes and effects analysis, and so forth.

- **Process management**
  Six Sigma emphasizes reducing the variability of the processes that manufacture products and deliver services. Process management means ongoing improvement to manufacturing, transactional, and/or service processes to satisfy customers’ needs and expectations by using preventive maintenance, workplace organization, and use of line-stop capability. Six Sigma emphasizes conducting process improvement as projects. Companies work on improvement projects to solve problems in the processes that critical to customer satisfaction and the organization’s strategic goals. The potential bottom-line benefits of the project are identified during the project.
planning period, and the project is continually reviewed throughout the process to evaluate whether the expected benefits are fulfilled.

- **Six Sigma role structure**
The Six Sigma green and black belt system is the role structure used to develop and manage employees by clearly defining their roles and responsibilities for continuous improvement. The employees are classified into the levels of champion, master black belt, black belt, and green belt, based on their knowledge and experience regarding quality management. Typically, champions are usually executive-level managers who promote and lead the deployment of Six Sigma in a significant area of the business; master black belts are statistical experts who are quality leaders responsible for Six Sigma strategy, training, mentoring, deployment, and results; black belts work as project managers and facilitators who lead improvement teams, work on projects across the business, and mentor green belts; green belts, who have some quantitative skills as well as teaching and leadership ability, manage the processes of the Six Sigma projects and are responsible for ensuring the smooth improvements of the processes, communicating process knowledge, obtaining necessary approval for any process changes, selecting team members, and maintaining team motivation and accountability. Six Sigma improvement projects are carried out by teams composed of members performing the above roles. This role structure clarifies the employees' roles so that they know their responsibilities and their benefits from their participation in continuous improvement efforts, which may increase the employees' contribution to Six Sigma. Also, this role structure requires that each belt receives training in leadership skills, technical skills, and soft skills (e.g., communication, mentoring, etc.) that are commensurate with their ranks. Six Sigma includes offering differentiated training programs to employees to increase training effectiveness.

- **Structured improvement procedure**
Six Sigma uses a formalized, rigorous procedure to conduct improvement projects, which is Define-Measure-Analysis-Improve-Control (DMAIC). DMAIC is a standardized process that consists of specific problem-solving steps with recommended statistical and non-statistical tools in each step. This procedure provides a methodological framework to assist members of improvement teams to select possible projects, to design resolutions that are sustainable once applied, and to understand how certain quality tools should be used in each improvement phase to produce an output that can be acted on.

- **Focus on metrics**
Six Sigma emphasizes using metrics to generate and control actions where improvements are needed. Six Sigma integrates the traditional quality metrics with some additional metrics to create a more comprehensive measurement system for quality management. The statistical meaning of Six Sigma, $6\sigma$ is a measure for evaluating process quality, which means 3.4 Defects per Million Opportunities (DPMO). Typical Six Sigma metrics include defects per unit (DPU), proportion defective, throughput yield, rolled throughput yield, and so forth. These metrics evaluate how well a process is performing in order to direct where and how to conduct appropriate improvement activities, and they evaluate improvement outcomes as well. Six Sigma uses the metrics with three features. First, the metrics and relevant tools are integrated with Six Sigma's structured improvement procedure. Throughout the DMAIC's five steps, metrics are used to select a project, to develop a project plan, to collect and analyze data, and to evaluate project outcomes. This integration of metrics and tools into the formalized DMAIC procedure is unique to Six Sigma. Second, when developing metrics for project selection and evaluation, Six Sigma takes business level performance measurement into account (Gupta, 2004). For example, in their Six Sigma framework, Breyfogle et al. (2001) suggest incorporating a balanced scorecard as a performance measurement tool. The balanced scorecard, first introduced by Kaplan and Norton (1996), attempts to “integrate financial and nonfinancial strategic measure variables in a cause-and-effect
relationship such as “measures of organizational learning and growth” to “measures of internal business processes” to “measures of the customer perspective” to “financial measures.” By connecting operational performance with financial and marketing performance, Six Sigma metrics help companies make decisions through a systematic consideration of both short- and long-term performance, and nonfinancial and financial performance. Third, Six Sigma metrics are clearly defined and measured to provide clear, explicit, and challenging goals for continuous improvement. In Six Sigma, goal setting begins in the early phases of a Six Sigma improvement project. Data are collected from the process for the computation of baseline process performance measures like DPMO and/or Process Sigma.

The effects are presented in the following figure.

Explanation of the four organizational cultures
The group culture focuses on flexibility and internal integration. Organizations emphasizing a group culture tend to value belongingness, trust and participation. The strategies used in these organizations concentrate on the development of human relations and member commitment. The leaders encourage teamwork, empowerment and concerns for employee ideas.
The developmental culture emphasizes flexibility and external orientation. Organizations with emphasis on this cultural orientation tend to focus on growth, resource acquisition, creativity, and adaptation to the external environment. The strategies used to manage business include innovation, resource acquisition, and the development of new market. Leadership styles in such organizations are entrepreneur- and innovator-type.

The rational culture is focused on the external environment and control. Organizations with emphasis on a rational culture encourage competition and the successful achievement of well-defined goals. The strategies are oriented toward efficient planning and control of production to achieve competitive advantages and high productivity. The leaders tend to be directive, goal-oriented, and functional.

The hierarchical culture emphasizes stability and internal integration. It stresses centralization and regulations. The strategies emphasize clear rules, close control, and routine. The leaders are conservative and cautious.
Appendix G – Stork’s company rules

Huisregels

1. Beschermingsmiddelen
   Wij dragen altijd onze werkkleding en persoonlijke beschermingsmiddelen conform de gebouwspictogrammen en andere aanwijzingen in de fabriek.

2. 5S methodiek
   Wij hanteren de 5S methodiek en zorgen tijdens en na onze werkzaamheden dat onze werkomgeving schoon, conform de in onze afdeling geldende afspraken.

3. Productdocumentatie
   Wij werken altijd volgens de geldende productdocumentatie. Bij afwijkingen of twijfel overleggen wij vooraf met de betreffende afdeling.

4. Routings
   Wij volgen routings altijd volledig in tijdens het productieproces waardoor wij de vooraf genoemde afspraken nemen en de mogelijke vertragingen vermijden. Wij vullen alle stappen in de operation in, bestellen juiste inzets, stempelen en meldens gemaakt.

5. Verlonen en gereedmaken

6. Ondersteund transport
   Wij verwerken uitgebreide producten of horizontaal, langer of bredere dan 20 cm, altijd volledig ondersteund op een daarvoor bestemd transportmiddel. Producten steekt nooit buiten het transportmidden of in werking uit tijdens transport, producten moet gestapeld, tenzij ze geëtiketteerd zijn en maximaal 1 meter.

7. Afwijkingen
   Wij bespreken afwijkingen en stagnaties altijd direct met onze leidinggevende of diens vervanger. Hoogte van deze producten en fictie moet gewaarborgd worden.

8. Aanspreken
   Wij spreken altijd aan op het naleven van deze afspraken.

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Appendix H – Facelift communication bulletin

The Facelift bulletin is distributed to all of the involved personnel and is published every month. Below 5 editions are shown.
Appendix I – Historical background information Stork

In 1868 Charles Theodoor Stork laid the foundations for many activities that would be developed under the Stork flag. At the fourth of September that year he opened a machine building factory in Hengelo. In 1954 Gebr. Stork&Co merged on an equal basis with Werkspoor (founded in 1827), to Verenigde Machinefabrieken (United Engineering Works). This means that the earliest date of this company’s roots can be traced is 1827. Stork concentrated mainly on industrial production equipment, while Werkpoor’s main activities were means of transport.

The combination of both companies grew in the post-war years in the heavy capital goods sector. Due to the vulnerable nature of this kind of market, the company turned to nice markets for lighter industrial production equipment. Therefore it acquired the company Bronswerk (specialized in technical service) in 1968 and Nolte (electrical installations) in 1989. Main concentration was on primary needs these days, such as: clothing, food, energy, water/air transport and technical services.

In 1992 Verenigde Machinefabrieken turned into Stork N.V., which grew into a structure with five groups. Those groups focused on: Aerospace (acquisition part of Fokker in 1996), digital (textile) printing technologies, poultry processing/fast food, industrials components and technical services. In 2004 Stork sold the Industrial Components group and three years later, in 2007, it sold Stork Prints.

In 2006 two hedge funds plead for dividing Stork. The board did not agree with this plea. At the end of 2007 the board did agree to a takeover by a consortium led by buyout firm Candover. The new owner sold Stork Food Systems and terminated Stork N.V.’s listing on Euronext Amsterdam.

Since 2008 there are only two groups left: Stork Aerospace and Stork Technical Services. Those groups have a few sub-divisions as can be seen in the schematic overview in Figure 16 (Chapter 6). Those two groups employ around 12.700 people, of which 10.000 in The Netherlands. In the year 2007 Stork realized a turnover of around 2.2 billion Euro and a profit of 70 million Euro.

Stork Technical Services is a professional provider of integral and technical services for installations and machines of the industrial market. Stork Aerospace is discussed in next paragraph.

Stork Aerospace – Stork Fokker AESP

Stork Aerospace is a highly innovative company, founded in 1919 by Anthony Fokker, that combines all the parts of Stork that are active in the aerospace sector. For a divers scale of clients, Stork Aerospace provides integrated technical and logistics services. It is an international company which operates in China, the USA, Rumania, Singapore, Turkey and of course The Netherlands. Stork Aerospace is involved in different projects for Airbus, Boeing, JSF, Gulfstream etc.

Stork Fokker AESP is part of Stork Aerospace. It focuses on development, design and construction of complex light weight structures and (parts of) landing gears of composites and metal for the aerospace and defense industry. Another focus is on project realization, systems engineering and supply chain management. Stork Fokker AESP has two locations/production facilities in Hoogeveen and Papendrecht.

Location Hoogeveen

Around 800 people are working in three different units at his location: Composites, Special Products and Machining. Light weight structures are being made for airplanes and helicopters. Examples are wing edges of the Airbus A380 and doors of the NH90 helicopter. Titanium motor parts for the JSF, a mobile hospital (MOGOS) and engine frames for the Ariane V program are examples of other product. At this location Stork Fokker AESP produces the J-Nose (fixed leading edge) for the Airbus A380 and A340. The project I’m participating in will be improving this production process. A J-Nose consists of skins and sub
spars as can be seen in Figure 2 and Figure 17. For every airplane one ship set is needed which consists of 16 skins and 16 sub spars. The planned production after 2009 is 30 ship sets..
Appendix J – Expert interview presentation

Figure 29: Expert interview presentation first page
Conclusions Literature

About Lean Six Sigma

- Not enough attention paid to leadership and communication
- Right project selection is critical
- Control the expectations of the project; it is also essential
- Hard to implement Lean Six Sigma throughout the whole company
- Time management of team members is critical (commitment/ prioritization)

Conclusions Literature

About other improvement methods

- Sustained management commitment and leadership is critical
- Control the expectations of a project
- Natural resistance to change
- Importance of right and clear focus and goals of project
- Be aware of an emphasis on form over function
- Lasting change achieved with ISO standards

Conclusions Literature

About leadership and communication

To make Lean Six Sigma successful:
- Transformational/transactional leaders
- Right combination of organizational cultures
- Right incentives for employees
- Management support for Lean Six Sigma for at least a few years
- Clear responsibilities and tasks for team members
- Clear communication to and between employees

Overall conclusions (1)

To make LSS more effective

- Framework of how to implement LSS (according to literature):
  - Select the right project
  - Select the right people
  - Train these people
  - Follow the method and validate savings
  - Secure results

- I think that you should make a few steps before that

Overall conclusions (2)

To make LSS more effective

- Create the right environment for change programs, in which employees have the opportunity, freedom and drive to think about improvements:
  - Combination of group, developmental and rational culture
  - Incentives to stimulate employees to think about improvements
  - Support throughout the whole company for Lean Six Sigma
  - Have the right leaders to achieve this
  - Clear communication to and between employees
  - Ensure that the expectations are not too high
  - Select the right method for the right project

Overall conclusions (3)

Program

| | | | | | |
|---|---|---|---|---|
| | | | | |

Figure 30: Expert interview presentation second page
Discussion

What do you think of my findings?

Figure 31: Expert interview presentation third page
Increasing the effect of Lean Six Sigma by creating the right environment by good leadership

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Abstract
Leadership is one of the most important success factors for Lean Six Sigma projects. Communication is for leadership also very important, because without communication, there cannot be leadership. But how can and should leadership influence Lean Six Sigma projects and organizations? That is the essence of this article.

Although leadership is such an important factor, it has not really been taken into account in literature and studies about Lean Six Sigma. There are a few aspects, to be influenced by leadership, which are very important for Lean Six Sigma. This articles shows that continuous management support, organizations’ cultures, incentives and expectations (of Lean Six Sigma) are very important aspects to be dealt with by leaders in order to create the right environment (a solid base) for Lean Six Sigma organizations and projects.

The main conclusion of this article is that, before implementing Lean Six Sigma, the organization has to create the right environment for Lean Six Sigma in order to make Lean Six Sigma more effective. This environment has to be created by good leadership.

Key Words: Quality Improvement, DMAICR, Six Sigma Framework, Advantages, Disadvantages

Introduction
Due to the financial worldwide crisis, many companies have adopted quality improvement methods to make their processes more efficient (Fontelaera, 2008). By adopting quality improvement methods, companies want to save money and satisfy their customers in order to be as guaranteed of product orders as possible.

Lean Six Sigma is one of the most popular methods in the quality improvement method sector. It is a customer focused method, which reduce production process variances by statistical analysis and by eliminating waste (non-value-adding processes). Although the method is very popular and much used, two of the most important critical success factors have not been paid much attention to. In different literature studies on the performances of Lean Six Sigma is mentioned that, although there are many and very well documented Lean Six Sigma trainings, scientific articles and books available, hardly any leadership and communication is taken into account (Loethen, 2007) (2008). While these are very important for an effective and successful Lean Six Sigma project (Antony & Banuelas Coronado, 2002) (Wyper & Harrison, 2000) (Van Solingen, 2007) (Snee, 2005) (van Daalen, De tien grootste valkuilen bij Lean Six Sigma, 2009), as well for any kind of project. This has to do with the formula provided by Van Solingen (Van Solingen, 2007): E = Q x A. The effect of the solution is the product of its quality and its acceptance (by the employees). Leadership and communication influence the acceptance of a solution. The key to acquiring and maintaining a successful organization in the 21st century is leadership, according to John P. Kotter (1996). So to make Lean Six Sigma even more effective, than it already is, it has to deal with leadership and communication.

This was the major part of the graduation project/thesis of the author of this article. In this article the importance of those two factors, and mainly of leadership, is made clear. Leadership and communication influence a few very important aspects of a Lean Six Sigma organization. Those aspects are: Sustained management commitment and support, establishing the right organizational culture, giving the right incentives to employees and shaping the right expectations of Lean Six Sigma as a method. All of the above mentioned aspects are essential for the
Increasing the effect of Lean Six Sigma by creating the right environment by good leadership

Increasing the effect of Lean Six Sigma organizations and therefore for Lean Six Sigma projects. Why are these aspects so important and how will they contribute to the successful implementation of Lean Six Sigma? This will be answered in this article. But first a small introduction will be given in the Lean Six Sigma method and what its critics are (some more literature research compared to what is stated in the first part of this introduction). The conclusions will deal with how to combine those aspects and make Lean Six Sigma more effective.

What is Lean Six Sigma?

Lean Six Sigma is the combination of two very important and popular improvement methods: Lean Thinking and Six Sigma. A short summary of both methods is provided and then the combination of both is discussed.

Six Sigma is originated from Motorola Inc. in 1985. It was developed to solve problems with the product quality and customer satisfaction and to improve processes by eliminating defects. Motorola had to improve their production because they were facing the threat of Japanese competition (Harry & Schroeder, 2000). With the adaptation by General Electric (in the mid 90s), which saved the company billions of dollars over a period of a couple of years (Henderson & Evans, 2000), Six Sigma became a significant and popular method. Other companies recognized the strengths and the potentials of Six Sigma and Six Sigma grew even more in popularity. The main goal of Six Sigma is to reduce the variation in production processes. The concept of Lean Thinking (often simply known as Lean) can be traced to the Toyota production system (TPS), which is a manufacturing philosophy (Inman, 1999). The just-in-time (JIT) principle is originated from TPS as well (Arnheiter & Maleyeff, 2005). Toyota grew very fast from a relatively small car manufacturer, to the world’s largest car manufacturer (Reuters, 2008). This caused growing interest in the “Lean” concept. Lean Thinking is a way of thinking. Its purpose is giving structure to improvement activities in organizations with the intention of increasing effectiveness of the complete organization. This means that this way of thinking stimulates continuous search for ways of making the organization function faster, cheaper and better. Lean is all about eliminating waste.

It is clear Lean Thinking and Six Sigma were derived from two different point of views. Lean focused on the increase of product flow speed by eliminating non-value adding processes, while Six Sigma focused on product quality by identifying and dealing with variances in production processes. Even shorter: Lean Six Sigma leads to a process which is logistical efficient (Lean) and of high quality (Six Sigma). The benefits of the combination is envisioned in Figure 32.

![Figure 32: Strength of Lean and Six Sigma combined (Arnheiter & Maleyeff, 2005)](image)

For implementation of Lean Six Sigma projects, the following steps has to be taken according to different literature (George, Rowland, & Kastle, 2004) (Van Solingen, 2007):

1. Select the right project
2. Select the right people for this project
3. Train those people
4. Follow the method and validate earnings
5. Secure results

The method is typically used in the following fields (IBIS UvA, 2009):

- Production industry
- Product and process development
- Healthcare
- Financial services
- Business services

So Lean Six Sigma is a method which has been described and researched many times, and a summary of points of attention are (2009) (2008):

- Leadership and communication (as described in the introduction they are seen as very important success factors)
- Right project selection is essential
- Too high expectations might endanger the project
- Implementation of Lean Six Sigma throughout the whole organization is hard
Increasing the effect of Lean Six Sigma by creating the right environment by good leadership

- Time management and prioritization is very important

The focus of this article lies with leadership and communication (expectations will be dealt with partly), but of course the other points of attention are also very useful to keep in mind when implementing Lean Six Sigma.

The next parts of this article will handle the importance of leadership and communication on the important aspects for successful Lean Six Sigma implementation, which are: management support, cultural change, incentives and expectations. It will be made clear why those aspects are very important as well as how they should be implemented.

To summarize: the lack of theoretical underpinning of leadership and communication for Lean Six Sigma organizations and projects is seen as an opportunity to improve Lean Six Sigma (by elaborate on these aspects), because these subjects (especially leadership) are seen as one of the most important success factors of Lean Six Sigma. So how can Lean Six Sigma be improved by leadership and communication? That is what this article is about.

Leadership and communication

So leadership and communication are the two leading subjects of the article, but what is actually meant by them? There are many different definitions for both leadership and communication, but this paragraph provides two very universal ones. This definition for leadership is:

“Leadership is not only about being the boss, but also about pointing out directions, changing and controlling. Leadership does not only apply to someone who is in charge, but also for someone who takes charge. Leadership needs decisiveness, persistence, vision and the willingness to change.” (Van Solingen, 2007)

There exists an important difference between managers and leaders, although not many people are aware of that. Management aims at planning, organizing, controlling and problem solving, while leadership focuses on constructive and adaptive changes (Den Hartog, Koopman, & Muijzen, 1997). Leadership is needed for realizing changes.

In the 1990’s a new paradigm about leadership started to exist. In this new way of thinking leaders are charismatic, transformational, inspirational and visionary. The differences between this new and old paradigm are described by Trist and Beyer (Makin, Cooper, & Cox, 1996) and are provided in Table 11.

Table 11: Old and New leadership

<table>
<thead>
<tr>
<th>“Old” leadership</th>
<th>“New” leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-charismatic</td>
<td>Charismatic</td>
</tr>
<tr>
<td>Transactional</td>
<td>Transformational</td>
</tr>
<tr>
<td>Management</td>
<td>Leaders</td>
</tr>
<tr>
<td>No Vision</td>
<td>Vision</td>
</tr>
<tr>
<td>Non-magical</td>
<td>Magical</td>
</tr>
</tbody>
</table>

The new leadership paradigm focuses on vision and mission instead of on planning, and on motivating and inspiring instead of inspecting. Although this new paradigm sounds very good, the combination of both transformational and transactional leadership (old and new) is the desired leadership style according to literature (Bass, Avolio, Jung, & Berson, 2003).

“Transformational leadership is based on the idea of motivating others to do more than they originally intended or thought possible. Transactional leadership is based on transactions between leaders and followers. It clarifies the role and task requirements of employees, initiates structure, and provides appropriate rewards” (Ozorovskaja, Voordijk, & Wilderom, 2007).

A definition for communication, covering most other definitions, is:

“Communication is the intentional production of messages in an informational, relational and situational context, reception and interpretation are the effects. The relation between senders and receivers are shaped this way” (Van Putte, 1998)

Communication is mostly used as a direct or as an indirect instrument (Van Putte, 1998). The management wants to achieve three effects by direct communication: enlarging involvement,
Increasing the effect of Lean Six Sigma by creating the right environment by good leadership

willingness to change and acceptance of organizational policy. All of those effects are very important in making Lean Six Sigma more effective, since the effect is the product of acceptance and quality. The acceptance is influenced by the willingness to change and by the involvement of the employees.

Indirect communication serves to achieve: clear and uniform organizational culture, influence on behavior of employees and informal organizing. That makes indirect communication very suitable for changing the organizational culture and for changing behavior of the employees. These subject will be discussed in the next paragraphs.

Management support

Continuous management support is of utmost importance, because the (highest) management has to provide the necessary means for Lean Six Sigma projects: money, time, people and involvement. If the highest management does not support Lean Six Sigma continuously, it might become “the flavor of the month” and disappear after a while. Lean Six Sigma has however the biggest impact when implemented throughout the whole organization. It has to become a way of thinking, and that will not happen overnight.

If the management is very well in order/arranged, the rest of the employees and managers will follow eventually. According to Lean Six Sigma implementation experts Mr. Adriaans (DAF, Stork) and Mr. Verhoeven (Stork, Nedtrain) (Boom, 2009), the highest management should know the capabilities of Lean Six Sigma and should have had some training on the subject. Mr. Verhoeven adds to these requirements that the ‘leaders’ have to be prepared to question their own paradigms and therefore have to be able to learn and listen. The leaders have to act accordingly that how they expect their employees to act. If the leaders do this, the employees will follow much more easily and almost automatically. During a case study at Stork Fokker AESP in Hoogeveen, the author of this article experienced this as well. The employees actually fabricating the products, were much more enthusiastic about changes if they felt the presence and involvement of their boss(es). The employees became more involved themselves due to the commitment and involvement of their boss(es). All of this make leadership as in continuous management support very important.

This brings the subject to the cultural change of an organization, which is discussed in the next paragraph.

Cultural change

Research of Zu, Fredendall and Robbins (2006) shows that, for a successful implementation of change programs and Lean Six Sigma in specific, a certain combination of cultures has to exists within organizations. There exist four major cultures in companies (Cameron & Freeman, 1991) (Denison & Spreitzer, 1991): Group, Developmental, Hierarchical and Rational Culture. Group culture appears to be the most important culture for successful implementation of Lean Six Sigma. The culture is followed by the rational and developmental culture. The hierarchical culture is not desired in Lean Six Sigma organizations.

The authors of this research paper are concluding that “to achieve the full benefits of implementing Six Sigma, companies should put emphases on at least three cultural orientations, i.e., group culture, developmental culture, and rational culture, in order to support the full implementation of Six Sigma”. They furthermore conclude that “in order to receive the full benefits of a quality management implementation, managers may find that it is important to assess their company’s cultural orientations and to develop necessary plans and policies to create a supportive environment in which all quality practices thrive”.

This means that the basis of the organization, the culture, should be arranged in such a way that Lean Six Sigma has the most chance to succeed. It has to be a balance between group, developmental and rational culture. This balance should be able to tend to each of those cultures when desired. Because for the different DMAIC phases there is a need for different cultures as well as leadership styles and leader-types:

- Define
  Transactional leadership (achievement-type leader) style and rational culture
- Measure
  Transformational leadership style (facilitator-type leader) and group culture
- Analyze
  Transformational leadership style (entrepreneurship-type leader) and developmental culture
- Improve
  Transformational leadership style (entrepreneurship-type leader) and developmental culture
- Control
  Transactional leadership (achievement-type leader) style and rational culture

In the phases the leader has to show a transactional style, decisions has to be made and the leader should manage it. In the other phases, it is more desirable to let the employees and team member do the job and make the decisions together. In those phases the leader should have a transformational style, show his vision and charisma and coach, guide and facilitate the employees in the improvement processes.

**Incentives**

How can the employees be aligned to the new organizational culture? This should be achieved by giving them incentives. But what kind of incentives? What are the incentives with the most desired effect?

In his literature (2007) about how to improve and manage performances, Mr. De Bruijn talks about incentives. There are many different kinds of incentives to give. A few examples are:

- **Financial sanctions/rewards**
  Financial sanctions and reward are linked to production figures and should be influencing peoples’ performances
- **Naming and shaming**
  Production figures are published hoping that employees will be ashamed of their negative production figures, because others can see them
- **Administrative and managerial interventions**
  Production figures that differ from average are likely to attract attention of managers. This can be in a positive or negative way.

One should be extremely cautious when implementing such kind of incentives with high impact, because it could lead to perverse behavior (de Bruijn, 2007). If too much is depended on the performance measurement, people tend to provide only the desired and, sometimes, wrong information. This effect is called ‘The Law of Decreasing Effectiveness’:

“If performance measurement has a high impact, the effectiveness of performance measurement declines, because strong incentives for perverse behavior arise”

This effect is presented in Figure 33.

![Figure 33: The Law of Decreasing Effectiveness](image)

Mr. Adriaans and Mr. Verhoeven are very clear about incentives. They both think that you should reward groups instead of individuals: celebrate successes with the group. Provide for example a diner check for the best performing group of employees. In this way you stimulate group processes and stimulate employees to help each other and learn from each other. This is part of the culture that is desired for a company that is implementing or willing to implement Lean Six Sigma.

Another major incentive is the commitment and involvement of the leaders and management of an organization. This is very important for the commitment and involvement of the employees and should not be underestimated! This is why leadership is so important in change programs and in organizations in general.

**Expectations of employees**

Before and during a project it is important to create the right expectations for the employees. If they know what to expect and if they are getting involved into the project, they are more willing to think about and accept improvement solutions. Mr. Adriaans thinks that every employee should get some sort of training about Lean Six Sigma to increase the involvement of the employees. The management of expectations is important, but once again Mr. Verhoeven emphasizes on the
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Importance of commitment and involvement of the highest management. If they are very involved, they will know what to and what not to expect from Lean Six Sigma. Communicating with each between the different organization layers is very important for the expectation throughout the whole organization. The focus and goal of projects have to be very clear, but also ambitious to stimulate people to do more that they originally thought they could do. Mr. Adriaans talks about an 'improvement board' to communicate to and with the employees. This board consists of three layers. The top layer deals with the goals of the organization. The middle layer elaborates on the present projects to reach those goals and the third layer is a place for employees to 'brainstorm' about practical improvements. By these means it is possible to manage the expectations of the employees is a good way.

Conclusions

In the second paragraph (What is Lean Six Sigma?) of this article, five steps of Lean Six Sigma implementation are provided:
1. Select the right project
2. Select the right people for this project
3. Train those people
4. Follow the method and validate earnings
5. Secure results

According to the graduating project of the author of this article however, there is an important step to make before those five steps: create the right environment for change programs. This is the conclusion of a literature research on Lean Six Sigma, other change programs, leadership and communication, a participative field research at Stork Fokker AESP and interviews with Lean Six Sigma experts who agree with this conclusion. During the case study at Stork Fokker AESP the author has seen the importance of the right environment. The willingness of the employees to change and to help changing depends heavily on the environment and on the (presence of) leaders. If the employees are getting involved into the project, they tend to think much more about improvements and they accept solutions much easier. So how to create the right environment? Although the realization might differ per company, the next points of focus are important for any kind of company willing to improve its quality (ranked in order of importance):
- Having the right leaders. A combination of transformational and transactional leadership style. Those leaders should be very persistent and persuasive about Lean Six Sigma to be successful (Mr. Adriaans). The leaders are setting an example for the employees and therefore have to be "prepared to question their paradigms" and have the willingness to learn, listen and change (Mr. Verhoeven).
- Supporting Lean Six Sigma throughout the whole company by the highest management for at least a few years (top-down implementation). The CEO of Stork is doing it since 2006 and this has been very important for the acceptance of Lean Six Sigma. Also Mr. Adriaans and Mr. Verhoeven told about the importance of management support at the highest level. The management has to make Lean Six Sigma happen!
- Having the right combination of organizational cultures (group, rational and developmental cultures are the most important ones for change programs). In those cultures you combine empowerment (group), with the drive for new product/processes (developmental) and right and clear focus/goals. There is a desired behavioral change required and the leaders have to set an example. The employees will follow their boss.
- Giving the employees the right incentives to let the be actively involved in the improvement (thinking) process. But be aware of perverse behavior! Celebrate successes and create an environment to let the employees think together for improvements with the 'improvement board' for example (Mr. Adriaans). Both of the experts think that group incentives are more desired than individual incentives, since that stimulates group thinking processes (that is desired in a change culture).
- Clear (well-thought-out) communication to (and between) all of the involved personnel (before and during the project). This is important because communication helps to create the willingness to change, and to accept solutions. Communication also helps to let the employees be more involved, by keeping them up-to-date.
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This can be done in several ways (mail, news bulletins, speeches, meetings etc.). If those points of attention are taken very well into account, then there exists a solid base for Lean Six Sigma projects. The proposed implementation steps, including the new first step, are:

1. **Create the right environment**
2. Select the right project
3. Select the right people for this project
4. Train those people
5. Follow the method and validate earnings
6. Secure results

As discussed in the ‘cultural change’ part of this article, the leadership style (and leader-type) and culture has to be flexible during the DMAIC phases to achieve the best possible results out of those phases. The phases should be arranged as follows:

- **Define**
  - Transactional leadership (achievement-type leader) style and rational culture

- **Measure**
  - Transformational leadership style (facilitator-type leader) and group culture

- **Analyze**
  - Transformational leadership style (entrepreneurship-type leader) and developmental culture

- **Improve**
  - Transformational leadership style (entrepreneurship-type leader) and developmental culture

- **Control**
  - Transactional leadership (achievement-type leader) style and rational culture

So before starting a Lean Six Sigma project, the right preconditions have to be met. That means creating the right environment “to provide employees with the freedom, autonomy and range of skills to engage in creative and effective continuous improvement activities, while encouraging the use of a systematic problem-solving approach to use quality tools to control its systems and processes.” (Zu, Fredendall, & Robbins, 2006). Such an environment will not happen overnight, which means that this must be a continuous creating process. Also during the project itself, the right environment has to be present and that should be the merits of a flexible, mostly transformational leader.

**Recommendations**

Since leaders have to create the right environment for Lean Six Sigma and also have to make sure Lean Six Sigma is successful, it is important that you have the right leaders. What are the characteristics of the right leader? Does the right leader exist? The leader should combine transformational and transactional leadership, as stated in paragraph 3, and should be able to switch between those styles. But a more detailed description of the characteristics of such a leader is desirable. Furthermore it is desirable to see how other companies cope with creating the right environment for change programs (Lean Six Sigma in particular). How long does it take to actually achieve the right environment? How can you speed this up? Are there any practical tips & tricks to enhance this process? These are questions to be answered to be able to give an advice to companies trying to create the ‘right environment’.

**References**


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