

UNIVERSITY OF  
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# MASTER THESIS

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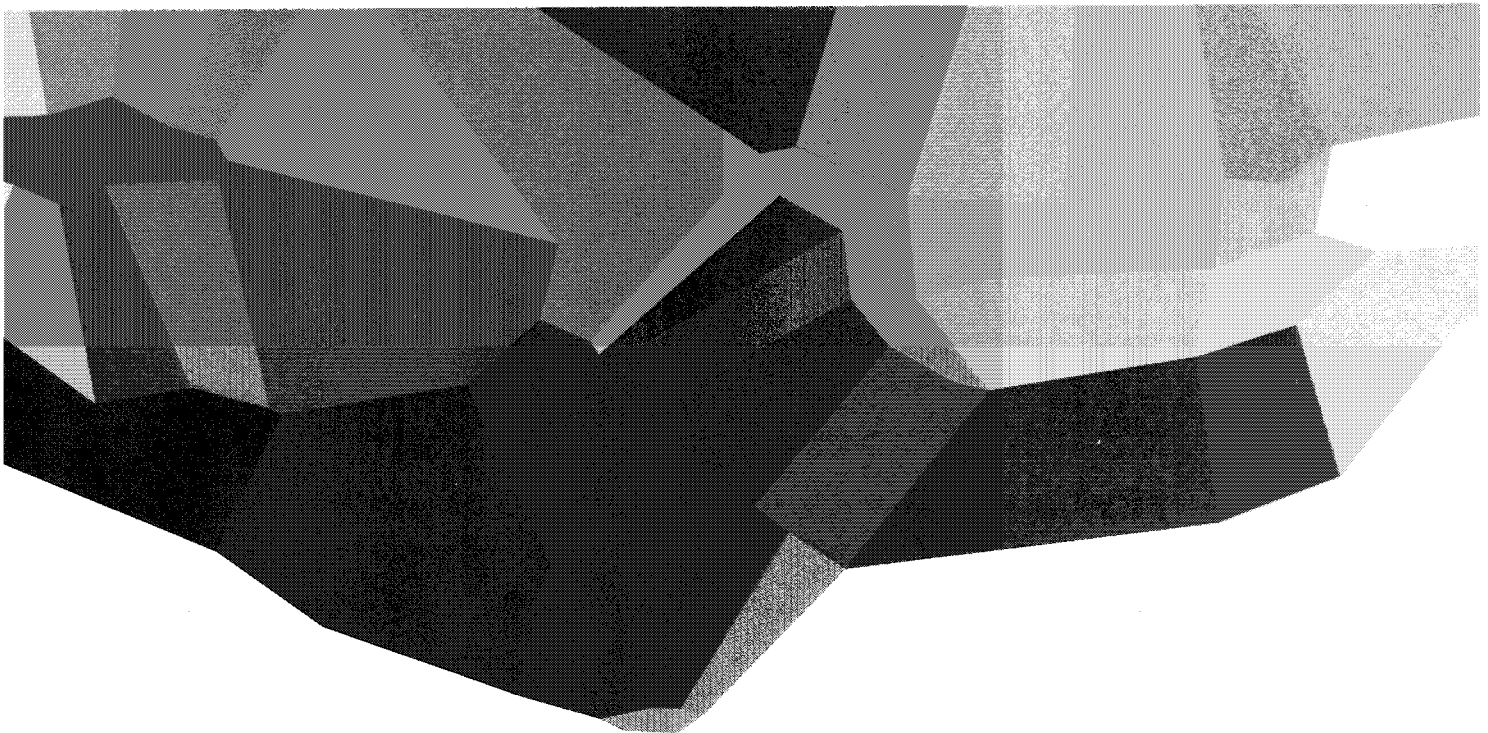
**What factors facilitate or inhibit the  
successful implementation of Lean  
Manufacturing**

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## **1. Abstract**

Although many Norwegian companies have the Lean Culture with success but a large number has failed when attempting this goal. As companies try to implement and apply Lean in response to competitive pressures, they often become one-dimensional in their approach. As the main purpose, this document seeks to study and analyse the underlying reasons surrounding companies' failures in their Lean initiatives and how to implement them in a successful and sustainable way. This document is based on a thorough literature research concerning the success and failure of Lean implementations, enriched through an assortment of individual interviews with Lean experts, acting as a precursor for the development of a novel roadmap as a practical guide to open up a window of opportunity for managers, who want to become Lean in an effective and sustainable way. Lean implementation, Manufacturing systems, Failure reasons, Critical success factors, Strategic management of Lean

## **2. Introduction**

“Hundreds of thousands of executives from thousands of businesses worldwide have toured Toyota’s plants in Japan and the United States but none have been able to replicate Toyota’s performance” Spear & Bowen (1999: 97). This is indeed a strong statement.

As competition increases in all branches of both the manufacturing and the service industries most organizations agree that it is imperative to optimize all their processes if one wants to survive and thrive, not only in times of increase when markets are booming but, during periods of recession as well.

The Toyota Production System has since the 1980’s been recognized as the optimal manufacturing system by industry worldwide. The interest for lean manufacturing has, since then, been increasing by leaps and bounds. Many companies, throughout the world, greatly impressed and in some cases stunned by Toyota’s success have pursued ways to optimize processes and make products more efficiently. They have tried very hard to implement Toyota’s methods and imitate Toyota’s success without, the most of them, making any appreciable headway.

Toyota has been extremely open and willing to share its philosophy, methodology and tools with anyone who so wished, even with major competitors like Chrysler, Ford and GM, none however have been able to duplicate Toyota’s success. Some organizations have come close others nowhere near.

Executives visiting Toyota are usually impressed by the various tools and other visible practices such as Just-in Time, Kanban, 5S, Quality Circles etc. and identify these as the key elements of TPS or Lean. Strangely enough although these tools and methods have the power and ability to greatly improve manufacturing and operational performance they have not been effective in the successful and sustainable implementation of TPS.

The excuses are many. The most commonly used excuse, or should one say alibi, when implementation grinds to a screeching halt is that Japanese culture is so different from western culture. But as stated by Spear and Bowen (1999) this is just not the case.

“Other Japanese companies such as Nissan and Honda have fallen short of Toyota’s standards, and Toyota has successfully introduced TPS all around the world including in North America” *Spear and Bowen (1999: 97)*

This does not however mean that culture does not play a role in the implementation. You do not have to be Japanese to implement lean but cultural differences do offer challenges.

The goal of this thesis is to investigate the reasons for this failure and give the reader an indication as to what factors or criteria facilitate or inhibit the successful implementation of lean manufacturing. The thesis does not discuss the advantages of Lean manufacturing. This has been established beyond any reasonable doubt by numerous other authors.

The research commenced with a thorough review of literature. The review pin-pointed three critical criteria that had to be met before a company could attain the successful and sustainable implementation of lean. Some of the traps one should avoid so as not to be misled into thinking one is successfully implementing lean, when in reality one is only scratching the surface and in many instances doing more harm than good, will also be addressed.

To investigate the validity of the three criteria thus uncovered a survey consisting of a twenty point questionnaire and a series of interviews was conducted. The survey is more closely described in the methodology chapter. Chapter three describes the literature review. This chapter also provides an insight into the Toyota Training program TWI. It is important that the reader understands the importance Toyota places on developing their people. They adhere to the Chinese proverb;

“If you want one year of prosperity grow seeds  
If you want ten year of prosperity grow trees  
If you want hundred years of prosperity grow people”

*Liker & Meier (2007: 3)*

Chapter four describes the philosophical assumptions as to knowledge, data gathering and analysis. The ontology platform for this thesis is relativist and the epistemology platform is constructionism which corresponds closely to the research methodology based on a survey.

Based on this platform the methodology chosen was a survey. Chapter five describes the methodology, the survey, the questionnaire and the results obtained from the twenty returned questionnaires and the analysis.

A brief history of manufacturing is described in chapter six with a couple of paragraphs being dedicated to the description of craft production. The chapter goes on to describe the birth of mass production before rounding off with a description on how the term “Lean” originated.

Chapter seven describes mass production thinking. This is important because it is later compared to lean thinking to give the reader a picture of the differences between the two manufacturing philosophies. Toyota took most of its ideas from Ford and the USA. The reader can, as he/she progresses through the chapters of this thesis, clearly understand how Toyota adapted the basic principles of mass production, American supermarkets (origin of JIT) and Ford’s assembly line and turned these techniques into the world’s most effective production system.

Chapter eight presents the history of Toyota from the very beginning, giving the reader a picture of the character of the founding fathers of Toyota and their moral fiber. One gets a far greater understanding of how and why Toyota managed to write this incredible success story. It is the story about a set of leaders with the highest possible morals, experts their business and with the necessary guts and gumption to reach the very top and stay there. Maybe it is here the myth that the success of TPS is dependent on Japanese culture started. High morals, hard work, honor and respect for people are not exclusive to Japan.

The philosophy of Toyota which resulted in Toyota’s culture - “The Toyota Way” is described in chapter nine where the fourteen principles are explained briefly. A thorough understanding of these fourteen principles is a great starting point for any company seriously contemplating the implementation of lean manufacturing. This will be a great guideline for setting up one’s own philosophy.

Chapter ten describes the two pillars, JIT and Jidoka, of the Toyota Production System (TPS) and the relationship between them. The TPS house illustrates the important elements within the system.

The problem has always been that companies outside of Toyota have tried to implement stand-alone tools or parts of systems and elements taken out of context. It would be worth noting what Fujio Cho once said:

*“The key to the Toyota Way and what makes Toyota stand out is not any of the individual elements, but what is important is having all the elements together as a system. I must be practiced every day in a very consistent manner – not in parts” Liker (2004: xv)*

Chapter eleven describes the foundations of the TPS house. Leveled production, Kanban, Stable and standardized processes, the four rules, waste and visual management are all described in some detail.

Chapter twelve touches on Toyota’s attitude towards leadership and what is expected of a Toyota leader

Chapter thirteen discusses why companies do not have any appreciable success implementing lean and focuses on the major trap many companies should avoid when initiating a transition to lean, i.e. focusing on implementing stand-alone tools cherry picked from the lean tool box. This chapter specially illustrates the fallacy of starting with 5S.

Chapter fourteen offers some important criteria that have to be met to lay the foundation for a successful transition to lean manufacturing.

Chapter fourteen touches on some requirements to succeed while chapter fifteen concludes the thesis with a brief road map for success, possible limitations and a suggestion for further research.



### 3. Literature review

Any cursory glance at manufacturing management literature in general and lean manufacturing in particular, reveals the existence of a large body of literature spanning the length and breadth of the subject matter. Books and articles on lean manufacturing have been written by hundreds of authors and describe every conceivable aspect of Lean Manufacturing. Naturally, there has been considerable attention paid to factors affecting the implementation of lean manufacturing; which is the core of this dissertation.

Early western literature was mostly dedicated to describing bits and pieces of TPS taken out of context or describing the tools, and systems of TPS. The authors did not connect these tools and methods to the overall philosophy. They were described as stand-alone methods, miracle cures for success. This led to the creation of some myths about TPS.

As Jeffrey K. Liker states the main myths created were that TPS was a tangible recipe for success, a management project or program, a set of tools, a system for the shop floor only, can be implemented in a short to mid-term period. *Liker (2004)*

One of the earliest pieces of literature published in the west was the English translation of the book “The Toyota Production System – Beyond Large Scale Production” authored by the father of the TPS, Taiichi Ohno. He introduced the world to the Toyota Production System, its development and management. It was a new method of manufacturing that would minimize costs and increase profits. This was mainly accomplished by learning to recognize and eliminate waste.

“The most important objective of The Toyota system has been to increase production efficiency by consistently and thoroughly eliminating waste” *Ohno (1988: xiii)*

Or as Ohno so succinctly put it

“All we are doing is looking at the time line. From the moment the customer gives us an order to the point when we collect the cash, and we are reducing that time line by removing the non-value added wastes” *Ohno (1988: ix)*

Ohno's book describes the foundation and pillars that support the "Toyota House", team work and the radically new thought process that is necessary to succeed. There is however one critical condition that Ohno explicitly and categorically states is necessary.

Ohno emphasizes the critical importance of top management commitment and support, for example in the implementation of Kanban. Kanban is considered to be an important part of the foundation of the "TPS house", i.e. the Toyota Production System house. Ohno states that Top management commitment is critical when implementing and practicing the first rule of kanban, which is that the later process goes to the earlier process to pick up needed products.

"To practice this first rule a superficial understanding is not enough. Top management must change its way of thinking and make a commitment to reverse the conventional flow of production transfer and delivery. This will meet lots of resistance and requires courage. **The greater the commitment however the more successful will be the implementation of the Toyota Production System**". *Ohno (1988: 30)*

Ohno repeatedly emphasizes the importance of top management commitment and support.

"I have a good reason for emphasizing the role of top management in discussing the first rule of kanban. There are many obstacles to implementing the rule that the later process must take what it requires from the earlier process when it is needed. For this reason management commitment and strong support are essential to the successful application of this first rule" *Ohno (1988: 31)*.

The implication is unmistakable. Top management commitment and support are imperative for the successful implementation of TPS.

It must be said however that Ohno did not propagate a definite strategy for the implementation of TPS. That was not his intention when writing his book. The book was originally written in 1978 in Japanese and whatever his motives were, one can safely assume, it was not written to teach westerners the philosophy or the systems of TPS.

Ohno describes some of the systems that make up TPS specifically Just in time, Jidoka, Kanban, continuous improvement and standardized work. These are the pillars and part of the

foundation of TPS. He also emphasizes respect for people by describing the value of teams and people working together in a coordinated fashion to produce value and to improve processes.

Soon after the publication of Ohno's book, other researchers began to examine his methods. The Lean classic "The Machine that changed the world" by Womack Jones and Roos first published in 1990 unraveled some of the mysteries of Toyota's success and unleashed Lean manufacturing on the western world. The book is a product of the International Motor Vehicle Program (IMVP) which was born at the Massachusetts Institute of Technology (MIT).

The book describes in very clear terms two fundamentally different philosophies about how people should go about creating value. On the one hand it describes Ford's mass production philosophy which became the production system of the industrialized world while on the other hand the book describes the philosophy and management system which was developed by Toyota in the twenty odd years after WW2, The Toyota Production System.

*Womack et al. (1990)* states three obstacles that stand in the path of a general lean industrial world. The book was first written in 1990 and describes some history, then moves on to certain elements of Lean Manufacturing but does not initially give any tangible suggestions as to how to implement Lean. However there is an afterword written in 2007 where the authors describe what they have learned since they published the book in 1990. From an implementation point of view the afterword is of greater interest. Here the authors discuss what they missed first time around and what they would include if they were writing "The Machine" in 2007.

In 1990 the authors focused on problem solving by work teams and job rotation among professionals but the role of the Line Managers in production, design and sales was hardly mentioned. *Womack et al. (1990)* In 2007 after almost twenty years of learning one can say in hindsight that although the problem solving work teams, which they focused on in 1990, are very useful in any organization, the work processes these teams improve have to be first standardized by the managers and industrial engineers if the teams are to have any hope of improving them at all. As Ohno said, "Without standards there can be no Kaizen". *Womack et al. (2007)*

The authors by their own admission missed out on the very important role played by management.

“We realized that problem solving by managers is a much larger fraction of their job than we had realized” *Womack et al. (2007: 291)*.

During their studies of the Toyota Production System from 1990 to 2007 the authors of “The Machine” discovered that management involvement and support was imperative to TPS. It was the managers that were trained to identify problems and improve the processes in their areas of management. This included leading the improvement process, developing implementation plans, measuring results and adjusting the process. Basically this is the Plan – Do – Check – Action system that Toyota learned from Edward Deming. Toyota took this one step further and developed the now famous A3 analysis tool which is a prominent management tool at Toyota. *Womack et al. (2007)*

This is very much in keeping with what Ohno states from the very beginning. That management commitment is imperative.

Then in 2004 Jeffrey K. Liker published his book “The Toyota Way” which became an international best seller. In the main body of the book Liker explains the fourteen management principles of the Toyota philosophy, what they really mean and how they work to optimize all processes.

Toyota practices these principles far beyond its high-volume assembly lines. For ease of understanding these 14 principles have been divided into four (4) categories all starting with “P” – Philosophy, Process, People/Partners and Problem solving. (*Liker –2004*) The principles describe the management commitment that is necessary to succeed in each of the four P’s.

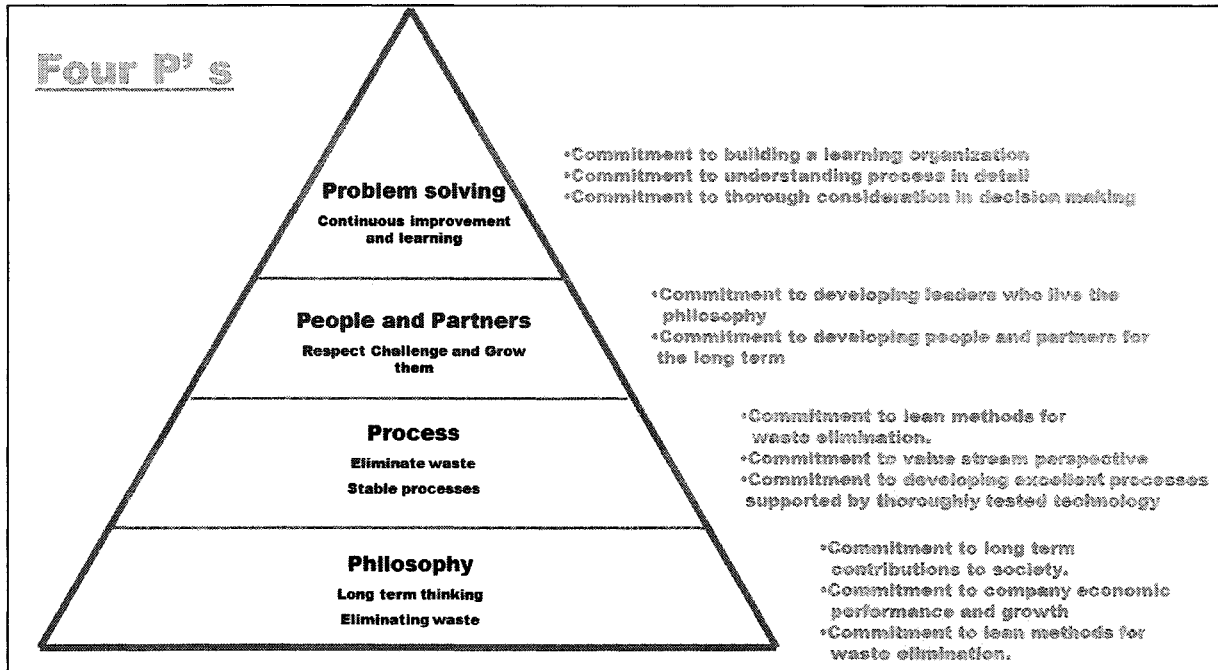


Fig. 1 The top leadership commitment required. Liker & Meier (2006: 26)

Liker emphasizes that the vital ingredient necessary is management commitment. He goes even further to state that according to the leaders at Toyota, there must also be a cultural transformation with regard to continuous improvement.

“When I first began learning about TPS, I was enamored of the power of one-piece flow, kanban, and other lean tools. But along the way, experienced leaders within Toyota kept telling me that these tools and techniques were not the key to TPS. Rather the power behind TPS is a company’s **management commitment to continuously invest in its people and promote a culture of continuous improvement**. I nodded like I knew what they were talking about, and continued to study how to calculate kanban quantities and set up one-piece flow cells. After studying for almost 20 years and observing the struggles other companies have had applying lean, what these Toyota teachers told me is finally sinking in”.

*Liker (2004:10) emphasis added*

Liker is adamant when he states that one problem that hinders successful implementation is that companies mistake a set of lean tools as deep “lean thinking”. Companies embrace lean tools but do not understand the how they must work together and what makes them work together in a system and the cultural change necessary.

Discussing management that just adopts a few technical tools Liker states;

“They do not understand the power behind true TPS and the continuous improvement culture needed to sustain the principles of the Toyota Way”. *Liker (2004: 12)*

Liker also describes the personalities and philosophies of the founding fathers of Toyota, the Toyoda family, and how they passed on their philosophy from father to son from Uncle to nephew. Yes one family has really formed Toyota’s culture and left its indelible mark on Toyota. There is however another very important fact to be taken into consideration. That is the remarkable consistency of Leadership that Toyota has achieved. This in turn has then lead to a consistency of philosophy and culture throughout the history of the company. All the roots of the Toyota way philosophy can be traced back to the very beginning of the company and the founding fathers. Every Toyota Leader whether family member or not is encoded with the DNA of the Toyota way. Liker (2004)

“The Toyota Way” like the “The Machine” confirms what Ohno stated. Management commitment is imperative to the success of TPS. Liker however goes further and points out the necessity of organizational and cultural changes the company is dependent on to make a successful transition to TPS.

Liker joined forces with another Toyota veteran, David Meyer, and in 2006 they published “The Toyota way Field book”. While “The Toyota Way” is more of an explanatory work, “The Toyota Way Field Book” is a practical guide for implementing the Toyota Production System. Throughout the book the authors define the most common traps companies usually walk into while attempting to implement TPS. They also give tips as to what companies can do to facilitate successful implementation. The authors not only emphasize the importance of leadership and management commitment but explains what this means in terms of what their activities as mangers and leaders should be.

“Leaders develop and mentor others to do many of the tasks often done by leaders within other companies”. *Liker & Meier (2006: 220)*

“Often companies focus on developing leadership “duties” or “responsibilities” rather than on expectations. This is similar to attempts to implement lean tools rather than

lean philosophies. People want to know “What does a leader do?” rather than “What are the objectives or expectations of leadership”. *Liker & Meier (2006: 221)*

There is also a great deal of emphasis on hiring, training and developing people. The Toyota way philosophy is always centered on its people and Toyota regards its employees as its greatest asset.

Toyota leaders say “We build people not cars” What they mean is that in the process of building cars and continuously improving the processes Toyota’s employees are learning and developing themselves. *Liker & Meier (2006)*

The development of employees was deemed so important that Liker and Meier published “Toyota Talent” in 2007. This book is all about how you can develop talented people to achieve great results. The principle of developing people is so important to the philosophy of Toyota that six of the fourteen principles described in the Toyota Way are related to it

*Principle 1: Base management decisions on a long-term philosophy even at the expense of short term financial goals:* The most important long-term investment Toyota makes is in its people and the passion to keep team associates employed for their careers reflects that value. *Liker & Meier (2007: 6)*

*Principle 6: Standardized processes are the foundation for continuous improvement:* Standardized work and job instruction training go hand in hand, and long term associates need to learn to see waste and make improvements. *Liker & Meier (2007: 6)*

*Principle 9: Grow leaders who thoroughly understand the work and who live the philosophy and teach it to others:* Teaching is the most highly valued skill of leaders, and leaders have to deeply understand the work to teach and coach others. *Liker & Meier (2007: 7)*

*Principle 10: Develop exceptional people and teams who follow your company’s philosophy:* Teams depend on well-trained people, and part of individual development is learning to work in teams. *Liker & Meier (2007: 6)*

*Principle 11: Respect your suppliers by challenging them and helping them improve:* Suppliers need to have the same talent level as Toyota team associates and are developed in similar ways. *Liker & Meier (2007: 6)*

*Principle 14: Become a learning organization through relentless reflection and continuous improvement.* This was intentionally at the top hierarchy of the Toyota pyramid because becoming a learning organization is viewed as the highest level of organizational effectiveness. *Liker & Meier (2007: 6)*

According to Toyota the central part of any manager's job is teaching. Toyota is convinced that if people are not adequately trained and developed the entire system will come to a screeching stop. At the very heart of TPS lie its people and their development. It is not just lip service when Toyota claims that its people are its greatest asset. As Liker states

“Within many parts of Toyota TPS is referred to as the “Thinking Production System”. When Taiichi Ohno started connecting operations to eliminate the waste in and between the operations, he made a startling discovery. When processes are connected problems become immediately visible and people have to think or the processes shut down”. *Liker & Meier (2006: 21).*

Only people can think and solve problems. This is why Toyota considers the development of their employees as critical. TPS stands or falls on this even if everything else is in place. AT the core of this development is a trained and committed leadership where leaders and managers are the teachers (sensei). They ensure that Toyota is a learning organization where improvements are carried out using a scientific method.

The culture at Toyota is the heart and soul of the Toyota way. In 2008 Jeffrey Liker and Michael Hoseus published their book “Toyota Culture”. This book discusses the human resources principles, hiring, training and generally Toyota's attitudes towards its employees and their development.

Just as the house of the Toyota Production System is built on a foundation of Leveled production, stable and standardized processes, visual management and the Toyota Way philosophy with the pillars of Just-In-Time and Built in quality (Jidoka) holding up the roof,



The house of the Toyota Way is built on a foundation of Management Commitment and the two pillars Respect for People and Continuous Improvement holding up the roof. It is this house that makes it possible for the Toyota Production System to work successfully.

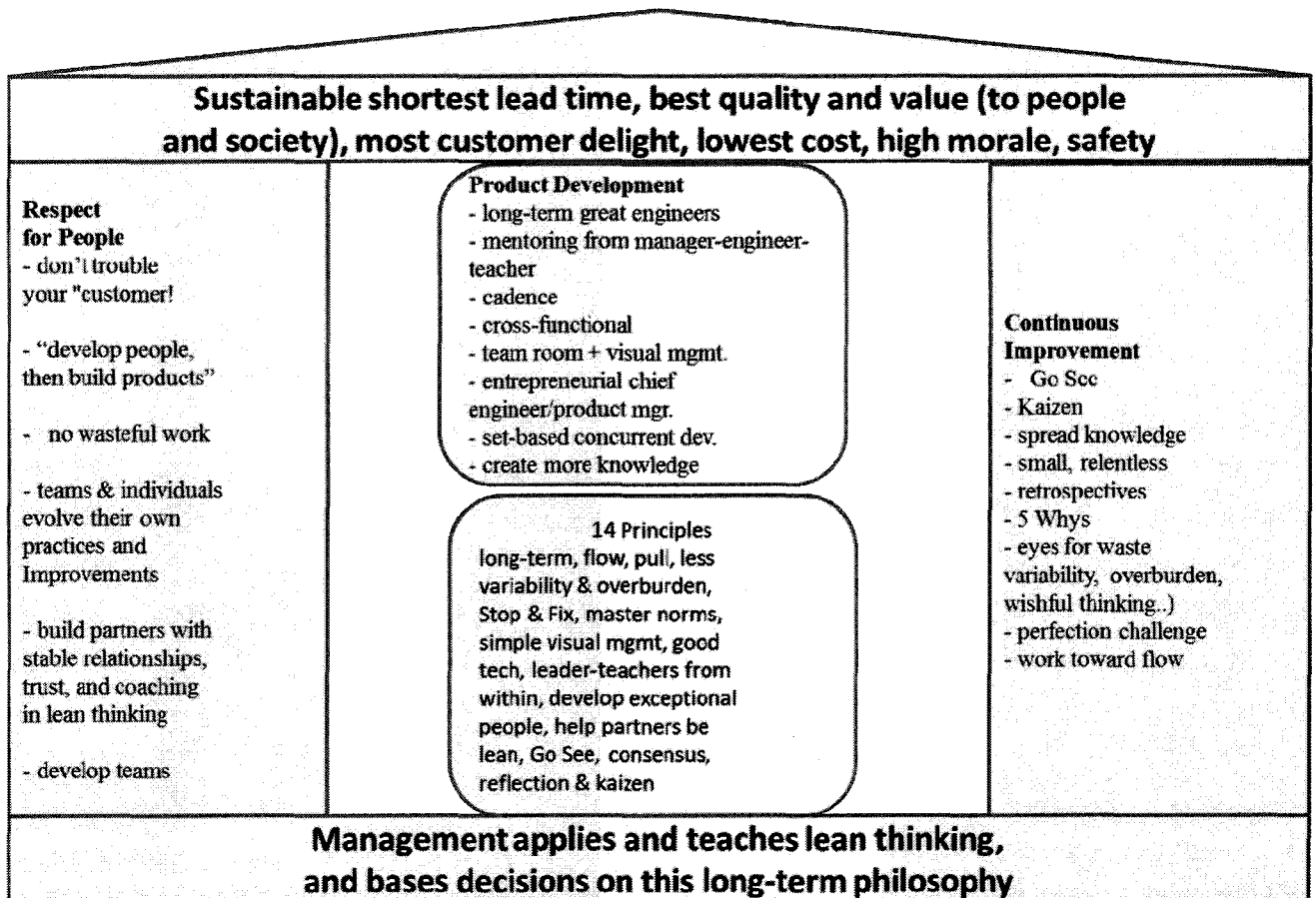


Fig.2 The "Toyota Way house". Larman & Vodde (2009)

If one now looks at the Toyota Production System house depicted elsewhere in this thesis, one may look at the two houses as one house with two floors. The TPS house can be considered as the upper floor and the Toyota Way house as the first floor. The Toyota Production System is built on the Toyota Way.

The literature studied can be categorized into six main areas;

1. The general description of Toyota's philosophy and its development
2. The general description of the Toyota culture born of its philosophy

3. Description of The Toyota Production System, its development and how it is managed.
4. Comparisons of Lean vs. Mass production and the advantages of lean.
5. Respect for people, hiring, training and working together as teams.
6. Descriptions on the use of the various tools of TPS.

The literature review clearly reveals that all the authors agree upon and are very emphatic that there are three major criteria that absolutely have to be met for the successful transition to TPS. These three are;

1. A philosophy that is thoroughly understood by all
2. Total Management Commitment –to living and teaching the philosophy and culture
3. Culture that promotes respect for people and their continuous improvement (learning organization).

### 3.1. Own company philosophy;

What has not been understood by the vast majority of companies trying to make the transition to lean is that lean is not about a set of tools or techniques. Lean is about philosophy. It is to be mentioned that simply writing down Toyota's philosophy will not get you to your goal. One has to develop one's own philosophy. The good news is that you do not have to start from scratch. You can build on what you have learned from Toyota – an excellent role model. The important thing is to really understand the philosophy as it is not possible to adapt something you do not understand.

A great place to start would be for top management to get together and take stock of the current situation. This is also the basis of any Toyota improvement process. Establish what the culture of the organization is as of today. Establish its roots. Toyota's principle of "genchi gembutsu" says that you have to go see for yourself to truly understand the actual situation in the organization. This is management by walking so leaders have to do some leg work. They have to go, see and talk to the employees, supervisors and lower level managers. One has to establish if the current culture of the organization matches up to the stated philosophy. There will be a gap. One has to then methodically close this gap as much as possible.

"There is a gap at Toyota – we suspect smaller than most" *Liker & Meier (2006: 23)*

The leaders have to map their way and decide on what they want their philosophy to look like. They have to decide their way. The figure below can help to focus on all the important elements

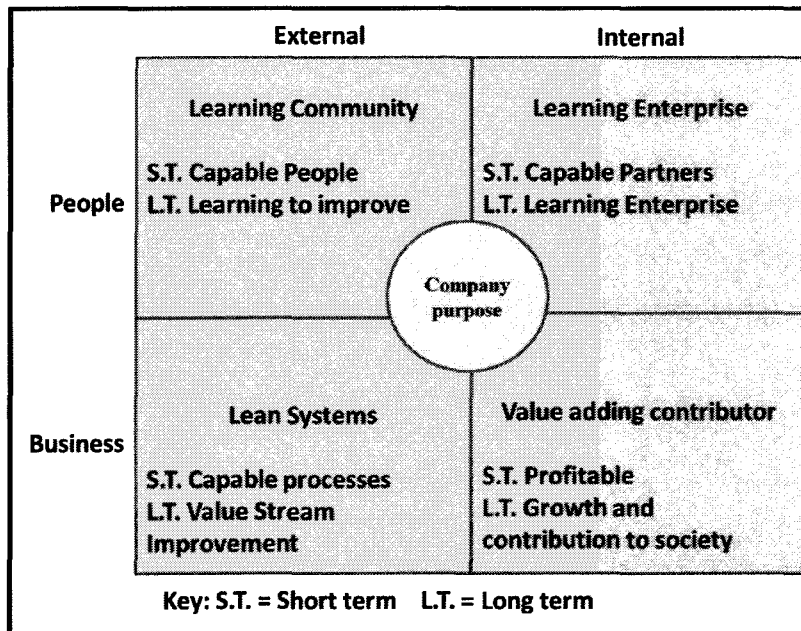


Fig. 3 The Company purpose Liker (2006)

The leaders have to decide on what they want to look like internally and externally. This is in terms of both people and the business. In terms of business one has to establish a broader corporate strategy. One cannot have a profitable and financially healthy organization without a well-developed, effective strategy based on the corporate philosophy. The danger of not having a strategy is that an organization can embrace tools like TQM, benchmarking, reengineering, six-sigma etc. and achieve remarkable operational improvements and the tools and techniques have gradually taken the place of strategy. These will however never be sustainable continuous gains that lead to sustainable profitability. Why? because although operational effectiveness is necessary for superior performance is just not enough. This is again because the tools and techniques are very easy to imitate and everybody can easily gain the same effectiveness. The very essence of strategy is in deciding on a valuable pattern of action rooted in a philosophy and systems of action that are very hard to imitate thus giving an organization its competitive edge.

A case in point is Toyota. The tools are easy to imitate and Toyota is very open in showing everybody what they do, but very few organizations have been able to copy them with any degree of success.

### 3.2. Total Management commitment

Most senior managers are convinced that their commitment and involvement are adequately demonstrated by the fact that they have agreed to and paid for the hiring of consultants to train the operators and that they have released one or two persons to be “Lean facilitators”. Now they just duck back into their offices and continue to turn their attention back to doing what they have always done in the same manner as they have always done. They think they are handling the company’s important issues. “Oh Lean can be handled by the consultants and the facilitators. We hope we get our money’s worth from these guys” is the general thought. This approach by senior management can be called the “Wash me but don’t get me wet” approach. They expect everyone else to change but do not see that it is necessary for them to do so, after all it was their past behavior that brought them to their current position.

What does true management commitment mean?

The 14 principles described in Jeffrey Liker’s best seller *The Toyota way*, form the basis of top leadership commitment. They are very well illustrated in the “4 P” model that Liker & Meier uses in his 2006 follow up, *The Toyota Way Field Book*. (*See fig. 1*)

To make lean work the organization has to live the philosophy. The responsibility for living the philosophy falls squarely on the shoulders of leadership.

“All executives, managers, directors, supervisors, group leaders or whatever else you call them have to live the philosophy every day in a very consistent manner. Leaders have to lead by example.....consistently. **To do this requires a major commitment, starting at the very top of the company.** It is not just an abstract philosophical commitment to support “lean.” It is a commitment to a “way.” – a way of looking at the business purpose, of looking at processes, of looking at people and a way forward in learning to learn as an organization” *Liker & Meier (2006: 25) emphasis added.*

It is critical that managers and leaders change their philosophy of management. First and foremost they have to quit the role of being the boss and take on the mantle of teacher and trainer (Sensei). This means that the leadership should truly learn, live and teach the philosophy. All leaders and managers have to have an in depth knowledge of the work. They have worked on the shop floor. In addition they have to have the ability to develop, to mentor

to guide and to coach and lead people. This earns them respect for their knowledge and they are followed because of their leadership abilities. One can say that you cannot manage people. You manage tasks and lead people. Gary Convis, the first president of Toyota Motor Manufacturing Kentucky (TMMK), is cited by Liker as to what Toyota expects of leaders who must go beyond the getting results and do things right in the Toyota way.

“We believe in hands-on knowledge and not someone who comes out of college and becomes the boss. We look for someone who has the ability, personal drive and appreciation for the team members’ work itself. A person who is humble and can respect the work others do and can use their problem solving skills as they slowly go up the ladder have greater influence” *Liker (2004: 200)*

Convis goes on to explain that Toyota expects their leaders and managers to get their hands dirty on the shop floor. Toyota believes that managing cannot be done from behind a desk in the office.

Although his book is mainly about TPS and the systems therein, Ohno (1978) mentions the importance of management in his book where he expostulates that only management skills acquired by training on the shop floor are of any use.

In the west it has always been thought that the person with an MBA or a Masters in economics could just walk in and immediately run any business by looking at numbers and by using general management and leadership principles. No self-respecting Toyota manager would subscribe to this notion. As *Liker (2004)* describes the least effective type of manager is exactly the above mentioned kind. They only have general management expertise. They are the bureaucratic managers. The only way these managers manage is to make a lot of policies and rules and then measure performance relative to these. This takes the focus away from the some of the main tasks of a manager such as customer satisfaction and building a learning organization.

One has to remember that the philosophy of Toyota was established and handed down by the founding fathers themselves and the top leaders of Toyota were saturated with, believed in, lived and taught the philosophy.

Toyota has had a consistency of leadership and leaders that is unparalleled. There have not been the frequent changes in top leadership that is so common in the west where large companies change CEO's, directors and other top leaders at the drop of a hat. At Toyota no one believes that a new broom sweeps better. When Gary Convis was the President of TMMK he was asked how long it took to teach a manager hired from outside the Toyota Corporation to be a Toyota manager he answered "about ten years". The challenge he explains is not about learning the technical skills but learning the right behavioral skills. (*Liker 2004*)

### 3.3. Culture that promotes respect for people

The Toyota culture or the Toyota Way as it is also known is a result of its philosophy described in the fourteen principles.

According to Merriam –Webster dictionary culture is defined as:

"The set of shared attitudes, values, goals, and practices that characterizes an institution or organization"

Culture is always about humans. It is the people in a society or organization who create its culture. The success of Toyota is dependent upon its people and the way they act and interact. This can be regarded as Toyota's culture and the DNA of Toyota lies in its culture. From the very beginning of Toyota, since they started operations the leaders at Toyota, men like founder Sakichi Toyoda, Kichiro Toyoda, Eiji Toyoda and Taiichi Ohno believed that the key to success was investing in their most valuable resource, their people. Toyota has tirelessly evolved its culture from the very beginning and taught the Toyota Way to all its employees. It is a strong belief within Toyota's culture that its managers are leaders and that leaders are teachers.

"The Toyota way is first and foremost about its culture – the way people think and behave is deeply rooted in its philosophy and its principles. At the core it is about respect for people and continuous improvement and this has not changed since the company's founding" *Liker & Hoseus (2008: 4)*

The book discusses what culture is and the challenges one faces when trying to establish the culture of the people in the immediate environment. The culture from country to country and

place to place is different. When Toyota starts up a plant in a new country, they carefully study the local community to determine how best to develop the Toyota culture in that particular environment. This requires time and patience, in fact it takes years. It took about fifteen years at Toyota Motor Manufacturing Kentucky (TMMK) to develop the Toyota culture *Liker & Hoseus (2008)*. The authors state that the DNA of Toyota lies in its culture.

In contrast although almost all western company leaders talk about culture and claim that people are their most valuable resource the question is do they really believe it? The first to go when things go bad and cuts have to be made are people. Jobs and there by employees are made redundant.

Most companies will, if given the opportunity, move their operations and set up shop in a low cost country. They find it hard to pass up the chance of paying maybe 40 kronor an hour instead of 240. New people can be hired after a standard hiring process given some kind of employee training and the company will be in business. Is this enough to imprint the existing company culture into these people? Would management even know exactly what culture they were trying to imprint.

Toyota uses another definition of culture which fits in very well with what the Toyota Way is all about:

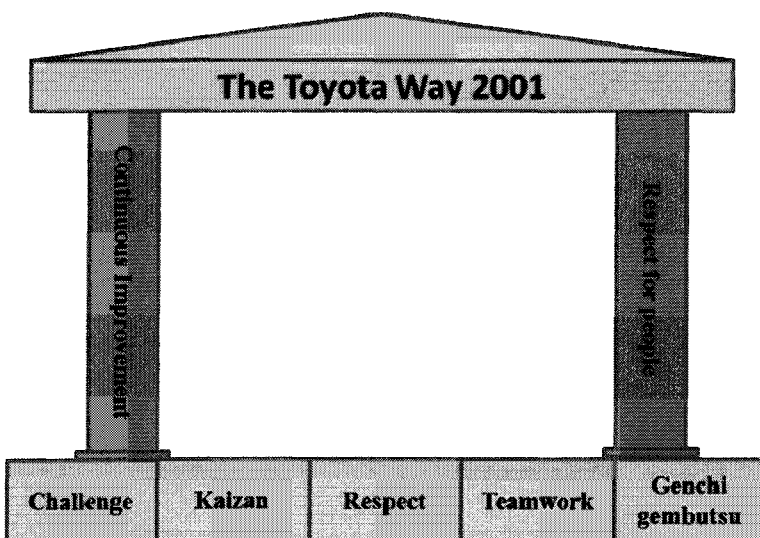
“The pattern of basic assumptions that a given group has invented, discovered or developed to cope with its problems of external adaption and internal integration, and that have worked well enough to be considered valid, and, therefore to be taught to new members as the correct way to perceive, think and feel in relation to these problems” *Liker & Hoseus (2008: 5)*

This shows us that culture touches deep into the hearts and minds of people in an organization, influencing how they perceive, think and even feel about common issues. Eiji Toyota led the company from the end of the 1940's for many decades. He led it through its most difficult times when it was struggling to survive and into and through its most prosperous times growing it into a global organization. Through all this he never wavered from his fundamental belief in what makes the company run. He is quoted by Liker

“People are the most important asset of Toyota and the determinant of the rise and fall of Toyota” *Liker & Hoseus (2008: 12)*

Until 2001 the Toyota culture had never been documented within the company. Toyota’s globalization and rapid growth however made it necessary to have some kind of documentation of the Toyota way particularly to teach the American managers. The project took 10 years and was led by Fujio Cho who was then the president of TMMK. After much debate, discussions and about twenty revisions Cho finally suggested they freeze it and call it “The Toyota Way 2001”

“The Toyota Way 2001” is an internal Toyota document. The figure below representing the Toyota Way house does not differ from the house described in fig.2. I would like to add this figure because this is the original Toyota Way house as described by the Toyota Leaders in 2001. It is important to understand that the continuous improvement that is one of the pillars refers to the continuous improvement of people, not processes.



*Fig. 4 The original Toyota Way house Liker & Hoseus (2008)*

Hiro Yoshi Yoshi who helped Cho in establishing TMMK is quoted here, Liker & Hoseus (2008), as he recalls the struggles in writing the document.

“The creation of Toyota Way 2001 took ten years. We started working on it in 1991. It was the first effort to explain to American executives Toyota principles. The Japan side could not really help because they never tried to articulate it. We created the first rough draft. Mr. Cho was here and we discussed it with Mr. Cho a lot. When Mr Cho went back to Japan and became the president of the whole company, finally The Toyota way came



up. Before that we had twenty revised versions of the Toyota Way. We could not get 100 percent agreement. We finally agreed to call it The Toyota Way 2001 to acknowledge there is not 100 percent agreement on what The Toyota Way is and it is always changing”  
*Liker & Hoseus (2008: 14)*

The document which is 13 pages long explains the Toyota Way House in fig 4. It is important to understand what Toyota means by respect for people. It is a very broad commitment and means respect for all people touched by Toyota including employees, customers, investors, suppliers, the local community there the plant is situated and society at large.

I will not go into any more detail about Toyota culture. I wanted to give the readers a peek at the enormous importance Toyota places on its culture and people for success. Just as I have attempted to do with regard to Philosophy and Leadership commitment.

### 3.4. Training

Although training will fall under the culture criterion, Toyota’s focus and passion for training is of such magnitude that I feel that this review would be incomplete without at least introducing the reader to a glimpse of their methodology.

Toyota’s training program is based on training its trainers who in turn train operators to perform each task? It is extremely interesting to note that Toyota has copied the “Training Within Industry” (TWI) manual developed by the Training Within Industry Service - American Bureau of Training under the War Manpower Commission. The manual was developed under the leadership of C.R. Dooley the Director of Training Within Industry foundation and published in 1941. The success rate of the TWI program used to train unskilled workers in the U.S.A. is documented. The increase in war time production compared to peace time production is given below.

1. Increased production 86 percent
2. Reduced training time 100 percent
3. Reduced labor hours 88 percent
4. Reduced scrap 55 percent
5. Reduced grievances 100 percent

600 client companies of the TWI service were monitored from 1941 to 1945, when it ceased operations, to obtain the above data. *Graupp & Wrona (2006)*

Dooley's dream was to use the program after the war in peace time industry to put America in the forefront of the industrialized world.

“We have learned a great deal in wartime which we can and must carryover to peacetime in that field of industrial activity, which, for lack of a better name, is called “training”. During the war plants needed to use training in order to supply the needs of the armed forces. Now, plants must use training if they are going to survive in competitive situations and if they are going to keep on providing jobs and wages for workers” *Graupp & Wrona (2006 xix)*.

This did not happen in the USA. While Toyota clung on to every word and implemented TWI as their training program, the interest for TWI was already fading in America by the end of 1944 as orders from the military declined. Dooley's words were soon forgotten.

One could say that Toyota had this wonderful knack of adapting every smart method, concepts and system the Americans came up with and adapting them to improve The Toyota Production System.

TWI was just another of these wonderful concepts.

TWI is based on three parts:

1. Job instructions
2. Job methods
3. Job relations

During WW 2 the TWI people developed a model for supervisors called the “Five needs model for good supervisors. The model describes the five essential needs that have to be satisfied before any supervisor can successfully fulfill his responsibilities on the job.

The first two needs focus on the types of knowledge while the last three focus on types of skill. The first two can be obtained by reading books or attending classes but the last three can

only be obtained by practice and repetition. *Graupp & Wrona (2006)* All Toyota's trainers are trained in the TWI methodology.

The trainers have pocket cards with the most important points of each of the three stages, job instructions, job methods and job relations. These act as a set of instructions describing points to remember for each stage. Each stage has four major points. An example of the job instruction pocket card both front and back is given below.

Fig.5 and fig.6 show the front and back of the job instruction pocket card that each qualified trainer carries.

<p><b><u>Front of the TWI Job Instructions Pocket Card</u></b></p> <p><b>How to Get Ready to Instruct</b></p> <p><b>Have a time table</b> How much skill do you expect which workers to have - by what dates?</p> <p><b>Break down the job</b> into concise Instructor Notes List the major steps (what to do)</p> <ul style="list-style-type: none"><li>• The important steps that advance the work</li><li>• Small enough to chew and swallow in one bite</li><li>• Ideally with roughly similar amount of work in each step</li><li>• Start each major step with an action verb</li></ul> <p><b>Pick out the key points (how to do it)</b></p> <ul style="list-style-type: none"><li>• Safety factors are always a key point</li><li>• Things that make or break the success or failure of the job</li><li>• Tricks of the trade that make the job easier to do</li><li>• If more than 5 key points, consider breaking into separate major step</li></ul> <p>Summarize the reasons for key points (why)</p> <p><b>Have everything ready</b></p> <ul style="list-style-type: none"><li>• The right equipment, materials, supplies, and instruction aids</li><li>• Ensure that all process documentation is up to date to accurately reflect current best practices</li><li>• Ensure that the worker has permanent and easy access to process documentation and <u>training materials</u></li><li>• <b>Have the work place properly arranged</b></li><li>• Just as the worker will be expected to keep it</li></ul>
--

Fig.5. Front of job instruction pocket card. TWI Service War Manpower Commission (1943)

## Back of the Job Instructions Pocket Card

### How to Instruct

#### Step 1 - Prepare the worker

- Put the person at ease
- State the job
- Find out what the person already knows about the job
- Get the person interested in learning the job
- Place the person in the correct position

#### Step 2 - Present the operation

- Tell, show, and illustrate each major step - one at a time
- Stress each key point, and reasons for each key point
- Written process documentation should be introduced only AFTER demonstration.
- Instruct clearly, completely, and patiently
- Teach no faster than the learner can master

#### Step 3 - Try out performance

- Have the learner do the job - with the instructor allowing the learner to work in silence, but correct any errors immediately and perhaps again demonstrate anything that wasn't fully learned
- Have the learner do it again - this time explaining each important step
- Have the learner do it again - this time explaining every key point
- Have the learner do it again - this time explaining the reasons for every key point
- Make sure the person understands. Continue until **you** know **they** know.

#### Step 4 - Follow up

- Put the person on their own
  - Make clear how much work is expected to be done over what period of time
  - Now might be a good time for a brief refresher on the concepts of takt time and pitch
- Ensure that the person knows where to find process documentation.
- Designate to whom the person goes for help.  
Almost always the same supervisor that did the original training.
- Check back frequently to see how things are going.
- Encourage questions.
- Taper off extra coaching as it become evident that the person has mastered the new skill.

**If the worker hasn't learned, the instructor hasn't taught. !!**

Training Within Industry War Manpower commission (1943)

Fig.6. Back of the job instruction pocket card. TWI Service War Manpower Commission (1943)

The trainers are equipped with similar pocket card for the other two stages of the training program, i.e. job methods and job relations.

The use of expert and qualified trainers using TWI ensures that Toyota has a standardized methodology for training its people. This in turn ensures that all team members receive exactly the same training in exactly the same way. The program to train the trainers takes six months.

In addition to the above mentioned books, many articles, papers authored by Toyota veterans and a couple of master thesis have been studied. They are all emphatic about the necessity of a philosophy combined with management commitment and respect for people are imperative for the success of a sustainable implementation of lean.

An article, written by Eiji Toyoda, Toyoda (1985) about the roots of TPS describes implementing the then new concept of flow production and just in time at the Koromo (Honsha) factory in 1937. The introduction of flow production and just-in-time in 1937 was, for Toyota, an epoch making change. The key issue was how to make this new concept stick within the new company. Before anything else could be accomplished Eiji Toyoda says they had to thoroughly educate the employees, namely the supervisors and managers. To bring this about Eiji Toyoda says they had to essentially brainwash these people accustomed to the old style of production. *Toyoda (1985)*

Here Eiji Toyoda again nails down the importance of management commitment and the amount of effort needed to bring about a cultural change. He specifically states that they had to brainwash, not the operators but, the managers and supervisors.

Another illuminating paper is “Decoding the DNA of The Toyota Production System” By Spear and Bowen”. Here too management commitment and the dedication to training and learning are emphasized. The leadership model is as relevant for the first level “team leader” supervisors as it is for those at the top of the organization. According to Spear and Bowen this is one of the ways that everybody at Toyota shares in the development of its human resources and thereby develops a learning organization. Spear and Bowen claim that, in reality, Toyota is developing an organization of scientists who through scientific experimentation are continuously improving the processes. They state that this scientific method is so ingrained at Toyota that it does not promote the command and control environment one might expect in a company with such a high degree of specification and structure. On the contrary the method and system actually stimulates workers and managers to engage in the kind of experimentation and knowledge sharing that is widely recognized as the corner stone of a true learning organization. *Spear and Bowen (1999)*

Ana Valentinova Kovacheva in her master thesis “Challenges in Lean Implementation”, *Kovacheva (2010)* also claims that, lack of company culture and senior management commitment are challenges that have to be overcome for successful implementation. Citing *Kettinger and Grover (1995)* as cited in *Motwani (2003)* Kovacheva claims that any significant change requires the following success factors.

1. Strategic initiative of top managers acting as leaders in defining and communicating the vision of change.
2. Willingness to learn.
3. Cultural readiness
4. Balanced network relationships
5. Knowledge sharing
6. Prescribed process management and change management practices  
*Kovacheva (2012: 20)*

The relevance of these points the three main criteria in this thesis can easily be seen.

In addition Kovacheva writes:

“What is needed most is that managers should essentially change their philosophy of management. The role of the manager as boss needs to be replaced by allowing responsibility in the lower levels of the organization”. *Kovacheva (2010: 21)*

I disagree with Kovacheva on one point though. She claims that the financial capability of a company is a critical factor in implementing lean. *Kovacheva (2010)* Toyota was practically bankrupt when they started with TPS and Taiichi Ohno had no money, consultants, presentations, post it cards or any of the fancy things modern companies seem to need to start any kind of improvement. Ohno just worked hard with his engineers on the shop floor and made it work.

Another thesis “Critical factors of Lean Implementation in Manufacturing Environments” *Victor Simões (2008)* shows reasons for failure categorized using a rating system from 1 - 10

Lack of management commitment and involvement	rating 9
Lack of vision and strategy ( <b>philosophy</b> )	rating 7
Lack of strong leadership ( <b>management commitment</b> )	rating 6
Lack of supportive Human resources ( <b>Culture-respect for people</b> )	rating 5
Lack of supporting organizational culture based on substantial pro-active improvement. ( <b>Culture - respect for people</b> )	rating 5
Failure to engage employees & mobilize Change champions ( <b>Culture - respect for people</b> )	rating 5

Highlighted text within brackets added by author

Once again one can easily see that the main reasons for failure can easily be tied to the fact one or more of the criteria stated in this thesis is lacking.

The table below *Ahrens (2006: 23)* agrees with what Toyota “Gurus” like Taiichi Ohno, Jeffrey Liker, Michael Hoseus, David Meier, Steven Spear, Kent Bowen, Gary Convis and Eiji Toyoda have been stating.

*Table 1: Critical success factors resulting from the TPS philosophy Ahrens (2006: 23)*

<b>Basic TPS and lean ideas</b>	<b>Understanding the TPS focus</b> - The TPS focus lies on improving quality and on-time delivery by lead-time reduction. Cost savings based on productivity improvement follow automatically.
	<b>Understanding the lean philosophy concerning productivity improvements</b> - The idea is to identify excess manpower and use it effectively in the continuous improvement process. Therefore the lean philosophy has nothing to do with headcount reduction.
	<b>Understanding the need to eliminate waste</b> - Waste has to be reduced in operations and offices.
	<b>Understanding the meaning of the basic TPS tools</b> - The basic tools just-in-time and automation help to implement the lean thought process in operations but they seem to lack adaptability the rest of organisation, i.e. in marketing or finance.
	<b>Understanding that the TPS is a fundamental management philosophy and not a set of tools to improve production</b> - The TPS is not a set of tools but a fundamental manufacturing and management philosophy, in which human development builds the central point.
	<b>Understanding the focus on people first</b> - The key element in the development of lean production is the role of teams and the individual.

1. Row one in the table is about strategy
2. Row two is about culture - respect for people
3. Row three is about strategy
4. Row Four is about strategy
5. Row five is about philosophy
6. Row six is about culture – respect for people

The papers and thesis studied also go down to the next level where the use of tools and methods are discussed. This thesis does not discuss tools and methods. The hypothesis is that if the three vital criteria are met then everything else will invariably fall into place. As mentioned elsewhere in this thesis, TPS did not come from the tools, the tools came from TPS.

I would like to include a story that illuminates the difficulties that outsiders can have of deciphering Toyota’s culture and thereby accessing the true secret of Toyota’s success.

When the former President of Ford Red Polling asked Mr. Cho the President of TMMK for a tour, Mr. Cho arranged a grand tour for Polling. Mr. Cho was extremely respectful of Polling as he remembered the contributions Ford had made in to the early development of Toyota. Polling and his party were allowed to go anywhere, see whatever they wanted to and ask anyone any question. A hour and a half into the visit Mr. Cho asked Polling what he thought. Polling replied saying he did not see anything unusual. Mr. Cho then asked Polling if he had any suggestions and Polling made a few. It was very clear to Mr. Cho that Polling was very disappointed with the visit as he had not seen what he had expected to see. After the visit Mr. Cho gathered his team that had arranged the visit and told them this. Liker & Hoseus (2008)

“We have learned a very important lesson today. We have the same equipment and systems as Ford, but what Mr. Polling did not see was our competitive advantage, which is our people. We are successful because we have intelligent, caring, highly successful team members”. *Liker & Hoseus (2008: 8)*

I would like to emphasize that Toyota addresses all its employees as team members.



## 4. Research methodology

### 4.1. Objectives of the thesis and the research questions

According to the Oxford English dictionary a scientific method is defined as: "A method or procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses".

The online dictionary <http://dictionary.reference.com> defines a scientific method as; "A method of research in which a problem is identified, relevant data gathered, a hypothesis is formulated from these data, and the hypothesis is empirically tested".

The method of course depends on one's world view or ontology. Once the ontological perspective is established, one approaches the epistemology which is the study of knowledge and justified belief. That is to say how we can establish what we really know about reality and how we can, in the case of social sciences, proceed to obtain knowledge about society and people. It is in a nutshell concerned with the nature of knowledge.

This in turn will influence one's choice of methods. (fig.7)

This aim of this thesis is to provide a theoretical guide to understanding some key philosophies, concepts and methods of Lean Manufacturing and some key factors that either help or hinder a successful implementation of Lean manufacturing.

There is a considerable amount of literature available already on this subject. The majority of authors like Jeffrey K. Liker in his books specially *The Toyota Way* and *Toyota Culture*, Taiichi Ohno in his classic book *The Toyota Production System*, Spear and Bowen in their paper *Decoding the DNA of Toyota*, to name a few, all argue that although manufacturing system analysis prior to implementation is an important criterion the total and absolute success of implementation is totally dependent on leaders understanding and practicing the philosophies, culture and principles of the company.

The author will provide an appropriate epistemology based on its suitability for the research aimed at conforming or denying the arguments presented by the authors. The question is important because successful implementation could mean that a company can, not only be

successful in times of growth but also in times of no growth or recession, have the ability to prosper. There is the additional factor that a botched implementation is an expensive and discouraging affair where all the resources invested in the failed implementation are lost.

#### 4.2. Philosophical assumptions

When starting out on any research it is imperative that the researcher is aware of his/her research philosophy assumptions and how his/her approach to the research subject. (*Falconer and Mackay, 1999*)

I will here clarify and discuss the ontology and epistemology and their influence on the lean research.

#### 4.3. The Ontology

There are several ways in which one can view the world: From a social sciences point of view the debate has primarily been between the positions of internal realism, relativism and nominalism.

The internal realists' position is that concepts within social sciences such as racial discrimination or social class can be treated as real phenomena that exist independent of the researcher. These phenomena have real consequences for the life chances and careers of the people and although measuring them or even agreeing on what they mean can be difficult they do exist and have consequences. (*Easterby-Smith et al.2012*)

The relativist stand is that these phenomena exist but are defined and experienced differently by different people depending on the class and race they belong to and the countries they live in. Basically the truth can vary from place to place and from time to time. (*Easterby-Smith et al.2012*).

The viewpoint of nominalism suggests that whatever we name or call our experiences are crucial. The position suggests that there is no truth. Social reality is created by people through language and discourse. How people try to establish different versions of the truth is the interesting question. (*Easterby-Smith et al.2012*).

The Ontology platform chosen is relativist and basically states that the truth can vary according to the location, time and individual experience. For example:

*“It is accepted that social class and racial discrimination are defined and experienced differently by different people and this will depend greatly on the classes and races to which they belong and the contexts or countries in which they live. Thus there is no single reality that can somehow be discovered, but many perspectives on the issue. The relativist position assumes that different observers may have different viewpoints” (Easterby-Smith et al.2012:20).*

One could say that; “what counts for truth can vary from place to place and from time to time” (Collins 1983: 88)

This relativist position fits best in regard to the research carried out as the qualitative data was collected through a questionnaire and interviews. Both methods register the individual opinions of the different people who participated, in different locations and their experiences varied in time, i.e. not all of them experienced lean implementation attempts at the same time.

#### 4.4. Epistemology

In the previous section we saw that our ontological approach is relativistic. Now we have to see how we can learn about our problem, or determine our epistemological direction. Epistemology describes different ways to examine and find out about the nature of the physical and social worlds

*“Epistemology is about different ways of inquiring into the nature of the physical and social worlds” (Easterby-Smith et al.2012:21).*

One could say that it is the study of knowledge and justified belief. That is to say how we can establish what we really know about reality and how we can, in the case of social sciences, proceed to obtain knowledge about society and people. It is in a nutshell concerned with the nature of knowledge.

Epistemology modifies the choice of the methodology and justifies the knowledge gleaned. The methodology will justify the method for data collection and analysis. (fig.7)

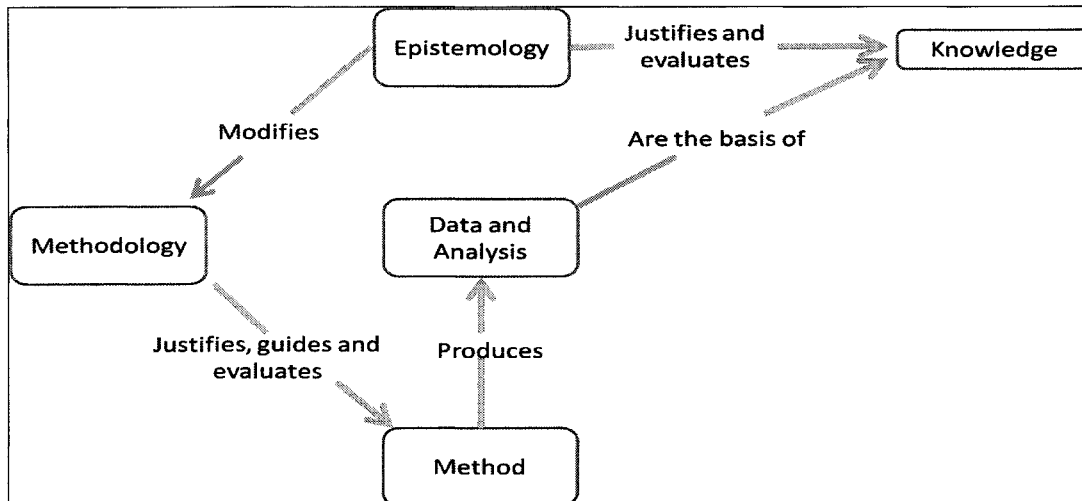


Fig. 7 The simple relationship between Epistemology, Methodology and Method (Carter and Little 2007)

A significant epistemological question is whether empirical data is needed to form the basis or foundation for research, or can knowledge be built solely on pure thinking and reflection.

According to the first perspective

*“Knowledge must be built on that which we observe. Everything else is pure speculation.*

*According to the second perspective there are powers and structures in society that we cannot observe” (Adam Smith 1759).*

For the purpose of data gathering for this thesis I would like to stay with the first perspective i.e. the data gathered for this thesis is empirical.

According to (Easterby-Smith et al., 2012), epistemology has focused on two contrasting views as to how social science research should be conducted. The one is **Positivism** and the other is **Social constructionism**.

### **Positivism:**

The key idea of positivism is that:

*“The social world exists externally and its properties should be measured through objective methods rather than being inferred subjectively through sensation, reflection or intuition” (Easterby-Smith et al.2012:22).*

(Easterby-Smith et al., 2012), states that positivism builds on the assumption that knowledge is only significant if it is based on the observations of an external reality being researched and the ontological assumption that reality is indeed external and objective.

**Social Constructionism:**

Social constructionism argues that reality in social sciences is not objective and exterior. Reality according to the epistemology of social constructionism is based on people’s experiences which they share mainly through language, that is to say that reality is defined more by people than by objective and external facts. The researcher using this epistemology should try to understand the how people’s experiences and understanding of situations will dictate their actions.

The features of these two epistemologies are in direct contrast to each other. (See tab.2

*Tab.2 Contrasting implications of positivism and social constructionism. (Easterby-Smith et al., 2012)*

	Positivism	Social construction
<b>The observer</b>	Must be independent	Is a part of what is being observed
<b>Human interests</b>	Should be irrelevant	Are the main drivers of science
<b>Explanations</b>	Must demonstrate causality	Aim to increase general understanding of the situation
<b>Research progresses through</b>	Hypothesis and deductions	Gathering rich data from which ideas are induced
<b>Concepts</b>	Need to be defined so that they can be measured	Should incorporate stakeholder perspectives
<b>Units of analysis</b>	Should be reduced to the simplest terms	May include the complexity of whole situations
<b>Generalization through</b>	Statistical probability	Theoretical abstraction
<b>Sampling requires</b>	Large numbers selected randomly	Small numbers of cases chosen for specific reasons

There is another distinction to be made and this is between constructionism and strong constructionism.

*“The idea of “normal” constructionism refers to those who construct their own knowledge, while accepting the existence of independent objective knowledge; whereas strong constructionism assumes that there is no difference between individual and social knowledge” (Easterby-Smith et al.,2012:25)*

The epistemology this thesis is based on is mainly that of constructionism but overlaps a little in the analysis/interpretation area where in addition to triangulation one also indulges in sense-making and understanding.

The questionnaire and interviews clearly accesses and uses the experiences of those who were directly involved in the implementation of Lean. This also makes a strong case for the constructionism epistemology.

## 5. Methodology

The research started with a comprehensive review of literature on the Toyota philosophy, culture, methodology and tools. The review identified a set of key criteria that, all the authors studied consistently insisted on, had to be met if one is to succeed in the implementation of true, sustainable lean in the spirit of Toyota.

*Tab.3 Methodological implications of different epistemologies Easterby-Smith et.al (2012:25)*

<b>Ontologies</b>	<b>Realism</b>	<b>Internal Realism</b>	<b>Relativism</b>	<b>Nominalism</b>
<b>Epistemology</b>	<b>Strong Positivism</b>	<b>Positivism</b>	<b>Constructionism</b>	<b>Strong Constructionism</b>
<b>Methodology</b>				
Aims	Discovery	Exposure	Convergence	Invention
Starting Points	Hypothesis	Propositions	Questions	Critique
Designs	Experiment	Large surveys, multi-cases	Cases and surveys	Engagement and reflexivity
Data Types	Numbers and facts	Numbers and words	Words and numbers	Discourse and experiences
Analysis/interpretation	Verification / falsification	Correlation and regression	Triangulation and comparison	Sense-making understanding
Outcomes	Confirmation of theories	Theory testing and generation	Theory generation	New insight and actions

Based on the epistemology of constructionism, the methodology chosen, to validate the propositions derived through the literature review, was a survey comprising of a questionnaire and a personal interview program. In keeping with the epistemology of constructionism, the data types so obtained comprised of words and numbers.

In the questionnaire the questions were put in a predetermined order and under the interviews the author did not in any way express his own views, but was just friendly enough to facilitate information extraction. This traditional model, Holloway and Jefferson (2000), assumes that ideas, feelings and knowledge that exist within a person and will come forth in the interview or the questionnaire, although the degree of truthfulness and completeness can vary.

There are two criteria that the success of this model is dependent on. One is how open and articulate the respondent is and the other is the skill of the researcher is with regard to creating good questions for the questionnaire and also in conducting the interviews.

Data was gathered from three different groups, who had been involved in the implementation of Lean, the consultants who sell implementation services, the top management who buys it

and the rest of the employees (middle management, supervisors and operators) who are directly involved in the day to day implementation and also bore the brunt of the work and frustrations involved.

Twenty different reasons for failure were described in the questionnaire. All the reasons are relevant to and can be connected to the lack of one or more of the three success criteria. Each reason was graded on a scale of 1 – 10 with ten being the most important reason for failure and one being the least important. The average score for each of the twenty reasons was calculated from the returned questionnaires. The results are presented in table 5

Tab. 4 Questionnaire

Nr.	Reason for failure	Lack of Philosophy	Lack of Management Commitment	Lack of Culture Respect for people
1	Management attempts to use lean as a method to reduce headcount			X
2	Management uninvolved - company philosophy unknown to the people		X	
3	Management does not understand the philosophy of Lean or its core concepts	X		
4	Management not competent enough to be teachers (sensei)		X	
5	Management trying to use lean as a quick fix for fast profits	X		
6	Management does not understand the concept of value stream mapping		X	
7	Management convinced that lean is dependent on culture ( Japanese)	X		
8	Management wants everyone else to change but is unwilling to change itself.		X	
9	Management does not devote enough resources to the implementation		X	
10	There is no consistency of leadership	X		
11	Implementing lean tools taken out of context – not understanding the philosophy or the principles behind the tools (exaggerated focus on 5S, kanban etc.)	X		
12	Continuous improvement is ad-hoc, not carried out scientifically, not a learning organization.			X
13	Management has no strategy for change	X		
14	No total understanding of waste within the organization	X		
15	No courage or true belief in lean philosophy to commit fully - lean is just something to try when people are not “busy working”	X		
16	Management does not trust the people to solve problems in times of crisis			X
17	Short term profits more important than long-term benefits – no continuity	X		
18	Training of personnel not in keeping with the philosophies of lean (learning organization)			X
19	Not adjusting the lean principles to fit own organization – trying to carbon copy Toyota’s philosophy	X		
20	Implementation of lean left in the hands of consultants		X	



Tab. 5 Results

Reason for failure	Points
Management does not understand the philosophy of Lean or its core concepts	9,5
Management uninvolved	9,3
Management not competent enough to be teachers (sensei)	9,2
No real organizational change – lean is just something to try when people are not busy working	9,1
There is no consistency of leadership	9,1
Management wants everyone else to change but is unwilling to change itself.	9
Training of personnel not in keeping with the philosophies of lean (learning organization)	8,9
Management trying to use lean as a quick fix for fast profits	8,8
Implementing lean tools taken out of context – not understanding the philosophy or the principles behind the tools (exaggerated focus on 5S, kanban etc.)	8,6
No total understanding of waste within the organization	8,1
Implementation of lean left in the hands of consultants	8
Management does not devote enough resources to the implementation	7,8
Concept of empowerment is not understood in the organization	7,7
Short term profits more important than long-term benefits – no continuity	7,3
Continuous improvement is ad-hoc, not carried out scientifically and not sustainable	7,2
Management convinced that lean is dependent on culture ( Japanese)	6,5
Not adjusting the lean principles to fit own organization – trying to carbon copy Toyota	6,4
Lean manufacturing or Six Sigma tools are used to solve every problem	6
Management attempts to use lean as a method to reduce headcount	3,7
Management does not understand the concept of value stream mapping	3,4

During the interviews the interviewer, (the author) to ensure that there was no bias, did not respond in a substantive manner to what the interviewee was saying. The questions asked were open and great care was exercised to ensure that no leading or suggestive questions were employed. Below is a list of the main questions.

- What do you think is necessary for the successful transition to lean manufacturing?
- What in your opinion is the most difficult challenge?
- Who should be responsible for the transition?
- Who do you think should lead the transition?
- Who did the training
- Why do you think the implementation attempt failed?
- How do you feel about the degree of management commitment?
- What was the company philosophy?
- How was the company philosophy communicated?
- What training was given?
- Where do you think the consultants were useful?
- How do you feel about the consistency of leadership?
- What was the change strategy?
- How do you feel about the tools that were recommended?
- What was the effect?
- Why do you think implementation did not succeed?

The points below summarize the responses to the interview.

- Top leaders were not involved other than in giving speeches and telling us lean was important
- Leaders never did any training they did not know anything
- There was never any company philosophy communicated
- Nobody ever mentioned philosophy or culture
- Leaders were only interested in the results of any improvement work. These had to come as quickly as possible.
- There was no formal training program or development program for the people
- The leaders depended on the consultants for everything
- We saw no advantage to all the boards and they hung up
- We spent more time in meetings than in doing work

What we can gather both from the results depicted in the questionnaire and the interviews conducted is that leaders are totally unaware of what is really needed for the implementation of lean.

## **6. A brief history of manufacturing**

In the early days before the industrial revolution manufacturing was done by individual craftsmen making products one at a time, by hand. Settlements and villages were isolated and most manufacturing was really cottage industries. Where people made and sold whatever products were necessary as a subsidiary to their main occupation which was agriculture. Textile manufacture is a good example of this where the people in the country made textiles cheaper than craftsmen in the city. The country folk also had a second source of income, agriculture. This enabled them to undercut the city craftsmen.

The quality of the products manufactured by craft production was dependent on the skill of each individual craftsman but it was generally of good quality. Repairs however could be expensive. Any spare parts had to be hand crafted and one could safely say that interchangeability between parts was nonexistent. Delivery times were long and volumes were low. The manufacturing skills were passed on to the next generation either within the family (father to son etc.) or by training apprentices.

The industrial revolution (1760 – 1850) replaced manpower with machines and muscle power with steam and later electricity to run the machines. This paved the way for the transition from craft production to mass production. This meant that machines could be used to make machines. As the precision of the machines increased the skill sets needed by the operators decreased.

According to many historians mass production began around 1800. In America it was in Eli Whitney's firearms factory that the first the labor process that likened the labor process of modern industrial production was initiated.

In England a French engineer Marc Brunel set up a process for producing wooden pulley blocks using a sequence of machine operations. Using this process he reduced the required work force from a 110 men to 10 men to produce 160000 pulley blocks a year.

During the 1880's – 1890's Taylor developed his ideas and they reached their peak during 1910 – 1920.

The other factor that contributed to mass manufacturing was the assembly line. The first assembly lines were used by the 19<sup>th</sup> century meat packing industry in America. Henry Ford observed this and in 1913 designed his assembly line for the Ford plant. He started with the manufacturing line for magneto flywheels where he cut the manufacturing time for a wheel from 20 minutes to 5 minutes. He then introduced the process to his chassis assembly and by the end of April 1914 had reduced the assembly time from an original 12.5 man hours to 93 man minutes. The stage was set and mass production took off. However it should be noted that the key to the enormous success of mass production was not so much the moving assembly line but the complete and consistent interchangeability of parts and the simplicity of assembly i.e. attaching them to each other.

From Fords manufacturing system developed the system that is hailed as the most efficient and effective manufacturing system of all the “Toyota Production System” or Lean Manufacturing as it is also called. In the 1930’s Toyota was a struggling auto manufacturer making poor quality vehicles. They made mostly trucks. Their technology was extremely primitive.

*“Hammering body panels over logs” Liker (2004:20)*

The Toyota leaders after carefully reading Henry Ford’s book “Today and Tomorrow” visited the Ford factory and GM studied mass manufacturing and the economies of scale and tested the mass manufacturing ideas in their loom production. They realized two things.

1. The Japanese market was too small and fragmented to support the high production volumes that the American mass manufacturing methods would produce
2. The Americans (Ford) were 10 times more productive than their counterparts in Japan

The challenge then as Toyota realized was to adapt mass production to suit the home market. To survive they had to succeed in this endeavor. This, as history has shown, they accomplished with great success. The Korean War (June 1950 – July 1953) was, for Toyota, a great opportunity to grow and they did this with success and had a growing automotive business.

In 1950 when the Toyota leadership revisited the US they found that the mass manufacturing techniques from the 1930 had not changed much. What they observed was a lot of waste. On their return Eiji Toyoda gave Taiichi Ohno one task. This was to catch up with the Americans in three years. Ohno went down to the place where he was most comfortable, the shop floor, and The Toyota Production System or Lean Manufacturing was born.

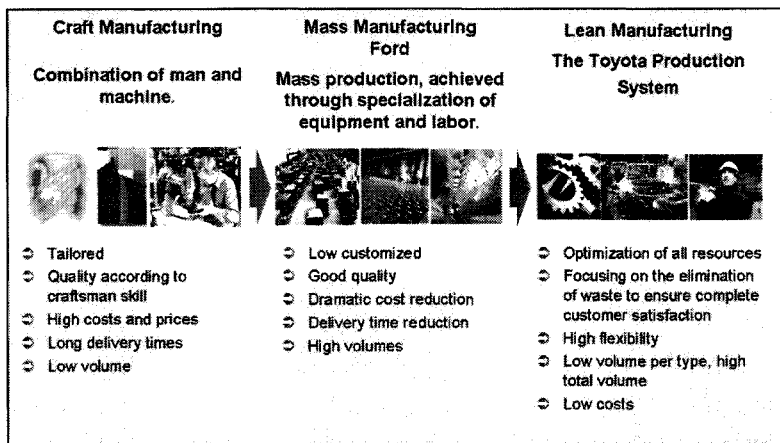


Fig.8 From craft to mass manufacturing to lean

### 6.1. How the term “Lean” was coined

Before proceeding any further I would like to clarify the term “Lean Manufacturing”. This term or nomenclature has been used and misunderstood on a worldwide basis and I wish to give the reader an orientation of how the term “Lean Manufacturing” originated.

In 1985 the International Motor Vehicle Program (IMVP) was started to undertake a detailed study of the new Japanese techniques in motor manufacturing. At the time the process of Craft Production and Mass production were defined and understood. An American engineer by the name of John Krafcik who was a member of the IMVP program posed a question. “How do we name the production system used by Toyota? He said. “It is not craft production or mass production so what shall we call it? Well since the Toyota Production System combines the advantages of craft production and mass production while avoiding the high costs of the former and the rigidity of the latter while using less of everything to produce quality products in enormous volumes and variety it was decided to call it “Lean” manufacturing.

The term “Lean Manufacturing” is therefore nothing more than another name for the “Toyota Production System” or its short form; TPS.

## **7. Traditional Mass Production Thinking**

TPS is in many ways an adaptation of mass manufacturing so what did Toyota do and not do when adapting mass manufacturing to suit their needs?

To be able to better understand the do's and don'ts when implementing TPS one should also have an better understanding of mass manufacturing.

Mass manufacturing is basically production en masse. Production is based on being able to manufacture large amounts of standardized products very quickly. One advantage is that exact copies of a defined product or spare part can be manufactured very quickly in large quantities. The assembly line is then used to send partially complete products down a designated production path to workers who each work on an individual step of the manufacturing process. This is far more efficient than craft production where a craftsman works on a whole product from start to finish. This solves the problem of having to make or customize spare parts for individual product

For the purpose of this thesis I will not describe craft production any further, but for the purpose of later comparison with TPS, describe some of the main principles of mass production.

Let us take a look at the way equipment is organized in traditional mass production. As Mass Production is based on producing large numbers of the same product, the ideal way to organize your equipment and processes is to group similar machines and similarly skilled workers together. There is never any one piece flow which is a hallmark of Toyota. This leads to the fact that mass production thinking sets up departments based on different disciplines.

For example most any company or plant in Norway is set up with a department of mechanical engineering, a department of electrical engineering, an accounting department, a purchasing warehousing and logistics department and a manufacturing department etc. The mechanical department can then be divided into sub-departments such as a sub-department for welding, a sub-department for sheet metal work and the like. The concept is to glean the following benefits or perceived benefits, the financial benefit of large scale manufacture i.e. economies of scale and flexibility of scheduling.

## 1. Economies of scale

The definition of Economies of scale is;

*“The increase in efficiency of production as the number of goods being produced increases. Typically, a company that achieves economies of scale lowers the average cost per unit through increased production since fixed costs are shared over an increased number of goods”* (<http://www.investopedia.com/terms/e/economiesofscale.asp#axzz2BH3Z5ggQ>)

What this means is that mass production focuses on getting the most out of every man and machine regardless of internal or external customer demand.

For example having one huge stamping press to meet the needs of all the factory's products would lead to the smallest capital cost per piece. You would then want to run that press flat out 100% of the time to get the greatest asset utilization stopping only to change dies. On paper this may look good but if there is no customer demand then who is buying the product. In times of great growth where customer demand is greater than rate of manufacture then one can get away with this. But the trick is to survive periods of no growth or even recession.

Similarly by organizing people into departments you can focus on best practice in each professional specialty and squeeze the highest productivity (or innovation) out of each person. The danger here is however that you also cause an atmosphere of competition between departments and people get more concerned about the good of their department than the common good of the company as a whole.

## 2. Apparent flexibility in scheduling

When you put all the welders together in one department, it's easier for the welding department manager to schedule available machines and welders to any job that comes up. This sounds very efficient. In one piece flow cells, you take those welders and welding machines and dedicate them to a one piece cell. They are now no longer free to do any other work that might come up. The point is should any other work than the work a customer pays for come up?

After World War 2 mass production focused solely on costs or cost reduction. Companies focused on making bigger machines and through the economies of scale thinking tried to bring down the costs. People were not thought of as an asset. Organizations would strive to automate to replace people if the costs were justified. *Liker (2004)*

One of the descriptions of mass production is that "the skill is built into the tool" which means that the worker using the tool need not have the skill. This eliminates the greatest resource any company has, its people. Mass production all but eliminates the use of the company's intellectual property, the brain power of its employees, and therefore eliminates the sustainable scientific continuous improvement that is a part of the foundation of lean manufacturing.

If you make a journey through almost any organization in Norway you will probably see materials, invoicing, service calls and prototype parts in R&D etc. being transformed into something the customer wants. But on closer inspection these are often being diverted into a pile of inventory someplace where they sit and wait for long periods of time until they can be moved to the next process step.

Certainly people do not like to be diverted from their journeys and wait in long lines. Taiichi Ohno, the father of lean, viewed materials as having the same degree of impatience. WHY? If any large batches of material are produced and then sit and wait to be processed, if service calls are backed up, if R&D are receiving prototype parts they don't have time to test, then this sitting and waiting to be moved to the next operation becomes waste. This results in both your internal and external customers becoming impatient and no value is being added to your product and thereby to your business. You are not making money as nobody is paying you for the waiting, the transport between the different departments or the extra personnel.

This kind of thinking ruled the manufacturing world, with the exception of Toyota until the 1980's. Then finally the business world got the message that Toyota had realized decades before. That focusing on the reduction of waste and quality of product and process actually reduced costs more than when focusing on reducing only costs. Then in the 1990's through the work of MIT's Auto Industry program, which really was a program to find out how and why Toyota and other Japanese manufacturers were so much better than U.S. manufacturers and through the best seller, "The Machine That Changed the World" (*Womack et al. 1991*),



based on the MIT program’s research the manufacturing industry discovered “Lean Production”. Let it, however, be said that discovering “Lean Manufacturing” does not in any way facilitate or guarantee its successful implementation.

Traditional mass production thinking is one-sidedly focused on achieving the lowest possible unit cost and then creating procedures and instructions to achieve the cost objective (fig. 9)

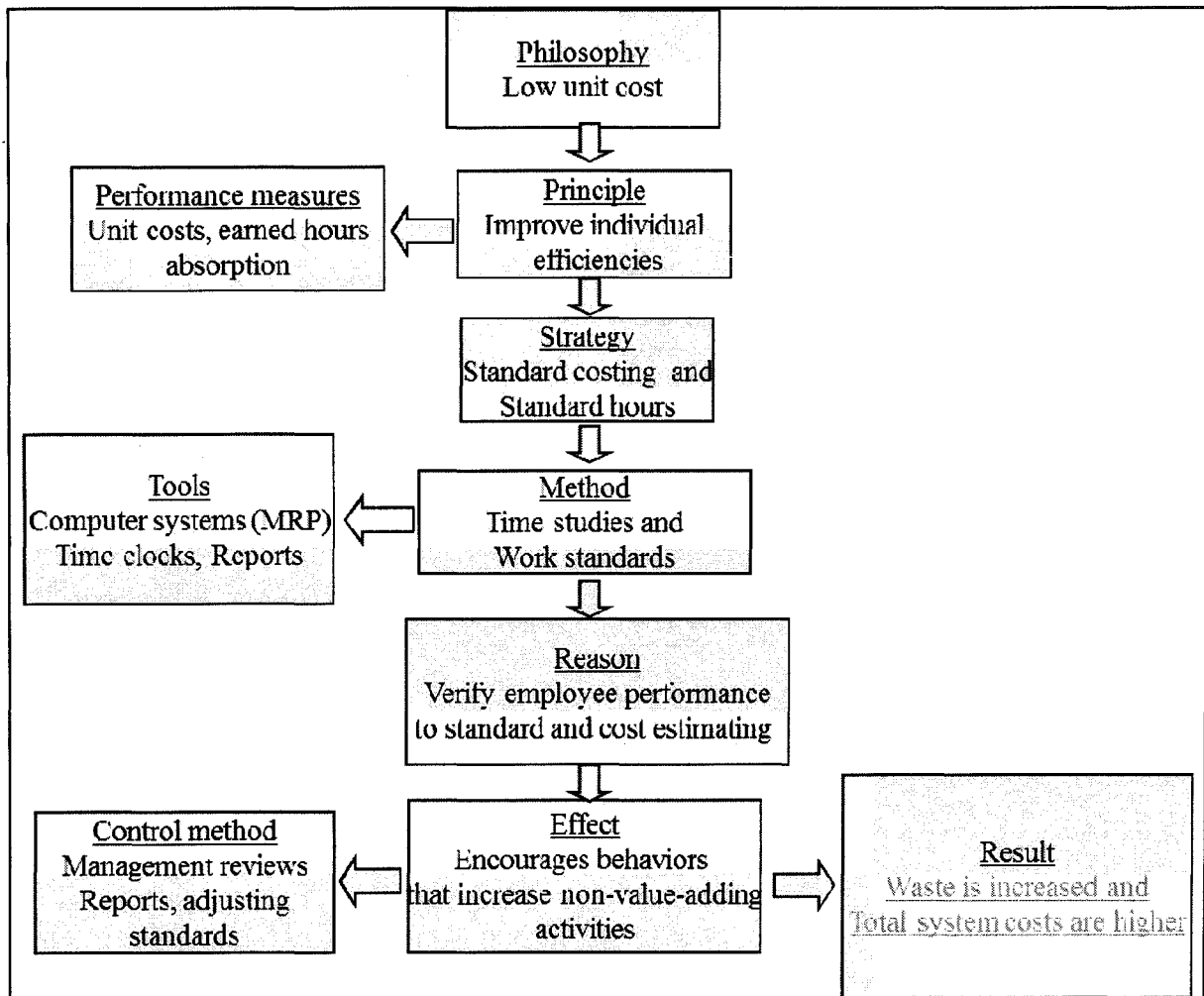


Fig. 9 Traditional unit cost focused manufacturing. Liker – 2006: 115)

This method considers individual efforts and “cost per piece” while The Toyota Production System (TPS) seeks to optimize the entire company and considers “total cost” via waste reduction as the primary indicator of success.

*“Traditional mass production utilizes time and motion studies to determine the most “efficient” work procedure and a standard time is allotted for the designated task. Typically an operator is observed and the work elements and times are recorded. The*

*way the operator is carrying out his task at this moment may not be the best or most effective way. It's just the way he is doing it at that point in time when being observed. This process creates a false standard that is then utilized to create efficiency" (Liker – 2006: 114)*

Another serious flaw is that since this has been set as the standard there is no incentive to improve it. The system does not in any way support the culture of continuous improvement that is needed to optimize all processes so that a company can be productive, efficient and competitive in times of low economic growth or to survive periods of recession.

Improvements made usually just cover one point or area. Sometimes these improvements to one area may be detrimental to another. This is because the system is not a whole system joined together by an uninterrupted flow, but a system of stand-alone departments each with its own manager striving for personal success through the success of his/her department with little consideration to the rest of the company. This negative impact is rarely discovered. As performance is rewarded on an individual or departmental basis everyone is more likely to work hard for personal gain and the employees will not necessarily pull in the same direction. There will be a discrepancy between the goals of the organization contra the goals of the employees. The organization would strategically like to move in a defined direction but the combined work efforts of the employees (red arrows in fig. 10) most probably will not contribute to taking the organization in the direction it wants to be going. (fig.10)

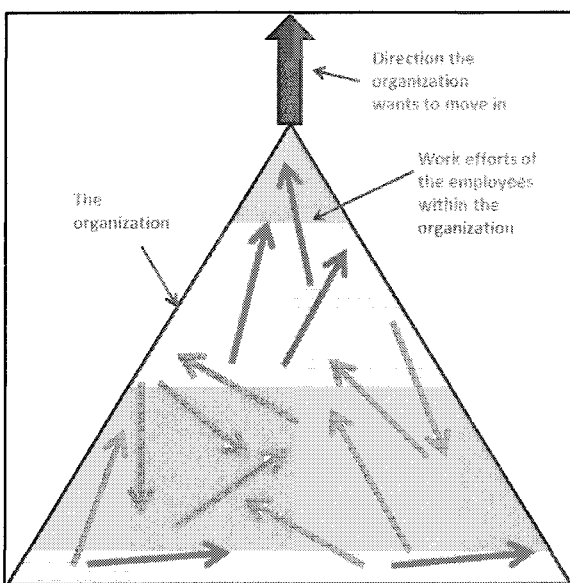
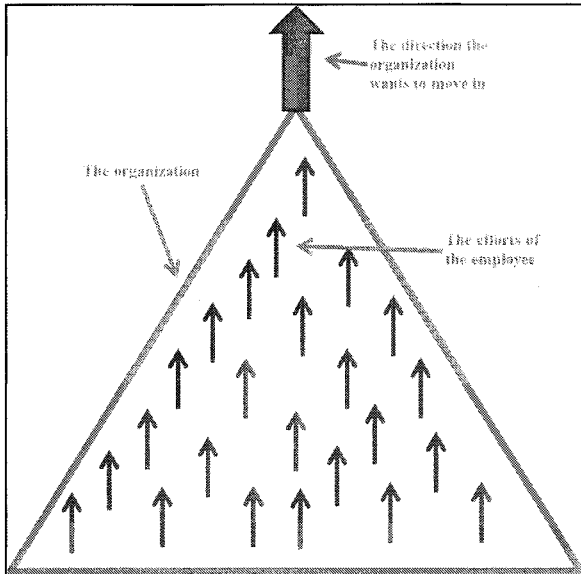


Fig. 10 shows discrepancy between goals of the company and the goals of the employees.

Organizations always speak of teams and team-work. These are popular buzzwords in today's industrial world and many a consultant makes a living propagating the concept. The sad part is these teams never last long or are not as effective as they could have been. Mass production thinking rarely gives teams and/or individuals the incentive to pull in the same direction for the common good of the whole organization as shown in figure 11. This is due to the fact that the reward system rewards only individuals and not the combined effort of all employees.



*Fig. 11 Organization where all teams and individual employees pull together in the same direction*

## 8. How it all began – a brief history of the Origins of Toyota

To understand TPS and the Toyota way, how Toyota became the world's most efficient manufacturer and to be able to discuss the difficulties of implementing genuine Lean and duplicating Toyota's success it is important to first understand the history and personalities of the founding family members and their life philosophies that left an indelible mark on the culture of Toyota. It is also necessary that one should be familiar with these philosophies on which the foundations of the Toyota Way were laid, without being sidetracked by particular tools and aspects of the system such as Kanban, 5S, SMED (Single Minute, Exchange of Die) etc. TPS did not happen overnight but through a series of innovations over a period of 30 years or so. I will give a brief description of the beginnings of Toyota and the mindset of the founding fathers and their closest associates.

The Toyoda's were a family of innovators. They were pragmatic idealists, they learned by doing and they always believed in the mission of contributing to society. They were relentless in achieving their goals, **but most importantly they were leaders who led by example.**

As Liker (2004) states the important thing is not so much that one family has control over the company. It is the remarkable consistency of leadership and philosophy that Toyota has achieved throughout its history. These roots of the Toyota philosophy and their principles can be directly traced back to the very beginnings of the organization. One could say that every leader is encoded with the "DNA" of the Toyota way.

The story begins with Sakichi Toyoda, who grew up in the late 1800s in a remote farming village outside Nagoya. As a boy Sakichi learned carpentry from his father and eventually used that skill to design and build spinning machines out of wood. Weaving was a major small industry and the Japanese government encouraged the creation of cottage industries across the nation. In 1894 Sakichi began to make manual looms that were cheaper but better than the existing looms.

Sakichi Toyoda was pleased with his looms but he was disturbed that his mother and grandmother still had to work so hard spinning and weaving with the manual looms. He wanted to find a way of relieving them of this punishing labor. He decided to develop a power-driven wooden loom.

This was an age where inventors had to do everything themselves. There was no large R&D department to delegate the work to. When Toyoda first developed the power loom there was no available power to run the loom. Steam engines were the most common source of power so he bought a used steam engine and figured out by trial and error and by getting his hands dirty how to run the loom from this power source. The “*Getting your hands dirty*” approach would become a part of the foundation of the Toyota Way, *genchi gembutsu*.

In 1926 Sakichi Toyoda started Toyoda Automatic Loom Works, the parent firm of the Toyota Group and still a central player in the Toyota conglomerate. Toyoda’s inventing genius resulted in sophisticated automatic power looms that became famous throughout world. Among his inventions was a special mechanism to automatically stop a loom if a thread broke – an invention that evolved into a broader system and also became one of the pillars of the Toyota Production System called Jidoka (automation with a human touch or as Toyota describe it autonmation). Essentially jidoka means building in quality or mistake proofing as an integrated part of the production process itself. It also refers to designing production and equipment so your workers are not tied to machines and can perform other value adding tasks while the machines are running knowing, that if a fault occurs, the machine will automatically stop and not produce non-conforming products.

Throughout his life Sakichi Toyoda was a great engineer and later referred to as Japans “King of Inventors” However his broader contribution to the development of Toyota was his philosophy and approach to his work, based on zeal and continuous improvement.

Interestingly this philosophy and the ultimately the philosophy behind the “Toyota Way” was significantly influenced by his reading of a book first published in England in 1859 by Samuel Smiley entitled *Self-Help*. It preaches the virtues of industry, thrift, and self-improvement. It was illustrated with stories of great inventors like James Watt. The book so inspired Sakichi Toyoda that a copy of it is on display under glass in a museum set up at his birth site. There are a few important things in this book that influenced Toyoda. First of all Smiles’ inspiration for writing the book was philanthropic. It grew out of his efforts to help young men, in difficult economic circumstances, who were focused on improving themselves. So Smiles goal was not to make money.

The book chronicles great inventors whose natural drive and inquisitiveness led to great inventions that changed the course of humanity. These were accomplished not through natural

talent but through hard work, perseverance and discipline. These are exactly the traits displayed by Sakichi Toyoda in making his power looms work with steam engines. The book emphasizes the importance of “management by facts” and getting people to pay attention actively - these are hallmarks of the Toyota’s approach to problem solving based on genchi gembutsu.

How many companies emphasize the importance of “management by facts” and getting people to pay attention actively?

Sakichi Toyoda’s son Kiichiro Toyoda was given the task of setting up the Toyota Motor Company. Sakichi Toyoda explained to his son:

*“Everybody should tackle some great project a least once in their life. I devoted most of my life to inventing looms. Now it is your turn. You should make an effort to complete something that will benefit society” Liker (2004: 18)*

Kiichiro studied mechanical engineering at the prestigious Tokyo Imperial University focusing his studies on engine technology. His approach to learning and creating mirrored that of his father. He too saw the great importance of practical work and experience on the shop floor. After world war two Kiichiro wrote:

*“I would have grave reservations about our ability to rebuild Japan’s industry if our engineers were the type who could sit down to lunch without ever having to wash their hands.” (Liker 2004: 18)*

Kiichiro built the Toyota Motor Company on his father’s philosophy and management approach but he added his own innovations. While Sakichi Toyoda was the father of the jidoka pillar of TPS, Just-in-time was Kiichiro Toyoda’s contribution. The idea for this and the Kanban system came from watching Ford during a study trip to the U.S and by seeing the U.S supermarket system of replenishing the products just in time as the customers bought them.

In 1948, for reasons beyond the control of Kiichiro Toyoda, The Toyota Motor Company was on the brink of bankruptcy. When voluntary pay cuts and other austerity measures did not work, Toyota asked, in spite of Kiichiro Toyoda’s policy against firing employees, for the

voluntary retirement of 1600 workers. This led to work stoppages and public demonstrations by the workers. Here Kiichiro Toyoda did something that earned him great respect. He himself accepted responsibility for the failing of the company and resigned as president even though in reality the problems were well beyond his or anyone else's control. His Personal sacrifice helped quell the worker dissatisfaction. More workers voluntarily left the company and labor peace was restored. Kiichiro's tremendous personal sacrifice had an even more profound impact on the history of Toyota. Everyone at Toyota knew what he did and why. To this very day the philosophy of Toyota is to think beyond the individual concerns to the long term good of the company.

In contrast when a company goes out of business in the west what do we hear? The usual story is the CEO hanging on and fighting to salvage his sweet options package or perhaps selling off the company to be broken up for any valuable assets. It is always somebody else's fault that the company has failed.

Kichiro Toyoda was leading by example in a way that is unfathomable to most of us. All Toyoda family members grew up with similar philosophies. They all learned to get their hands dirty, learned the spirit of innovation and understood the value of the company in contributing to society. They learned to accept responsibility and moreover they all had the vision of creating a special company with a long term future.

After Kiichiro another member of the family leaders who influenced the company was Kiichiro's cousin Eiji Toyoda. When he graduated from the Tokyo Imperial University he was given the task of setting up a research lab in a "car hotel" in Shibaura. The "car hotel" was just a large parking garage. Here Eiji set up shop by clearing a room in a corner of the garage. He built up a group of about 10 people in a year's time. He researched machine tools of which he initially knew nothing. He checked defective cars by taking them apart and in his spare time he checked out companies that could make auto parts for Toyota.

He too like his uncle Sakichi and cousin Kiichiro grew up saturated by the same philosophies and work methods. Get your hands dirty and learn by doing were the order of the day. Eiji eventually became the president and then the chairman of Toyota Motor Manufacturing. How many chairmen in Norwegian or Scandinavian corporations can boast such hands-on experience and detailed knowledge of the end-product?

Eiji Toyoda played a key role in selecting and empowering the leaders who shaped every facet of Toyota's activities from sales to engineering and product development to manufacturing and most importantly **The Toyota Production system**, commonly called TPS, or "Lean Manufacturing".

In the 1930's while Toyota Motor Corporation was struggling Toyota's leaders visited Ford and GM to study their assembly lines. Back home they tested the conveyor system, precision machine tools and the economies of large scale production idea in their loom production and realized that Japanese market was too small and the demand too fragmented to support high production volumes as in the U.S. The Toyota managers realized that if they were to survive in the long run they would have to adapt the mass production approach for the Japanese market. The question was, how?

The greatest asset that the Toyota Motor Company acquired was Taiichi Ohno who moved over from the Toyota loom company to the Toyota Motor Manufacturing company. He joined Kiichiro Toyoda's loom company in 1932 and moved to Toyota Motor Manufacturing in 1943. Taiichi Ohno is widely credited with being the father of the Toyota Production System. In the early 1950's Eiji Toyoda returned from another U.S tour and gave Ohno a huge assignment. The assignment was to improve Toyota's manufacturing system so that it was as productive as Ford's. He was given a time-frame of three years.

Toyota had nothing of the enormous resources in cash, machinery, infrastructure, etc. that Ford had at his fingertips. Based on the conditions of the day this was like David taking on Goliath.

The Toyota managers however did not think this impossible. On their 12 week study tour of the U.S. plants in the 1950's they had expected to be dazzled by the progress and improvements to the manufacturing processes in the U.S. Instead they saw that nothing much had changed since the 1930's. They noticed that the system had many inherent flaws.

What they saw was lots of equipment making large amounts of product that was then stored in inventory, only to be later moved to another department where big equipment further processed the product, and so on to the next step. They saw how these discrete steps were based on large volumes, with interruptions between the steps causing large amounts of material to sit in inventory and wait for longer periods of time. They also observed the high



cost of the equipment and it's so called efficiency in reducing the cost per piece, with the workers keeping busy by keeping the machines busy.

They looked at the traditional accounting measures that rewarded managers who cranked out lots of parts and kept workers and machines busy. This only resulted in a lot of overproduction and a very uneven flow, with defects hidden in these large batches that could go undiscovered for weeks. Entire workplaces were disorganized and out of control. With big forklifts moving mountains of materials everywhere, the factories looked more like warehouses than production plants.

The Toyota managers were to say the very least not impressed. **In fact they saw an opportunity to catch up.**

Taiichi Ohno's assignment from his boss Eiji Toyoda was not to compete head on with Ford but to focus on improving Toyotas manufacturing within the protected Japanese market. This in itself was a daunting task. What did Ohno do? He benchmarked the competition through further visits to the U.S. He also studied Henry Ford's book "Today and Tomorrow". Ohno believed that one of the major components of manufacturing that Toyota needed to master was continuous flow. The best example at the time was Ford's moving assembly line. In his book Ford also preached the importance of creating continuous material flow, standardizing processes and eliminating waste. But while he preached it his company didn't practice it with any degree of diligence or success. One can assume it was the reward system where quantity was the main criterion that was the root cause of this.

Ford turned out millions of black Model T's and later Model A's using wasteful batch production methods that built up large banks of work-in-process inventory throughout the value chain pushing the product onto the stage of production (*Womack et al. 1991*). Toyota saw this as an inherent flaw in Ford's mass production system. Toyota could not allow itself the luxury of creating waste during production. They lacked warehouse space and money. They did not produce large volumes of just one type of vehicle. They were however determine to use Ford's original idea of continuous material flow (as illustrated by the assembly line) to develop a system of one-piece flow that was flexible enough to be changed according to customer demand and was efficient at the same time. This type of flexibility

requires marshaling the ingenuity of the workers to develop a continuous improvement system and philosophy to continually improve all processes in the plant.

In the 1950's Ohno returned to the place he understood best, the shop floor, and went to work to change the rules of the manufacturing game. One must remember that he did not have big consulting firms, post it notes or Power Point presentations to reinvent his business processes. He could not install an ERP (Enterprise resource planning) system or use the internet to make information move at the speed of light. But he was armed with his shop floor knowledge, dedicated engineers, managers and workers who would give their all to help the company succeed. With this he began his many hands on journeys through Toyota's few factories applying the philosophies and developing the principles of The Toyota Production System.

We must remember that Ohno and his team did not do this work alone. The irony of it is that TPS borrowed many of its ideas from the U.S. and Henry Ford. For example one very important idea was the concept of the "pull system" which was inspired by the American supermarkets. In any well run supermarket individual items are replenished as each item begins to run low on the shelf. Material replenishment is initiated by consumption. Applied to the shop floor it means that step 1 in a process shouldn't make more parts (replenish) until the next process step – step 2 uses up its original stock from step 1. In TPS when step two is down to a small number of safety-stock a signal is triggered to step 1 asking for more parts (Kanban system). This eliminates the costs of stocks of work-in-progress material lying around waiting to be processed.

Toyota also took to heart the teachings of the American quality pioneer and guru E. Edwards Deming. Deming's teachings were at this time not taken seriously in America. He taught that meeting and exceeding customer requirements was the task of everyone within the organization. Most importantly Deming broadened the definition of "customer" to include internal customers. An operator in production normally cannot relate to external customers or end users. His customer is the next person or process step that takes over his work and adds further value to it on its way through to being a finished product. This meant that each person or step in a production line or business process was to be treated as a "customer" and to be supplied with exactly what was needed, at the exact time, in the exact quantity and to the specified quality. This was the origin of the Deming principle "the next process-step is the

customer”. The Japanese phrase for this “atokotei wa o-kyakusama”, became one of the most significant expressions in the Just-In-Time system. (*Liker – 2004*)

Let it be said that when Ohno and his team finally emerged from the shop floor with a new manufacturing system, it wasn't only for one company in a particular market and culture. What they had created was a new paradigm in manufacturing or service and delivery. It was a new way of seeing, understanding and interpreting what is happening in any type of production process that could propel beyond the mass production system. By the 1960's TPS was a powerful philosophy and system that all types of businesses and processes could learn to use. Toyota took the first steps to spread “Lean” by diligently teaching the principles of TPS to their key suppliers. This moved its isolated Lean manufacturing plants towards a total Lean extended enterprise – where everyone including your suppliers is practicing the same TPS principles - a powerful business model indeed.

One can say that Toyota effectively combined the advantages of mass production with the advantages of craft production to come up with TPS.

## 9. The Toyota Way

The fourteen (14) principles described below define the foundations and the philosophy of The Toyota Way. This is the way The Toyota Corporation conducts its business.

### 9.1. The 14 principles of the Toyota Way – its philosophy

#### Section I: Long-Term Philosophy

##### **Principle 1**

***Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.***

- Have a philosophical sense of purpose that supersedes any short-term decision making. Work, grow, and align the whole organization toward a common purpose that is bigger than making money. Understand your place in the history of the company and work to bring the company to the next level. Your philosophical mission is the foundation for all the other principles.
- Generate value for the customer, society, and the economy—it is your starting point. Evaluate every function in the company in terms of its ability to achieve this.
- Be responsible. Strive to decide your own fate. Act with self-reliance and trust in your own abilities. Accept responsibility for your conduct and maintain and improve the skills that enable you to produce added value.

#### Section II: The Right Process Will Produce the Right Results

##### **Principle 2**

**Create a continuous process flow to bring problems to the surface.**

- Redesign work processes to achieve high value-added, continuous flow. Strive to cut back to zero the amount of time that any work project is sitting idle or waiting for someone to work on it.
- Create flow to move material and information fast as well as to link processes and people together so that problems surface right away.
- Make flow evident throughout your organizational culture. It is the key to a true continuous improvement process and to developing people.

##### **Principle 3**

**Use “pull” systems to avoid overproduction.**

- Provide your down line customers in the production process with what they want, when they want it, and in the amount they want. Material replenishment initiated by consumption is the basic principle of just-in time.
- Minimize your work in process and warehousing of inventory by stocking small amounts of each product and frequently restocking based on what the customer actually takes away.

- Be responsive to the day-by-day shifts in customer demand rather than relying on computer schedules and systems to track wasteful inventory.

#### **Principle 4**

##### **Level out the workload (heijunka). (Work like the tortoise, not the hare.)**

- Eliminating waste is just one-third of the equation for making lean successful. Eliminating overburden to people and equipment and eliminating unevenness in the production schedule are just as important—yet generally not understood at companies attempting to implement lean principles.
- Work to level out the workload of all manufacturing and service processes as an alternative to the stop/start approach of working on projects in batches that is typical at most companies.

#### **Principle 5**

##### **Build a culture of stopping to fix problems, to get quality right the first time.**

- Quality for the customer drives your value proposition.
- Use all the modern quality assurance methods available.
- Build into your equipment the capability of detecting problems and stopping itself. Develop a visual system to alert team or project leaders that a machine or process needs assistance. Jidoka (machines with human intelligence) is the foundation for “building in” quality.
- Build into your organization support systems to quickly solve problems and put in place countermeasures.
- Build into your culture the philosophy of stopping or slowing down to get quality right the first time to enhance productivity in the long run.

#### **Principle 6**

##### **Standardized tasks and processes are the foundation for continuous improvement and employee empowerment.**

- Use stable, repeatable methods everywhere to maintain the predictability, regular timing, and regular output of your processes. It is the foundation for flow and pull.
- Capture the accumulated learning about a process up to a point in time by standardizing today’s best practices. Allow creative and individual expression to improve upon the standard; then incorporate it into the new standard so that when a person moves on you can hand off the learning to the next person.

#### **Principle 7**

##### **Use visual control so no problems are hidden.**

- Use simple visual indicators to help people determine immediately whether they are in a standard condition or deviating from it.
- Avoid using a computer screen when it moves the worker’s focus away from the workplace.

- Design simple visual systems at the place where the work is done, to support flow and pull.
- Reduce your reports to one piece of paper whenever possible, even for your most important financial decisions. (A3 reports)

### **Principle 8**

**Use only reliable, thoroughly tested technology that serves your people and processes.**

- Use technology to support people, not to replace people. Often it is best to work out a process manually before adding technology to support the process.
- New technology is often unreliable and difficult to standardize and therefore endangers “flow.” A proven process that works generally takes precedence over new and untested technology.
- Conduct actual tests before adopting new technology in business processes, manufacturing systems, or products.
- Reject or modify technologies that conflict with your culture or that might disrupt stability, reliability, and predictability.
- Nevertheless, encourage your people to consider new technologies when looking into new approaches to work. Quickly implement a thoroughly considered technology if it has been proven in trials and it can improve flow in your processes.

### *Section III: Add Value to the Organization by Developing your people and partners*

### **Principle 9**

**Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.**

- Grow leaders from within, rather than buying them from outside the organization.
- Do not view the leader’s job as simply accomplishing tasks and having good people skills. Leaders must be role models of the company’s philosophy and way of doing business.
- A good leader must understand the daily work in great detail so he or she can be the best teacher of your company’s philosophy.

### **Principle 10**

**Develop exceptional people and teams who follow your company’s philosophy.**

- Create a strong, stable culture in which company values and beliefs are widely shared and lived out over a period of many years.
- Train exceptional individuals and teams to work within the corporate philosophy to achieve exceptional results. Work very hard to reinforce the culture continually.
- Use cross-functional teams to improve quality and productivity and enhance flow by solving difficult technical problems. Empowerment occurs when people use the company’s tools to improve the company.
- Make an ongoing effort to teach individuals how to work together as teams toward common goals. Teamwork is something that has to be learned.

### **Principle 11**

**Respect your extended network of partners and suppliers by challenging them and helping them improve.**

- Have respect for your partners and suppliers and treat them as an extension of your business.
- Challenge your outside business partners to grow and develop. It shows that you value them. Set challenging targets and assists your partners in achieving them.

### ***Section IV: Continuously Solving Root Problems Drives Organizational Learning***

### **Principle 12**

**Go and see for your-self to thoroughly understand the situation (genchi genbutsu).**

- Solve problems and improve processes by going to the source and personally observing and verifying data rather than theorizing on the basis of what other people or the computer screen tell you.
- Think and speak based on personally verified data.
- Even high-level managers and executives should go and see things for themselves, so they will have more than a superficial understanding of the situation.

### **Principle 13**

**Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (nemawashi).**

- Do not pick a single direction and go down that one path until you have thoroughly considered alternatives. When you have picked, move quickly and cautiously down the path.
- Nemawashi is the process of discussing problems and potential solutions with all of those affected, to collect their ideas and get agreement on a path forward. This consensus process, though time-consuming, helps broaden the search for solutions, and once a decision is made, the stage is set for rapid implementation.

### **Principle 14**

**Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen).**

- Once you have established a stable process, use continuous improvement tools to determine the root cause of inefficiencies and apply effective countermeasures.
- Design processes that require almost no inventory. This will make wasted time and resources visible for all to see. Once waste is exposed, have employees use a continuous improvement process (kaizen) to eliminate it.
- Protect the organizational knowledge base by developing stable personnel, slow promotion, and very careful succession systems.

- Use hansei (reflection) at key milestones and after you finish a project to openly identify all the shortcomings of the project. Develop countermeasures to avoid the same mistakes again.
- Learn by standardizing the best practices, rather than reinventing the wheel with each new project and each new manager.

The 14 principles above are described in *Liker (2004: 37 – 41)*

The Toyota way is centered on the philosophy that people truly are the greatest asset.

Toyota's leaders are very fond of saying that they don't just build cars they build people

*Liker (2004)*



## **10. The Toyota Production System (TPS)**

The goal of the Toyota Production System is to provide products at world class quality levels to meet the expectations of customers, and to be a model of corporate responsibility within industry and the surrounding community. The Toyota Production System historically has had four basic aims that are consistent with these values and objectives: The four goals are as follows:

1. Provide world class quality and service to the customer.
2. Develop each employee's potential, based on mutual respect, trust and cooperation.
3. Reduce cost through the elimination of waste and maximize profit
4. Develop flexible production standards based on market demand.

Being a lean manufacturer requires a way of thinking that focuses on first defining what is of real value to the customer and then making the product flow through the value adding process without interruption (one-piece flow). This is accomplished by implementing a pull system that cascades back from customer demand through the whole production process. This means replenishing, at short intervals, only what the next operation downstream uses. This is supported by a culture in which everyone is striving continuously to improve. Here comes the rub. Even though lean includes flow and pull production real TPS or lean is not just about "flow" or "pull production" or "cellular manufacturing" or any of the other catchy phrases or tools you may frequently hear.

It is quite possible to use a variety of TPS tools and still be following only a select few of the Toyota Way principles. The result will be short-term jumps on performance measures that are not sustainable. This is what usually happens when most organizations attempt to implement lean. On the other hand, an organization that truly understands and practices the full set of Toyota Way principles can successfully implement TPS and be on its way to gaining a sustainable competitive advantage.

Sometimes one hears the question "How does TPS apply to my business? We do not make high-volume cars; we make low volume, specialized products" or "We are a professional service organization so TPS does not apply to us." This line of thinking clearly shows that they really do not understand what lean is all about and are completely missing the point.

Lean is not about imitating the tools used by Toyota in a particular manufacturing process. Lean is about developing principles and processes that are right for your organization and diligently practicing them to achieve high performance that continues to add value to customers and society. This means, of course, being competitive and profitable. To be able to do this one has to be able to reduce manufacturing costs,

Let us take a look at the formula

$$\text{Selling price} = \text{profit} + \text{actual cost}$$

Here we are trying to make the customer or consumer responsible for all the costs. This principle has no place in today's competitive business world, be it in the motor, cell phone or any other consumer goods industry. Today cool-headed, knowledgeable customers with a myriad of brands and choices within a given industry can pick and choose from hundreds of different and competing companies and products. They do not care about manufacturing costs. It is not their problem and they will not shoulder this burden. The only question is if the product is of value to the buyer. If a high price is set because of the manufacturer's cost, consumers will simply turn away.

**Cost reduction** (fig.12) must be the goal of consumer goods manufacturers trying to survive in the market today. During a period of high growth any manufacturer can achieve lower costs with higher production. The challenge is to survive and achieve cost reduction in the low growth periods.

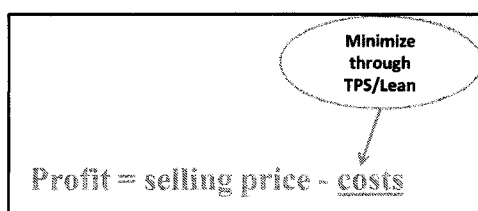


Fig.12 Toyota's formula.

Although mathematically similar to the earlier formula the picture portrayed by this formula is radically different. Toyotas profits depend on how much of their production costs they can reduce.

There is no magic method. A total management system, that develops human ability to its fullest capacity to best enhance creativity and fruitfulness, to utilize facilities and machines well and there-by eliminate all waste, is not only needed, it is imperative. The Toyota Production System with its two pillars of Just in Time (JIT) and Built in Quality (Jidoka) advocating the absolute elimination of all waste is just such a system and was born in Japan out of the necessity for survival.

Today in this time of slow economic growth worldwide and recession, The Toyota Production System and the Toyota Way philosophy, represents a concept and philosophy in management that will work for any type of business.

For over fifty years Toyota has been concerned with making a profit, and satisfying the customer with the highest possible quality at the lowest cost in the shortest lead-time. TPS has enabled them to achieve this goal by developing the talents and skills of its workforce through rigorous improvement routines and problem solving disciplines. In every piece of TPS literature from Toyota, this stated aim is mixed in with the twin production principles of **Just in Time** (make and deliver the right part, in the right amount, at the right time), and **Jidoka** (build in quality at the process), as well as the notion of continuous improvement by standardization and elimination of waste in all operations to improve quality, cost, productivity, lead-time, safety, morale and other metrics as needed. This clear objective has not substantially changed since the first internal TPS training manual was drafted over forty years ago.

The Toyota Production system and its workings are beautifully depicted in the figure commonly known as the “TPS house”. (See fig. 13)

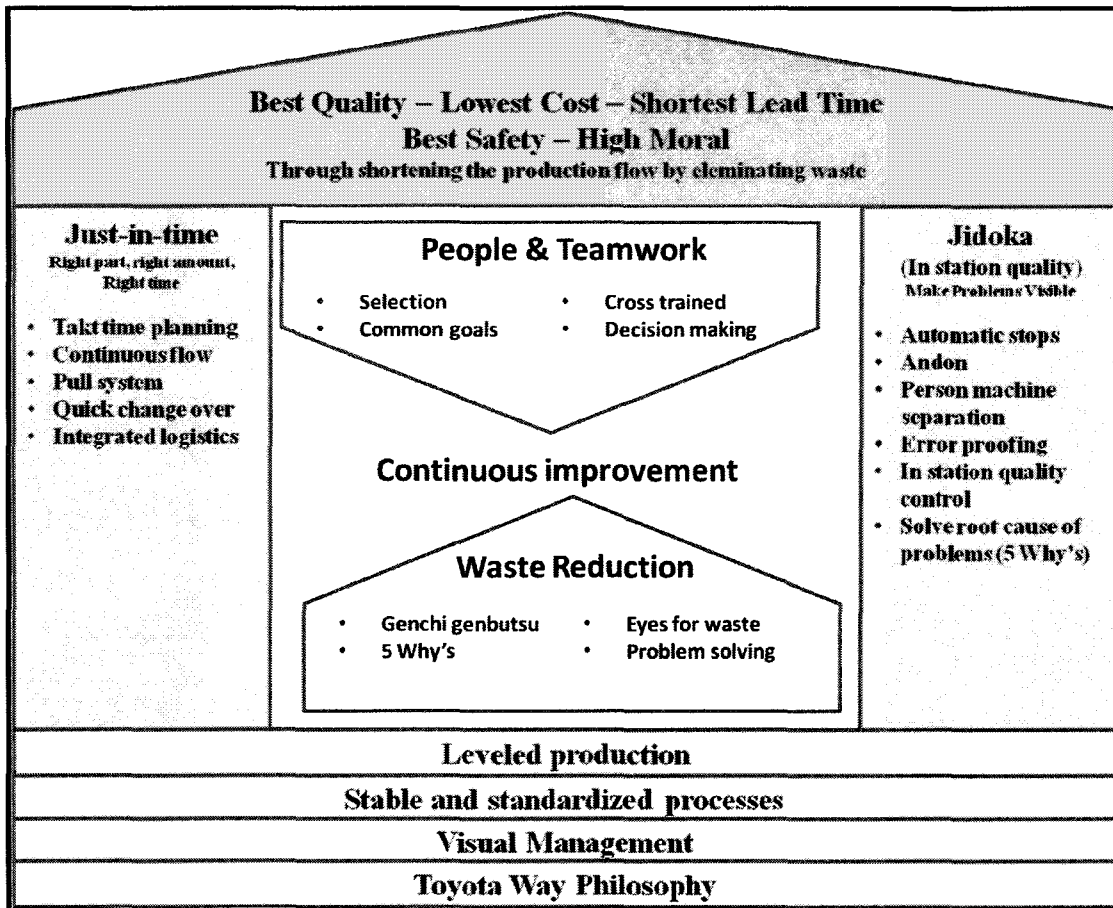


Fig. 13 the Toyota production system – TPS house Liker (2004: 33)

As one can see from the figure above the two pillars Just in Time (JIT) and Built in Quality (Jidoka) stand solidly planted on a foundation built up of the following four main components

1. The Toyota Way Philosophy
2. Visual Management – management commitment
3. Stable and standardized processes – the four rules in use
4. Leveled Production - Kanban

Within the house one can see that people working as teams are the instigators of continuous improvement through waste reduction. The final results are described in the roof. The house illustrates that these final results are obtained (held up) by the foundation and pillars of the house.

The tools that are so popular with consultants and most companies trying to go “Lean” are not mentioned in the pillars or foundation. The pillars and foundations are the causes of the final results. The tools are just used as needed as a means to get from the cause to the result or to be

discarded when not needed. Toyota has a myriad of tools, methods and systems, all of which are designed to facilitate and strengthen the two pillars and the foundation of the Toyota House. In other words these tools are used when following the four Rules in Use. The driving force of TPS is at all times identifying and eliminating the three deadly sins in any kind of enterprise.

1. **Mura – uneven production**
2. **Muri – overwork**
3. **Muda – waste**

These three will be explained more closely in a following chapter.

To give the reader an understanding of the Toyota Production System I will describe in a little more detail the main points of the two pillars of the house and the foundation of the house.

#### 10.1. Just-in-time – JIT

Just-in-time (JIT) was Kiichiro Toyoda's brain child.

JIT means that in a flow process the right parts needed in assembly reach the assembly line only when they are needed and only in the amount needed. A company establishing this flow throughout, **with the systems needed to support JIT**, can approach Zero inventory. This is an ideal state for production and thereby product management.

So how does JIT work? The principle is to look at the production line in reverse. Where a latter process step goes to the step before it to pick up only the right part in the quantities needed and at the exact time it is needed. Now in a system like this isn't it logical for the earlier process to make only the number of parts that the later process withdraws?

Every link in the Just-in-time chain is connected and synchronized. This enables the management work force to be drastically reduced. This in itself is a huge saving as managerial staff rarely contributes to any value adding work.

Now to make this system work, as far as communication between the different process steps is concerned, it is then sufficient to clearly indicate what and how many parts are needed. This means of communication or indication of needs, which among other things eliminates the use

of managers, is called Kanban (signboard) and is a part of the foundation of TPS and will be described later on in more detail.

So what are the great advantages of JIT? Let us first take a look at the traditional factory set up where each department lives a life of its own totally and is to a great extent unconnected with the rest of the organization.

This is when each process step has its own production schedule and produces a budgeted amount of product whether needed immediately or not. Each department needs a manager and his performance is measured according to the amount of parts his department produces. This inducement then pushes the manager or foreman of each process step to produce according to his/her schedule without regard to necessity. No regard is shown to the fact that a process step down stream might have problems and cannot process incoming material. This in turn creates enormous piles of work in progress and increases the need for floor space and warehousing. Workers will be engaged in wasteful non-value adding work moving half-finished material from workstation to warehouse and back etc. Fig. 14 below shows the traditional factory set up organized by departments consisting of the warehouse, the cutting department, the grinding department, the heating department etc. each with a separate manager and specialized workers with forklift trucks moving piles of inventory between the departments.

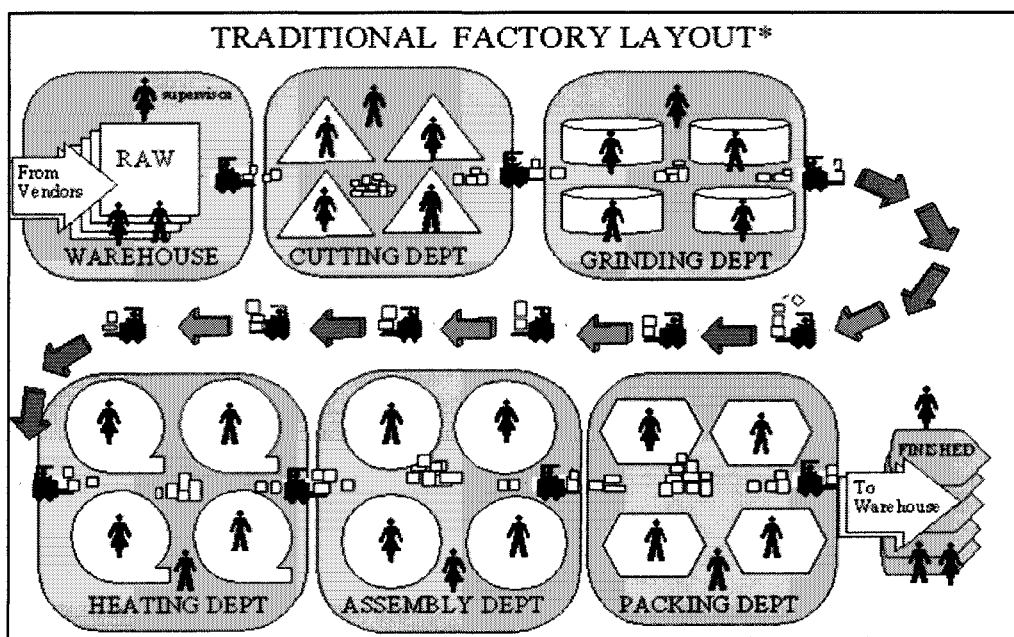


Fig. 14 Traditional factory set up

When JIT is implemented effectively it eliminates what is considered the greatest waste of all over-production. In addition it eliminates the waste of rework. If only the exact number of parts that the next process step needs is produced, any non-conforming product will be discovered immediately by this process step. They will then inform the previous process step allowing them to correct the problem before making more non-conforming product. This way not many non-conforming product is produced and the cost of re-work/scraping is eliminated or kept to a minimum. This is also a great quality control. In the case of mass production where JIT is not used a previous process can churn out hundreds of non-conforming parts before it is discovered causing huge expenses due to re-work or scrapping. The cost of warehousing is also practically eliminated as suppliers (vendors) arrive with the required raw materials just-in-time. Figure 15 gives a simple example of a Lean manufacturing Just-in-Time set up.

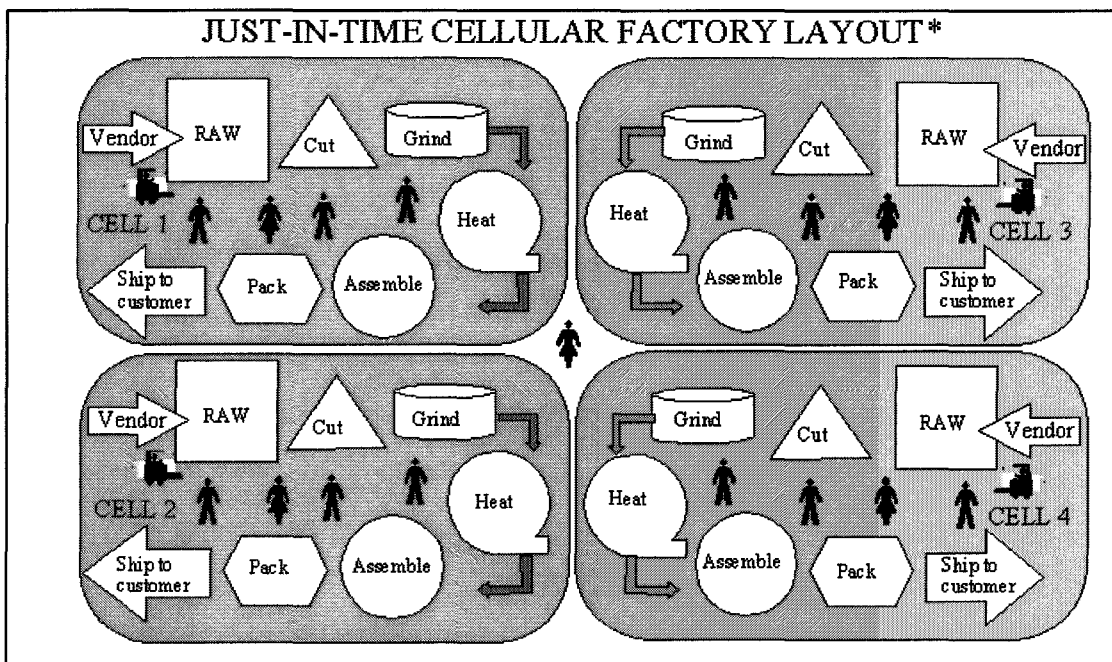


Fig. 15 set up for JIT

The factory in fig. 15 is reorganized into four cells or production lines with all the necessary machines needed to manufacture the finished product. As one can easily see the arrangement needs fewer supervisors, workers and fork lift trucks. There is much less piles of work in progress and no finished goods inventory. The cost of production has been significantly reduced.

A word of warning is in place here. When implementing JIT, a company must make sure that the systems needed to support JIT are in place. If these systems are not in place, trying to implement JIT can be catastrophic for an organization. This is another of the big mistakes made by many companies. JIT is a delicate system one has to take into consideration the “hiccups” that can turn up in any organization. These can be a mistake in paper work, defective product, trouble with equipment, absenteeism – the problems are countless. These problems will, if not handled properly, cause the stoppage of the production line in a JIT system causing loss in productivity and profitability.

If an organization disregards such problems and tries to implement JIT as a stand-alone tool it will be doomed to failure. The result will still be the production of parts without regard to the needs of the later process steps. This would result in waste. Defective parts and huge inventories of parts not needed immediately would certainly be two of the major wastes generated. This again reduces both productivity and profitability. Furthermore the operators will lose faith in the system. It will be harder to change their opinion at a later time for another try. The company can then lose one of their most valuable assets, the knowledge of their employees.

To sum up Just-In-Time is;

Making only "what is needed, when it is needed, and in the amount needed!"

JIT Produces quality products efficiently and profitably through the complete elimination of wastes such as inconsistencies, unnecessary stocks of WIP (work in progress), unreasonable requirements on the production line, leveled production and minimum transport etc.

In order to deliver a product ordered by a customer as quickly as possible, the product is efficiently built within the shortest possible period of time by adhering to the following:

1. When an order is received, a production instruction must be issued to the beginning of the production line as soon as possible.
2. The assembly line must be stocked with required number of all needed parts so that any type of ordered product can be manufactured.



3. The assembly line must replace the parts used by retrieving the same number of parts from the parts-producing process (the preceding process).
4. The preceding process must be stocked with small numbers of all types of parts and produce only the numbers of parts that were retrieved by an operator from the next process.

The JIT concept aims to produce and deliver the right parts, in the right amount, at the right time using the minimum necessary resources. This system reduces inventory and manning to a minimum, and strives to prevent both early and over production.

Producing in a JIT fashion exposes problems quickly. By having minimum inventory in a system, the “rocks” (obstacles) below the surface that are disrupting the flow in the production stream are quickly exposed. Most companies shy away from solving problems immediately and use inventory to hide these problem and avoid potential disruptions. At Toyota however the opposite logic is applied. By reducing inventory you expose the real problems in a production process quickly and focus on the need for improvement. This notion of *surfacing problems and abnormalities* is a critical concept in TPS. Of course unless you can solve the problem that you expose quickly there is a danger to this approach.

## 10.2. Built in quality - Jidoka

The other pillar of the Toyota Production System is the Built in quality (Jidoka). Toyota even coined a new name for this “Autonomation”. This is not to be confused with simple automation. Autonomation can be defined as automation with a human touch or human intelligence. In other words Toyota builds “human intelligence” into their machines. Many machines operate by themselves at the turn of a switch.

Today’s machines have such high performance production capability that even a small abnormality, such as a tiny piece of scrap falling into the machine can damage it in some way or that it can then be put off its settings so as to produce non-conforming goods. When this happens the automatic machine will keep on producing anyway resulting in hundreds if not thousands of defective goods are produced and quickly pile up. With automated machines this type of mass production of defective products cannot be prevented. There is no built in automatic checking system against such mishaps.

This is why Toyota emphasizes automation. Automation is about machines that can prevent the above mentioned problems autonomously – over simple automation. The idea itself originated with the invention of the auto-activated weaving machine by Sakichi Toyoda (1867 – 1930) the founder of the Toyota Motor Company. The loom stopped immediately if any one of the warp or weft threads broke. This is because the machine could distinguish between the normal and abnormal condition. That is to say the ability to distinguish between if there something wrong (thread broken) or if everything all right was built into the machine. This ensures that defective product is not produced. Quality assurance is built into the automated system. The machine is given a bit of human intelligence.

At Toyota a machine automated with a human touch is one that is attached to an automatic stopping device. In all Toyota plants most machines are equipped such devices as well as safety devices and other fool-proofing systems to prevent defective products from being manufactured. In this manner Toyota provides human intelligence or a human touch to its automatic machines. This is what is termed “automation”.

Automation changes the meaning of management work as well. In a plant with automation an operator is not needed for every machine and as long as the machine in running in a normal condition the operator can carry out other necessary tasks. It is only when a machine stops because of some abnormal condition that it gets the attention of an operator. As a result one operator can attend several machines again making it possible to reduce the number of operators and increase production efficiency. So the key to successful automation is to give human intelligence to the machine and to simplify the movement of the human operator between the autonomous machines. Automation then performs a dual role. It eliminates overproduction one of the largest wastes in manufacturing and it prevents the production of defective products.

- To sum up the Jidoka or automation concept;
- Quality must be built in during the manufacturing process!
- There must be no overproduction!

If equipment malfunctions, a defective part is discovered, or the defined production quantity is achieved the affected machine automatically stops, and operators cease production and if necessary correct any problems

1. Jidoka means that a machine safely stops when the normal processing is completed. It also means that, should a quality / equipment problem arise, the machine detects the problem on its own and stops, preventing defective products from being produced. As a result, only products satisfying quality standards will be passed on to the following process steps on the production line.
2. Since a machine automatically stops when processing is completed or when a problem arises and is communicated via the "andon" (problem display board), operators can confidently continue performing work at another machine, as well as easily identify the problem's cause to prevent its recurrence. This means that each operator can be in charge of many machines, resulting in higher productivity.

### 10.3. The relationship between the two pillars – JIT and Jidoka

What is the relationship between the two pillars holding up the Toyota Production System. For the Just-in-Time system to function, all of the parts that are made and supplied must meet predetermined quality standards. This is achieved through jidoka.

Ohno (1988) uses the analogy of a baseball team. Autonomation corresponds to the skill and talent of the individual players while Just-in-time is the team work involved in reaching an agreed upon objective. For example a player in the outfield has nothing to do as long as the pitcher has no problems. But when a problem arises, – the opposing batter gets a hit – this activates the appropriate out-fielder who catches the ball and throws it to the baseman “just in time” to put the runner out.

Managers and supervisors in a manufacturing plant are like the team manager and the coaches respectively. A strong baseball team has mastered the plays; the players can meet any situation with coordinated action. In manufacturing the production team that has mastered the just-in-time system is exactly like a baseball team that plays well together.

Autonomation then performs a dual role. It eliminates overproduction which is one of the largest wastes in manufacturing and it prevents the production of defective products. To accomplish this standard work procedures, corresponding to each player’s ability, must be adhered to at all times. When abnormalities arise – that is when a player’s ability is not peaking or he is performing under par (not adhering to procedures or is unable to do so)

special instruction must be given to bring the player back to normal. This is then an important duty of the coach (supervisor). In the automated system visual control or “management by sight” can bring production weaknesses (in each player that is) to the surface. This allows the coaches and team manager to take measures to strengthen the players involved.

A championship team combines good teamwork with individual skill to reach the best possible results. Likewise a production line where just-in-time and automation work together is much stronger and more efficient than other lines. **Its power is the synergy of these two factors.**

## **11. The foundation of the TPS house**

. I will now describe the foundation of the TPS house. The foundation is mainly comprised of these four elements.

- The Toyota Way Philosophy
- Visual Management – management commitment
- Stable and standardized processes – the four rules in use
- Leveled Production – Kanban

I have already, in chapter nine, described in some detail the Toyota philosophy. I will now discuss the concept of leveled production.

### **11.1. Leveled Production**

The Japanese term for leveled production is “Heijunka” and refers leveling production so as to achieve a more even and consistent flow of product and thereby work through the whole production line. As you can see Heijunka is designed to level the production volume and to level the production by product type.

Toyota’s philosophy is that lack of level production leads to two of the deadly sins mentioned elsewhere in this paper. These two sins are “Muri” which means uneven production and “Mura” which means overwork. These two in turn lead to “Muda” which means waste. These terms and concepts will be explained more closely later on. Leveled production is the opposite of the mass manufacturing philosophy based on the economics of scale. In leveled production one produces only the amount of product the customer wants evenly over a defined period of time.

Toyota combats Muri and Mura by manufacturing on a long-term average demand and carrying a small amount of inventory to meet with any unforeseen increase in demand. This gives them a stable production process. Briefly put, one produces only the amount needed at the time needed. Successful leveled production is a prerequisite for the next component of the foundation, Stable and standardized processes. Before we discuss Stable and standardized processes however I would like to introduce the reader to Kanban.

I wish to pay special attention to kanban as this is the glue that holds the Toyota Production System, TPS, together and is also the single most important factor for achieving leveled production.

### 11.2. Kanban

Taiichi Ohno got the idea for Kanban while studying the American supermarket and refined it to suit the needs of Toyota. Kanban is the operating system of the Toyota Production System. Roughly translated from Japanese Kanban means “signal” or “a card you can see and touch”. The card, (fig. 16) carries all the necessary bits of information on it.

“The Toyota Production System is the production method and Kanban is the way it is managed” Ohno (1988: 33)

Kanban is also the way to achieve Just -In-Time and is the autonomic nerve of the production line.

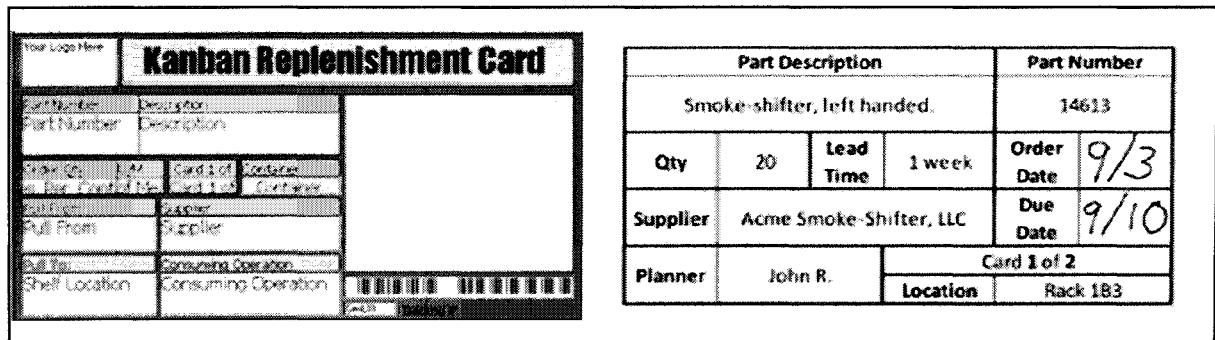


fig.16 examples of Kanban cards. (www.velaction.com/kanban-card)

The information can be divided into three categories.

1. Production information
2. Transfer information
3. Pick up information.

They all supply the following information. What is to be delivered (production information), in what quantity it is to be delivered (production information), when it is to be delivered (transfer information), how it is to be delivered (transfer information), where it is to be

delivered (pick up information), by who it is to be delivered (pick up information), to whom it is to be delivered (pick up information).

In an ideal lean situation this information will not only be carried vertically and horizontally within the organization but also between the organization and its outside partners or co-operating firms, f.eg suppliers.

In short a kanban system signals the authorization to move material or product from the supplying location to the consuming location. It can also be used to signal the authorization to produce additional product.

There are two standard types of kanban cards used in a basic kanban system. They are the withdrawal kanban card and the production kanban card.

- **Withdrawal Kanban:**

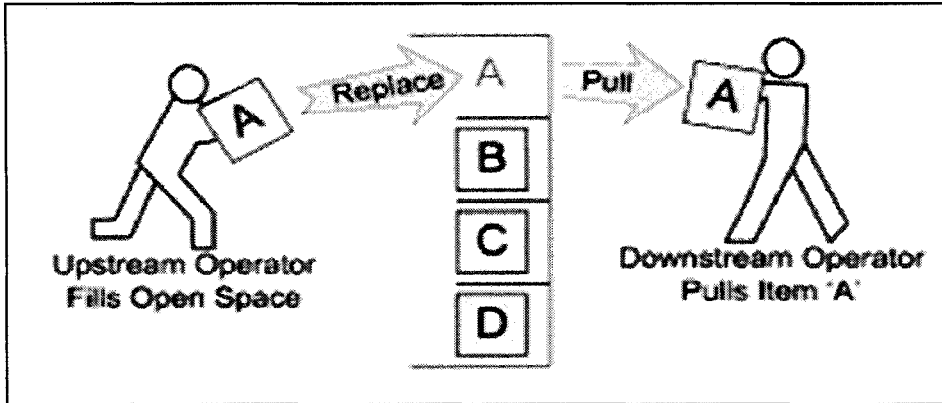
The withdrawal kanban specifies the kind and quantity of the component which the manufacturing process should withdraw from a preceding process. The withdrawal kanban identifies the location in the previous process where the components can be withdrawn from.

- **Production Kanban:**

The production kanban is sometimes called an in-process Kanban. This type of kanban card specifies the kind and quantity of the component which the preceding process must produce.

The card will identify the part to be produced and the location where it must be placed.

It is important to note that a kanban system does not necessarily need to use visual cards only. An empty shelf or container can be used as a signal for a refill instead of a card if the situation is right. (Fig 17) shows a very simple example.



*Fig. 17 simple example of kanban using an empty shelf as a signal*

Here the downstream operator removes a part A necessary for his process step. The upstream operator who supplies the downstream process step sees one empty spot on the shelf. This is a signal or kanban for the upstream operator to replenish the shelf with one part A, no more no less. Here there is no necessity for a physical card as the signal is visual.

So how does Kanban work? I will explain how basic kanban works with a simple example.

Imagine a factory manufacturing some form of mechanical product. The finished product requires that two parts be put together at the factory. Let's call them Part A and Part B.

The manufacturing process consists of three "stages": The receiving area where parts A and B are received and stored, the "assembly" area where parts A and B are put together to form the device and the shipping area, where the devices are shipped off to various stores for sale.

The two parts are stored in separate bins. The completed devices are placed on pallets. When a pallet is shipped to a store, an empty pallet is returned to the worker's area.

The factory might operate something like this:

The factory worker starts by getting one of Part A and one of Part B from their respective bins. They assemble one device. The device is then placed on a pallet. When the pallet is full it goes to the shipping area.

When a store needs more products, the pallet is shipped to the store. The pallet of completed product stays in the shipping area until it is shipped. If there is a pallet in the shipping area, the worker knows not to make any more products.



The Kanban signal here is not a card but an empty pallet in the shipping area. If it is empty, more of the product must be made. If it is full, no more of the product will be made. This is the Kanban between the organization and the external customer. This is the easiest type of Kanban where no cards need to be filled in.

The most important Kanban is however the Kanban between internal customers, i.e. between the different process steps. This is important because there usually are many process steps and several production lines. The savings will be much greater than with just the Kanban between the customer and the finished product. Let us take a look at a simple internal set up.

In the bins for Part A and Part B there is a label (the Kanban card). This card informs workers that when the level of parts drops below a certain defined level, more should be ordered.

Obviously, in a high volume factory there might be 20 assembling stations and 30 pallets. Each individual system must be continually modified to find the exact right level for the kanban to signal that an action is required.

Let us look at a more concrete example. Let's say one of the components needed to make the product is a 20cm stem-bolt and it arrives on pallets. There are 100 stem-bolts on a pallet. When the pallet is empty, the operator assembling the product takes a Kanban card that was attached to the pallet and sends it to the stem-bolt manufacturing area. Another pallet of stem-bolts is then manufactured and sent to the assembler. A new pallet of stem-bolts is not made until a card is received. This is Kanban, in its simplest form.

A more realistic example would probably involve at least two pallets. The product assembler would start working from the second pallet while new stem-bolts were being made to refill the first pallet. In a high volume manufacturing facility, each product assembly station might empty a pallet of stem-bolts in just a few minutes, and there could be 15 or 20 product assembly stations. Thus there would be a continual flow of cards going back to the stem-bolt manufacturing area that would cause a continual flow of pallets of stem-bolts to be sent to the assembly stations.

Kanban supports the "pull" type of production system. In fact "pull" is hardly possible without kanban. As one can see here the number of stem-bolts that are made depends on the

customer demand--in other words the number of cards received by the stem-bolt manufacturing area.

Systems other than cards may be used. For example, the empty pallets may be returned to the stem-bolt manufacturing area. Each empty pallet received indicates a need to manufacture 100 more stem-bolts. For other types of components, bins, boxes or cages might be used instead of pallets. Or components might be stored on shelves in the widget assembly area. When a shelf became empty that signals that more components need to be manufactured and the shelf refilled.

In Kanban the method of handling the components is flexible, and depends on the needs of the manufacturing process.

Kanban can also operate like a supermarket. A small stock of every component needed to make a product can be stored in a specific location with a fixed space allocation for each component. That is each component having its own designated space. The assemblers come to the "supermarket" and select the components they need. As each component is removed from the shelf, a message is sent to a "regional warehouse" or component manufacturing facility, requesting that the component be replaced. The "supermarket" might then receive a daily shipment of replacement components, exactly replacing those that were used.

If one just changes the term "supermarket" to "warehouse" we have our manufacturing example.

This "supermarket" model is different from the first Kanban example in that it would be used when components are manufactured in facilities that are distant from the assembly plant. Instead of moving around small quantities of components, larger quantities are shipped once a day to the centralized warehouse.

Kanban results in a production system that is highly responsive to customers. In the above examples, production varies depending on customer demand. And as the product demand varies, so will the internal demand for components. Instead of trying to anticipate the future (predicting the future is difficult), Kanban reacts to the immediate needs eliminating expensive stockpiling.

Obviously Kanban is directly associated with Just-In-Time (JIT) delivery. However, Kanban is not another name for just-in-time delivery. It is a part of a larger JIT system. There is more

to managing a JIT system than just Kanban and there is more to Kanban than just inventory management. I cannot go into the complete management of a JIT system. That in itself could be the topic of another paper. It suffices to say that for the whole JIT system to work one has to also consider systems for such things as total maintenance, training, hiring etc. Toyota has excellent processes for these areas

Kanban, while incredibly efficient, and requiring less predictive modeling than many other organizational techniques like MRP, requires a firm leadership commitment. Kanban also highlights the primary goal of waste elimination. Using kanban immediately exposes waste, which generates creative study, ideas and improvements.

*“It is not an overstatement to say that Kanban controls the flow of goods at Toyota. It controls the production of a company exceeding \$ 4.8 billion a year” Ohno (1988: 29)*

This was the 1988 figure, I am sure the production today is higher

### 11.3. Stable and standardized processes

The challenge is to get the processes from chaotic to stable and precise. This is only possible by eliminating all waste from the processes. As Spear & Bowen (1999) state Toyota does this by adhering to their four rules.

1. How people work
2. How people connect. Internal customer supplier relationships
3. How the production line is constructed. Flow of the product from start to finish
4. How to improve. The system for continuous improvement of people and processes.

To start eliminating waste we must have standardized work. Every one carrying out a task must do it in exactly the same way. The work in process moves from one process step to the next. This hand over is strictly regimented and is unambiguous. The flow of the product from raw material to finished product is made as simple and as direct as possible. This brings stability to the processes. Then the processes are continuously improved until they are not only stable but precise. This continuous improvement of the processes also improves the problem solving skills of the people. I will now give a brief description of the four rules.

#### 11.4. The Four Rules

The Toyota Production System is just that, a system. A system does not work itself. The most important component in the system is the people who run it. They are important because only the people have the intelligence and knowledge to **continuously IMPROVE** the system. Their intellect and skills are the most important property and asset of any company. Their knowledge and expertise is mostly in their brains and never written down. It would be impossible to do so in a dynamic and changing manufacturing system.

This tacit knowledge is captured in four basic rules described by Spear & Brown (1999) as the DNA of TPS. Faithful adherence to these tools ensures operational stability, Standard work and a scientific, sustainable continuous improvement. As one can see from the TPS house these are elements from the foundation and contents of the house itself. Following the rules contributes to every aspect of TPS not only the foundation but to the two pillars and also to choosing and using of all the pertinent tools of TPS.

##### **Rule # 1 - How people work**

AS Spear & Brown (1999) state, Toyotas managers recognize that the “DEVIL IS IN THE DETAIL” that’s why they ensure that all work i.e. each individual task is highly specified as to content. Rule #1 is one of the most important and least understood of the rules. At Toyota, each activity is specified with detailed instructions. For example, when assemblers install seats with four bolts, the bolts are inserted and tightened in a precise sequence to a precise torque. Every worker installs them in the same way, every time.

This regimentation increases the linkage between the way work is done and the results. That is the traceability between the individual’s activity and its result. If everyone worked in different ways, the link would be broken or obscure and there would be no traceability between the work and the result. Such regimental exactness is applied to the work, not only to the repetitive motions of the production workers but to the activities of all people regardless of their functional specialty or hierarchical role. How do we reconcile such regimented work with the experimentation and concern for individuals that is supposed to be a part of the system? The answer is that while individual workers cannot vary the process, teams are required to, actively analyze, experiment, change and improve the process. This improvement process is carried out in a scientific manner according to rule 4. Rule # 1 seems simple

enough but in reality most managers outside of Toyota and its partners do not take this approach to work design and execution even when they think they do.

### **Rule # 2 - How people connect**

While the first rule describes how each person performs his or her individual task the second rule describes how they connect with each other. Simply put the rule describes the relationship between internal suppliers and internal customers. That is, how the work of one individual or earlier process step is handed over to the next individual or process step for further work as the material progresses down through the production line. These connections have to be standardized and direct. They must unambiguously specify the people involved, the form and quantity of the goods and/or services to be provided, the way requests are made by each customer (Kanban) and the time at which the requests should be met. These connections must have a clear yes/no signal there is no room for misunderstanding or ambiguity.

This implicit rule gave rise to Kanban, Direct Link, Super markets and other lean scheduling systems or tools. It tells us that every operation should send its products to subsequent "customers" directly using methods and algorithms that are clear and precise. It precludes separate warehouses and separate people or departments whose only function is inventory management. As a result there are no gray zones when deciding who provides what to whom and when.

### **Rule # 3 - How the production line is constructed**

Every product and service travels a single, simple and direct flow path. There are no forks and loops to convolute the flow of any of Toyota's supply chains. Toyota's U-shaped work-cells are the ultimate manifestation of this rule. It means that every piece of finished product has been through the same equipment and precisely the same process. It improves consistency and traceability, makes trouble-shooting easier and simplifies material handling and scheduling. The path does not change unless the production line is expressly changed. The material travels or is transported along the most direct and simplest route possible from process step to process step.

## Rule # 4 - How to improve

Workers at the lowest feasible level, guided by a teacher (Sensei), improve their own work processes using scientific methods. This is the basis for continuous improvement or any kind of change at Toyota. Rule #4 ties closely with Rule #1. It prevents Work Instructions from becoming moribund memorials rather than living guides. It ensures that these work instructions are dynamic. It enlists the entire workforce in the improvement (Kaizan) efforts.

Identifying a problem is only the first step. For people to consistently make effective changes they must know how to change and who is responsible for making the changes. They must also ensure that everyone learns from the change. Every improvement is regarded as a learning experience. This is where the rule for improvement comes in. Rule # 4 stipulates that all improvements must be carried out in accordance with Toyota's scientific method under the guidance of a teacher and at the lowest possible organizational level. So who does the improvement? Front line workers make the improvements to their jobs and their supervisors provide direction and assistance as teachers.

We can in summary say that the first 3 rules are about ensuring quality work and its flow through the production line (see fig 17). The fourth rule is how to continuously improve in a scientific manner that ensures learning (fig. 18).

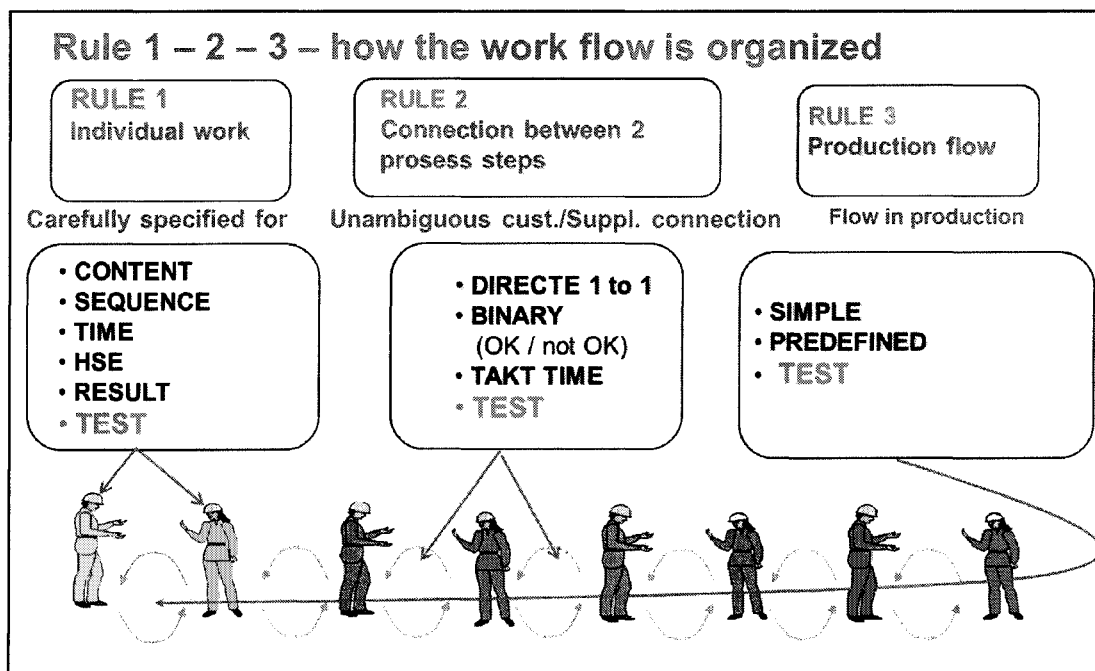


Fig. 17 the 3 first rules

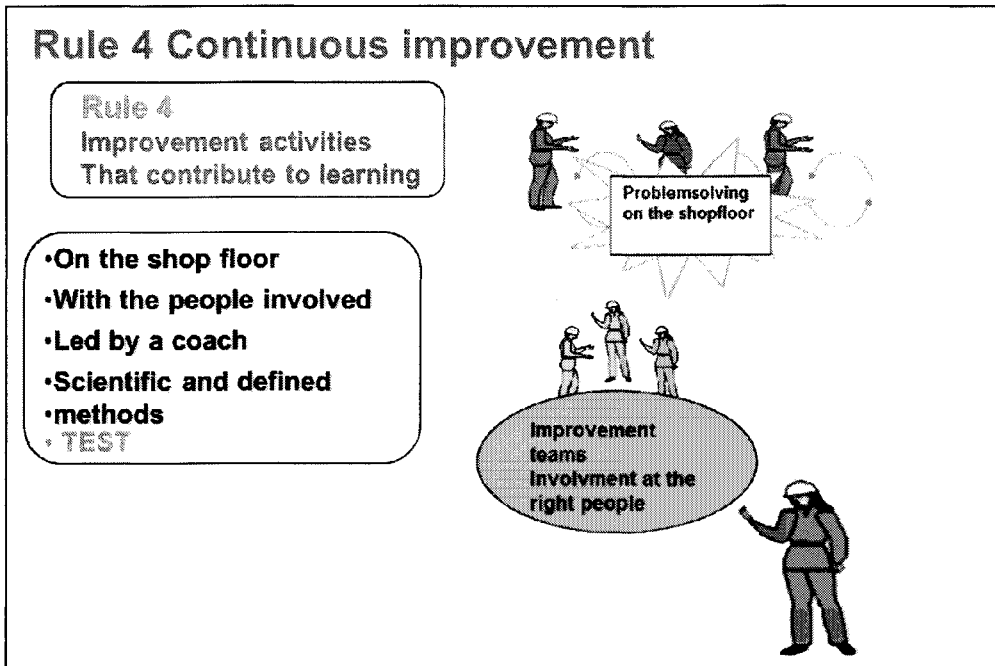


Fig.18 Rule 4 Scientific way for Continuous improvement

At Toyota nothing is changed unless the change is necessary and leads to an improvement that reduces the costs, improves quality or HSE (Health Safety Environment). All improvements are arrived at by using the scientific method based on facts, data and analysis.

The 4<sup>th</sup> rule basically stipulates that any improvements must be made in accordance with the scientific method. This rule teaches people how to improve and how to sustain improvements made. It is about how everyone can learn not only from personal experience but from the experience of others. As we mentioned earlier these four rules lead to sustainable continuous improvement that eliminates waste and finally to the end result of stable and precise processes leading to minimal production costs and greater profits.

Continuous improvement is the driving force of TPS. A culture and methodology for sustainable continuous improvement is what keeps Toyota ahead of every other manufacturing company. Every organization improves but the sustainable almost eternal continuous improvement that is needed for true lean manufacturing has not been achieved by many. Usually companies improve by fits and starts and improvements are only thought of when things go bad or in times of slow growth. In a lean organization the improvement is continuous regardless. This improvement is used to constantly reduce waste, and cut costs by incessantly optimize all the processes in the organization. Figure 19 sums up the chapter rather well

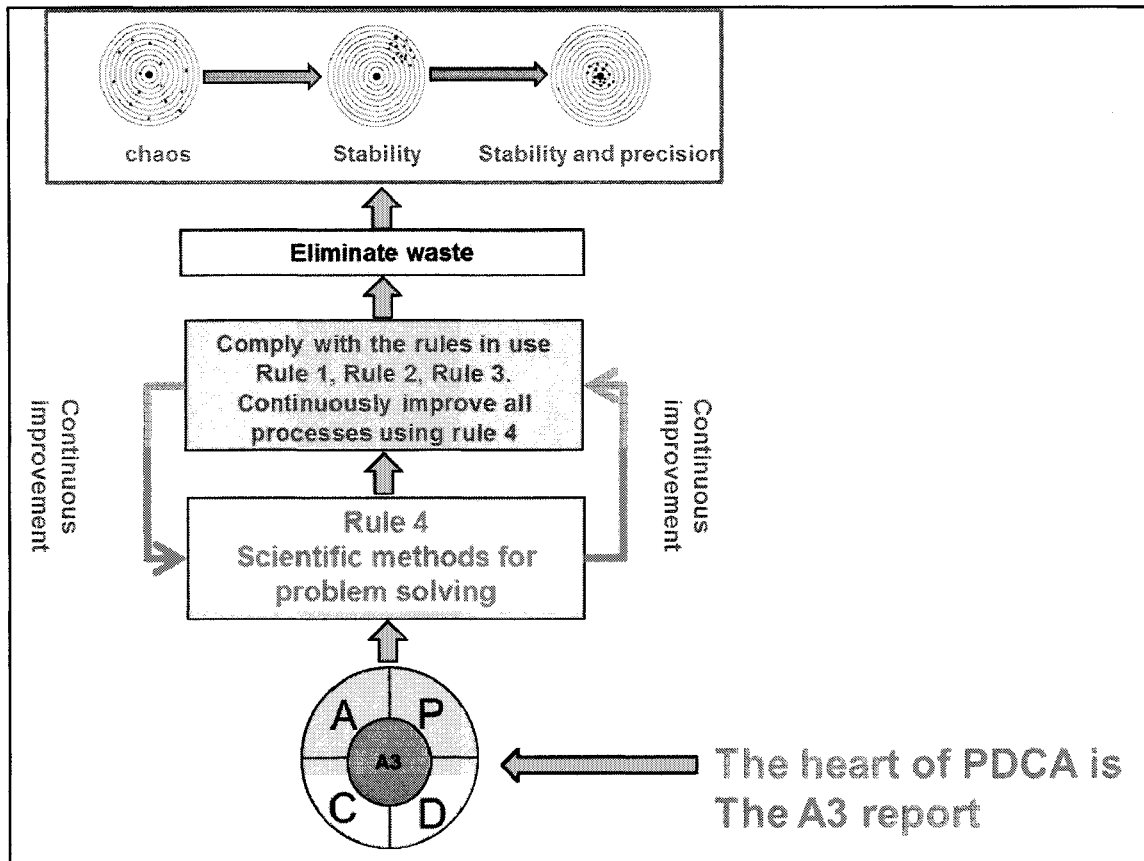


Fig. 19 Achieving stable and precise processes

Basically what we can glean from figure 19 is that stable and precise processes are achieved through elimination of waste. This waste elimination is achieved by setting up the first three rules and continuously improving them using the fourth rule. The figure does not describe the nitty-gritty details of how this is done it is just an overview of how the system is set up to work. It is worth noting that the PDCA circle or the Deming circle plays a central role in the system along with Toyota's extremely effective method of reporting, the A3 report. This is however outside the scope of this thesis and there is some good literature available for any reader who is interested in delving deeper into the A3 and PDCA methodology.

### 11.5. Eliminating waste – The main goal TPS

Having touched on the subject of stable processes and continuous improvement I feel it would be remiss of me not to describe the main goal or one could even say the greatest result of TPS. It is the elimination of waste. It is basically through the elimination of waste that Toyota keeps their processes stable, standardized and optimized.



Toyota believes that profits increased not by trying to transfer the costs of inefficient production over to the customer but by eliminating unnecessary waste in the production process and thereby reducing the cost of production to a minimum.

One can say that; “Lean means eliminating waste”

Toyota uses this formula;

$$\text{Profit} = \text{Price} - \text{Costs} + \text{Volume}$$

The company has three choices to increase profit.

1. Increase the price
2. Increase the volume
3. Reduce costs

### **Price**

In a highly competitive industry like the automobile industry Toyota is convinced that they cannot dictate the price. The customer has a myriad of choices regarding makes models and prices.

### **Volume**

The volume (amount of product sold) is controlled by the market

### **Costs**

The only thing a company really has control over are its internal costs, the costs of production. Note that when Toyota says production they do not only mean the manufacturing costs on the shop floor. They mean the costs of the whole company as a whole and this includes the administrative costs, maintenance costs, R&D costs etc. Toyota goes so far as to include the costs of their suppliers. This has led to Toyota going in and helping their preferred suppliers to be Lean as well. Toyota has identified two major causes of waste and eight major types of waste.

The two major causes of waste

**4. Mura – uneven production**

**5. Muri – overwork**

Lead to

**6. Muda - waste**

**Mura:** This word means “unevenness”. It applies to everything. This word embodies the concept of JIT, or Just-In-Time. If we have unevenness, we are batching. We are not making the right parts, in the right quantities, at the right time. The concept of “takt” time is used to create a pace for people to work to. “Takt” is a German word, just to make it more confusing, meaning pace or beat. The takt time is the pace of customer demand which in turn dictates the pace of production. If we build to demand, we avoid unevenness in our work. We are making the most efficient use of people, materials, and machines available.

**Muri.** This word means “heavy burden”. This word embodies the concepts of standard work. When we observe the job, we see what is actually happening from the viewpoint of the worker. We see the potential safety issues, the ergonomic issues, the searching for tools, the walking for help, the waiting for approvals, etc. In other words, our current system, as we designed it, is a burden for our customers, the operator. All improvement is done for the operators in order to reduce the burden. The lean tools of standard work help us improve the job for operators, while improving the process for our quality, cost, delivery and safety objectives.

**Muda.** This word means “wastefulness”. It applies to everything that is non-value adding. It seems Kiichiro Toyoda and Taiichi Ohno were able to classify waste into 8 categories commonly seen on the shop floor, but most importantly in the context of the conditions of that time. For them, they faced a small market controlled by the government, where materials, machines, money and people were a scarcity. Wastefulness was not an option. They found that inventories that were too big hurt the ability for cash to flow through the business, where it was needed, when it was needed. (See fig 20)

This was true for the American war production story during WWII as well and Toyota learned a lot from the U.S by studying how the War Production Office controlled steel, copper, people, equipment and even entire factories. Profits were slim. Wastefulness, in the form of

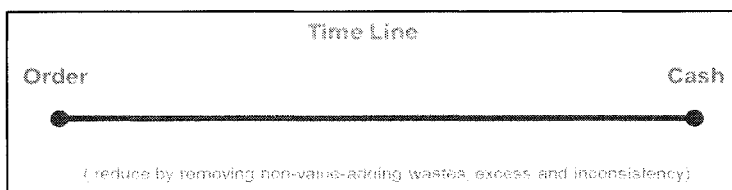
large stockpiles of material inventories, was not an option during critical war production and is not an option today in any highly competitive business environment.

How does Toyota define work and waste? Work that is needed is regarded as real work. All other work is regarded as waste.

### **Present capacity = work + waste**

Taiichi Ohno, founder of TPS, said it very succinctly:

*“All we are doing is looking at the time line from the moment the customer gives us an order to the point we collect the cash, and we are reducing that time line by removing the non-value -added wastes” Ohno (1988: xi)*



(Fig. 20) Ohno's time line Ohno (1988: xi)

The result is a lean process that delivers high quality products to the customer at a low cost, on time and allows Toyota to get paid without holding enormous amounts of inventory. Similar lean processes extend through all of Toyota, from product development to sales to business support functions.

Ohno attached a very particular meaning to non-value-added waste. It had nothing to do with running labor and equipment as hard as possible. It had everything to do with the manner in which raw material is transformed into a saleable commodity, i.e. production.

Lean is about identifying activities that add value to raw materials getting rid of everything else. One has to learn to map the value stream of the raw material moving through the production process that turns it into a finished product that the customer is willing to pay for. This is a radically different approach from the mass production thinking of merely identifying, enumerating and eliminating the wasted time and effort in the existing production system.

True efficiency comes when one produces zero waste and brings the percentage of value adding work to 100 percent. The preliminary step of TPS is to identify waste completely. Eliminating these wastes will improve the operating efficiency by a very large margin. To do this we must only make the quantity needed thereby releasing extra manpower. It is management's responsibility to identify waste, eliminate it and utilize the released excess manpower effectively.

Hiring people when business is good and production is high just to lay them off when recession hits is a very bad practice. On the other hand eliminating wasteful and meaningless jobs enhances the value of work for workers. Everyone's job is needed and important. Toyota has identified what they think are the eight (8) primary wastes (Muda) that result from Mura and Muri (fig. 22)

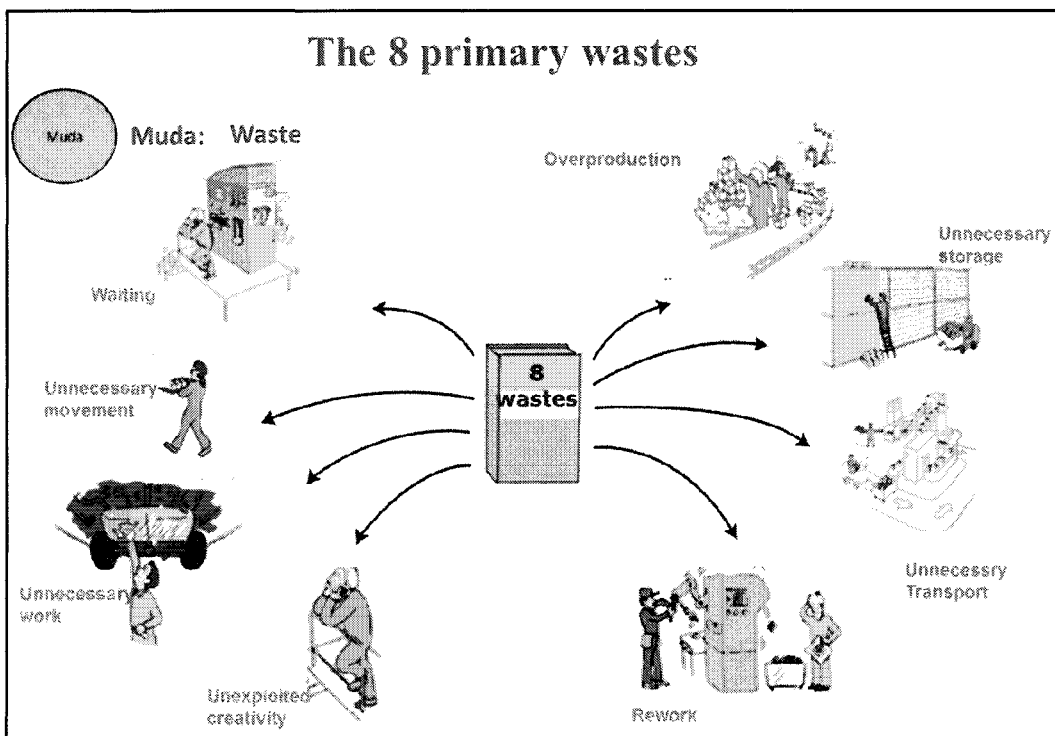


Fig. 22 the eight primary wastes according to Toyota

When thinking about the absolute elimination of waste one should however keep two points in mind.

1. Improving efficiency only makes sense when it is tied to cost reduction. To achieve this we have to start producing only the things we need using minimum manpower.

2. Look at the efficiency of each operator, each department and/or line, then the efficiency of the whole plant (all departments and/or lines). Efficiency must be improved at each step at the same time for the whole plant. One has to be careful that the improvement in one department or line does not lead to problems in another department or line.

The Philosophy and strategy of systematically eliminating waste results in the organization being able to optimize all its processes. This means that an organization gradually brings all its processes from a state of chaos where nothing is predictable to a state of stability and precision whereby the organization is able to predict the output and the resources needed to ensure that the outcome is in accordance with given specifications. This means the best possible quality with no waste. This is the end result of TPS. (See fig 22) and enables Toyota to dispense with end product quality control which is a very costly process. Quality is built into the process. (The Jidoka pillar in TPS) The stable and precise process gives operational stability (Heijunka) which is a major part of the foundation of TPS.

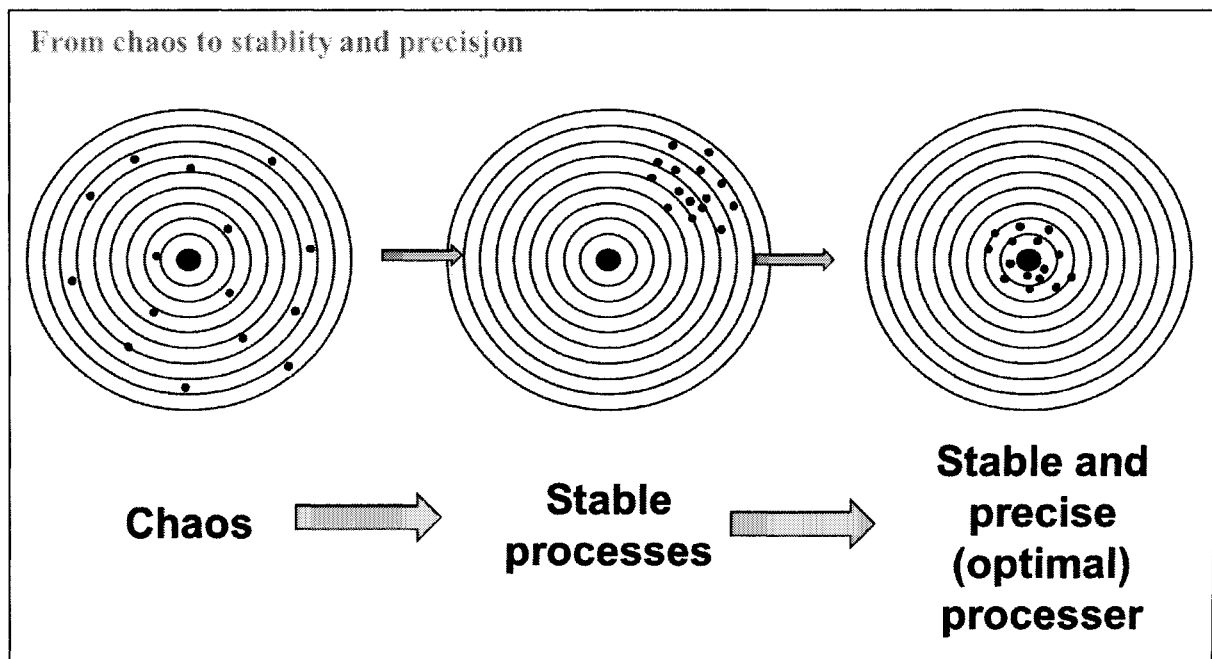


Fig. 22 from chaos to stability and precision

In sum waste reduction sounds easy but there is much to it. It cannot be accomplished by making one pass over your operation to seek and destroy waste. This is not the purpose either. The basis of waste reduction is to create a connected value stream in which all team associates are being forced to think, solve problems and eliminate waste. The initial process of moving

through the continuous improvement cycle to achieve system wide stability and flow can take years of effort.

It is helpful when trying to implement lean to think about the relationship between one piece flow and waste reduction in the context of a broader model. This is the waste reduction model (fig. 23).

Rather than blindly leaping into implementing whatever tools are suggested for flow and pull by some “Lean” consultant it is imperative that an organization first understands the purpose. This model emphasizes the relationship between the primary principle of Lean which is the identification and elimination of waste and the method for achieving that objective which is to reduce the batch size to move towards continuous flow. The creation of continuous flow is often thought to be a primary objective when creating a lean process, but in reality, the creation of continuous flow is designed to drive waste from any operation. **Waste elimination is the primary objective.**

Real success comes from an improvement process for identifying waste – understanding the root cause of the waste and putting into place countermeasures to eliminate the root cause. Unfortunately this is much more difficult than just installing a piece of software or some kind of automation. This knowledge and understanding of continuous improvement is also what, the earlier mentioned, rule # 4 is all about.

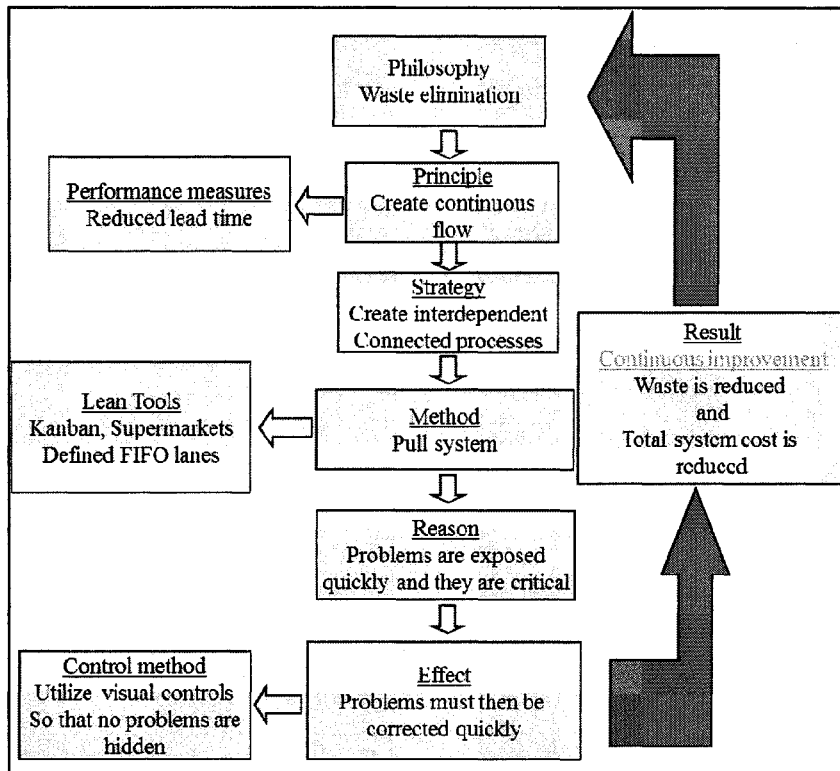


Fig. 22 Toyota's Waste reduction model Liker (2006:83)

## 11.6. Visual Management

There has been a great deal of misunderstanding about visual management. It has been assumed that visual management was achieved by upper management walking around the shop floor or by hanging up all kinds of shadow boards and other visual aids.

It is this author's opinion that the word management has automatically led to people to assume that visual management had something to do with managers. In this case management means the management of the processes by the people responsible for them.

All processes at Toyota have a defined normal situation where everything is running as it should, all other situations are abnormal and corrections have to be undertaken. This is standardization. The purpose of visual management is to make visible when a process is running normally or if an abnormal situation has occurred. Visual management motivates people and encourages continuous improvement.

The problem usually is that organizations, not understanding the true purpose of visualization, just put up a myriad of shadow boards and other information about production. These serve no purpose. Random visualization will yield random results and unintended consequences. The countermeasure is to make sure each visual artifact has a clear and specific purpose. To

make sure the visual boards are useful and attain their intended purpose, Dave Logozzo proposes that an organization should ask these three simple questions.

1. What is the purpose?
2. Who is it for?
3. How often do you use and/or respond to indications of abnormality – what is your PDCA pulse?

*Dave Logozzo as quoted by John Shook Shook  
(<http://www.lean.org/shook/DisplayObject.cfm?o=2095>)*

To obtain effective visual management arrange the flow of work so that problems are highlighted as they arise, enabling and encouraging individuals and teams to tackle them right away. All visualization should support this.

It can be said that how we arrange the physical environment to represent and optimize the way we want to work and ensuring that our way of thinking about work is embodied in the way we configure our physical environment, are methods to help us tap into natural human motivations.

Visual management and how it works are illustrated in the following example described, in an e-letter, by John Shook who became Toyota’s first American manager in Japan.

“A young woman was doing a quality check at the end of an assembly line of electromechanical components. For two years she had been collecting the same quality information. Performing a series of checks, she would confirm that all connectors were firmly attached, components all assembled and in working order. As she found problems, she recorded them into a computer database, which was then compiled into a larger database. The database was reviewed, analyzed, and results fed back to the production group and others.

Like this:



There was no direct connection between the workers making the errors and the inspector finding the errors, and the information that was eventually shared followed a long and irregular time line. Management began looking at the situation because of a



perceived "lack of motivation" in the workers and inspectors. As plant management explored various means of increasing worker engagement and motivation, a quality engineer noticed the disconnect between the workers and feedback on their performance. Problems that could have been fixed right away took days and weeks to even surface, and the time required for errors to be corrected could take much longer. The engineer wanted to fix his technical problem.

It was the woman doing the inspecting who made the suggestion. "How about," she offered, "instead of me just entering the error information into a database, I tick off each example as they occur on this unused white board?" She found it easy to simply make a quick note of each problem on the board, and to enter it later into the database.

Like this:



What happened next was unplanned. The production line leader started noticing what she was doing. He was a little nervous, seeing the performance – the mistakes – of his team members displayed for all to see. The next suggestion was his. "How about," he offered, "if I bring my team over to take a look at the board at the end of each day, so we can see how we are doing?"

What happened next was interesting. As the inspector and the workers looked at her board together, they started to talk about it. Turned out, one of the workers who had been committing many of the mistakes mentioned that he had always had a problem with one of the connectors. The two ends of the connector were very small, his hands weren't, and the space he had to work in was very tight. A recurring problem had been uncovered, its cause identified, and the engineer was delighted as he knew he could make the situation better with a relatively easy engineering adjustment. Other problems that got raised were often even easier to remedy, often right on the spot.

*What motivates?*

What happened next was even more interesting. As the inspector and workers got to know each other better, instead of waiting until the end of the shift, they started stopping by during their lunch break. They could see how they had done so far in the

shift. Before long, the inspector and the team were engaged in a day-long exchange of how production was proceeding. Importantly, workers were struggling less while producing more and the inspector's very role in the process had changed dramatically. Management had sought to improve motivation and they did, but not at all in the way that they had expected. It turned out that what was needed to increase motivation among the employees was more effective support in helping them to be successful and engaged in their work". *Shook* (<http://www.lean.org/shook/DisplayObject.cfm?o=2095>)

The example above gives the reader an insight into what visual management is all about.

## 12. Toyota leadership

The most important aspects of lean, its philosophy, systems and what brings it all together and both the Toyota way house and the TPS house have been described at some length. There is however one point the author would like to focus on. This is the importance that Toyota places on leadership. In the end it is Toyota's Leadership that makes it all happen. The fact, that the implementation and sustenance of real lean manufacturing is totally dependent on the right leadership, has been vigorously expostulated by all the recognized authors on the subject and the research conducted for this thesis has also verified this fact pretty decisively.

*"The Toyota way is designed to cultivate leaders" Liker (2008: 318)*

This statement says it all. Without the right leadership and its commitment the Toyota Way will never stand. If one looks at principle 9 of the Toyota Way it states that Toyota aims to "Grow leaders who thoroughly understand the work, live the philosophy and teach it to others".

The right leaders are absolutely imperative, not only to teach the philosophy and create the culture but they must also spread culture to all corners of the organization and the sustain it.

As Liker & Hoseus (2008) so aptly put it, there are no self-maintaining systems or cultures. They tend to decay unless new energy is being fed into them. Leaders provide that energy. Growing their own leaders internally allows Toyota to maintain, develop and grow the culture that they live and work in. Toyota leaders are expected, in fact it is a large part of their job, not only to understand the Toyota philosophy but to also maintain and further evolve the Toyota culture. In addition they must truly live it and teach it to others.

To be able to do this effectively, incur the necessary credibility and get the Toyota Culture into their DNA leader recruits have to be grown and developed from within Toyota. This is the reason that Toyota cannot easily recruit mass produced leaders. The guy waving his newly acquired MBA and applying for a managerial post at Toyota will not succeed If he is to receive any consideration it will not be on account of his MBA.

*“We believe in hands-on knowledge and not in someone who comes out of college and becomes the boss” Liker & Hoseus (2008:199)*

Toyota recruits people from within, who they feel have some natural leadership abilities, and develops them to think and act in the Toyota Way every day. This process can take up to ten years. How many western or Scandinavian companies can boast of this process for recruiting and developing leaders?

Many western companies do not distinguish between managers and leaders. One could say that you lead people and manage tasks you cannot, with any degree of appreciable success, manage people.

*“To better understand the difference between leadership and management we can draw on the example of the push – versus – pull systems. Traditionally top-down management is a push system in which workers are pushed to follow the orders of managers. Leadership on the other hand, is a pull system. Followers feel a magnetic pull that compels them to follow the direction of the leader. They seek the leader’s direction, believe in the leader, want to learn from the leader and relish the time they spend with the leader”. Liker & Hoseus (2008: 318)*

Leaders have power and effective leaders use their power to build a shared culture. No wonder Toyota is so successful.

### **13. Why companies fail – some major inhibitors**

Most attempts at implementing Lean are superficial and most implementation efforts dissolve and dissipate into failure sooner or later. The main cause of this failure, as has been described in all recognized literature and also verified by the research done in this thesis, is the total lack of skillful, dedicated leadership wholly committed to the philosophy of lean manufacturing and teaching the philosophy and resulting culture to the people.

*“To really effect a change in the process you must change the people. Peoples’ beliefs and values are rooted in their cultures” Liker & Hoseus (2008: 17)*

The author does not believe that Scandinavia has yet produced the kind of leaders that can accomplish this, at least not in the manufacturing industry.

This lack of true committed leadership is the root cause of the failure of lean manufacturing in Norway. The effect of this is that uninitiated managers expect and depend on everybody else but themselves to implement lean.

If one takes a look within the 4P model introduced in an earlier chapter one could say that most companies are dabbling at one level – the “Process” level and trying to improve results by implementing lean tools. The other 3 P’s are not being addressed (see fig below).

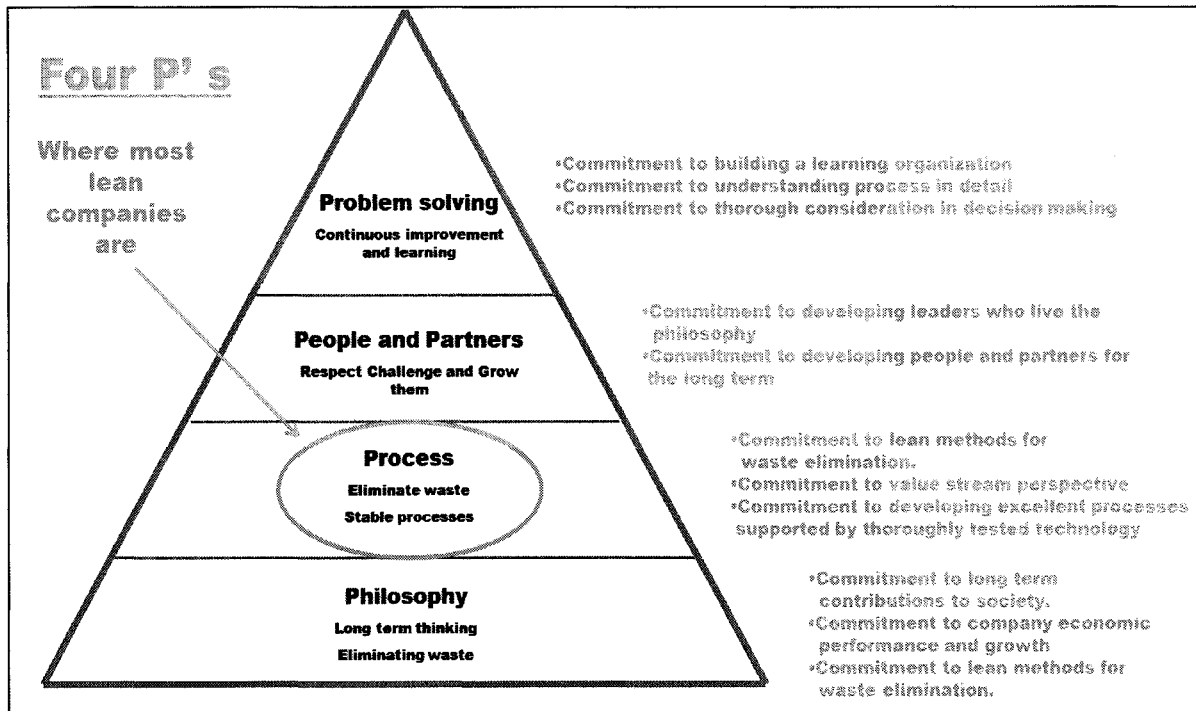


Fig. 23. Where most "Lean" companies are. Liker – 2004: 13)

These companies will do little more than dabble on the surface of the lean ocean because the improvements they make will not have the heart and intelligence behind them to make them sustainable throughout the company or after a while even in the improved process.

Norway has been exposed to lean for at least two decades. The basic concepts and tools are not new. The problem I believe is that Norwegian companies have embraced lean tools but do not understand what makes them work together in a system. Typically management, cheered on by equally ignorant lean consultants, adopts a few of these technical tools and usually struggles to go beyond the amateurish application of them to create a technical system, but they do not understand the power behind true lean: the continuous improvement culture needed to sustain the principles of the Toyota way.

Another misunderstanding is continuous improvement. Leaders think that continuous improvement pertains only to the improvement of the production process. No, it pertains more so to the continuous improvement of the people which in turn results in the continuous improvement of the processes.

The research results clearly show that the responsibility for the lack of success rests squarely on the shoulders of leaders and management. They have not been willing to really study and

understand the philosophy behind lean so as to be able to teach the rest of the organization and lead the implementation themselves.

Leaders and managers do not seem willing to undertake the radical changes, in their philosophy and methods of management, necessary for successful implementation. They want to be managers and bosses, not teachers. Too many leaders have the “*wash me but don't get me wet*” attitude when it comes to implementing lean. This has led to the fact that implementation has been left in the hands of consultants.

This situation has understandably been exploited to its fullest by consultants who have sold companies all kinds of “lean implementation packages”. But just like leaders and managers most consultants themselves do not understand the true philosophy of lean. Of course it is much easier to sell visible tangible results however short-lived they may be than to sell philosophies and tacit knowledge.

The same mistakes have been made repeatedly. The emphasis has been on tools, tools and more tools. “Start with 5S” has been the mantra of most consultants. “Build teams”. “Quality circles are the thing”. “We need to start with Kanban”, etc. etc. has been the cry.

This “cherry picking” from a myriad of lean tools, (fig. 24) taken out of context has been the bane of successful lean implementation. True these tools may pluck some really low hanging fruit but successful implementation of lean manufacturing itself will be conspicuously absent. The improvements thus obtained will never be sustainable in the long term or even in the medium term.

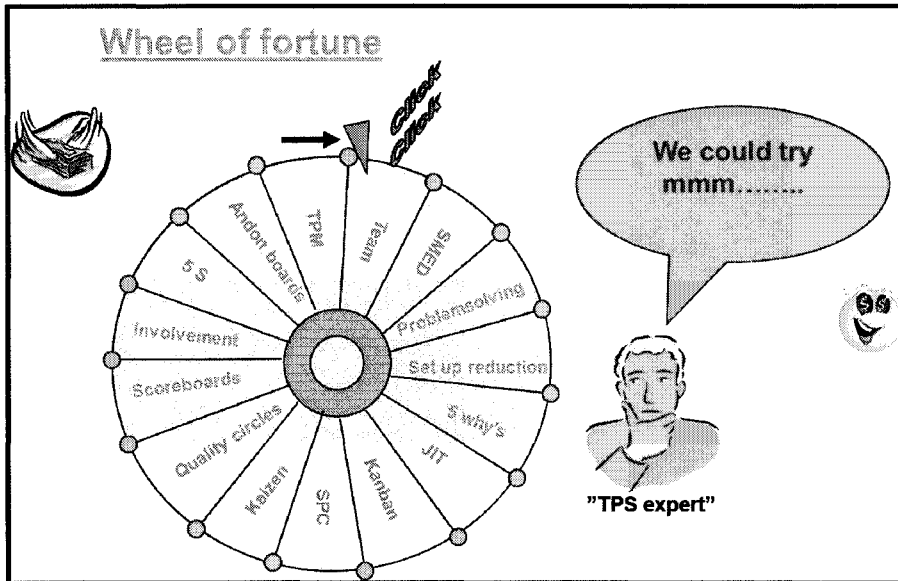


Fig. 24 "Cherry picking" the tools

Although these efforts have cost companies hundreds of millions of kroner they have not delivered anywhere near the expected results and certainly not lean manufacturing. This leaves leaders and managers extremely disappointed and skeptical to lean but at the same time not understanding that the reason for their lack of success is their own lack of understanding. Sadly *they don't understand that they don't understand*. Even more detrimental is the "BOHICAS" (Bend Over Here It Comes Again) syndrome it causes among the workers.

Over the year workers have experienced numerous lean drives in their workplace initiated by new leaders coming in or by old leaders persuaded to try again by more convincing consultants who sell a new twist to the old story. Some workers are so disillusioned that it will take a great amount of convincing before any new attempts can even get off the ground.

It is well worth noting that Ohno did not have consultants, post it notes, power point presentations or any of the modern technologies but yet he, together with the rest of Toyota's leadership, came up with and successfully implemented the most effective production system in world. The system is still surviving and continually improving after more than five decades.

### 13.1. Making 5S a stand- alone program

5S is the classic way most consultants start off a lean implementation program. This is one of the major traps that many companies immediately fall into when they start their lean journey.



I would like to quote Jeffrey Liker on this.

*“Doing 5 S is fun. Doing 5 S is liberating. Anyone who has experienced the joy of cleaning the basement or garage, after a few years of garbage has accumulated knows the feeling. But 5 S is just one tool that enables stability that enables flow. The biggest mistake companies can make is to make 5 S into a stand-alone program with fanfare, rewards and signs everywhere. One could humorously say that if you stand in a place long enough you are apt to get a circle drawn where you are standing. There is nothing wrong about being diligent about 5S. But in most cases one just organizes and cleans up existing waste until it looks beautiful but well-organized and sparkling clean waste is still waste. **Getting bogged down in 5 S is an avoidance pattern** – avoiding the real hard work of thinking about how to create flow and solve the real root cause problems inhibiting flow”. Liker (2006: 64). Emphasis is added by author*

When tools are implemented as stand-alone programs any improvements experienced are local, one time happenings and sustainable gains and improvements are never achieved

The first thing a company should be aware of when starting on the path to lean manufacturing is that 5S is just another tool in the lean toolbox and certainly not the start of the lean manufacturing journey. It is also a favorite alibi for managers. The plant looks really neat and tidy, something to impress the visiting CEO who is just as ignorant as everybody else. The waste is not removed just made to look pretty as Jeffrey Liker states above.

Tools and techniques are not the key to Lean manufacturing: Rather the power behind Lean is the company’s management commitment to continuously invest in its people and promote a culture of continuous improvement.

**Lean is not a result of the tools and techniques. The tools and techniques are a result of Lean. !!**

## **14. Foundation for success**

There are no magic bullets. As we have already established lean is totally dependent on a “new” management philosophy based on completely dedicated and committed leaders coded with the DNA of the company philosophy, establishing and sustaining a company culture, living and teaching it to all employees.

Assuming that this critical criterion is met, the first major step is for these dedicated leaders to honestly define why the company exists. What is your company’s true purpose? It’s a tough question to answer with absolute honesty.

If you are convinced that your company exists simply to make money then all you have to do is to put a big dollar sign on a poster for the employees and managers to see and forget all about elaborate mission statements and philosophies. If there is something more than that you should consider carefully and honestly what the company is trying to achieve both internally and externally. The company has internal and external stake holders. The internal stakeholders are the employees. The external stakeholders are the owners/investors, society, the authorities, suppliers, customers etc. You have to consider what you are trying to build for your internal stakeholders and what impact you are trying to have on the outside world. This was the philosophy and starting point for Toyota.

A true lean organization is built on a two part mission. One part is about people the other part is about business. Figure 3 (chapter 3.1) represents company purpose as a matrix combining internal and external goals as they relate to people and business. It includes simple statements based on Toyota’s purpose and shows both the short-term goal and the longer term purpose of the company.

The short term goals for each of the four cells is what every company wants. Capable internal processes, capable people who can do the work, capable partners who can do their jobs and they want to make money. That’s pretty straight forward. The great challenge is getting a sincere commitment from top management to long term thinking even at the expense of short term gains. *Liker – (2006)*

The author is not in any way propagating copying Toyota's philosophy as is. In fact this will not get you to lean. Each company must develop its own philosophy. So the hard work still remains. This is why you need the type of leaders described above. But you do not have to start from scratch. A company can build on what they have learned from Toyota – s superb role model.

## **15. Conclusion**

Although hundreds of Norwegian companies have started on the “lean journey” none seem to arrive at the end station which is a sustainable and credible lean manufacturing organization. In today’s highly competitive world optimizing ones processes is of paramount importance to an organization’s survival especially during times of recession or low growth.

### **15.1. Main conclusions**

This thesis sets out to investigate and identify the necessary requirements to ensure the success of lean implementation in Norwegian companies and to establish the reasons for the thousands of failed attempts that have fallen far short of successful implementation and have never come even close to duplicating Toyota’s enormous success.

The empirical data gathered for the research was obtained using the survey method. A twenty point questionnaire was distributed among the respondents and a series of interviews were also conducted. The questionnaire and the interview questions were based on a thorough review of literature authored by the world’s foremost experts on Toyota, its philosophy, culture and methodology.

The purpose of the survey was to map what people who had been directly involved in implementing lean in Norway saw as the reasons for failure. The people themselves came from three categories, 1) Leaders and managers, 2) Supervisors operators and “lean facilitators, 3) Lean consultants. These categories represent management, the shop-floor and the outside interests.

Looking at the six highest scoring statements (on a scale of 1 - 10) in the questionnaire presented in table 5 we see that, the first place goes to “Management does not understand the philosophy of Lean or its core concepts” with 9.5 followed by “Management uninvolved” with 9.3, while third place goes to “Management not competent enough to be teachers (sensei)” being given 9.2. Fourth place goes to “No real organizational change – lean is just something to try when people are not busy working getting” with 9.1, while “There is no consistency of leadership” also earns 9.1 and lastly “Management wants everyone else to change but is unwilling to change itself” scoring 9.

Summarizing the responses to the interviews one can again see that responses like, top leaders were not involved other than in giving speeches and telling us lean was important, or that there was never any company philosophy communicated and nobody ever mentioned philosophy or culture, leaders were only interested in the results of the improvement work and these results were expected to come as quickly as possible are very revealing as to what the people were missing.

Furthermore the training and development of people was also missing and is confirmed by the statement there was no formal training program or development program for the people. The dissatisfaction and frustration with consultants is illustrated in the statement, the leaders depended on the consultants for everything and that the operators saw no advantage to all the shadow boards and other information boards they had hung up. This also confirms the “cherry picking” mentioned in chapter thirteen. Finally we have the complaint that people spent more time in meetings than in doing actual work.

The results of the research can be synthesized into three major criteria that have to be met if one wants to ensure a successful transition to lean.

These are 1) A company philosophy that is communicated to and thoroughly understood by all. 2) Top leaders committed to living and teaching the company philosophy and culture throughout the company. 3) A company culture that promotes respect for people and their continuous improvement (learning organization).

The question then is does the literature review confirm the findings of the research?

Discussing the philosophy of training and development at Toyota the former president of Toyota in North America stated that every leader at Toyota must be a teacher. Liker & Meier (2007)

Chapter 9.1 of this thesis describes Toyota’s 14 principles. A close study and analysis of these principles tend to confirm the findings of the research.

Principle one lays company philosophy down as the foundation of lean. Principle nine categorically states that a company should grow leaders who thoroughly understand the work,

live the philosophy and teach it to others. Principles ten, eleven and fourteen handle respect for people. There is however overlap between the fourteen principles but this only strengthens them and interconnects them in such a manner so that one cannot leave out any of them without detrimental effects to another.

The company philosophy when it is lived and taught by leaders results in a common company culture.

Close study of the Toyota way house in figure 2, The Toyota production System house in figure in figure 13 and the Toyota way 2001 house in figure 4 all illustrate that the philosophy and culture are built into the foundation and/or the walls.

The propagation of the philosophy is not possible without the total commitment of leaders who live and teach the philosophy thereby establishing a common culture throughout the organization. What true management commitment involves is clearly illustrated in figure 1.

One can thus conclude that the literature study also emphatically confirms that the three critical criteria revealed by the research are the foundation for a successful transition to lean manufacturing.

While the literature review confirms the findings of the research, the results of the research also clearly indicate that the vast majority of leaders are unaware of the importance or even the existence of these criteria and consequently do not make any attempt to meet them.

It is obvious that it is this lack of knowledge and understanding, of what lean demands of its leaders, that is the primary reason for failure.

This ignorance of the necessary criteria results in leaders, attempting a transition to lean, being incapable of behaving as lean leaders should. They just don't know how. This is the root cause of failure. Its effect is that these leaders also fail to recognize or understand the other many critical factors that are necessary for the successful implementation.

This leaves such leaders in the hands of, in many cases, equally ignorant consultants who prolonging their engagement with the company for as long as possible by “cherry picking” tools from the lean toolbox.

The implications of this study are that the way in which companies attempt to implement lean has to be radically revised.

It is imperative that leaders realize and take into account the fact that in reality it is they who have to lead the transition by being true and credible lean leaders. This credibility has to be earned by living and teaching the lean way. Leaders cannot buy themselves an alibi by hiring lean consultants, pointing out a “lean facilitator” chosen from amongst the supervisors or operators and leaving the implementation of lean in their hands.

The leaders of any company that really wants to implement lean and approach the level of success enjoyed by Toyota have to radically change their thinking. They have to meet the criteria identified in this study to lay the foundation for a successful transition. If this is accomplished and the company can ensure consistency of leadership then it is well on its way. It is not sufficient for leaders, excited by the prospects of great profit margins promised by implementing lean manufacturing, to hire a few consultants, lean back and wait for it to happen. The success of implementation lies squarely on the shoulders of the leaders.

### 15.2. A brief road map

A company can start with a dedicated set of leaders who are willing to put in the time and effort necessary to really understand the philosophy of lean. Their first task would then be to define the purpose of their own company and put in the necessary work to establish a company philosophy that supports this purpose. The leaders then have to live and teach this philosophy throughout the organization and create a common company culture in keeping with the philosophy. These leaders should put in the necessary legwork to really go and talk to the people, get their feedback and identify the gap between the culture needed to attain the purpose of the company and the current company culture. This gap has to be closed or narrowed as much as possible. Closing that gap is a task that can only be accomplished by leaders.

Respect for the team members (employees) should be of paramount importance. Only people can solve problems and optimize processes. With this in mind leaders should ensure the continuous improvement of all team members. Leaders and managers should shrug off the need to be boss and put on the mantle of teacher and guide. A training program that has proven its worth both in wartime USA and at Toyota is the “Training Within Industry” (TWI) program described earlier in this thesis.

The next step would be to ensure the consistency of leadership by recruiting leaders from within the company, recruits who are saturated with the DNA of the company philosophy and culture. If a company can come thus far then they will be well on the way to becoming a true lean organization.

### 15.3. Limitations

The study does not include considerations to culture. Spear and Bowen (1999) categorically state that culture is not an obstacle and point to the fact that the Toyota way is just as successful in North America as in Japan. However it may be wise to examine the culture of the environment one is implementing lean in. Further research spanning over a wider range of cultural contingencies such as, would certain words or terminology be acceptable in that particular environment?, the ethnic mix of the work force in the environment etc. Research should also be carried out to identify the possible existence of legal barriers to methods used in Japan and even in the USA that may not be allowed in Norway.

Although the study has no limitations with regard to sphere of application, the participants of the survey came mainly from the manufacturing industry with the exception of some of the consultants who had experience from service industries.

### 15.4. Future research

There is one area that is of great interest for future research. As mentioned in the thesis, kanban is the glue that holds TPS together. It has up till now mostly been a manual system using visual cards, empty shelves etc. Nowadays implementations of any kind without information and communications technologies are becoming increasingly difficult. Research conducted on how Enterprise Resource Planning (ERP) software can be used to enhance the kanban methodology would be of great interest. This would be especially advantageous in very high volume, diversified product environments.



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## **19. Terminology**

### **Kanban:**

The word kanban is Japanese. Roughly translated, it means “card you can see.”

Toyota uses Kanban as a visual signal that to trigger an action, i.e. to produce a defines quantity of product

### **Kaizen:**

Kaizen (pronounced ki-zen) is a Japanese word that means a change for the better. Kaizen is commonly used in the lean context to represent continuous improvement. Kaizen can also be used to label a group of methods that improve work processes.

### **Jidoka:**

In lean or TPS jidoka is defined by Toyota as automation or machines with a certain amount of human intelligence. Toyota calls this autonotation. Jidoka and implies intelligent workers and/or intelligent machines identifying errors and taking quick countermeasures.

### **Heijunka:**

In a lean context heijunka means production leveling by transforming the typical peaks and valleys of customer demand into something flatter. That flatness, in turn, makes standardizing of production processes easier.

### **Mura:**

Mura means unevenness, irregularity, lack of uniformity, or inequality". It is a key concept in the Toyota Production System and is one of the three types of waste.

### **Muri:**

The word means over burden or overwork.

### **Muda:**

Muda is the Japanese word for, waste. Toyota has identified 8 major wastes that any company has. TPS is about eliminating these 8 wastes.

### **Genchi gembutsu:**

Genchi genbutsu, means “go and see” in Japanese. It is a central tenet TPS or lean. The term refers to the idea that problems are best understood and solved where they occur – for example, on the factory floor. Rather than looking at information from a distance – in an

office, for example – regarding process issues, managers should go see for themselves what is happening and even get their hands dirty by doing the work themselves.

**Atokotei wa o – kyakusama:**

This means the next process step is the customer

**Andon:**

Means “light” in Japanese. However, in a TPS environment, an andon is a visual control device in a work area, typically a lighted overhead display giving the current status (green, yellow, red) of each step in the production system. An operator experiencing a problem can at any time pull on the andon cord and alert team leaders and supervisors the problem.

**5S:**

5S is a housekeeping methodology for the shop floor. There are five rules of housekeeping for a lean environment and they help to expose waste and support the discipline needed to implement the Toyota Production System. The 5 S’s are described below.

**1. Seiri (Organization):** Keep just what is needed, clearly distinguish between what is needed and kept and what is unneeded and thrown away.

**2. Seiton (Orderliness):** Have a place for everything and implement a system whereby everything is in its place. Organize in a way that ensures that necessary things are kept close at hand. Tools and other objects should be easier to find and returned to their proper location.

**3. Seiso (Cleanliness):** This can be viewed as systematic clearing where everything is cleaned, inspected and maintained on a regular basis.

**4. Seiketsu (Standardization):** Establish methods within the company that will ensure the effective continuation of steps 1 through 3.

**5. Shitsuke (Discipline):** Set up systems that sustain the five S process. Ensure that all 4 steps are maintained.

**Super market:**

The supermarket in lean is based on the function of the American super market system that Kiichiro Toyoda and Taiichi Ohno observed. In lean it is a tool of the pull system that helps

signal demand for the product. In a supermarket, a fixed amount of raw material, work in process, or finished material is kept as a buffer to schedule variability or an incapable process. A supermarket is typically located at the end of a production line.

**Just-in-time (JIT):**

A strategy that exposes waste, makes continuous improvement a reality, and relies on total employee involvement. It concentrates on delivering what the customer wants, when they want it, in the quantity they want. The key elements of JIT are flow, pull, standard work and takt time.

**Takt time:**

Takt is a German word that means rhythm or beat in reference to music. At Toyota Takt time is the name of the adjustable time unit used to synchronize the rate of production with the rate of demand.

**IMVP:**

International Motor Vehicle Program

**MIT:**

Massachusetts Institute of Technology

**TPS:**

Toyota Production System

**TWI:**

Training Within Industry

**TMMK:**

Toyota Motor Manufacturing Kentucky

**SMED:**

Single minute exchange of dies

**ERP:**

Enterprise Resource Planning

## 20. Appendices

### 20.1. Appendix 1. Overview of the Toyota's total philosophy.

Continuous process flow	Standardized processes and procedures	Building a culture that stops to fix problems (Eliminate waste of correction)	<b>PHILOSOPHY</b> Waste Elimination	Make technology fit	Develop suppliers and partners
<b>PHILOSOPHY</b> Eliminate waste	<b>PHILOSOPHY</b> Eliminate waste	<b>PHILOSOPHY</b> Eliminate waste (waste of correction)	<b>PHILOSOPHY</b> Meet TAKT by flexible reliable low cost human-machine systems	<b>PHILOSOPHY</b> Eliminate waste	<b>PHILOSOPHY</b> Eliminate waste in supply chain
<b>PRINCIPLE</b> Create continuous flow	<b>PRINCIPLE</b> Eliminate variation	<b>PRINCIPLE</b> Get quality right the first time	<b>PRINCIPLE</b> Equipment supports people and processes	<b>PRINCIPLE</b> Use only reliable thoughtfully tested technology that serves the people and the process	<b>PRINCIPLE</b> Suppliers are extensions of a learning Lean Enterprise
<b>STRATEGY</b> Create interdependent processes	<b>STRATEGY</b> Develop consistent process capability	<b>STRATEGY</b> Stop to fix problems, never knowingly pass defects to the next process step	<b>STRATEGY</b> Selectively automate to support "Lean" process	<b>STRATEGY</b> Improve good decision processes with IT	<b>STRATEGY</b> Selectively outsource with strategic partners
<b>METHOD</b> Pull system	<b>METHOD</b> Standardized work and procedures	<b>METHOD</b> Fixed position stop and support culture	<b>METHOD</b> Kaizen manual process fans (Process analysis)	<b>METHOD</b> Develop good human processes first	<b>METHOD</b> Develop 2-4 partners per component
<b>REASON</b> Problems are surfaced quickly and are critical	<b>REASON</b> Able to determine normal from abnormal	<b>REASON</b> Increase urgency to identify and correct problems. Challenge people to think	<b>REASON</b> Technology augments human capability, supports "Lean" Philosophy	<b>REASON</b> Support human decision making with fast reliable data	<b>REASON</b> Optimize total product as a system for high customer value
<b>EFFECT</b> Problems must be corrected quickly	<b>EFFECT</b> Abnormal condition can be corrected quickly, return to best method	<b>EFFECT</b> Motivation to identify and solve problems. Long term strengthening	<b>EFFECT</b> Automation supports people in waste reduction	<b>EFFECT</b> IT supports problem solving and Kaizen	<b>EFFECT</b> Best cost, best quality, minimum inventory
<b>RESULT</b> Waste is reduced	<b>RESULT</b> Waste is reduced and total system cost is reduced	<b>RESULT</b> System waste and cost is reduced, cooperative environment for improvement	<b>RESULT</b> Flexibility, reliability, waste reduction	<b>RESULT</b> Reduced waste make better decisions	<b>RESULT</b> Waste reduction, flexibility, reliability

