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The Assembly of Lean Production

An Analysis of Doing Production Improvements

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Preface and Acknowledgments

We, the thesis and I, would both like to thank all the people, structures and materiality that contributed to make this a reality.

First and foremost I would like to thank my dear colleague, mentor and friend Per Kirkebak (1951-2010), which introduced me to the field of enterprise development and work life research. You and your practice of research, often provoking and always engaging, are deeply missed.

To my supervisors Ann Martin and Roger Klev: Thank you for opening the doors to literature and discussions I did not even know existed. Thank you for giving me the opportunity to explore new literature, get acquainted with discourses challenging the conformities and mythologies, and not least to challenge my own thinking and practice. This way research has become a fascinating, challenging, mind-twisting and practical venture, involving scallops, the two faced Janus, il regimento, four-color silkscreen printers, delta wings, quality systems, automated trains, dinosaurs, rugby and nuns. I love it.

The VRI Østfold team and my colleagues at Østfold University College and Østfold Research, is my home base. We have come a long way together, from the early steps and a precarious alliance in 2004, to a vital and inspiring knowledge community today. Thank you for managing the multiplicities of friendliness and criticism, and thus contributing to make this study a reality.

All students and faculty part of EDWOR II: Thank you for introducing me to Action research, Aristotle, bridges, Habermas, dancing and boxing, Latour, the red thread, Lewin, shop stewardesses, learning communities, evolutionary theories and the organizations of hypocrisy (clusters and triple helix I still can do without), but most of all for the discussions and comments and thinking, shared and challenged in our seminars.

Special thanks are due to Glomma Papp AS that opened the factory gates and their way of doing production to an outsider. Thanks for letting me work together with you in the assembly of *our* new way to do production. I hope I contributed something to you. You did for sure contribute a lot to me, both as part of this thesis, but even more as letting me be part of the learning community in the factory and not least, continuously reminding me of the importance of practice and workability.

It is a pleasure to acknowledge all those other sources contributing to the assembly of this thesis and to thank those who have taken the time and trouble to read parts of this work and make helpful comments and criticisms. Finally, I want to give my best to my children, Jenny and Aksel, who challenge the rationality in writing a thesis at all.

Fredrikstad, January 21 2011

Preface by Glomma Papp AS

In all kinds of business there will be some ”frictions”. Often the ones that make their “daily work” will not have the time to dive deep into the problems to find the real causes, or they have become accustomed to their own way of working and don’t realize why the work doesn’t turn out in the most optimal way. Therefore, many times, changes might be “at the surface” and the real reasons to the problems are not found. Then the problems occur again but differently.

To take scientists (researchers) into an “everyday business” in order to work within the organization to find solutions to streamline work, may establish a gap one have to jump over. Everyday work is something else than science? - Or is it? Most often there are differences in the way of working and the way of talking. In science there are so many sayings that working people don’t understand and the scientists don’t fit in with the organization, especially the operators at the shop floor, the ones that most often faces, the problems and frustration.

If one could establish a common platform where the researchers showed deep respect for the daily work in the plant and the actors were confident that the work that was to be carried out was for their own benefit, and they were very much involved in the process, there might be a possibility to succeed in working together against a common target.

In this case we wanted to try. To have suitable economy in a business one have to avoid waste. We wanted to find the real causes for our waste and head against the 0-defect strategy.

To us, it was important to have some external persons that were able to “look across” the daily work and have the above mentioned target in mind although we had to cope with customers, delivery times and so on. Someone who kept sight on project schedules and looked over our shoulders and reminded us about the important project. We found our partners at Østfold University College - Gunnar Andersson and Per Kirkebak took the challenge.

Fortunately, these two researchers were very aware of the need for information, information and information. To establish the needed confidence, especially with the workers (the operators at the shop floor), they worked together with them to really experience the problems they faced everyday. Such a good communication was very important to get the two parties to understand each other.

Then the researchers were able to understand the whole organization and they were able to explain and discuss what they thought they had to do to reach the target. They also involved the actors in a lot of smaller projects, which together was aimed at the main target, which all parties had agreed upon.

We, and they, succeeded. Why so? The researchers were able to work together with the whole organization. The researchers were able to explain their methods in a way that all the employees understood and not least accepted. They were working on the same level and trusted one another. To obtain the main target, smaller projects were brought to conclusions along the way so the actors understood that this work helped them to a simpler working day. This was very important in order to keep the enthusiasm. During a long-lasting project the most important thing is to fulfill goals along the way so everyone can understand and feel the progress. Then the organization will get the energy to keep on with the project during a hard working day filled with all the usual tasks.

We reached the goal, although we realized there is a lot more work to be done in the future. But we got the very valuable experience on how to put together two very different backgrounds to solve some difficult problems in addition to learn to see how researchers can use their know-how and exceed their knowledge in order to help companies to complete a working day with less waste, stress and frustration. That is better economy and not least: A better working day for all of us.

We thank Gunnar and Per for their job and all the know-how and experience they have brought to us. We are sure they also learned something from us. The interaction between these two parties is what is needed to develop stronger and longer lasting businesses.

27/10-10 Thor-Erik Bergersen

Summary

This thesis is an analysis of the assembly of the zero-defects project at Glomma Papp AS, a company on manufacture of paper, corrugated board, solid board and display, in Sarpsborg Norway. The zero-defects project was a local production improvement project based on approaches, tools and methods known as Lean. The project is seen as an actor-network, which means that its reality, and the understandings and practices of it, are effects of the web of people, structures, technologies and others who relate to it. The analysis is thus an exploration of the networks of relations, how these relations assemble or not, and the effects of these networks.

The goal of the zero-defects project was to contribute to a zero-defects practice based on mutual learning processes and broad participation. Accordingly three objectives were defined early in the process:

- All products leaving the factory shall be without faults (we shall discover the faults ourselves)
- Customer satisfaction shall be 100% (because of increased quality)
- A faultless production (because of increased quality) shall contribute to increased productivity in the factory

The theoretical contributions in this thesis draw on the perspectives on the construction of facts and assembly of technologies and practices found in the works of Bruno Latour, John Law, Michel Callon and others - part of what is known as Actor-Network Theory (ANT). The theoretical contributions also draw on the perspectives on theory and practice, as well as the approach to research and validity that are found in the works of Kurt Lewin, Einar Thorsrud, Eric Trist, John Heron and others - part of what is known as Action Research (AR). The thesis views the Lean'ish project as an effect of the network of relations, including both human and non-human actors. Together the people and materiality in the factory made up a web of relations that produced and assembled an understanding and a practice that became the Lean'ish project. The web of relations includes computer systems, hardware, literature, groups, conferences, people and structures. It is the people and materiality that comprise the Lean'ish project.

Lean as a basis in the project is a precarious landscape. There have been many success stories associated with Lean, resulting in an almost mythical image of Lean. Different ideologies and

different traditions all seem to have found a haven inside the box of Lean. Despite the differences in ideologies and legacies Lean is treated as one thing, a single entity, a black box.

The descriptive but analytical approach is about opening up the black box of Lean and challenging the mythological image. That is, not to look at the end product or result of Lean alone, but to look at the processes leading up to the construction of something Lean'ish in the company. Lean this way becomes a way to do production embedded and entangled in the people and materiality of the company, and no longer a universal or homogenous method or approach.

The analysis is based on three nodes (or actor-networks) part of the actor-network: The quality system, the project team and the four-color silkscreen printer.

In the first node data from the case establish the adapted quality system as a hub connecting other actors in the assembly of the new way to do production. The adapted quality system embed the work of for example the project team and the literature chosen in the electronic documents and thus make the inscribed experts mobile as part of the system. This way the quality system turned procedures and schemes into emissaries bringing the experts into the daily practice and this way contributing to both strengthening and aligning the network. The data also reveal the strange relationship between resistance and support where one does not rule out the other. This is a relationship linked to the existence of alternative actor-networks turning both support and resistance to something beyond individual acceptance or rejection to include practices, structures and technologies.

In the second node the data show how the project team contributed to hold the project together and make it sustainable, illustrated in the way the project became embedded and entangled in the people, structures and materiality of the factory. The data also introduce the duality in the growth of the project and the understanding of what it was all about. The analysis this way challenges Lean as something to implement and replace it with something that is part of the people, structures and materiality and that changes as these elements change. Finally the data show the paradox of how the significance and relevance of the project is inversely proportional with the coherence in the way we understand the project. The greater strength and legitimacy to take actions the more multiplicities present on what to do.

In the third node the data establish the four-color silkscreen printer as an actor that interacts, shapes and is shaped by people and technologies in the factory. The printer also expands the network both in time and space, making elements located elsewhere and historical elements part of the assembly of the project in the factory. The reshaped printer also contributed legitimacy to the project by the increased quality of production with drastically reduced waste and thus greatly improved efficiency, value creation and work quality. The printer is no more a neutral actor but an actor that shapes and takes part in how the Lean project was assembled. The data also reveal the unpredictable and un-deterministic part of the project making Lean a precarious venture in the factory. The interactive shaping and reshaping of technologies this way becomes important processes that are part of the assembly of the alliance making up the project.

Opening up the Lean black box and thus the complexities, challenges our initial beliefs about Lean as a single entity for us to implement, contributes new understanding of a Lean'ish project in practice, and contributes new knowledge on how something Lean'ish is assembled. The challenge is highlighted in the way old dichotomies become part of the same space and multiplicities in the findings. The findings suggest that the Lean'ish project is anything but a singular product brought in from the outside. The Lean'ish project is made up of odd bits and parts, not as a product of a Lean philosophy, culture or methodology, but rather a heterogeneous and manifold group of actors creating a multifaceted being.

The findings also introduce a set of processes. These processes are seen as effects of the network of actors and explain the way the odd bits and parts of the project assemble in this project. They are also precarious, un-deterministic and dynamic illustrated in the multiplicities, dualities and paradoxes introduced. The focus is shifted from the single event or action towards the interactions. It is not about if Kaizen is the best way to establish autonomous groups or if dialogue conferences contribute to increased participation. It is about building an awareness and sensitivity toward the complex ventures where Kaizen methodology and Dialogue conferences may be a part, but where the effects are results of the interaction of actors and not the single actor. The four processes identified in the findings are examples of how the relations assembled gave birth to the new practice and way of doing production in the factory.

Opening up the black box also removes the mythological image of Lean. I will argue that the origin of the mythological image is in the lack of observations of Lean practices and the materiality. Without the practices and the materiality we are left with vague, non-contextual and mythological concepts linked to culture, philosophy and methods, isolated from the actors that created the practices and thinking we call Lean. My ambition with this thesis is to bring those people, structures and materiality back in, as parts of Lean, revealing a more material and less mysterious ways of doing production. The thesis challenges the search for simple structural explanations and replaces them with a case study on how relations assemble the project. This thesis represents a change in our approach to Lean; in the way we analyze, understand and practice it. It introduces a new set of tools and methods that treat the Lean project an effect of the network of relations. It opens the black box of Lean, remove the mystery and make visible processes and materiality in the assembly of Lean. It replaces the dichotomy of theory and practice and sees theory as embedded and extended in practices.

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1 Introduction

Lean and associated efforts to improve production are a reoccurring theme in this dissertation. It will be discussed more thoroughly later, but the reader unfamiliar with the concept should for a start think of it as a methodological effort to improve the quality in production based on removing waste (in a broad understanding) and optimizing flow of goods and information. It is important to note that even though Lean is a returning issue, this is not a study celebrating Lean. It is not a study denouncing Lean either. It is not really a study of Lean at all. This study is an exploration of the people, processes, technologies, devices, controversies, changes and development in a Lean'ish industrial project. It is an exploration of the networks of relations, how these relations assemble or not, and the effects of these networks. This way the thesis becomes a heterogeneous study of organizational change that treats innovation as enmeshed and entangled in people, structures and materiality (Latour, 2002).

Or to put it another way: What started out as a project where organizational change and development theories were meant to illuminate Lean has turned into a venture where a Lean'ish project is explored to illuminate our understanding of organizational change.

It is also a venture involving local stakeholders in the theoretical reflections and involving the researchers in the practical solving of problems. I have spent more than two years as a researcher and a project leader in the company, taking an active part in planning, identifying pitfalls, developing measures, initiating actions and implementing changes together with (Coghlan & Brannick, 2005; Heron, 1996; Reason & Bradbury, 2001) the local actors, giving me a detailed, situated and in-depth knowledge of the project in action and the organization.

> "*There is nothing so practical as a good theory."* (Lewin, 1943, p. 288)

The rationale is to make the research more significant and relevant for the local actors in the new way to do production in all its aspects.

> "*Research that produces nothing but books will not suffice.*" (Lewin, 1946a, p. 144)

But it is also to make the research more theoretically sensitive by being there when the changes take

place, and thus enable building thick descriptions of the heterogeneity present and the actions taking place. This way approaching theory as something separated from practice is rejected. Theory and practice are seen as two faces of the same, and theory as embedded and extended in the practices.

This perspective on theory and practice is mirrored in the ambition to contribute not only in a theoretical sense, but to also contribute to the way we do production in the factory. Opening the Lean black box and thus opening up for the complexities part of the assembly of the new way to do production contribute new understanding of a Lean'ish project in practice, and not least contribute new knowledge on how that something is assembled. The practical implications are explicit and contribute to increased knowledge on how to handle the complexities, but most of all, it contributes to an increased sensibility and awareness to the precarious practices of what we call Lean. I use the word precarious throughout the thesis as in something unpredictable, delicate and dependent on chance, and the opposite to something fixed, given and safe.

1.1 Why a Lean'ish project in a Local Company?

The last ten years I have been working at a regional university college in the faculty of engineering and natural sciences. During this period there has been an increased focus on collaboration between industry and the university colleges in the different national regions. This focus and the implicit new role of the university colleges have gradually and partially been implemented in teaching and research and development activities. The main intention has been to contribute to increased regional value creation and development (and now regional innovation). In my own practice these changes are visible as involvement in a new bachelor program on technological innovation and entrepreneurship in close collaboration with the regional industry and as participation in national research programs on regional development with partner Østfold Research. These research programs include the Norwegian Research Council funded Enterprise Development 2000[1] (ED2000) (as reference), the Value Creation 2010[2] (VC2010) and Measures on regional R&D and innovation[3] (VRI). These programs may be seen as part of the legacy[4] (H. D. Finsrud, 2009) from the Norwegian Democracy Projects represented with the works of Einar Thorsrud and Fred Emery (Thorsrud & Emery, 1970) with an emphasize on participation and industrial democracy to improve the quality of the work life for the organization's employees. But it is important to note the ongoing weakening of the democracy dimension in these programs in favor of the competitiveness dimension. It is not only in the naming from *democracy* and *participation* to *value creation* and *measures on regional R&D* that the projects have changed. This is especially significant relative to the early Norwegian Democracy Projects and the direct impact they had on work life laws, legislations and agreements in favor of the right to participate and democratization in the companies (Gustavsen & Hunnius, 1981). The same type of impact is difficult or even impossible to envisage from today's programs. Participation has in many ways become a means to accomplish competitiveness and not a goal in itself.

The industrial project that form the basis of my work started as part of the VC2010 project module in Østfold. VC2010 was a national research program in cooperation with the Confederation of

1 A detailed account of how the program was developed and action research reflections can be found in Levin (2002)
2 For more on VC2010 (in Norwegian), the foundations of the program and experiences made with the two-parts development projects can be found in Gustavsen (2002; 2003)
3 A historical overview of national work life development programs and critical discussion on how the focus has shifted from enterprise develoment to regional innovation can be found in Finsrud (2009)
4 A short introduction to the Norwegian Democracy Projects can be found in the section "The Norwegian Experiences" in Greenwood & Levin (2007)

Norwegian Business and Industry, The Norwegian Confederation of Trade Unions, Innovation Norway and The Norwegian Research Council. It was initiated in 2001 and has since autumn 2007 continued in the VRI (Measures on regional R&D and innovation) research program. The main objective is to encourage and contribute to organizational development and innovation, both within enterprises and in networks between enterprises. New forms of co-operation between the industrial (social) partners and other actors in the value creation processes are central (Gustavsen, 2003). This is done by active use of researchers as development partners.

1.2 Problem Statement

The introduction of technological superior solutions and methods of production do not always have the intended effects. The dilemma was experienced fifty years ago with the introduction of the Longwall methods of coal getting in a coalmine (Trist & Bamforth, 1951). Management introduced a new mechanized method (the Longwall method) that organized the work over a span of three specialized shifts, each shift responsible for different tasks of the work, resulting in an increased level of interdependence of tasks and between shifts. This was a change from the old organization with some degree of autonomy, and as Trist and Bamsforth argue, it destroyed the social structures present in the organization. The results showed difficulties in the coordination of the work and caused low productivity rather than increased productivity as anticipated.

In my experience the dilemma still exists, but today after the introduction of Lean and joint efforts to improve efficiency. According to Rubrich:

> Industry Week reported that 72% of the 884 U.S. companies responding to their survey were in various stages of implementing an improvement strategy such as Lean or World Class manufacturing, Agile manufacturing, Six Sigma, TPS, Theory of Constraints, or others. Of these companies, 75% reported that they had made 'no' or just 'some' progress toward their World Class manufacturing goals. Only 2% of the companies reported achieving World Class manufacturing status. (Rubrich, 2004)

In what way does the dilemma still exist? The dilemma exists in what I encounter as a belief in the universal validity of a family of methodologies despite the failures to deliver what is promised (Eccles, Nohria, & Berkley, 1992; Muthiah & Huang, 2006; Rubrich, 2004). In what I perceive as a conflict with (or a neglect of) the materiality in the ongoing processes within the organization, it leads to the creation of "a logical superhighway" to nowhere (Lewin, 1951, p. 164).

The problem is that we do not understand what actually is going on when introducing these new methods like Lean, with the Japanese labels and exotic examples that create an almost mythical image. The problem statement challenges our understanding of what's going on. What do we miss? What escapes the mesh? What is inside this black box of Lean?

1.3 Literature Reviews

The problem statement introduces the dilemma in the belief in the universal validity of Lean despite the failures to deliver what is promised. The problem is that we do not understand what is actually going on. This rough sketch of literature is thus about taking a closer look at what is known as Lean, on structural models introducing the contextual for understanding what is going on, and finally on alternative literature that picks up on what slips away or gets lost in the earlier literature.

First, the critical review of Lean illustrates a practice of paradoxes. Within the same label of Lean, we find practices with conflicting ideas and both conflicting and different origins in time and place. I will argue that Lean becomes a very precarious process, not only in the eventual result of the implementation, but also in the processes, tool boxes, agenda, goals and ideologies associated with what is called Lean.

Secondly, the critical review of structural models as ways to understand organizational improvement rejects the apparent clarity of the link between national deep structures and the Norwegian worklife in the structural models, because without the processes or micro level mechanisms or without going beyond the correlation of facts and statistics, the structural arguments become more a justification than an explanation. Another issue is that just pointing to Norwegian deep structures and social capital as the cause in these structural models, without showing the processes, merely enhances, rather than reduces the puzzle or mystery of what is going on.

Third, the critical review of some contextual approaches to human practices establishes handling the complexities as the key to understanding what is happening in the project. The contextual approaches introduce several approaches to handle the complexities, and identify detailed case stories and thick descriptions as well as the strategy of following the actors in action as an important approach. The perspective put forward argues that it is no longer a question about structures or linear correlations, but more a matter of the project as an effect of dynamic relationships between many elements, both human and non-human.

1.3.1 A Critical Review of (some) Modern Concepts of Production Improvements

Before it is possible to explore what is going on, what we miss and what is inside the black box of Lean, it is necessary to elaborate on some modern concepts of production improvements, including Lean. What are they and where do they come from? Why are they used when they so often fail? When are they good ideas and when are they only hype (Birnbaum, 2001)?

To try to answer these questions, I will present a critical look at some central, modern concepts of production, including a special focus on Lean and related efforts to improve efficiency. The rationale is to establish an understanding of the history, origin and ideology of some central approaches and practices.

The concepts are as much commerce as academic discourse. The titles are dominated by quick fixes that will bring the company safely into the future, such as: *How to…*; *Transforming by…*; *Simple methods for…*; *Shaping…*; *Reducing…*; *Untanglin ….* The infrastructures supporting the different methods are likewise, where the companies are offered a wide variety of consultant's services and facilitators. These new concepts of production system improvements have been tried and mapped, introducing concepts like *business fads* (Pascale, 1991), *guru theory* (Huczynski, 1993) and *trends* (Rolfsen, 2000) to describe the ephemeral characteristics of many of these new methods and theories. Despite the somewhat negative touch to the concepts used about them, they are heavily influential in how companies work and they have a lot of success stories in their wake. The tension between the widespread use of these methods and the success stories on one side and the commercial products and failures to deliver what is promised on the other, is a large paradox.

A successful business fad has the following typical characteristics (Rolfsen, 2000): Primarily, that it should be easy to understand; and secondly, should be of relevance to the reader at the time of introduction. Here timing is seen as very important: the fad should be in the early waves, but not too early. The fad should also be easily recognizable, preferable by the use of simple slogans and concepts like Just-In-Time or for instance as easy to remember three-letter abbreviations like TQM (total quality management) and JIT (just in time). Secondly, that it should include easily remembered recipes and toolboxes for implementing the method. Like that of a set of steps, phases and guidelines (4P, 5S) or graphics (the Deming wheel) summarizing the ideas. Third, the message

sent must optimistically point to ways out of the problems. The argumentation is very often polarizing between the good as in sorting out, set in order in 5S, and the bad as in chaos and inefficiency.

One example illustrating the tensions and the challenges linked to these new methods may be the story of Reengineering[5]. Reengineering emerged in the late 1980's in the Boston area by academics and consultants linked to MIT among others. The idea was to link computing and business change by not only working more efficiently but to change the way one works, i.e. the "clean sheet of paper change program." In spreading the idea in the early phases, publications like Sloan Management Review and Harvard Business Review were important. From this background a new leading fad evolved, growing to a $51 billion industry in 1995 (Davenport, 1995). And as in "the bigger they are the harder they fall," reengineering went from the leading star on the management sky to something "ugly" that associates with "mindless bloodshed" layoffs and failed change programs.

> The 1994 CSC Index 'State of Reengineering Report' had the answer: 50% of the companies that participated in the study reported that the most difficult part of reengineering is dealing with fear and anxiety in their organizations; 73% of the companies said that they were using reengineering to eliminate, on average, 21% of the jobs; and, of 99 completed reengineering initiatives, 67% were judged as producing mediocre, marginal, or failed results (Davenport, 1995).

Another example is Lean. The reader who is unfamiliar with Lean could think of it as a methodological effort to improve quality in production based on removing waste (in a broad understanding) and optimizing flow of goods and information. So far there is not much to be offended by. But now we need to go in more details on the subject.

Primarily, Lean is not an acronym. It is Lean as in "thin in a healthy way" used as a metaphor for a company that has removed waste and achieved flow. Secondly, Lean is much more complex and difficult to describe and analyze as it is not so isolated in time and place as Reengineering. Where Reengineering was so closely related to computers and a more or less a well defined set of features, Lean has a longer history and numerous sources of origin, a wide set of practices and

5 A personal narrative of reengineering as seen in retrospect by one of its creators is found in Davenport (1995)

understandings creating a complicated and almost incestuous relationship where the one who is regarded as father or mother, brother or sister to whom varies. Krafcik first used the label in 1988 (Krafcik, 1988), based on experiences from Toyota and *The Toyota way* (J. Liker, 2008; J. K. Liker, 2004; J. K. Liker & Meier, 2006; 2007). In practice Lean and the Toyota way are used as synonyms and this makes it possible to talk about a fifty years long history. Lean is thus not an isolated effort, but part of a larger family of methods and tools.

It is in its tools and practices that Lean moves away from rhetoric and the haven of flow and waste. I will try to tell two different stories of Lean to illustrate the differences in origin and ideology (Barnett, 2003). None of the stories are extreme in any way, but will hopefully illustrate the diversity within Lean. To be specific I will focus on the differences in how to think about participation.

If you take away the exotic labels of a lot of the tools and methods, Lean is much more common sense. That is not to say that they are unimportant or trivial, because many important and advanced things are also common sense, but still hard to do in practice. 5S is a good example. The S's are Seiri, Seiton, Seiso, Seiketsu and Shitsuke. Translated into English, keeping the S's would be something like Sorting, Set in order, Shining, Standardizing and Sustaining. The ideal is first to remove everything unnecessary and only keep the essentials. That is keeping not only the essential machines and tools, but also only the essential parts and procedures. Secondly, to organize all items in a dedicated and well labeled place close to where they are used. In other words, it's not only about putting thing in their place but also simplifying the use of them. Third, to keep the shop floor shining, clean and tidy. Not as a weekly cleaning, but as a continuous approach to doing production. Fourth, to make the work practice standardized and consistent so that it is easy for all to understand, practice and manage. Finally, to keep the practice on the new level and not fall back into earlier (mal) practice and not least to continuously to look for improvements. In my experience a typical 5S factory is easily recognizable in a shop floor of yellow lines, marking the place for everything. But as indicated in the S's there should be something more. 5S identifies continuous improvements as an issue and an ongoing process (Kaizen).

So far, still harmony, but from now on I will try to take two different turns.

Story 1: Kaizen

The last S in 5S translates to sustaining, and points to continuous improvements (Kaizen). In my experience Kaizen is used most in local improvements in a workstation or part of a production line. The improvements in this context are often small and very local and material, but in sum and over time often produce convincing results both on efficiency and in the quality of the workplace. A typical manifestation of Kaizen is a whiteboard with ongoing improvements with status and work and a list of new improvements. The decisions on what to take forward are made in the local group and a history of improvements and decisions are kept. Large-scale programs are in many ways replaced by a local agenda when the Kaizen is established, with a large degree of autonomy. As with 5S it is not about a static position but improvement as an ongoing process and a system perspective like that found in the Shewhart cycle where it is set as part of a never-ending cycle (Deming, 1986).

The history of Kaizen goes back to the 1950's and includes the work of Deming (1986) and others in Japan. It became part of the Toyota way and later Lean and represents one of the many competing origins and ideologies, which are part of today's Lean thinking. Kaizen takes a stronger position on involvement and participation indicated more vaguely in 5S. Participation and autonomy became a requirement for Kaizen, but not as a means to increase efficiency alone, but to also humanize the workplace. It is not about getting the most out of the workers, but to encourage and value the human resources in the company (Deming, 1986; Tozawa, 1995). This position on participation and collaboration indicates an explicit link to the *industrial democracy* thinking and the democracy projects in Norway (NDP) (Emery & Thorsrud, 1974). This alliance establishes pride of workmanship as a goal, puts education and self-improvement on the agenda, substitutes management by numbers with leadership and autonomous groups and makes the transformation to Lean a venture of everybody in the company as seen in the fourteen principles of transformation (Deming, 1986, pp. 23-24). Participation turns into empowerment:

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and stay in business, and to provide jobs.
2. Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for massive

inspection by building quality into the product in the first place.

4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move towards a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.
10. Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.
11. a. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
    b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.
12. a. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.
    b. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, inter alia, abolishment of the annual or merit rating and of management by objective.
13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Story 2: Lean Management

Another perspective on Lean is seen in what is known as Lean management or world class

enterprise (Rubrich, 2004). In this perspective the lines back to Japanese work life are weakened and that to industrial democracy invisible. The links back to management literature are enhanced including that of scientific management (Taylor, 1911) and Fordism (Ford, 1922). The difference is best summed up by the literature itself. "The one and only reason to go Lean is to make more money" (Carreira, 2005, p. 301)

It is no longer about education and self-improvement or industrial democracy but "*step-by-step, dollar-by-dollar guidance on creating a Lean process at virtually any manufacturing company, from laying out processes to transitioning and training employees*" (Carreira, 2005, p. 301).

The different perspective is highlighted in the ten reasons why failures occur (Rubrich, 2004).

Reason #1: Lack of Top Down Management Support
Reason #2: Lack of Communication
Reason #3: Lack of Middle Management/Supervisor Buy-In
Reason #4: Not Understanding That This Is About Your People
Reason #5: Lack of Customer Focus
Reason #6: Lack of Improvement Measures
Reason #7: Lack of Lean Leadership
Reason #8: People Measures Not Aligned With Lean Goals
Reason #9: Using Kaizen Events As The Sole Improvement Measurement
Reason #10: Bonus Pay Systems Where The Only Measure Is Company Profitability

Some of the ideas from the first perspective are recognized, but the overall image drawn is quite different. Participation is still important, but it's linked to efficiency and not industrial democracy anymore.

This understanding of participation as a management driven process and a means to reach higher efficiency is nothing new, but something that can be traced all the way back to Taylor and Ford. This way Lean may also be seen as having origins in the very same literature and practices that other parts of Lean may be seen as a reaction to.

What are they and where do they come from? Why are they used when they so often fail? When are they good ideas and when only hype?

As the two examples illustrate, what we call Lean can include very different processes, ideas, goals, understandings and origins (Table 1).

Participation as empowerment	**Participation as hegemony**
The process as a transformation	The process as a translation
About education and self-improvement (for all)	About training of employees
Eliminate management by numbers, numerical goals	Eliminate lack of improvement measures
Leadership	Management
Participation as in industrial democracy	Participation as a mean for efficiency
Lean as a collective venture	Lean as management driven

Table 1: Two Perspectives on Lean and Participation

Primarily, the examples illustrate the flaws and challenges when trying to categorize practice. Both examples focus on waste and flow and thus may be labeled Lean. But it can also be questioned if it makes sense to put them in the same category of approach to production because of the differences in approaches to participation.

Secondly, I will argue that the problem is not necessary the ideas themselves, but the focus on purely instrumental concerns as set of steps, phases and guidelines and exaggerated promises that lead to simplistic and normative recipes for solving complex problems. That is because there are no theoretical frameworks to understand, explain and interpret in the actions. There are few, if any, concerns with situational or contextual issues and different work life traditions. The methods are general in nature and built and promoted as one size fits all. I will argue that work life processes and change processes especially are situated, complex ventures in both social and technological change, which is not possible to understand using such simple models. It can be argued that this is

intentional, but when the instrumental recipes and methods don't work, it is valid to question the lack of theoretical frameworks of understanding.

However if the approaches don't work, why are they used?

Many of the approaches include good ideas and relevant practices. But a good idea does not automatically make good practice and thus an approach may be both hype and a good idea at the same time.

It has been pointed to the introduction of professional management (Pascale, 1991) based on universal concepts and “management everywhere” thinking as a reason for why the methods are used (Huczynski, 1993). With professional management and management everywhere, I understand the practice of generic management where a good manager can manage all kind of companies. This way Lean may become an argument for the “management everywhere” thinking in the company, and a way to preserve and strengthen this perspective because of the shared generic message. Lean in the understanding a generic approach to production matches that of the generic approach to management already in place.

It has also been indicated that the practice of using the new ideas has an added layer on top of and not as an alternative to “business as usual” (Pascale, 1991). The new methods this way become part of the “business as usual”-thinking, where the continuous new layers end up as representative of the same old way of doing production.

The last argument for why they are used is that they sound like they should work (Birnbaum, 2001, p. 60). As if that illustrates the polarization between good—as in set in order - and bad - as in chaos and inefficiency - which was introduced earlier in the literature reviews.

As the two examples of Lean show, it is a practice of paradoxes. Within the same label we will find practices with conflicting ideas as well as conflicting and different origins. Consequently this discussion implies that implementing Lean becomes a very precarious process. Not only in the eventual result of the implementation, but also in the processes, toolboxes, agenda and goals associated with Lean.

1.3.2 A Critical Review of Structural Models as a Way to Understand Organizational Improvement

After the elaboration on some concepts of production improvements, including Lean, it is time to return to the main challenge, introduced in the problem statement. What's going on? What do we miss? What escapes the mesh? What is inside this black box of Lean?

The link between Lean and what is known as the Norwegian cooperation model has been strengthened and made explicit in the concept of *lean in Norwegian* (H. Finsrud, 2009). The Norwegian cooperation model will be discussed in more detail later, but for now think of it as a worklife model emphasizing cooperation and participation between employers and employees both in practice and formally, anchored in the Norwegian welfare model. The strengthened alliance is illustrated in the work of the national Lean Forum Norway[6] where research and development on these two topics are the main agenda for the forum. The ambitions are to combine Lean management with the Norwegian tradition of cooperation and participation associated with the Norwegian cooperation model. This way Lean is treated as something consistent with the Norwegian cooperation and welfare model, and thus becomes linked to research and literature on Norwegian worklife.

To explore how we can approach the challenge of what is going on I introduce literature using structural models and explanations to address the problems identified in the problem statement. This literature is also relevant, because of the dominance in the national discourse and the influence and impact on how national and regional governmental actors as legislators and funding partners understand, explain and relate to modern concepts of production. This starting place introduces the specific Norwegian work life and work organization and the Norwegian order of society.

The literature introduces the national specific and the contextual and represents a step away from the generic models discussed earlier. This way the specific Norwegian work life and Norwegian order of society becomes part of the analysis and understanding. The literature also becomes important to illustrate a way to include the contextual in the analysis, even later, when I challenge the significance and (practical) relevance of this kind of national materiality.

[6] http://www.leanforumnorge.no/

A starting point to introduce the literature, and the way to include the national materiality in the analysis, can be the economic growth (GDP) in Norway compared to EU. The Norwegian GDP is almost twice (190%) the average number in EU (100%). The same goes for workforce productivity, despite the high employment numbers in Norway. At the same time Norway has a low score on investments in research and development (R&D) (Grimsby, Grunfeld, & Sverdrup, 2009).

The message is that Norway has high value creation and productivity, but low investments in R&D and low scores on innovation indexes. This message has made OECD (2007, p. 125) to introduce the concept of *the Norwegian puzzle*. How do we understand and explain the paradox of low investments in R&D and low score on the innovation indexes with a high economic growth and value creation?

This puzzle has been linked to the way society is organized and the political established structures (Hernes, Grimsrud, & Hippe, 2006), a result of the coordinated market economy associated with the social-democratic element in the Norwegian society (Gustavsen, 2007, p. 651). In other words the way that society is organized and the political established work life structures explain the puzzle.

As an example illustrating this I will use selected writings from Hernes (researcher and former minister). In a series of publications he expands and develops his arguments on understanding the Norwegian worklife. Essential in these writings is how general structures are used to explain both the prevalence and effects in society.

> The prevalence and impact of partite co-operation in Norway can however, only be understood out of the frame of reference it is set in. It is largely arenas that are regulated by central laws and agreements (Hernes et al., 2006, p. 41).

> In Norwegian society, there are some normative deep-structures. One of them is the notion of distribution of justice (Hernes, 2004, p. 124).

He builds a line of arguments based on national statistical data on issues like competitiveness, corruption, earnings disparities and taxes to establish what he labels the Norwegian macro model (Hernes, 2006; Hernes et al., 2006). The Norwegian macro model is thus about politically

established worklife structures, where the paradox is explained as a consequence of these structural characteristics of the Norwegian society.

A common critique of structural models and a line of arguments like the one presented in the macro model, is the difficulty to see through what processes or micro level mechanisms the structures are meant to impart (Little, 1991, chap. 5).

A related issue is the type of explanation used. In the macro model the line of facts and especially the numbers on competitiveness are explained by the facts about the (politically established) structures in the Norwegian society (Hernes et al., 2006). This is illustrated in the way competitiveness (as GDP) is linked to statistics on gender gap, earning disparities, tax levels, trade unions and corruption. Again this is not an explanation (Elster, 2007, chap. 1), but a correlation of facts.

When going into the companies, a third critique is introduced because the arguments are based on statistical facts and numbers. Aggregated numbers from a group of companies cannot account for the individual events and actions in a specific company and any statistical explaining of what is going on in a single company based on these data are not applicable.

Without the processes or micro level mechanisms, or without going beyond the correlation of facts and statistics, the structural arguments become as much a justification of administrative action as any explanation.

I understand the later *micro model* as an attempt to address some of these critiques. Central in the Norwegian micro model is the company and the interaction between management and employees. The interaction is split into two types, that of negotiations and that of participation. The latter part is also often referred to as the Norwegian cooperation model, and will be discussed in more details later. Based on the degree and type of cooperation and participation practices established in the individual company six categories are constructed (Table 2).

		Management		
		Unilateral	**Formal, by the book**	**Involving**
Employee	**Unorganized**	1 Unpredictable, random management "no voice"	2 Statutory, minimum participation, safety deputy etc. "ritual"	3 Direct participation, individualized "empowerment"
	Organized	4 Minimum participation "no nonsense"	5 Participation according to laws and regulations "reduce risc, avoid turbulence"	6 Broad participation and collaboration "democratic innovation management"

Table 2: Categories of Cooperation and Participation (Hernes, 2006, p. 24)

Social capital (Putnam, 1995) is the basic precondition for the micro model to work. This way the development of the micro model is seen as the development of social capital. According to Hernes, "One can say that the Norwegian micro model historically has consisted in the development of social capital with specific features on the company level" (Hernes, 2006, p. 33).

The GDP and competitiveness are linked to the increased social capital built into the companies. But to cite social capital as the cause does not explain it; the processes and mechanisms must also be provided. The lack of processes and mechanisms make social capital almost meta-physical, because it works as a new generic structure, and not as part of the processes or micro level mechanisms that explain the structures in the macro model. The gap between the six categories and the concept of social capital is too big.

Despite the dominance in the national discourse and the influence and impact on how national and regional governmental actors understand, explain, practice and relate to modern concepts of production, it is difficult to see the observed processes and development as a natural or given result of these structures and national regulations alone (Emery & Thorsrud, 1974; H. D. Finsrud, 2009; Gustavsen, 2007). Experiences from seemingly similar companies, sharing the same structures, but with very different practices and successes illustrate this.

The practice of trying to structure, order, divide, simplify and not least exclude, as shown in the example may be rhetorically and pedagogically sound, but are also “dangerous because they seem to be able to tell good from evil and to discern who is to blame who is not” (Mol & Law, 2002, p. 2). This danger is illustrated in what structural characteristics of the Norwegian society, which establish the Norwegian work life so pleasantly, resonate with public mythology. We want to believe that our society is so unique that it explains the puzzle. Moreover the apparent clarity of the link between national deep structures and the Norwegian work life does not survive a closer examination. That is because without the processes or micro level mechanisms or without going beyond the correlation of facts and statistics, the structural arguments become more a justification of political actions than any explanation. Another issue is that just pointing to Norwegian deep structures and social capital as the cause in these structural models without showing the processes just enhances rather than reduces the mystery of what is going on.

1.3.3 A Critical Review of Some Contextual Approaches to Human Practices

So far the elaboration on Lean and related methods has drawn an image of a precarious practice of paradoxes, conflicting ideas and different origins. Lean as an entity is challenged. Further, it illustrates that the structural models like the Norwegian macro and micro model fail to address the challenges of what is going on in the companies. They do so because they fail to identify the events, actions and processes explaining how the structures are meant to impart in a satisfactory way.

I will argue that much of the writings discussed so far miss the nuances and materiality of what is actually happening. The instrumental "one size fits all" approach found in parts of the Lean literature and the structural models advocated are unsatisfactory to understand the internal processes as well as the development in industrial projects like the one in this study.

This is not to denounce the literature covered, "That we are studying a subject matter does not mean that we are attacking it. Are biologists anti-life, astronomers anti-stars, immunologists anti-antibodies?" (Latour, 1999a, p. 2)

Yes, I am critical to the way many of these methods are described in literature. But at the same time I am part of the practical work of improving production and reforming things in the factories that are strongly influenced by some of these concepts. My point is to turn the attention to what slips away or gets lost in the literature. This way the agenda is not to attack the field, but to contribute. A starting point is the critique raised so far on how to answer the questions posed in the problem statement of what is going on?

As a participant in different industrial projects, I am confronted with projects where structures like the wage system, organizational model, national structures and laws are important contributors to the way things turn out. Other contributors are the technology involved, networks established, individuals like burning souls and not least coincidences like in things that could have turned out differently. They are all examples of elements that can be essential for the progress in the project. This complexity is lost in much of the Lean literature and in the structural models.

There are voices that directly challenge and criticize the importance of generalization in social

explanation and the idea of simple reality of order. This challenge and critique also has several interesting implications on how we see science and how we see data. In 1973 the American anthropologist Clifford James Geertz challenged the "*grand idée*" (1973a, p. 4) that promised to solve all fundamental problems (a critique of general social systems theory as one of many). The search for simple causal patterns or structural and functional explanations is replaced by interpretation of human practices, values, goals and choices. Science thus becomes a venture in *thick descriptions* (Geertz, 1973a, pt. 1) to handle this complexity introduced as a contrast to the targeted observational activity often put forward, based on simple causal patterns or ruling structures.

As an example we can use the excerpts from Geertz's field journal making up a narrative from Northern Africa. Some background information: Among traders and buyers in Northern Africa a trade pact exists as a way of doing business and a tradition for compensation when criminal actions takes place. This tradition existed alongside the official French legislations. To complicate it further, the story involves two Berber tribes and a Jewish merchant. The story shows how the co-presence of several different frames of interpretation resulted in a systematic misunderstanding and as a result the merchant ending up in jail for doing what he thought was correct. The key argument is the complexity and interpretations involved in research as in the case of the Berber, Jew and French, and how "the complexities are possible, if not practically without end, at least logically so" (1973a, p. 7), and continues, "... what we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to" (1973a, p. 9).

This approach challenges not only generalizations, but has implications on how we can understand science and data, as discussed in the last paragraph.

This way the organizations and change processes we explore may no longer be regarded as a simple system of order, but a dynamic system of processes with a high degree of complexity. Or put another and more direct way, what we study is complex and will never fit within our structures, categories, orders, divisions and simplifications. A different way of generalization is introduced, based on the complexities and the contextual of the thick descriptions, as in the example of the merchant. It is no longer the removal of the contextual that makes it generalizable, but as in the case of the merchant it is the thick descriptions and the contextualization that make the processes more

universal.

Yet, celebrating complexity[7] is not the agenda here. Yes, the practice of trying to structure, order, categorize, divide, simplify and exclude dominate both the literature on modern concepts of production and the structural models of explanation, but critique of complexity alone is neither new or especially helpful.

> Things-in-themselves? But they're fine, thank you very much. And how are you? You complain about things that have not been honored by your vision? You feel that these things are lacking the illumination of your consciousness? But if you missed the galloping freedom of the zebras in the savannah this morning, then so much the worse for you; the zebras will not be sorry that you were not there, and in any case you would have tamed them, killed, photographed, or studied them. Things in themselves lack nothing, just as Africa did not lack whites before their arrival. …" (Latour, 1988, p. 193)

We need approaches, theories and metaphors on how to relate to complexity, not just another well-established and comfortable critique of simplification (Mol & Law, 2002). Also this is not about sinking into relativism saying that all literature is equally valid, but more that we will have to challenge our understanding and open the dominating literature to inquire and introduce new ways of relating to complexity and especially new ways to identify what contribute to the way things turn out in the project.

A comprehensive theoretical framework taking up many of the elements discussed so far is Science and Technology Studies (STS). The view of science and technology (Bijker, Hughes, , and , Pinch, 1987; Latour, 1979; 1987) as socially embedded enterprises, the concept of black boxes, the strategy of focusing on practice and the history behind the facts and the detailed case histories with thick description and richness of data are addressing many of the arguments brought up in the contextual literature and discourses so far. It can also be a starting point on how to explore related complex phenomena like modern concepts of production system improvements.

STS is an interdisciplinary program on how social, political and cultural values shape scientific

7 The not so straightforward relationship between simplifications and complexity is elaborated in Law and Mol (2002).

research and technological innovation and vice versa, how scientific research and technological innovation shape social, political and cultural values. The common ground is in viewing science and technology as socially embedded enterprises.

Bruno Latours analysis of science (Latour, 1987), arguing how social context and technical content are important to understand scientific activity can serve as an example of STS writings. Science is considered as a collective action and information or facts about nature is the outcome of this collective action. Latour's point is that facts are constructed and it takes work to establish and maintain them. Central in this framework for research are the focus on action; to observe the scientists at work and find out what they do and not what they say. This is important because when first established as a "*fact*" the scientific discoveries are difficult to understand and deconstruct; a *black box* is created that is no longer discussed and challenged.

STS also includes literature on innovations in organizations. Pinch & Bijker (1987) conceptualize innovations as complex, social processes where construction of new technology is dependent on all involved actors. All actors bring knowledge, ideas and influence into the development of activities. There is no one-dimensional logic that guides the process. Different knowledge, interests, perspectives and social understanding are integrated into the same development activity, where gradually, a shared understanding about what the innovation results should be evolves. The development process is "ended" when a majority of actors with power in a kind of consensus decide that the results are achieved.

Another significant contribution and an example of STS writing, which is especially interesting on a more tactical level, is the study of Salk Institute (Latour, 1979). In this study Latour develops a detailed study "*of the daily activities of scientists in their natural habitat*" (p. 274). From October 1975 he worked at Salk Institute for a two-year period where he became part of the laboratory.

> To follow closely the daily and intimate processes of scientific work, while at the same time to remain an 'inside' outside observer, a kind of anthropological probe to study a scientific 'culture' — to follow in every detail what the scientists do and how and what they think (12).

Latour combine participant-observation and an "*ethnomethodological approach"* in a book length

and detailed study of processes and actors linking the theoretical framework and observations close to the empirical material in a transparent way ” (Lowood & Sussman, 2003).

The short review introduces several approaches to handle the complexities. These approaches include how the complexity in the thick descriptions may contextualize the project and thus make the processes of general interest like that of the narrative of the Jewish merchant. This way detailed case histories and thick descriptions become important and will be discussed in further details in the methods chapter.

Detailed case histories and thick descriptions and the strategy of following the actors in action also becomes important because the literature includes a view of technology as a socially embedded collective enterprise. This perspective makes people and materiality part of the same framework like that of the researchers, machines, graphs and papers at Salk Institute. It introduces several different elements that all contribute and play a role in the construction of a fact or in my case the assembly of a project. It is no longer a question about structures or linear correlations, but more a matter of the project as a result of dynamic relationships between many elements. This understanding will be further challenged, mirrored and elaborated in the theory chapter.

1.4 Thesis

The almost mythical image of Lean associated with Japanese labels, exotic examples and not least success stories is challenged in this study. The literature reviews draw an image of Lean as a precarious and complex practice of paradoxes, conflicting ideas and different origins. On trying to understand what's going on in this kind of project the structural models fail to address the complexities and the precariousness introduced. They do so because they fail to identify the events, actions and processes explaining how the structures are meant to impart in a satisfactory way.

I will argue that the origin of the mythological image is in the lack of observations of Lean practices and materiality. Without the practices and the materiality we are left with vague, non-contextual and mythological concepts linked to culture, philosophy and methods, isolated from the actors that created the practices and thinking we call Lean. My ambition with this thesis is to bring those people, structures and materiality back in, as parts of Lean, revealing a more material and less mysterious ways of doing production. The thesis challenges the search for simple structural explanations and replaces them with a case study on how relations assemble the project. This thesis thus represents a change in our approach to Lean in the way we analyze, understand and practice it. It introduces a new set of tools and methods that treat the Lean project as an effect of the network of relations. It opens the black box of Lean, removes the mystery and makes visible the processes and materiality in the assembly of Lean. It replaces the dichotomy of theory and practice and sees theory as embedded and extended in practices.

This study focuses on the local Lean project as a socially and materially embedded collective enterprise. This perspective makes people and materiality part of the same framework where different elements contribute and play a role in the assembly of the project and the understanding. It is not a question about structures or linear correlations anymore, but more a matter of the project as a result of dynamic relationships between many elements. It is about the blend of individuals, technology, structures and coincidences that together establish something in continuous translation during the project. This way, taking part in the project, being there when the changes take place building a detailed case history of thick descriptions becomes important.

The introduction of a new approach to production, like Lean, is thus not about a new great method or new way of management only. It is rather about industrial change in all its different flavors, and

how to make a team of methods, structures, management, individuals, technology, market and the rest, that can contribute to the assembly of a new way to do production.

1.5 The Preliminary Research Question

I want to challenge the almost mythical image of Lean associated with Japanese labels, exotic examples and not least success stories. I want to challenge the idea that different ideologies and different traditions seem to have found a haven inside the box of Lean; that Lean is treated as one thing, a single entity. I want to open the black box of Lean.

I want to explore how we can understand the assembly of the Lean project and identify the processes and actors contributing to make it happen. My agenda is a more descriptive approach for understanding how the processes are undertaken in an organization, integrating structural, technical, organizational, individual and coincidental elements from the experiences.

Based on the problem statement and the discussions so far my preliminary research question is:

- ***How did the new way to do production assemble in the factory?***

What I mean by *how* is to understand both the process and actors who contribute to the assembly and how the processes ended up in the new approach of doing production.

Why is this question important to answer? It is important for two main reasons. First that it will open the black box of Lean and challenge the mythical and homogenous image created. Second that it will go beyond the simple normative recipes and structural models and make us better able to handle the complexities and the precariousness introduced in these kinds of projects.

1.6 Outline of the study

In Chapter 1, I develop the problem statement and give a rough sketch of relevant literature to the study. I present a critical review of Lean and structural model. I then discuss how arguments in my work resonate with other writings that directly challenge the earlier literature and sketch a different perspective on these issues. From the problem statement and rough sketch of literature a thesis and a broad research question are developed.

In Chapter 2, I describe the context of the project and provide a narrative description of the actual case. Basic elements like Lean and the Norwegian Cooperation Model are discussed as part of this context.

In Chapter 3, I discuss the literature on selected issues identified in Chapter 1. Chapter 3 closes with an elaboration on my theoretical position and stand, and a metaphor for understanding the project.

Chapter 4 is a detailed description of the methodology used in this study, closely linked to the theoretical position taken. Complexity is a central issue part of this discussion.

Chapter 5 is an analysis of the zero-defects project. I develop and discuss three actor-networks that are part of the project. The analysis is an analytical description of how the relations assemble the understandings and practices that make up the project.

In Chapter 6, I interpret and discuss the findings in order to understand and explain the processes and development from the Lean industrial project. I discuss how our new understanding may be used in a practical way and as a guideline for a collaborative and participative approach to innovation and development. Finally I present suggestions for further research.

2 Context

2.1 The Company and the Factory

This study was conducted at Glomma Papp AS in Østfold, Norway, an international private company that manufactures paper, corrugated board, solid board and Display. Glomma Papp is a company with a 460-million NOK turnover in 2007 and about 250 employees.

The company was chosen for practical, historical and methodological reasons. Practically, the company is located relatively close to my workplace making it easy to take part in the project activities and on a short notice come and visit the plant. Historically, the enterprise has taken part in different development and regional innovation programs and researchers from the same group as myself were well known with individuals and within the organization, making my entry as a researcher unproblematic. The company also had a member in the board of the present regional research program this study is a part of. The approach to research, the practices and methods are also well known in the company.

The actual site for the project and the study is the Display factory located a six km drive from the main location where the other factories and administration are located. The company has a flat organizational hierarchy (Illustration 1) and the display factory is an organizational part of the bigger unit on corrugated board.

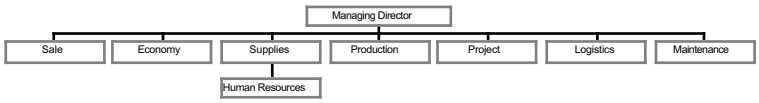


Illustration 1: Organization Chart

In a regional setting the company is often labeled “traditional” because of the products and the long history. At the same time it is untraditional in the way it has a history of participation in a family of research programs. Through participation in seven related development projects over a period of six years the company has established experiences and a continuous practice (Illustration 2) within the family of research programs described earlier.

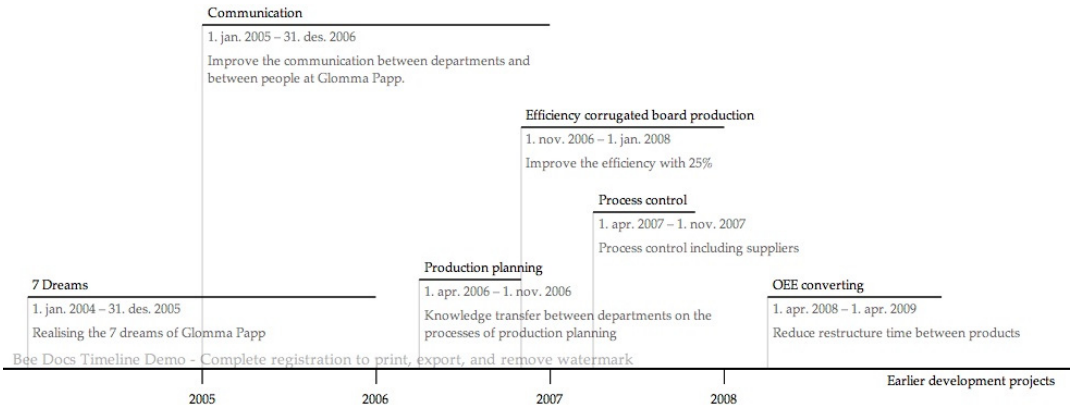


Illustration 2: Earlier Development Projects in the Company

We experience the projects as chapters in the same story where participation and collaboration are central elements. The established practice of involving outsiders such researchers to take part in the company's development projects and taking active part in the making of the regional research programs makes it very different from what normally is called traditional. This way the company represents both the traditional in the type of industry and long history but at the same time something unique in the experiences with organizational work life research as part of the development projects.

2.2 The Research Context

The main objective in the research programs (VC2010 and VRI) is to encourage and contribute to organizational development and innovation within companies and in networks of companies (Gustavsen, 2003). New forms of co-operation between the industrial social partners and other actors in the value creation processes are central (Gustavsen, 2003). For this objective and these forms of co-operation to make sense a short introduction to Norwegian work life and work life programs are in place. These issues will be discussed in more details in the theory chapter.

As discussed in the introduction Norway has more than fifty years of history of work life projects. These projects are initiated and funded by a partnership between the Confederation of Norwegian Business and Industry and The Norwegian Confederation of Trade Unions. The early projects are often referred to as the Norwegian Democracy projects or the Cooperation projects where participation and work place democracy were emphasized (Thorsrud & Emery, 1970). The role of the partnership has gradually decreased but it is still important in the making of these projects. These projects are not isolated academic practices but have been highly influential in the development of work life legislation and practices established in many companies.

The practice of participation on a company level is often referred to as the Norwegian cooperation model (Gustavsen, 2007). It is a localization of the Norwegian macro model discussed earlier. This cooperation covers both local wage negotiations and cooperation on productivity improvements, business development and value creation in the companies. The partite cooperation on productivity improvements, business development and value creation is regulated in the form of a formal agreement (Øyum & Finnestrand, 2010, p. 9). In many companies the trade unions and the employees have a central position in the organizational development projects and in the continuous improvements taking place. This practice of local cooperation and participation is often credited to the high Norwegian value creation and productivity discussed earlier, and today's research program may be seen as part of this understanding (H. D. Finsrud, 2009). This way it differs from the macro model discussed earlier in that it is about the local contributions and solutions and not an effect of the macro structures discussed earlier.

The project is based on an active use of researchers as development partners. This approach implies an understanding that the phenomena studied can be best understood in action and by following the

transformations taking place. Based on these underpinnings we made strategic choices of researchers as development partners that take active part in the project and that of "living" in the factory for a long period as a *friendly outsider* (Greenwood & Levin, 2007, pp. 115-130) where the researchers take roles and participate in the actual project, being there when the transformations take place. This implies both work in depth and over time in the enterprise project. This approach to research draws on the action research and socio-technical legacy found in the family of research program. As introduced earlier the rationale in this study is to make the research more significant and relevant for the local actors in the new way to do production in all its aspects, and to make the research more theoretically sensitive. It is also about participation as part of industrial democracy, empowerment and quality of work life best illustrated in the unfolding of the project in the context chapter and in the analysis.

2.3 Project Conditions

First, as stated, we made strategic choices of researchers as development partners that take active part in the project and that "live" in the factory for a long period as a friendly outsider. The researchers took roles like the project leader and participated in the actual project, being there when the transformations took place.

Second, we chose a project organization that included the trade union representative as part of the steering committee. This choice may seem radical but it was not. As discussed earlier the factory is a representative arena of the Norwegian cooperation model[8] with close collaboration between employers and employees on the company level (H. D. Finsrud, 2009). On an operative level we wanted a corrective to management that could challenge, support and present a possible different perspective on issues in the project. It was also, in practice, a premise given by the VRI project module Østfold for participation in the project.

Third, we wanted to establish horizontal and vertical integration in the different forum with representatives from all involved departments and all levels in the organization where practically possible. This is because we believe in involvement and participation for 1) getting different perspectives[9] and experiences on issues of importance for the project, and 2) anchoring the project among all involved in, and affected by, the change project (Gustavsen, 2003).

Fourth, we chose a practice of openness and transparency in the change project. The project meetings were open in the sense that everyone could join in and new members of the organization took part in the discussions, depending on the subject. All project information was available on whiteboards, the intranet and on various electronic displays all over the company for everyone to see. This is because we wanted to support and build trust between the project, management and workers, and prevent speculations of hidden agendas, which could create an unsatisfactory environment for a demanding change project.

8 The Norwegian cooperation model are presented and discussed from the perspective of the question: "Is there a Scandinavian model for workplace development and what are its characteristics?" by Bjørn Gustavsen (2007)

9 For more on the importance of the workers perspective on Quality, Productivity and management, see Juravich, T. (1985).

2.4 Project outline

The change project was big measured in the number of people taking part (about fifty people participated active in the project in part or the whole), the hours used (we reported 2,445 in house hours on development in 2008 to the Research Council of Norway Skattefunn[10] scheme) and a time horizon of more than two years. The change project has been a big leap for the employees, management and researchers. The rationale for the project was part strategic and part linked to the Display department on quality and related issues because of the recent challenges. It was strategic in the way that the company wanted to gain experiences in Lean and other related approaches to do production.

A traditional project organization with a steering committee and project team was used. But it is important to note that this was a "factory project" and not an isolated project involving only a few. Everyone in the Display factory and selected people in affected departments participated in the project on main activities and events, especially in the development of measures on selected pitfalls and the actual implementation of measures developed.

Early in the change project the project team presented three objectives:

- All products leaving the factory shall be without faults (we shall discover the faults ourselves)
- Customer satisfaction shall be 100% (because of increased quality)
- A faultless production (increased quality) shall contribute to increased productivity in the factory[11]

In the initial phase of the project before it was formally a project in the company we (the researchers) ran a workshop elaborating on and discussing the book "Out of the Crisis" (Deming, 1986), which established an explicit methodological approach to the suggested project. This early version of Lean production, based on systems thinking (von Bertalanffy, 1973) and strongly influenced by Japanese production philosophy (Deming, 1986), is easily recognizable in the objectives like quality versus production, and established a framework for running and

10 For more about the Skattefunn scheme and funding for supporting R&D projects in industry see: http://www.skattefunn.no

11 For a detailed discussion on why productivity increases as quality improves see Deming, W. E. (1986, pp. 1-17).

understanding the change project. We chose this explicit starting point because as discussed earlier Lean include a diverse, heterogeneous group of methods and approaches to production systems improvements and is a practice of paradoxes and precariousness. By choosing an explicit starting point we reduced the implied precariousness. Lean is also often associated with the technical, operational artifacts and recipes like the 5S, Just-In-Time and Kaizen. We decided to go the other way and ask what is really the message in these approaches?

Keywords in our early understanding of Lean were the goal of production smoothing by removing waste based on participation. Systems thinking and a new understanding/logic of quality are other important elements together with emphasis on the employees as the most important resource. User driven innovation was put on the agenda.

The project team also decided on a set of guidelines for the work in the project:

- We shall work smarter – not run faster
- We will stimulate formal and informal participation and use the social partners to strengthen the project
- We will use participation and cooperation (the legacy from the Norwegian cooperation model) as a possible competitive advantage
- The researchers take part in projects and implementation of changes necessary

In the same way as early Lean was easily recognizable in the objectives, the guidelines make no secrets about the connection to the Norwegian Democracy Projects and The Norwegian Cooperation Model. Again no surprises, the project being a part of the VRI context, the strong, active trade unions in place and a history of action research projects.

Parallel with the work on the project objectives and guidelines a theoretical framework connecting the objectives and guidelines in the project were discussed explicitly in the project team. We (the researchers) argued for a socio-technical systems thinking approach, a focus on both social and technological subsystems in the search for the best overall solution (Susman, 1983). Tavistock instituted use of this theoretical framework in the 1960's socio-technical system models in the Norwegian Democracy projects (Elden, 1979; Thorsrud & Emery, 1970). In this perspective the relations between the social and technological subsystems are in focus as shown in the name. This

theoretical framework was agreed on and the main arguments were an explicit systems thinking approach to establish social context as important to reach the objectives and to understand the project. This theoretical framework also directed our attention to the boundaries between the sub-systems as places of pitfalls/problems and associated possibilities for innovation and change (Trist & Bamforth, 1951). The latter attention evolved to include the boundaries between social sub-systems as two departments and not only between social and technological sub-systems.

From this project outline the active role of the researchers is characteristic. It can be questioned if the researchers dominate the arena too much leaving the local stakeholders on the outside? I will argue that we are obliged to participate and contribute to the discussions and the development of the project. As action researchers our role is not the "objective passive observer" but on the contrary the friendly outsider. For me the active role of the researchers is a question about respect for the local stakeholders and their capacities as development actors in their own factory. In other words, the friendly outsider builds on a "fundamental respect for and trust in human capacities" (Greenwood & Levin, 2007, p. 116).

2.5 Project Activities, Milestones and Events

The work was organized in three phases (Illustration 3). The first phase targeted the mapping of the work processes and organizational culture for identifying pitfalls. The second phase targeted how to develop measures and activities for selected pitfalls and the third phase targeted the implementation and ongoing evaluation of measures taken. The project activities, milestones and events are used as described in the project's progress reports (see timelines) part of the project documentation. All timelines used are included in a larger format in the Appendix chapter.

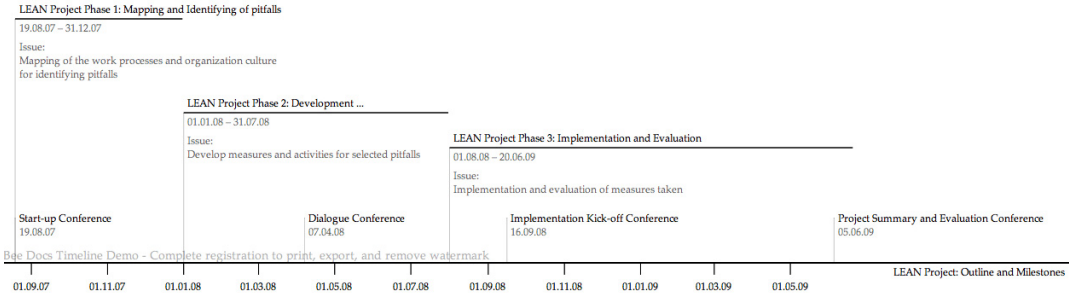


Illustration 3: Project Phase 1-3

In the first phase the work was concentrated in the project team with regular meetings approximately every fourteen days (Illustration 4). As stated in the project conditions we wanted to establish horizontal and vertical integration with representatives from all involved departments and all levels in the organization, resulting in a large project team of about ten individuals. There where some changes in the time of the project, but the core took part during the whole period.

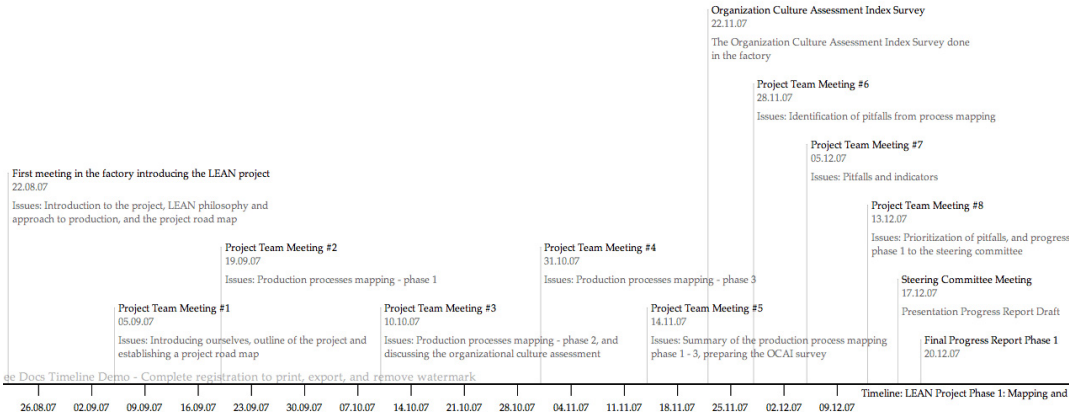


Illustration 4: Project Phase 1

We chose to spend a lot of time mapping the processes in the organization. We wanted to map both the production processes at the time and the organizational culture in the factory. To do this we used traditional process mapping (Illustration 5) to identify pitfalls and problem areas and a standardized method to map the organizational culture.[12]

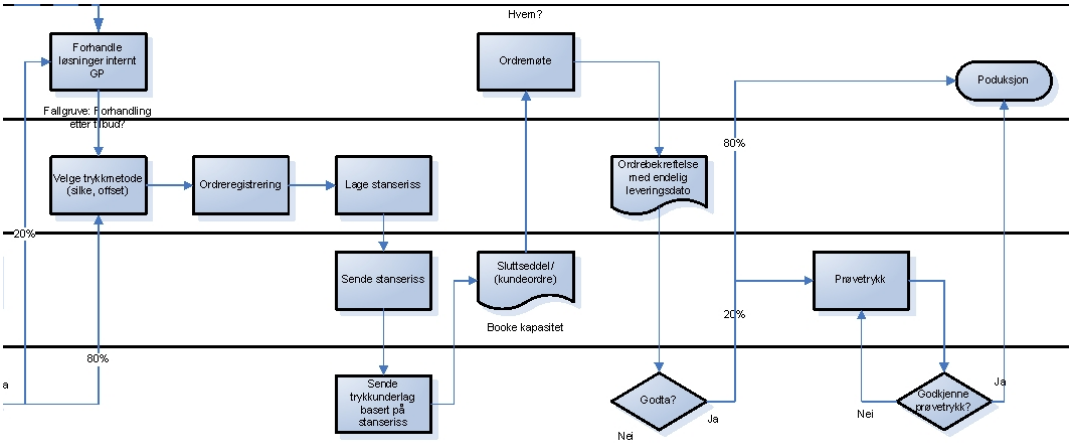


Illustration 5: Process Map Example

The process mapping was carried out in collaboration between the different members in the project

12 We used the Organizational Culture Assessment Index (OCAI). An introduction to the assessment index is given in Cameron & Quinn (2006)

team. The project team started in the end and traced the product backwards to the start of the cardboard machine in the other department. All the different processes, different fields of responsibilities and different tasks involved were discussed in detail. After the mapping most of the members expressed surprise in the complexity of what they thought was a simple process. The exercise was repeated for the other parts of the production chain to ensure a shared understanding of the complete line. During the process obvious pitfalls were identified and preliminary measures and actions were proposed. The mapping work was intensive and demanding. One member of the project team suggested that the experts, the one responsible of the process studied, should do the work and present it for the group as an alternative to the collaborative approach, as it involved members who weren't directly involved in that part of the process. It is interesting to note that several members of the project team emphasized the importance of knowing the what, why and how emerging from the collaborative approach, as were the ideas on measures and actions coming from friendly outsiders in the process.

After the initial process mapping the project team concentrated on the pitfalls and identifying indicators describing the pitfalls. In this work the quality system (QMS) and the accompanying divergence (internal complaints) - complaint database became pinpointed as a major source of data. Adjustments were done to the databases to address the pitfalls in even greater details because the responsibility of the QMS was part of the project team. The importance of the divergence – complaint ratio was discussed and a shared goal to increase the ratio was agreed on, based on the need for more knowledge on the reasons for the divergences and the level of impact from the different divergences. This issue was linked to the new shared understanding growing in the project team. From the mapping process we were all reminded that we did not know the processes in detail and all information on what was really going on and what problems really challenged us were important. The importance of both the QMS and the divergence – complaints statistics grew in the group, and several procedures were changed or removed and new one established to handle this better. The project established a practice where the one actually doing the job wrote the procedure changes – not management or those responsible for the QMS. It is also important to note that one leading member of management joined the team in this phase, thus influencing both the possible impacts from the teams work and the agenda. Quick fixes and small continuous developments were given more priority. The introduction of the new member also increased the team's ability to make changes in areas of importance for the project, but still all decisions were made in the formal

organization hierarchy. Later others from management also took part in the project meetings on their own initiative. My notes from this early phase read, “something has started to happen before we have actually started,” referring to the shift from management written procedures to operators taking the lead part of editing and writing the actual procedures making up the QMS.

In the second phase the work opened up to involve a broader group, including everyone in the factory and other involved actors identified in the production processes mapping. This way the project went through a major metamorphosis. What had been a project of people choosing to take part became a project involving everyone, including outside services and departments that were now pushed to change their own practices. This change challenged the project in the way we worked, in the way we understood the project and what we wanted the project to become. The project now involved people from production, sales, marketing, management, quality and logistics.

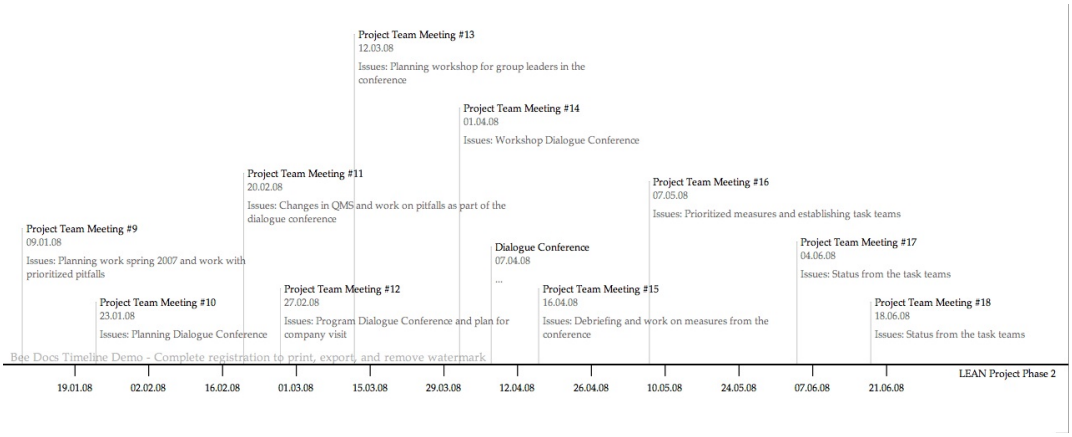


Illustration 6: Project Phase 2

In this phase a central workform was the Dialogue conference (Gustavsen, 1986). Dialogue conferences are a workform closely linked to AR and the work at Work Research Institute in Norway. It is about go into an interaction with the local stakeholders about the phenomena and problems or in this case the pitfalls, and to promote collaboration within an organization. The Dialogue conference took pitfalls identified in Phase 1 and began the development of measures and activities. All staff and management at the display factory and sales, and other involved departments

and services like the cardboard machine operators, transport and logistics and QMS were part of the conference. The factory was shut down for one day to make this possible. The conference used a traditional approach with work in groups versus plenary sessions and in homogenous versus heterogeneous settings.

The conference ended with designated task teams that continued the work started at the conference on the pitfalls in collaboration with the project team, bringing the work to a set of prioritized measures and activities during the spring 2008. The task teams were partly designed and partly a result from individual interests but involved a major part of the participants from the conference and was finished June 2008.

In the third phase the project went from plans to changes in the way we did the production. There had been quick fixes and correcting measures taken but the major changes were done in this phase. The measures developed in the Dialogue conference and the task teams were implemented and corrected. The broad involvement continued in the task teams and in general meetings.

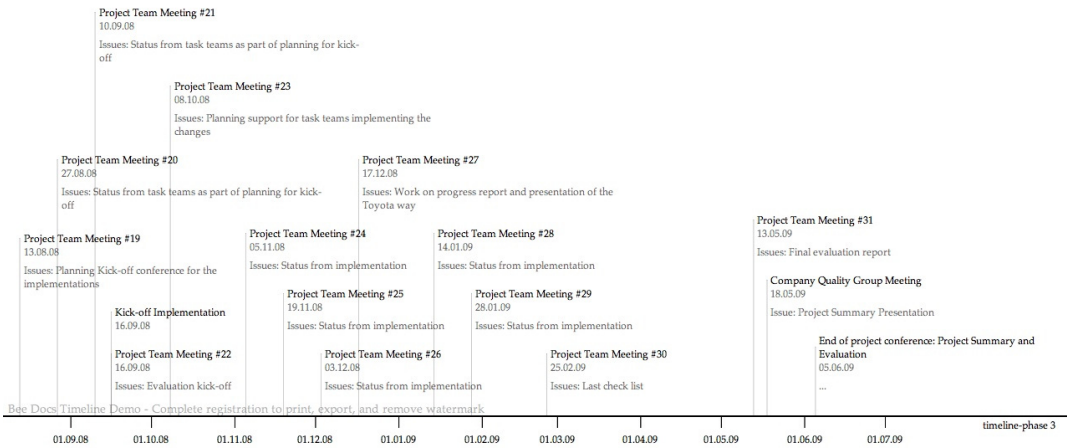


Illustration 7: Project Phase 3

In this phase a central workform was the Kick-off conference. This event marked the start of implementing the bigger measures and changes to do production developed in the task teams. The implementation was split in three sub-phases to make it easier to reflect, learn and make corrections

where needed. The teams worked very differently in this phase. Some made good progress while others had more problems depending on the complexities involved and the nature of the measures. All the task teams reported to the project team regularly in the meetings, both written and oral. The implementation and evaluation phase was ended June 2009 but the more practical issues were ended March 2009.

Summary:

The project team ran more than thirty meetings. In addition there were plenary sessions in the factory, general meetings, conferences and a kick-off. The project team has estimated the total workload and resources spent to be about 1.6 millions NOK[13].

The project team evaluated the project on an ongoing basis. But in the final phase of the project in spring 2009 a set of activities were put forward to ensure a full evaluation:

- Identify success criteria
- Describe changes in the way we do business
- Identify positive elements and changes
- Develop a shared history
- Make a survey

The first three activities were organized as a shared brainstorming in two steps. Important factors were written down on the white board located in the Display department restroom, first in the project team and later in the plenary. The shared history was organized as a timeline (wall paper 1 x 5 meters) for important events and decisions for everyone to write on. From the first four activities a more traditional survey was run.

The end report handed to the steering committee in June 2009 concluded that the project had delivered results on the objectives given. The improvements are most visible in the following areas:

- All location of parts and products are now registered and updated online resulting in improved logistics, management and transparency for all
- Major improvements on quality of card boards from internal suppliers resulted in improved efficiency (little waste) and reduced complaints both internally and related to customers

13 This number is taken from the Skattefunn funding scheme year report 2008

- Reduced errors on production orders, and shared routines with the rest of the company
- A computer terminal for employees to use on the shop floor to check on location, available resources and handling in divergences and complaints online
- A checklist for the sales department for improved quality in production orders

The effects are also registered in the quality management system:

- The number of routines and instructions are reduced in half (easier to use)
- The number of complaints on card board (a major economic post) drastically reduced
- The number of complaints from customers on products from the department reduced
- The ratio on divergences versus complaints increased (meaning that we catch the errors before sending them to the customers)
- From the mapping we have documented that the divergences reported in large can be related to outside production (on parts, and resources)

Other spin-offs from the project:

- Funding from the national Skattefunn (Skattefunn is "qualification-based and regulated in the statutory framework, and is open to all branches of industry and all types of companies - regardless of size" (2010)
- National and Nordic exposure in industry journals on packaging in Emballering (Nordberg, 2007) and Packnews (Nordberg, 2008)

As the project team assesses the situation the main challenges left are:

- To keep the momentum on quality, divergences and complaints documentation
- To keep the open communication and transparency established vertical and horizontal
- To establish a shared, open and explicit organizational culture across vertical and horizontal boundaries

There are of course several things to improve and learn from the project. Perhaps the most important seems to be to establish a broader involvement from the start. The ones actively involved have knowledge about the whole project and work towards the objectives in their day-to-day activities. But the ones more distant to the project (in the department or in different support departments) do not, even though they are central to making things work. The national and Nordic

articles from the factory have increased the pride of work and the workplace.

3 Theoretical Dialogues and Stand

This study views the Lean'ish project as a socially and materially embedded collective enterprise. It is through interaction with others, that someone or something becomes produced. The project is thus an effect of the network of relations including both human and non-human actors.

> More profoundly, it [the ANT approach] is a sensibility to the messy practices of relationality and materiality of the world. Along with this sensibility comes a wariness of the large-scale claims common in social theory: these usually seem too simple (Law, 2008, p. 142).

This theoretical discussion is a continuation of the dialogues introduced in the earlier literature reviewed in Chapter 1. In sum they represent the assembly of how to understand the industrial project and the way it turned out. What started with a challenge and finally a rejection of structural, generic and linear ways of understanding the industrial project, ends up in a framework strongly influenced by actor-networks discussed in depth in this chapter.

The arguments developed, the position taken and the research practiced draw on a wide set of literature and studies more or less interrelated. The legacy is most explicit in the disparate families of Action Research (AR) and Actor-Network Theory (ANT). Some of the more important contributions in the assembly of my practice are shown in the theoretical genealogy (Illustration 8).

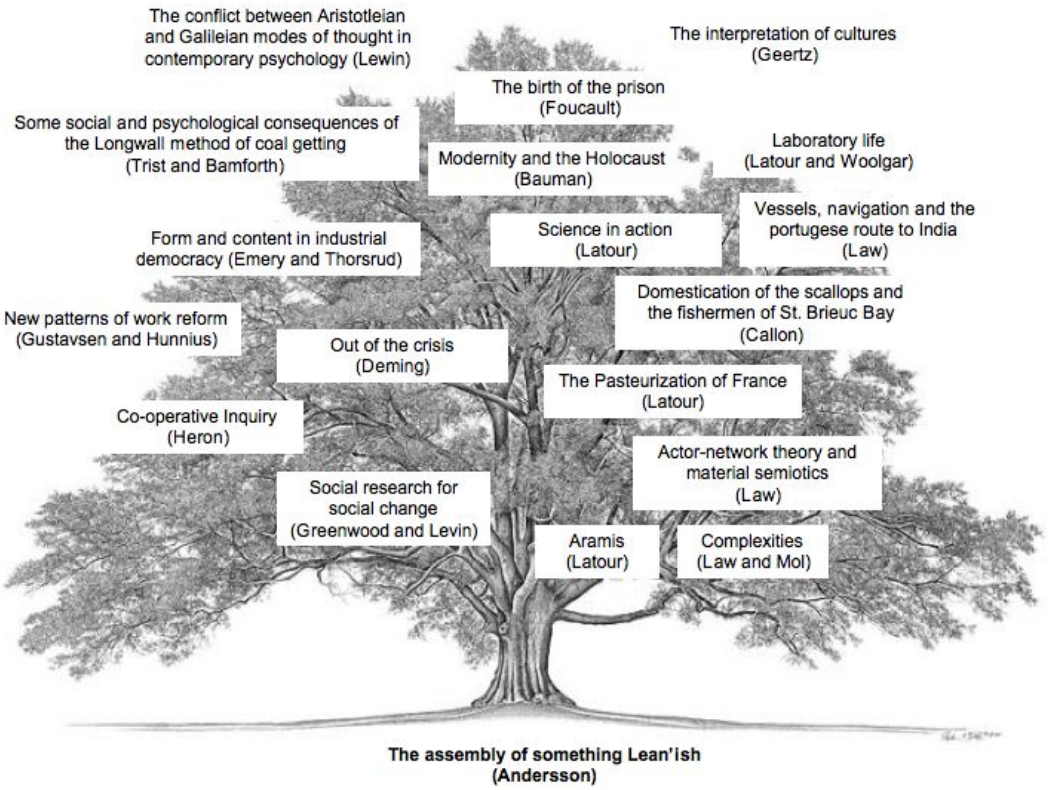


Illustration 8: The Theoretical Genealogy[14]

Why these contributions?

We can think of the theoretical contributions as ancestors in the genealogy tree of this thesis. This way different theoretical discourses are seen as family branches that together make up the genealogy of this thesis. As a starting point I will give an outline of some of these family branches of literature

Family branch 1: Antireductionism: A sensibility to precarious practices

The article "The Conflict between Aristotelian and Galilean Modes of Thought in Contemporary Psychology" (Lewin, 1935, chap. 1) introduces the sensibility family part of this thesis. This part is developed further in the AR family of literature (Emery & Thorsrud, 1974; Gustavsen & Hunnius,

[14] Tree illustration: http://freepages.genealogy.rootsweb.ancestry.com/~natesgenealogy

1981; Trist & Bamforth, 1951), in making the social and technological part of the same theoretical framework, and in the ANT family of literature, in concepts like irreductions and the non-human actors (Callon, 1986; Latour, 1979; 1987; 1988; 2002; Law, 1986). A common ground is the rejection of reductions like that of treating for example a Lean project as a social venture alone, and presuppositions, like that of giving things or humans properties based on a category we chose to place them in. These discourses represent an alternative to the large-scale claims, as those found in the generic, linear and structural models discussed earlier, and establish openness, uncertainty and diversity as parts of this thesis (Law, 2008; Law & Mol, 2002).

The book *The Interpretation of Cultures* (Geertz, 1973b) shares the rejection of large-scale claims and the search for simple causal patterns or structural and functional explanations, replacing those with interpretations of practices and a venture in thick descriptions (Geertz, 1973b). This thinking is developed in different ways in literature like *The birth of the prison* (Foucault, 1979) and *Modernity and the Holocaust* (Bauman, 1989), where the non-contextual ideal is rejected, and multiplicities replace dichotomies. This way the simple and structural picture of society is challenged and replaced by precariousness and materiality, for example in our understanding of modernity (Bauman, 1989) and the rationalities in the development of the western prison system (Foucault, 1979).

Family branch 2: Democracy and social change: A sensibility to ideologies

The book *Form and Content in Industrial Democracy* (Emery & Thorsrud, 1974) introduces what you can call the democracy and social change family part of this thesis. This part is developed further in different ways in the AR family of literature especially (Greenwood & Levin, 2007; Gustavsen & Hunnius, 1981; Heron, 1996), but is also part of the Lean literature (Deming, 1986). A common ground is the embodiment of democratic ideals, illustrated in the work on industrial democracy and the contributions to the Law on employee representation on the board of directors in 1973 and the Work Environment Act of 1977.

When we introduce a new way to do production we also impose ideologies and rationalities on the workplace. Not only when we are explicit about it, as in the AR literature, but maybe even more so in literature that is silent about it. Practices are not neutral. This way ideology becomes part of our way of doing production and our approach to research (Barnett, 2003), illustrated in the two

approaches to Lean discussed earlier.

Family branch 3: Material semiotics: An exploration of networks of relations and how these relations assemble or not

This thesis is an exploration of networks of relations and how these relations assemble or not. It can be labeled a material semiotic analysis of doing production to emphasize the broader perspective taken, including also literature and contributions outside what is known as ANT. It is also an acknowledgement of the widespread misunderstandings and misuse of ANT (Latour, 1996):

> This [material semiotics] better [than ANT] catches the openness, uncertainty, revisability and diversity of the most interesting work. Thus the actor-network successor projects are located in many different case studies, practices and locations done in many different ways and draw on a range of theoretical resources (Law, 2008, p. 142).

The book *The Birth of the Prison* (Foucault, 1979) introduces the extended material semiotic family of this thesis, illustrated in the relations of people, structures and materiality part of the development of the western system of prisons. This part is developed further in the ANT family of literature especially (Callon, 1986; Latour, 1987; 1988; 2002; Law, 1986; 2008; Law & Mol, 2002).

But is this genealogy at all possible, or is it like trying to argue for the communion between a fish and a horse?

I will argue not. I will argue that there is a kinship among these theories and contributions, and to illustrate the kinship I include two examples. First is in the approach to social explanation and second is in making elements usually separated part of the same framework.

Kurt Lewin introduced the Aristotelian and Galilean mode of thought to describe the differences in social explanations (Lewin, 1935, chap. 1). He argues that too much research is Aristotelian in the way we try to label, categorize, put in different boxes and give things properties based on the box we put it in. He argues for more Galilean mode where causation is linked to the total interaction with others. In the Galilean mode there is no sense in categorizing objects based on inner essence because it is the total circumstance and interactions that decide what will happen. Later Latour

(1988, p. 193) introduced the term irreductions saying that things are what they are and are just fine with that. He argues that there is no hidden core of structural elegance and simplicity or any underlying or hidden reality for us to discover or take for granted. It is through interaction with the other, that someone or something becomes produced. This way there is no sense in categorizing objects as this inevitably will reduce the complexities leaving us with a caricature of little practical use. The kinship on social explaining is thus close and the message sent is: "assume less."

The same close kinship is seen in how AR in the socio-technical systems thinking makes the social and the technical usually separated domains part of the same system and analysis (Trist, 1981). In ANT this is taken some steps further in the concepts of *radical indeterminacy* (Callon, 1999, p. 181) where everyone and everything that contributes to the assembly of the network is seen as an actor, and *generalized symmetry* (Callon, 1986, p. 200) that introduces the same theoretical framework for all actors, with no prior assumptions based on what type of actor it is.

Now that we have sorted out some of the legacies and argued for the communion, what then is this study? This thesis is neither ANT nor AR per se. Yes, it draws on these contributions, but there is also other literature as well as contributions to part of the practice and materiality from the VRI Østfold and the factory. If you have to put a label on it, I prefer *a material semiotic analysis of doing production*. It sounds nice, and if it is understood the way it is discussed as part of the families making up this thesis, it covers a lot of the ambitions in this thesis.

The discussion will include parallel literature and alternative discourses that mirror, contrast and challenge the literature chosen. It will also include important literature in the process toward what was to become the study. A lot of dead-ends are forgotten and left out, and only literature that has contributed directly are included. The discussions are a continuation of the earlier discussions part of the Context chapter and the literature review in the Introduction chapter.

First, the context chapter has revealed a highly complex situation; several departments, functional structures, many people involved over a two years period, changing conditions, new technology and many tasks more or less interlinked. There are what looks like structural elements like the Norwegian cooperation model but also influential individuals, certain technological installations and organizational culture present in the processes taking place. The context chapter also introduces

a preliminary understanding of Lean.

Second, the literature review part of the problem statement elaborates on modern concepts of production systems improvements including the Lean tradition. It further challenges the structural, generic and linear ways of understanding the industrial project with focus on literature linked to Norwegian work life especially. Handling the complexity becomes identified as the key to better understand the project, introducing an alternative way of thinking of the industrial project.

My rationale is to come in dialogue with theoretical frameworks of importance for understanding the industrial project as a development of the rough sketch of literature introduced earlier. These are discourses including linear innovation approaches, socio-technical systems thinking and actor-network theory.

These are the frameworks that have a stronghold in practice and the organization. They are also the frameworks embedded in structures like laws and regulations in Norwegian work life, and frameworks that can contribute to new understanding of what's going on within the actor-network assembling as part of the project. The approaches as they are outlined are more explicit and coherent than that of anyone in an industrial change project, but the dialogues can hopefully help us sort out the different arguments and messages in the literature. There are no ambitions to present the different frameworks for themselves in full, but to go in dialogue on aspects relevant to this study.

3.1 Complexities

But before I discuss the different theoretical frameworks I need to elaborate on the not so straightforward relationship between simplicity and complexity. Complexity as an issue was early introduced both in the literature reviews and in the practical unfolding of the industrial project and the many elements influencing the way the project turned out. But arguing for complexity alone is neither new nor especially helpful. So far complexities have been defined in large by what they are not. But what is complexity and how can it contribute to the understanding of the assembly of something Lean'ish in the factory?

I will argue that complexities are something more than the opposite of simplicity. It is not the same as everything goes as in chaos, and when handled it does contribute to our understanding of the Lean'ish project. This way complexity is something more than a system or network of so many elements that it is hard to handle. Complexity is also part of rejecting any strong ruling principle or structure of causality.

Then what is it?

My computer dictionary definition:

> complexity |kəm ˈ pleksitē|
> noun (pl. -ties)
> the state or quality of being intricate or complicated

Handling the complexities was identified early as the key to better understand the project and to introduce STS and ANT as contributions to the theoretical practice found in this study. We needed approaches on how to relate to complexity relative to understanding the processes in an industrial project. ANT is one such approach that focuses on the events and actions that contribute to establish the network of actors and thus assemble the project. The events establish the relations between actors and the explanation is part of this description (Latour, 1996; Law, 2008), thus the focus will be the stories about how the relations assemble or not.

So far I have used the word complexity quite loosely as something different or opposite from simplicity. Or more concretely, complexity has been used as the cause for why the linear models of

innovation and the structural models of work life do not add up in the industry project. But what is complexity more than the dictionary's truism or the supposed opposite of simplicity?

> There is complexity if things relate but don't add up, if events occur but not within the processes of linear time, and if phenomena share a space but cannot be mapped in terms of a single set of three-dimensional coordinates (Law, 2002, p. 1).

The simple definition introduces elements for us to focus on but it also introduces new simplifications in the dualities of add-up or not, linear time or not and a single space or not. So if the definition is not directly wrong it becomes part of the same dichotomies and simplifications it argues against. This way an exact or simple definition of complexity will turn out to be an oxymoron, because the very point is not either this or that like in a dichotomy.

To elaborate on complexities I will therefore abandon any further attempts to define complexity and instead use three examples to illustrate complexities taken from different fields. These three examples illustrate alternatives to both simplicity and the alter ego chaos, and not least why and how complexities can contribute to our understanding of the field. This is not an exploration of the field of complexity theory and certainly not any attempt to develop a new complexity theory. It is a way to handle complexities that contribute to our own practice part of the assembly of something Lean'ish in the factory.

The first example is taken from our understanding of modernity. I include this example because it illustrates how opening up for the complexities not only adds some new details to our established understanding, but how it may turn things upside down and challenge our fundamental beliefs.

> There appear few causal links more transparent than that between antisemitism and the Holocaust. The Jews of Europe have been murdered because the Germans who did it, and their local helpers, were Jew-haters. The Holocaust was the spectacular climax of a centuries-long history of religious, economic, cultural and national resentment. This is the explanation of the Holocaust that first comes to mind. It "stands to reason" (if one is allowed to indulge in paradoxes). And yet the apparent clarity of the causal link does not survive a closer examination (Bauman, 1989, p. 31).

Bauman shows in his alternative approach how modernity[15] and the modern society do not defend us against cruelty. That it does not act as the moralizing force as we are used to think. On the contrary, the study shows how modernity and the modern society not only work as a blessing, but that it also makes a thing like the Holocaust possible. This way our belief in civilization, progress and reason as something unambiguous is turned into an "*ambivalent endowment*" (Law, 2002, p. 2).

> What is untenable is the concept of our – European – history as the rise of humanity over the animal in man, and as the triumph of rational organization over the cruelty of life that is nasty, brutish and short. What is also untenable is the concept of modern society as an unambiguously moralizing force, of its institutions as civilizing powers, of its coercive controls as a dam defending brittle humanity against the torrents of animal passions (Bauman, 1989, pp. 212-213).

What Bauman tells us is that what we hold as the truth, and what we base our simple rationalities and causalities on do not add up. The complexities involved this way ruin our assumptions of modernity as part of a dichotomy and replace it with the multiplicities of modernity.

The second example is a bit closer to the Lean'ish project and is taken from our understanding of scientific facts. I include this example because it illustrates how opening up for the complexities not only challenges our fundamental beliefs like in the example on modernity, but also contributes to our understanding of a knowledge practice like science. Latour does this not by challenging the soft sciences but goes head on into the most universal, neutral and objective field thinkable, that of natural sciences. By studying science in action he elaborates on the process from a quest embedded and entangled in materiality, people, practices, feelings and controversies in the making of the fact, to something outside, neutral and objective (the nature) when the controversies are settled.

> The distinction between reality and local circumstances exists only after the statement has stabilised as a fact. To summarize the argument in another way, "reality" cannot be used to explain why a statement becomes a fact, since it is only after it has become a fact that the effect of reality is obtained. … It is because the controversy settles, that a statement splits into an entity and a statement about an entity; such a split never precedes the resolution of

[15] Another elaboration on the modern is found in *We have never been modern* (Latour, 1993).

controversy (Latour, 1979, p. 180).

Exemplified in the discovery/construction of the double helix structure of DNA science in action becomes something very different from a neutral and objective activity dictated by nature or reality. We are introduced to the double-talk of the two-faced Janus to illustrate the two very different modes of science. On the one side the rationality when we are in the making of the fact and on the other the rationality when the fact is established. In the end product, nature is turned into the cause for the actions that in the first place were part of controversies between people, institutions, technologies and beliefs. One of the lessons made are how only looking at the end result, which is the simplifications where the people and materiality are replaced with nature, blur our understanding of science in action.

Illustration 9: The double-talk of the two-faced Janus[16]

Only looking at the end result stops us from dealing with the complexities part of the assembly of the facts, and thus stop us from understanding the processes and the way they work.

The two first examples illustrate not only how it is possible to handle the complexities, but also how the introduction of complexities has not led into chaos or relativism. The two examples illustrate how opening up for the complexities contribute to challenge both our beliefs and our understanding of knowledge practice. It also challenges established beliefs and practices in the way of assumptions as an approach to understanding. The rejection of assumptions may also be seen as a contribution to what was introduced in the discussions on Aristotelian and Galilean modes of research and in the

[16] (Latour, 1987, p. 99)

concept of irreductions, which told us to look at the interactions assembling the end result.

The third example is even closer to the Lean'ish project in the factory and is taken from the design of aircrafts with a focus on the wings especially. I include this example because it illustrates how opening up for the complexities not only challenges our fundamental beliefs and contributes to a new understanding of a knowledge practice, but how it also contributes to our understanding of how something, like that of the design of an aircraft wing, assembly. By going beyond the formalism and re-introducing elements left out, Law goes beyond the formal and reductive expression and explains the final design. He describes a design not only the result of cold calculations and equations and the laws of nature:

> I will talk about its wings, about the design of its wings. Like a paper dart, these were to be delta shaped, their leading edge swept back at 50˚. They were to be thin – their thickness only 2.5 percent of their breadth at the tip. They were to be short and broad – their aspect ratio (the span from wing tip to wing tip divided by gross surface area) was to be 2.77. And their gross surface area was to be 597.3 square feet. So why where they to have this shape? What was the reasoning that lay behind them? (Law, 2002, pp. 116-117)

Leading us through the design and controversies in seven stories we leave the simplicity of the formalism and are introduced to the people and materiality like the oscillations in the airplane leading to strain on the pilots and navigators, parts left out or lost in the formal mathematical expressions. We are also introduced to the political climate hidden in the fixed speed (2M) to minimize the effect of the enemy (Russian) defenses. Finally we are introduced to the economical world of business favoring single engine aircraft because of the lower price and thus wider overseas sales potential. One of the lessons made are how the formal explanations for why something ends up the way it does. That is because heterogeneities like the ones introduced are hidden, but at the same time essential for the story to add up in a better way.

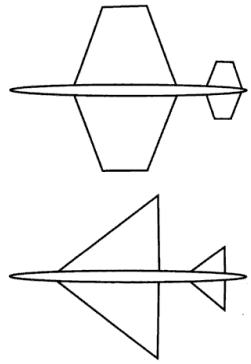


Illustration 10: Trapezoidal and Delta Wings[17]

These examples on modernity and the Holocaust, on the construction of scientific facts and on the design of aircrafts, illustrate ways to relate to and handle complexities in practice and contribute to handling the complexities part of the assembly of something Lean'ish in the factory. These examples show how opening up for the complexities challenges our fundamental beliefs, contribute to a new understanding of knowledge practices and how something assembles. The understanding of complexities also contributes to ways of relating to and handling the black box of Lean, and thus contributes to challenge Lean as a single entity and a product for us to implement in the factory.

[17] (Law, 2002, p. 133)

3.2 One-dimensional Linear Innovation Approaches

The linear frameworks represent in many ways a competing or alternative understanding out there. It is included in the discussion because our understanding will be mirrored and challenged by this discourse.

Linear models of innovation

A linear model is roughly describing innovation as a linear progression of separate phases. Starting with scientific discovery, by applied research & development to production. The main mechanism by how it "travels" is diffusion (Rothwell, 1994). In a linear perspective the implementation of the new methods and approaches to production, like that in the industrial project, is reduced to more or less unproblematic (diffusion as a natural process, natural action and spread) transport of already developed models/methods with a proved success elsewhere. Implicit in the industrial change project in this model is about setting the phases and clearly defining the actions based on the proved success elsewhere. The project progress is controlled against previously established milestones (between the different phases). The development work takes place only in one direction where the different tasks in the innovation process are passed from department to department and workstation to workstation according to a previously decided pattern without any extensive cooperation between them.

The linear approaches to innovation are challenged. It is argued that these models are not only both naïve and simplistic to the extreme, but dead for a long time (Rosenberg, 1991).

I will argue it is important to include them in the discussions because the remnants of this thinking still exist (Godin, 2006) and will be part of the established way to do production and "resist" the assembly of any new and different approaches.

There are several reasons for the survival of this "dead" approach. First the statistics and the way the statistics function as a representation of the linear models. As Godin explains, "Having become entrenched with the help of statistical categories for counting resources and allocating money to science and technology, ... the linear model functioned as a 'social fact'" (Godin, 2006, p. 661).

Second, that the organizational structures like that in the company chosen, with functional

departments in a hierarchical system (Taylor, 1911) mirrors that of the linear models thinking.

Third, that the linear models match that of many quality systems, a central element in the industrial change project. This way the quality system will keep the linear approaches alive as part of the system of innovation procedures (Kirkebak, 2000).

Conclusion:
The positive effects of the systematic approach to industrial change projects advocated in the linear models—including putting innovation on the agenda, allocating resources to development and top-down management support—are soon confronted with problems linked to lack of a holistic project perspective (Andreasen & Hein, 1986) and simplistic mechanisms like that of diffusion and normative or generic recipes for solving complex problems.

These models are important because, as discussed earlier, they still have a foothold in industry and in the company, and especially in the way it is inscribed in the organizational structures and statistics.

The Linear Heritage
Around 1990 the linear models of innovation were replaced in literature by a new paradigm and an integrated approach to innovation (Jakobsen, 1995). The new paradigm may be seen as a reaction to and critique of the earlier linear models. It is presented as a result of an evolutionary process from simple linear models to integrated models where the models go through a refinement and combination of earlier models illustrated in Rothwell's (1994) generations of innovation (Illustration 11).

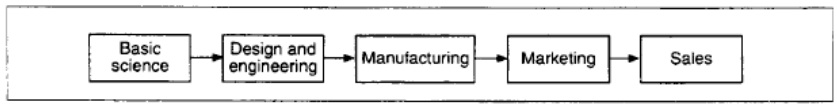
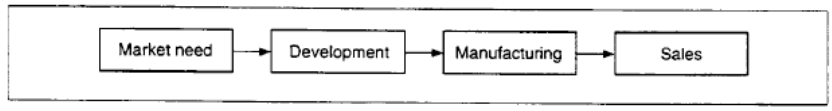
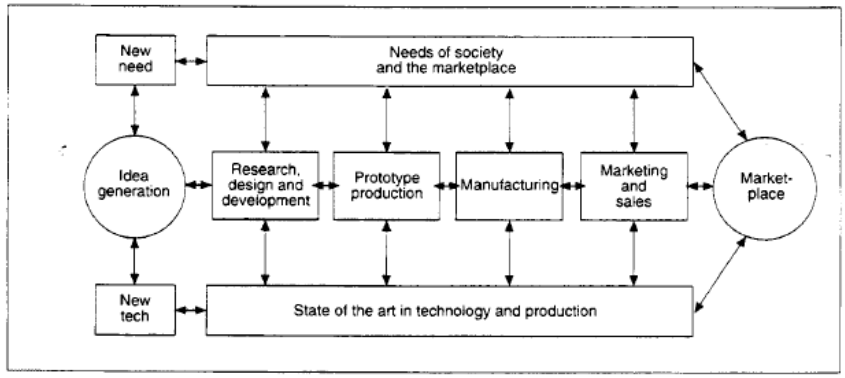
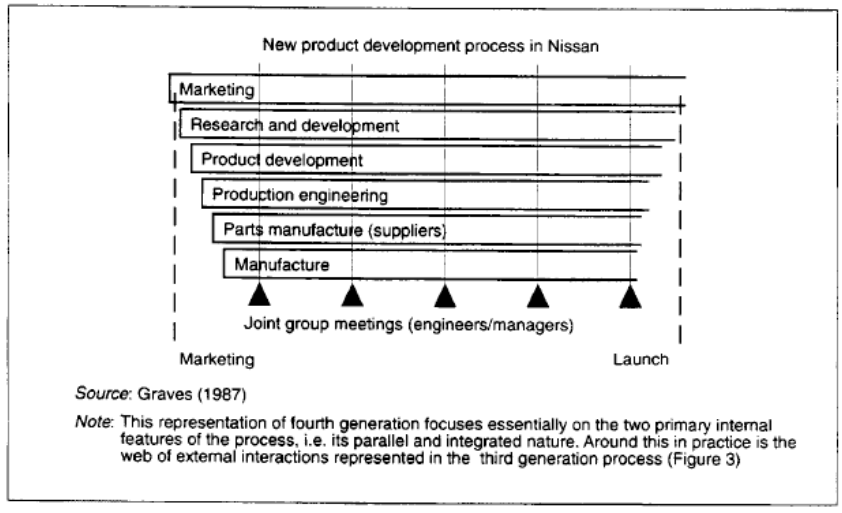
Technology Push	
Market Pull	
The «Coupling» Model	
The Integrated Innovation Process	

Illustration 11: Rothwells Innovation Models

This new paradigm signaled a new way of organizing innovation projects, with focus on quality including a new understanding of quality,[18] reduced costs and development time, and combining knowledge and competence across functional and hierarchical borders in teams based on consensus and characterized by an open communication and information structure. Major industrial change contributions that may be seen as part of the integrated approach to innovation are different flavors of Lean. This leaves us with a widely used and sometimes successful array of methods and concepts. However, as stated earlier the new systems of work organization including the integrated models often fail to deliver what is promised (Levin and Klev, 2002).

The competing concepts of *paradigm* and *evolution* are both introduced in the short description of the linear heritage found in the integrated models of innovation. The integrated models of innovation turn out not only as a new paradigm, but also like a continuation (evolution) of the linear models. This duality creates tensions and contradictions in the project and our understanding.

I will argue that it is important to include a linear perspective on the integrated innovation models because it is a perspective we must anticipate to experience alongside with the system perspective advocated. The presence of the linear heritage forces us to challenge the practices part of the integrated models.

In the different generations (Illustration 11) of innovation models the kinship between the models are obvious. The number of boxes have increased and the arrows go both ways but the linear models are still present as elements of the total model. And as discussed they still have a foothold both in industry and in the company and powerful allies in the way it is embedded in the organizational structures and statistics.

At the same time, as discussed in the introduction, Lean include different ideologies, different modes of thinking and different methods under the same label. Everyone will find something to agree on and the Lean philosophy is this way a bit like a fortune cookie: it holds wisdom difficult to disagree with that makes Lean an all-inclusive and precarious approach because it blurs the differences in origin, ideology and practice.

18 One example of the new understanding of quality may be found in Deming (1986)

Some examples[19] of Lean wisdom:

> "There is nothing so useless as doing efficiently that which should not be done at all," Peter F. Drucker

> "A bad system will beat a good person every time," Edwards Deming

> "The most dangerous kind of waste is the waste we do not recognize," Shigeo Shingo

Conclusion:
I will argue that the combination of a linear based organization model and technologies discussed earlier, in combination with an all-inclusive Lean, turn many of the projects towards a linear practice of innovation, a practice illustrated in diffusion as mechanism of transportation and a focus on Lean as a product and ready-made recipes illustrated in the concept of *installing LEAN*. Innovation thus becomes expert and management driven associated with simplistic and normative recipes for solving complex problems. The linear elements of these models become emphasized.

Even more fundamental is the absence of people and active processes of knowledge transportation in the models. Where are the people? Where are the technologies and machines? Where is the materiality? Is it possible to create any meaningful understanding without these actors? I will argue the answer is no.

As stated in the beginning of the chapter the linear frameworks represent in many ways the competing or alternative understanding of the project. In many discussions the linear models are treated, as both naïve and even dead and the shortcomings are many, even though in practice they are worthy competitors. Linked with the all-inclusive and precarious Lean and the way the thinking is embedded in technologies and the organization of the company the linear models become powerful.

[19] Quotes from http://www.quotegarden.com/Lean-manufacturing.html

3.3 Two and three dimensional Socio-technical systems thinking

Socio-technical systems thinking (Emery, 1959; Thorsrud & Emery, 1970; Trist, 1981; Trist & Bamforth, 1951) may be seen as part of what is known as General system theory (von Bertalanffy, 1973). The study of the Longwall methods of coal getting (Trist & Bamforth, 1951) mark the first use (Emery, 1959, p. 4) of the label socio-technical but more important it represent a break with splitting the study of interrelated elements in work life into isolated problems. This way the study did not approach the organization as a social or a technological system only, but as a system of interrelated parts.

The study contributed to the development of the conceptual framework known as socio-technical systems, but also in part in the assembly of an innovative work practice and new organizational design (Ramage & Shipp, 2009, chap. 27). Last but not less important the study showed that there was an alternative to scientific management and job fractionization, represented with a new, effective and alternative way of organizational design (Trist, 1981).

It is legitimate to question the position in contemporary research and discourses on work life. Or as the Network on organizational research in Norway (NEON) questioned rhetorically in a panel debate on the meeting in 2007:

> "What happened with socio-technical systems theory? Is socio-technical systems theory passé or is it alive and kicking?"

I will argue it is important to include socio-technical systems in the discussions because the framework represents a clean break with linear innovation models discussed earlier. Socio-technical systems thinking introduced systems thinking as an alternative approach to understand work life processes and a framework where the social and the technological are interrelated parts of the same system and not disconnected universes. Socio-technical systems thinking also introduced technology within the same analytical framework including people and thus the social and psychological requirements of the individual as an issue. Second it contributed to the non-linear understanding of the integrated innovation models discussed earlier and the system perspective on Lean which will be discussed later. Lastly it contributed to the highly influential Norwegian democracy projects including major influence on laws and regulations in Norwegian work life

discussed earlier and a contributor to the development of the Norwegian collaboration model.

a) Socio-technical systems thinking introduced systems thinking as an alternative approach to understand work life processes.

Socio-technical systems thinking introduced a break with the linear thinking described earlier. Not only as a new generation evolved from linear parents but as a new way to address the problems; a new frame of reference or way of approaching work organizations and the people in them (Emery, 1959, p. 3). Socio-technical systems thinking challenged the way of treating the problem by dividing in separate boxes and hierarchies like that associated with scientific management (Taylor, 1911).

> Similar general conceptions and viewpoints have evolved in various disciplines of modern science. While in the past, science tried to explain observable phenomena by reducing them to an interplay of elementary units investigatable independently of each other, conceptions appear in contemporary science that are concerned with what is somewhat vaguely termed "wholeness" (von Bertalanffy, 1973, pp. 36-37).

Socio-technical systems thinking is rooted in general system theory and the understanding of society as so complex that linear ways and means are not sufficient. This thinking has been developed with bases in the understanding that it is not enough to study only parts and processes in isolation, but to solve problems found in the organization from dynamic interaction of parts (von Bertalanffy, 1973). Systems thinking is a collective conception for methods, concepts and techniques that are used to understand a system where there are strong interactions between different parts which together make up complex systems like those in work life studies.

b) It contributed to the non-linear understanding of the integrated innovation models discussed earlier and the system perspective on Lean, which was the later part of our understanding of these concepts.

There are many links between the integrated innovation models and the system perspective on Lean and socio-technical systems thinking. I will present just some to illustrate the point using literature

(Deming, 1986) from the project and how the socio-technical systems thinking implicitly contributes by way of the system perspective on Lean.

A starting point can be the fourteen key principles (Deming, 1986, chap. 2) for transforming business effectiveness introduced in the discussion in Lean.

There are strong and explicit relations between socio-technical systems and what I have called system interpretations of Lean. Both advocate a systems approach and interdependence of tasks as illustrated in the social and technical sub-systems, and in the break down of barriers between departments, and thus challenge the linear way of organization in industry.

People and social and psychological requirements are put on the agenda and seen to emphasize the challenges linked to fear and alienation in work life. Thorsrud and Emerry question, " …how is it possible to reduce or prevent the 'alienation' that exist quite extensively in modern working?" (Thorsrud & Emery, 1970)

The problem of alienation is addressed in a somewhat similar way illustrated in the job design criteria, and elimination of barriers that rob the employees of the right to workmanship and the goal of ending dependency on inspection.

Deming and Thorsrud and Emery share an understanding of the importance of greater empowerment of the operators, most visible in the autonomous work groups known from both the Norwegian democracy projects and the later Kaizen work. Many of the ideas from these projects, with the autonomous groups being the most visible, were exported to Japan by the *Quality of Working Life Network* where they were linked to what was to become Total Quality Management (TQM) (Wig, 1996) and the successful Japanese car industry. Many of the ideas from the Norwegian Democracy Projects this way resonate with much of the thinking in Lean being part of the same legacy. The concepts have transformed over the years and in the transportation from Norway to Japan to the US and back. At the same time it is important to note that there are voices that question the hypothesis of empowerment (Mehri, 2006) as a part of Lean and that Lean on the contrary creates "intensified work pace and demands" and little real empowerment (Landsbergis, Cahill, & Schnall, 1999). I include this as a reminder on the multiplicities of Lean and the problems

when talking about Lean as a singularity.

The strong and explicit link between socio-technical systems and the system perspective on Lean can be illustrated in the story of a press conference on Kaizen and related Japanese methods on continuous improvements held in the US. Here they were asked about Thorsrud and his work and answered something like, “Oh yes, that is the Norwegian that has taught us these things the Americans now learn from us. He must be a great man in your country” (Dagbladet, 1982).

What contributed to the highly influential Norwegian democracy projects including major influence on laws and regulations in Norwegian work life and the development of the Norwegian collaboration model?

The socio-technical systems movement developed from projects in the British coal mining industry to include the Norwegian Democracy Projects (Elden, 1979) represented with the works of Einar Thorsrud and Fred Emery (Thorsrud & Emery, 1970), and the emphasis on participation and democracy to improve the quality of work life. Vital understanding and knowledge developed in these projects was the importance of organizational choice, participation and ownership among the employees exemplified in concepts like autonomous workgroups, analysis of variance and participatory democracy. This focus also introduces the normative agenda in a particular organization form linked to industrial democracy. Especially autonomous or self-managing work groups become linked to the perspective on industrial democracy (Elden, 1979, p. 230) and later embedded in the AR approach.

In Norway these works went beyond theoretical development and practical relevance in the way they got embedded in national laws and regulations (Gustavsen & Hunnius, 1981) illustrated in the Law on employee representation on the board of directors in 1973 and the Work Environment Act of 1977 including participatory democracy on one’s own work situation (Gustavsen & Hunnius, 1981, chap. VII). These legislations still have a central position in the formal structures in Norwegian work life.

The findings from the Norwegian Democracy Projects also challenged the structural approach to industrial democracy as seen in these later laws and regulations as any solution to industrial

democracy alone (Thorsrud & Emery, 1964, chap. 7):

> If industrial democracy is to be something more than extended negotiations and consultations, it must involve a certain transfer of real executive authority to the employees. However, it is very difficult to understand how such a transfer of authority can begin at the top level, that of the board room (Thorsrud & Emery, 1964, p. 114).

It is argued based on empirical data that industrial democracy must include participation and transfers of authority also in the daily work. According to Thorsrud and Emery, "Experiments in the US, UK and India have shown that the sharing of executive authority on this level [the operators] can be both stable and effective because it promotes both the employee and management interests" (Thorsrud & Emery, 1964, p. 115).

This way the socio-technical democracy projects not only contributed to the national laws and regulations but also the emphasis on local participation and collaboration part of the Norwegian cooperation model discussed earlier, going beyond structures and including processes on the shop floor (H. D. Finsrud, 2009).

Conclusions:

The socio-technical literature introduced a change of topology from lines to surfaces and spheres introducing systems thinking in our understanding of innovation. The interface between surfaces thus becomes important, as did the processes of transfer between the spheres.

The socio-technical literature also contributed to establish a strong alliance between the initial theoretical framework found in socio-technical analysis, the Norwegian work life legislations, a later practice like that found in the Norwegian cooperation model and the system perspective of Lean (Deming, 1986).

However, the socio-technical systems thinking have also changed from what was initially a theoretical framework in the early studies (Trist & Bamforth, 1951) to what was to become a way of working (Elden, 1979). This way it emphasized the action research approach but lost the analytical position and framework, illustrated in the answer from Herbst in 1975 on what happened with the

analytical part of socio-technical systems.

> "*We don't do much socio-technical analysis here any more*" (Elden, 1979, p. 227)

Socio-technical systems thinking left the building of analysis!

3.4 Multi-dimensional Actor-Network Theory

The socio-technical systems thinking challenged the analytical split between technology and people. They did so making people and technologies interrelated parts of the same system as discussed earlier. Actor-network theory (ANT) developed this even further and proposes the end to the dichotomy between nature and society altogether (Latour, 2004a).

> Actor-network theory is a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterise the webs and the practices that carry them. Like other material-semiotic approaches, the actor-network approach thus describes the enactment of materially and discursively heterogeneous relations that produce and reshuffle all kinds of actors including objects, subjects, human beings, machines, animals, 'nature', ideas, organisations, inequalities, scale and sizes, and geographical arrangements (Law, 2008, p. 141).

This description tries to define actor-network theory (ANT) but inevitably misses the important stuff. The important stuff is in the way the relations establish and assemble the actors in the practices. ANT is about practices and actions part of a materiality, and not about abstract principles or generic definitions. Any generic and abstract definitions are thus in many ways an oxymoron or contradiction, because the messages practiced are that of materiality and the way our subjects are understood as generated effects of this materiality.

ANT (Callon, 1986; Latour, 1988; Law, 1986) as a theoretical framework is grounded in the case studies, the practices and the empirical material (Law, 2008). In the discussions to come I will connect the previous definition to materiality and case-studies in a quest to establish an understanding of ANT and the way it has contributed in this study.

First of all why include ANT in the discussions?

Complexity was introduced early as part of the critique of the literature on modern concepts of production and general and structural models for explanations. Complexity and how to relate (Law

& Mol, 2002) to it was the rationale behind the exploration of an alternative literature and case studies like that from Salk institute (Latour, 1979) and Institut Pasteur (Latour, 1987) such as the black box and metaphors like the Janus faces of science. This literature established science and technology as socially embedded enterprises, viewed as a collective action where information, or facts, about nature are the outcome of the collective action.

ANT may be understood as a development of the science and technology studies and an attempt to better understand processes of innovation and knowledge-creation in science and technology. The rationale for ANT is explained using a metaphor from physics, where sociology of the social (or the sociology that is restricted to human actors) represents classical or pre-relativist physics (mechanics, electromagnetism) and ANT represent theories of relativity in physics (Latour, 2005, p. 12), not to be confused with relativism and everything goes. As classical physics, sociology of the social will work in most cases, but as things start to approach the speed of light a relativistic theoretical framework is needed to handle the different frames of references and what seems like a mess in a classical theoretical framework. ANT is that theory of relativity framework in sociology devised to handle innovation and change situations that involve elements from different frames of references moving at different speeds like that of the change project.

The ambition to include elements from parts usually separated establishes a link between ANT and socio-technical analysis discussed earlier and the preliminary efforts to include the social and the technological as part of the same system.

I will argue it is important to include ANT because it assembles a theoretical framework that makes it possible to handle the complexities introduced by establishing a framework and concepts for all contributions, that being the work of structures, political or cultural values, technology or an individual.

Case 1: The researchers, the scallops, the fishermen and the scientific colleagues of St Brieuc Bay.

Is it possible to analyze people, structures, technological artifacts and things within the same framework, concepts and terms?

Yes, because that is exactly what is done in the analysis of what started as a controversy over the causes for the decline in scallops and ended up in an attempt to develop a conservation strategy for those scallops (Callon, 1986).

In this analysis the researchers, the scallops, the fishermen and the scientific colleagues are treated as equals. They are all actors with goals treated within the same frameworks and concepts for all actors. This practice is named the principle of *generalized symmetry* (Callon, 1986, p. 200) and establishes the goals of the different actors on the same level, or maybe more precisely removes the leveling between the different actors taking part in the associations altogether. This way the three researchers and their goals to advance knowledge and repopulate the bay to the profit of the fishermen are treated within the same analytical framework as the scallops and their goal to perpetuate themselves. The analysis removes the presumptions of the special nature and given principles or structures for any actors including humans.

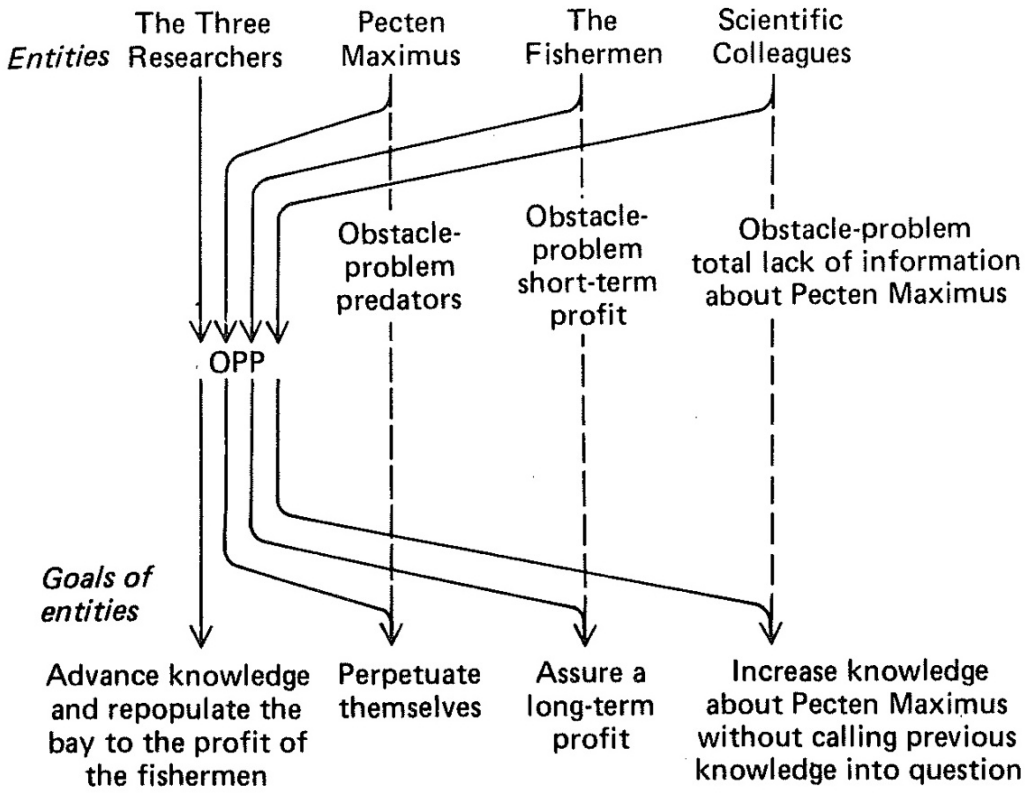


Illustration 12: The alliance of actors of St. Brieuc Bay[20]

This issue on humans and non-humans distressed many readers. But it is not about giving properties like intentionality to non-humans, it is not about to presuppose intentionality (or other properties) at all in any entities. We must follow the entities in action and describe what we see as in contrast to give them presupposed attributes based on a general principle or classification. Of course there might be intentional actions taken, but we cannot presuppose that all actions taken by an entity are intentional just because the entity is a human. This rejection to reductions and any presuppositions is named *irreductions* (Latour, 1988, pt. 2).

Case 2: The Portuguese Route to India

The rejection of any presupposed properties lead us to *radical indeterminacy* (Callon, 1999, p. 181).

[20] (Callon, 1986, p. 207)

This indeterminacy gives us a lot of trouble because a lot of things end up as actors. But at the same time that is exactly what enables ANT to include the materiality (the mix of humans and non-humans) within a theoretical framework. This way ANT is also freed from the dead-end debates on macro versus micro or actor versus structure. Structures may for example be an actor in an ANT network together with an individual human actor.

> Consider one case, that of the table of solar declination. This represented the distillation, as it were, of many years of astronomical expertise, of thousands and thousands of calculations, of correspondence, of argument and of innovation. When it created a table the commission was therefore creating a kind of surrogate astronomer. It was not necessary to take along Jose Vizinho or Abraham Zacuto in person. Their force, and the work of their predecessors, was being borrowed, converted into a highly transportable and indefinitely reproducible form, and being put to work on every ship. The production of tables of solar declination for the purpose of navigation may thus be seen as a way of reducing the relevant aspects of a weighty astronomical tradition to a form that, in the context of the vessel, was more mobile and durable than the original (Law, 1986, p. 252).

The case of the table of solar declination also introduces constructed actors. It illustrates how the commission turned a piece of paper into a mobile astronomer ready to take part in the work of getting not only one but numerous boats to India in a safe way.

An actor can then be anything as long as it is a source of an action (Latour, 1997, p. 51). One of the more radical ideas from ANT is thus that of non-human actors like microbes (Latour, 1988), scallops (Callon, 1986) and the *Regimento* of the Portuguese (Law, 1986) in social theory. In an ANT perspective the company and the factory in this study are full of actors that are to be treated totally democratic in the sense that no category of actors are above anyone else.

How then do these actors relate to each other? ANT asks us to explore particular actor-networks like that of the fishermen and the scallops and that of the Portuguese and their way to India. Another example to focus on the network part is that of Pasteur and the development of a vaccine to stop anthrax (Latour, 1988, pt. 1). A vaccine developed not as a result of a single great man, but as an effect of the heterogeneous network of farms, technicians, laboratories, veterinarians and bacilli

(Law, 2008, pp. 145-146).

The actors establish the network that becomes the project. But it is not a metaphor of network in the meaning of a digital network like the Internet where the message is sent as a perfect copy and transported instantaneous. It is clearly the opposite, a network as a series of transformations and translations[21] where the message sent is altered from its origin (Latour, 1997, p. 47) like the game of starting with a spoken message in one end of a line of people and ending up with a complete different message in the other end of the line. It is in effect an approach to understanding experiences and a theory[22] arguing that by following *circulations* (Latour, 1999b, p. 3) or the related metaphors of *fluid* (Law & Mol, 2000) and *trails* (A. Cussins, 1992) in a network we can get more than by defining boxes and categories.

Case 3: ARAMIS
Everything contributing work to assemble the network becomes an actor and the network is the result of this continuous assembly and reassembly.

Aramis is an acronym for 'Agencement en Rames Automatisées de Modules Indépendants dans les Stations' (Arrangement in Automated Trains of Independent Modules in Stations). The idea was to combine the flexibility of a car with the efficiency of a railway. Work on the system commenced in 1969 and was abandoned in 1987.

> You see my friend, how precise and sophisticated our informants are, Norbert commented as he reorganized his notecards. They talk about Oedipus and about proximate causes ... They know everything. They're doing our sociology for us, and doing it better than we can; it's not worth the trouble to do more. You see? Our job is a cinch. We just follow the players. They all agree, in the end, about the death of Aramis. They blame each other, of course, but they speak with one voice: the proximate cause of death is of no interest – it's just a final blow, a last straw, a ripe fruit, a mere consequence. As M. Girard said so magnificently, "It was built right into the nature of things." There's no point in deciding who finally killed

21 The understanding of translation and the "sociology of translation" as a new approach to the role played by science and technology in structuring power relationships are outlined in Callon (1986) and (Latour, 1986).

22 «*Michael Lynch once pointed out that ANT should actually be named "actant-rhizome ontology,"a term that Bruno Latour found accurate but horribly unaesthetic*.» http://www.cwrl.utexas.edu/currents/fall03/spinuzzi.html

> Aramis. It was a collective assassination. An abandonment, rather. It's useless to get bogged down concentrating on the final phase. What we have to do is see who built those “things” in, and into what “natures”. We're going to have to go back to the beginning of the project, to the remote causes. And remember, this business went on for seventeen years (Latour, 2002, p. 10).

> But anything can become more real or less real, depending on the continuous chains of translation. It’s essential to continue to generate interest, to seduce, to translate interests. You can never stop becoming more real (Latour, 2002, p. 85).

This way the assembly of the project is not a single event, but an ongoing process of assembly and reassembly. Lack of contributions as in the case of Aramis is the reason for the end of the network and thus the project. This illustrates the precariousness in the project.

Conclusion:

Instead of surfaces as in systems thinking ANT introduces a change in metaphors to filaments in a network (Latour, 1997, p. 48). This metaphor focuses on the multidimensional approach given in ANT where all sorts of actors are invited with different frames of references. Based on irreductions, general symmetry and radical indeterminacy, ANT assembles a theoretical framework that makes it possible to handle the complexities introduced in an industrial project like those in this study.

3.5 Theoretical Perspectives and Stand

The challenge is how to handle the complexities introduced. The three topologies, the linear innovation models, the socio-technical systems thinking and ANT, represent three different contributions. The linear models represent the mirror, the alternative actor-network or discourse most probably present in the factory. This study will draw on contributions from socio-technical systems thinking and ANT and the assembly of what we could call the actor-network of the theoretical position in this study.

The way this study draw so much on ANT also means that the theoretical discussions are not isolated to theory alone, but are extended and elaborated on in practice and methodology. The perspective and stand outlined here are thus preliminary and will be extended in the methodological discussions and the analysis.

3.5.1 Mode of Thought

Lewin (Lewin, 1935) distinguished between two modes of thought using the metaphor of Aristotelian and Galilean physics. In Aristotelian mode causation is linked to inner essence or what is natural for the object as part of a category. For example, a stone will fall to the ground because that is the natural place to be when you are a stone. It is the inner sense of being a stone. In Galilean mode causation is linked to the total interaction/forces between other objects and the stone. In the Galilean mode there is no sense in categorizing objects based on inner essence like that of being a stone because it is the total circumstance and interactions that decide how fast it will fall or if it will fall at all (Hergenhahn, 2009). Too much work on Lean is still Aristotelian in the way we try to label, categorize, and split in different levels, taxonomies or binaries of different parts and boxes.

Related to our discussions switching from an Aristotelian to a Galilean mode would mean deemphasizing different classifications or boxes to put everything in giving them properties based on the box it is put into. It also means deemphasizing governing simple structures and inner essences like that of the *Norwegian cooperation model* discussed earlier. It means emphasizing the complexity, the dynamics and situated processes in an industrial project. This way the modes of research resonate with the concept of *irreductions* (Latour, 1988, pt. 2) discussed earlier. Irreductions in this way are all about *concreteness* (Harman, 2009, p. 15). Things are what they are and are just fine with that (Latour, 1988, p. 193). There is no hidden core of structural elegance and

simplicity or any underlying/hidden reality for us to discover. It is through the interaction with other, that someone, something or somewhat becomes produced.

This means that it is the relations and interactions with others that produce the effects and web of actors, or in other words the project that we study.

3.5.2 Explanations and Networks

Does this make it too complex to handle? Not necessary. Our search for explanations and answers to our questions put forward are—one way or the other—distorted simplifications (Harman, 2009). Our mission is to develop models and theories that capture some elements and disregard others and view theory as only "the best possible at the moment" (Greenwood & Levin, 2007, p. 74).

The big theoretical question is thus what elements should we capture and what should we disregard?

It is no longer about explaining based on category or any pre-determined or governing "outside" structure or principle. It is about who or what contributes work to the assembly of the project network and the processes taking place. The thing, the person, the structure or whatever contributing work is this way an actor. Or turned the other way, the elements, or actors, to capture are those who contribute. The elements to disregard are those who don't contribute. The actor-network this way becomes an image of the contributors and gives rise to the rejection of any outside explanations. All explanations are to be found inside the network.

3.5.3 Someone and Something

The theoretical framework introduces actors not based on categories but on actions and contributions. Removing the categories implies removing the presumptions of the special nature of someone or something and introduces the same theoretical framework and concepts for all actors.

This may be the most challenging position but also the most rewarding. It is rewarding because it enables us to treat the different elements in the industry project not as something alien or unrelated parts of a different theoretical framework, but as parts of the same theoretical framework and project network.

Treating all actors within the same framework also makes it possible to build an awareness and sensitivity based on findings from the same literature criticized earlier. If for example structures are part of the structural models reviewed in the Introduction chapter turned out to contribute to the assembly of the project, that structure will become an actor. Rejecting the structure as a universal explanation is thus not the same as rejecting it as an actor in a specific case. The rejection of any outside explanations is not the same as rejecting the contributions, but by identifying the contributions the network simply extends to include this new actor.

3.6 A Metaphor

Clearly we have to simplify the theoretical framework and stand to make the ideas communicable in a way that hopefully preserves the essential features of the problem. The simplifications will have to describe the reality in a meaningful though limited way (Levins, 1966).

I have chosen to use a metaphor to simplify and envision the theoretical stand taken. My arguments for the choice of a metaphor as part of making the ideas communicable are elaborated in more details in the Methodological discussions.

A metaphor for understanding the project is the game of rugby, an extension of Latour's metaphor (Latour, 1987, p. 104) made part of the materiality and actors of the Lean project. The Lean approach to production being the ball and the different actors being the players. What this rude metaphor tells us is that the Lean idea goes nowhere on its own; There is no diffusion or other passive transport. Someone has to take it up and run, kick or throw it; they have to do some work. The other thing is that bringing the ball forward involves resistance and pain; someone or something willing to try and stop us will be resistant to this new approach. Third, going solo will only end up in a disaster. However good one actor is it is a lost venture; you will have to play as a team to succeed. It's not about the best consultant or best manager; it is about the best team. Participation in this perspective is not only an ethical or legislative issue but also a necessity to succeed; you need all the players to engage and work together. Fourth, you will have to play until the game is over and hopefully won. Being superb in one quarter and then leaving the arena is the same as losing however good you are in that quarter. You win when the new approach is inscribed in the organization; when a black box is established. Fifth, unforeseen things happen. One player may get injured or have a bad day for some reason. A pool of water on the field may stop a pass that normally would have ensured an easy goal. A strong wind may deflect a perfect shot. Finally as every supporter knows: the best team doesn't always win. No method or approach, however good, can take the win for granted.

In addition to the inevitable simplifications in this metaphor, one important element especially is lost in the metaphor and that is the way the ball (that is the Lean approach) stays the same over the game. We lose the translations. To reflect the theoretical perspective the ball should have changed as it got passed between the players (actors) in the team (network). The forward in this perspective

could end up with a hockey puck or a sofa. In the metaphor you also have a finite number of players (actors) and they very, very seldom switch teams during a game.

3.7 The Refined Research Question

I want to challenge the almost mythical image of Lean associated with Japanese labels, exotic examples and not least success stories. I want to challenge the idea that different ideologies and different traditions all seem to have found a haven inside the box of Lean; that Lean is treated as one thing, a single entity. I want to open the black box of Lean.

This study explores how we can understand the processes and development from a Lean'ish industrial project from the inside. My agenda is a more descriptive approach for understanding how the process is undertaken in an organization, integrating structural, technical, organizational, individual and other elements from the experiences. Rather than seek a strong ruling principle or structure, this study will look at how the combined efforts of the actors, processes and relationships within the network itself, and not any outside structures or principles, produce the reality of the Lean'ish project.

Based on the preliminary research question and theoretical discussions and stand my refined research question is:

- *How did the new way to do production assemble (and reassemble) in the factory?*

What I mean by *how* is an understanding of both the actual processes and how the processes ended up in the assembly of the new approach to do production. This analytical understanding of how they developed in the theoretical discussions also implies contributions from several different elements and not any strong simple accounts of causality.

The research question can be divided into four more specific questions:

1. *Who and what contributed to the assembly of the new way to do production?*
2. *How did they contribute to the assembly of the project?*
3. *How was the assembly of the project challenged?*
4. *Through what processes did the actor-network affect the assembly of the project?*

4 Methodological Discussions

> We had not from the beginning any clear hypotheses we wanted to try out in this study. Nor did we work with methods that would easily give us the results we could include in matrixes of the type: so many believe or do this and so many that. The idea was to "live on the inside of" the company to gain insight into a company's structures and functions (Lysgaard, 1981, p. 77).

My idea was to live inside the factory and gain insight into how the new way to do production was developed in the factory.

This methodological discussion is a continuation of the dialogues introduced in the theory chapter. What started with a challenge and finally a rejection of structural, generic and linear ways of understanding the industrial project, became the grounds for the assembly of a framework strongly influenced by actor-networks, irreductions and matter semiotics, and thus also a methodological position viewing methods as embedded and entangled in the theoretical framework.

The theoretical framework assembled, the arguments developed, the position taken, and the methods chosen draw on a wide set of literature and studies more or less interrelated. The legacy is again most explicit in the disparate families of Action Research (AR) and Actor-Network Theory (ANT), but also other contributions are discussed. The methodological approach includes conventional social science methods such as observation and document review with participation and engagement in the change processes and the theoretical reflections.
The arguments for the approach chosen and the practical ways to do it are further elaborated in this chapter.

4.1 The principle that does not govern

From the discussions so far *irreductions* (Latour, 1988, pt. 2) emerge as a central concept of not only ANT as a theory (Law, 2008) but also the whole theoretical approach including ontology and methodology (Harman, 2009). This way the idea of different levels, taxonomies or binaries of different parts and boxes lose interest not only regarding understanding the subject under study but also in how we address the subject – the methodological approach. What we call theory, methodology and ontology are not to be seen as isolated or separated parts but as intermeshed and as different faces of the same coin. Thus methods become an embedded part of the theoretical framework and a wider theoretical universe, in strong contrast to the view of methods as a means for describing reality in any objective way. Methods go from being technical and neutral tools to political and value laden decisions (Law, 2004).

The methods chapter is thus a stylistic move and a confession to norm and tradition in academia and not a confession to any implied reductions. This chapter should only be read in conjunction with the problem statement, context and theoretical discussions. In the methodological practices elaborated in this chapter I will show how these are not mere techniques to construct meaning from data, but practices that extend the theoretical position taken.

It is also important to note that this is not a philosophical discussion. It is about establishing the rationalities for how I have addressed the subject.

Before taking an analytical view on how to answer the questions posed in the dissertation a short outline of the central problem, research question and theoretical issues of methodological importance are in place. Primarily, this dissertation argues that organizational change processes are situated, complex ventures not possible to understand using simple instrumental or structural models. Thus it is not possible to understand these processes unless organizational, social, technological, economical and other elements and structures are seen as interrelated. Secondly, I draw on actor-network theory rather than instrumental and structural theories and models because I find the latter unsatisfactory to handle the complexities and understand and explain the internal processes and the development in an industrial project. Third, the central research question put forward is: *How did the new way to do production assemble (and reassemble) in the factory?*

Why this seemingly descriptive rather than explaining approach part of the examples and ANT? What does the focus on the stories about how the relations assemble or not contribute to our understanding of organizational change?

First, as discussed in the context chapter there has been created an almost mythical image of Lean associated with Japanese labels, exotic examples and not least success stories. Different ideologies and different traditions all seem to have found a haven inside the box of Lean as pointed out earlier. Despite the differences in ideologies and legacies Lean is thus treated as one thing, a single entity; a black box (Latour, 1987) has been created that is no longer discussed or challenged.

The descriptive but analytical approach is about opening up the black box of Lean and to challenge the mythological statue. That is not to look at the end product or result of Lean alone, but to look at the processes leading up to the construction of something Lean'ish in the company. Not as a universal or homogenous method or approach, but as a way to do production embedded and entangled in the methods of the industry, company, technologies and people, with references to the processes that assemble the understanding and the practice. It is about contributing to an increased sensitivity towards the practices and processes of what we call Lean.

Second, central to the position taken is that we cannot begin from a given principle or structure (Harman, 2009, p. 14). Any explanations will have to come from within the network. The descriptive approach is thus not about simply documenting as in contrast to explaining. It is a descriptive explanation based on the network as its own frame of reference discussed earlier. The process part of the assembly of the network becomes the effect of the network, or its structures, processes and roles within the network itself and not of any outside structures or principles. But it also means that this is not about finding the ruling outside principle or structure. If we were to reduce Latour to a philosopher it could be argued that the discussions on *irreductions* so far converges with writings known as *phenomenology* (Harman, 2009, p. 100), not least in the antireductionist approach shared. This way our reductions become the tools and a necessity to grasp how something or someone assembles, but without reducing it to that image only. It is not about reducing that someone or something to what we are able to understand at a given time or place. Despite these convergences *irreductions* is not about *phenomenology* (Harman, 2009, p. 26), because it is not limited to human consciousness but include nonhuman actors.

According to Latour, “The pre-relativist debate between providing an explanation and ‘simply’ documenting the historical circumstances falls apart: there is no difference between explaining and telling how a network surrounds itself with new resources” (Latour, 1996, p. 378). In this way the research question on how the new way to do production developed, and the descriptive approach chosen, becomes part of the explanation.

4.2 Actors and Events

As stated earlier, the position taken is that we cannot begin from a given principle or structure. That is, we do not know beforehand what parameters and what data are of interest and significance. There are no ready-made principles or structures for us to use. We will have to explore, look for connections and events and actions, include aggregated and statistical data where suited and helpful, confront and discuss and gradually build an analysis on a detailed account of actors, actions and events taking place. This way the data needed are related to establishing the completely specific events making up the project.

How do we establish these events?

We need thick descriptions (Geertz, 1973b, chap. 1) and heterogeneous data of actions and events taking place. Thick descriptions and heterogeneous data are important for several reasons, because we don't know beforehand what actions, actors or events are of interest, and because we need data to interpret the practices, actions and events. The complexity and interpretations involved in research on complex processes depends on all involved actors, like that in the case of a two year long change project involving more than fifty people including numerous technical and social changes, "are possible, if not practically without end" (Geertz, 1973b, p. 7). The search for simple causal patterns or more refined structural and functional explanations as part of an underlying or hidden reality for us to discover is replaced by interpretation of practices. We need to know how our data are part of a situated action to be able to interpret the data in any meaningful way.

The *unpredictable and un-deterministic* elements in the project introduce the precarious as an issue. The reflection goes on the unpredictable and un-deterministic behavior of how the project developed. For example, small events turned out to have big effects on the network like that of minor technical adjustments on a corrugated cardboard machine. In the same way, unplanned events played an important role in the end. For example the global financial crisis hit the project in 2008 and left us with a feeling that luck or chance were vital elements in the project. At the same time we acknowledged the hard work involved.

The complexities and the precariousness of the project introduce a rephrased question: how do we establish thick descriptions of precarious events taking place?

The Janus-metaphor on the construction of scientific facts are very close in mind (Latour, 1987), the striking difference between the disorder during the project and the order and rationality when the practice is fully inscribed in the organization. Similar to the study on the construction of scientific facts from the Salk Institute discussed earlier, what the participants do and the events taking place become the focus in the methodological approach. This leads me to choose an approach that combines observations with being a participant in the project, and document review to establish a research practice with an awareness and sensitivity towards the complexities and the precariousness in the project.

The approach outline turns our attention to the researcher as a participant in the project.

4.3 Being Inside as an Outsider

How do we assemble the data needed to establish these thick descriptions?

The most obvious will be to follow the actors in action and describe what we see in great detail (Harman, 2009; Latour, 1979; 1987) to establish the events making up the network of actors. Accordingly we made strategic choices of researchers as development partners that took active part in the project and that of living in the factory for a long period. The researchers took roles and participated in the actual project, being there when the transformations and actions took place. This way we went beyond the observer (Latour, 1979; 1987) and toward the *friendly outsider* (Greenwood & Levin, 2007, pp. 115-130) introduced earlier.

So far I have used the *friendly outsider* in an operational way as the researcher that takes a role and participates in the actual project, being there when the transformations take place. This role implies both work in depth and over time in the enterprise project, but it is also something more than the blend of a researcher and a consultant. Being the outsider is about contributing the external perspective opening up the group for change in the their own practice. Being the friendly outsider is about contributing the external perspective including criticisms, but in a way that is experienced as supportive and that contributes to change. In my understanding the friendly outsider is not about trying to establish a client—mentor or student—professor relationship. The researcher as a participant is about respect for the local stakeholders and their capacities as development actors in their own factory as discussed earlier. This perspective is mirrored in the way the local stakeholders are involved also in the theoretical discussions. To elaborate on my role I thus describe it relative to how being inside as an outsider is an advantage in the work to establish the thick descriptions needed.

This meant both work in depth and over time in the enterprise project. The project started in August 2007 and I took part throughout the whole process from the initial planning to the end in June 2009 as the project leader in the factory. During the project the team ran more than thirty meetings where I did the work as the project leader. As discussed in the context chapter these were work meetings not formal administrative meetings and in the first phase of the project we did the mapping of the work processes on site in the different locations and in dialogue with the local operators where possible. The result of the first preliminary session was a graphical process map identifying the

product flow, the information flow, the points of decisions and possible pitfalls. This map was discussed again in the next meeting for an additional proof check and establishing a shared understanding. In this process the lack of any common language and images for discussing organizational change and development surfaced. To address this and related challenges the project team decided to do an organizational culture assessment, in part to build knowledge about the organizational culture but more importantly to establish a language and way of communicating how we do production in the factory. This experience illustrates the importance of the friendly outsider approach; the possibility to take action together with the local stakeholders and that way both contribute to the factory project but also to get the data necessary to establish the events of interest to build knowledge.

In addition there were plenary sessions, general meetings, conferences and a kick-off. As in the project team my work associated with these activities had two sides, one to document the processes and actions in formal documents like summaries and activity reports and in my own research log, and second to take part in the project activities as a contributor on both technological and process issues. The same approach was used where all reports and summaries were open for all to comment on both written and in plenary sessions.

The examples illustrate a practice where the researcher is not someone sitting in the corner observing the natives, but someone who contributes to problem-solving in the local part of the industrial project. The researcher thus became a part of both the successes and the failures establishing a legitimacy to be in the factory and reflect on the work. Once legitimacy was established, this opened me up to otherwise hidden data, like the conversations and dialogues with local stakeholders in situated actions trying to solve problems—situations otherwise not accessible for me as a researcher. Gaining legitimacy also gave me access to data like that from the quality system, recording the different procedures, complaints and divergences and actors and changes taking place, which were all important elements in establishing the thick descriptions.

The duality of the researcher places emphasis on the role of the researcher and being part of the project under study. The researcher this way seeks to contribute on two different areas: first, to contribute to solving the practical concerns of people; and second, to contribute to research Co–generative learning is an example of a model describing the cooperation between researchers and

local stakeholders (Greenwood & Levin, 2007, p. 94). These models help us as researchers to understand our role, where together we work with the local stakeholders to identify problems, make changes and evaluate these changes.

It must however be emphasized that when the model is talking about the role of the friendly outsider it is often in the sense of an established role. My experiences from the project are that such a role must be developed, and that it is in no way given or static. The role was negotiated through most of the project, depending on the way I contributed or not in the different tasks and activities, but also depending on elements from outside the project as in the economical and organizational changes in the company, taking place in parallel with the project. The role as the friendly outsider this way was determined not by the researcher alone, or as a result of any rational process, but as an interplay of many forces, events and actors (Andersson & Strand, 2010). This way the role of the friendly outsider may be seen as an actor-network, assembled by the people, structures and materiality in the factory. At the same time the researcher thus becomes part of the network making up the new way to do production and embedded in the materiality and structures in the factory.

My role as a friendly outsider contributed essential data to establish the thick descriptions of how the new way to do production assembled. These data are most obvious in the otherwise hidden data described earlier, but in retrospect I also emphasize the contributions are an effect of the strategic choice of researchers as development partners that take part and live in the factory for a long period of time. This strategic choice created an in-depth and over time knowledge of the way to do production, enabling not only co-generative learning and reflection as part of the project, but also the details needed to interpret the events and actions taking place.

4.4 Sources of Data

So far the data needed are identified: thick descriptions and heterogeneous data to establish the events making up the network of actors. The strategy is laid out: to follow the practitioners in action and participate in the actual project, being there when the transformations and actions take place. This implies a rich set of sources of data. Written material such as Meeting protocols, Research log, Reflection notes, Reports and Observations are important, but also data from the Quality Management System databases and surveys will complement the written data.

The strategic choice of involving the local stakeholders in the theoretical reflections part of the practices in the project and illustrated in co-generative learning and as part of the ongoing assessment, implies transparencies and the use of open sources of data where possible. For us to discuss and reflect on our practice we need access to the same data. With open sources I mean material like the meeting summaries and reports available for all from the company's intranet pages. Examples include the articles published in industrial journals, presentations held by different participants in the project, and statistics from the official quality management system. My personal research log will complement this data. To keep the openness the data will be commented on by the local stakeholders in the analysis when used. This continuous involvement of the local stakeholders marks another development where we move beyond research about people towards research with people (Coghlan & Brannick, 2005). The research with people is not isolated to solving the practical concerns, but includes the theoretical constructions (Heron, 1996; Reason & Bradbury, 2001; Reinharz, 1984; Wadsworth, 1998), not as identical contributors, but as equals (Dick, 2007, p. 406). This way the project team, plenary sessions, workshops, general meetings and conferences become important areas for reflection and dialogue including theoretical issues and sources of thick descriptions.

The list of research data (a full list is found in the Appendix B) includes official meeting summaries from the project team, the various project reports (half-year reports, conference reports, assessment reports) and different presentations and articles published as part of the project. In addition my personal research log will complement the data, to establish the events making up the project.

4.5 Going in Circles

Earlier, I pointed to the striking difference between the disorder during the project and the order when the practice is fully inscribed in the organization. The experiences of things do not always go as planned. This way reality talks to us and challenges our thinking and preliminary understanding by the way things are turning out during the project. This ongoing challenge is mirrored in the ongoing dialogue with literature, initiated by the experiences to try to understand the new issues introduced during the project, for example on organizational culture discussed earlier. The 'research with people' strategy chosen, and the involvement of local stakeholders in the theoretical discussions brings in alternative approaches to the issues and contributes to the continuous challenge of the understandings and practices of the development of the project. This practice of continuous challenging our understanding and our practice became part of the activities to establish the new way to do production. This was especially visible in phase 3 where we took the measures we developed and put them into practice. How did our measures turn out in practice? What adaptations are needed? Who took part or not in the assembly? What new measures are needed? How can we understand the successes or failures? Shall we keep the new practice as the way to do production, or discard it?

How is this ongoing challenge and going in circles part of any theoretical discourse and the genealogy of this work?

Several related discussions inspire and illuminate the willingness to modify our thinking practiced in this project. Primarily, the ANT legacy argues for constant revisions of our research strategies, plans, technologies and practices (Latour, 2004b). Secondly, the AR legacy argues for the involvement of the local stakeholders in the ongoing theoretical reflections, and a willingness to modify, adjust, reject and rethink the approach and plan new actions together. Third, methods like Grounded Theory Method that argues for a systematical approach to building theory grounded in experiences (Charmaz, 2006; Poonamallee, 2009; Strauss & Corbin, 1998).

The ANT legacy contributes with a plea for constant revisions, as a cyclic approach to research part of a critical review of ANT and STS. The argument is that what started as an attempt to show the lack of scientific certainty (Latour, 1979; 1987; 2004a), has turned into an argument for artificially maintained controversies (Latour, 2004b). It is argued that what started as a venture to add

materiality to the process and thus get closer to facts and empiricism, has been used by the enemies to get away from facts and empiricism (Latour, 2004b).

> It does not seem to me that we have been as quick, in academia, to prepare ourselves for new threats, new dangers, new tasks, new targets. Are we not like those mechanical toys that endlessly make the same gesture when everything else has changed around them? (Latour, 2004b, p. 225)

The contribution is thus about an awareness towards our own practices and line of argument as researchers, and how these do not belong to us alone, but may be turned against us by others. It is a warning against repeating the same old arguments, as if the world was a static place.

The AR legacy contributes with the approach to research as an ongoing theoretical reflection, linked to practice and found for example in the *action-reflection cycle* (Lewin, 1946a). According to Dick, "During critical reflection, theory emerges in the form of an understanding of what happened, and how. The understanding helps in planning the next action" (Dick, 2007, p. 400). This general statement has been further developed in the *cogenerative action research model* (Illustration 13).

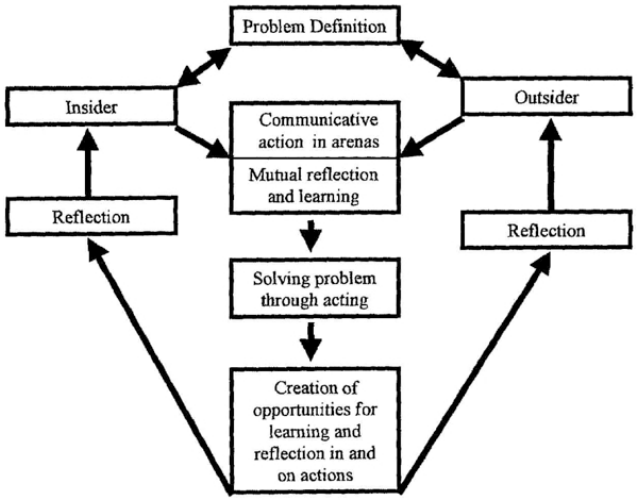


Illustration 13: The Cogenerative Action Research Model[23]

[23] (Greenwood & Levin, 2007, p. 94)

This approach to research introduces two important elements. Primarily, the theory-practice relationship, where practice is first, and the quality and validity of a theory is assessed relative to practical relevance (Greenwood & Levin, 2007, p. 18). Secondly, the partnership between the researchers and the local stakeholders discussed earlier and emphasized in the cogenerative action research.

Other contributions not part of the legacy from ANT and AR emphasize the practice of going in circles. One example is Grounded Theory Method (GTM). GTM is a method about building theory grounded in experiences. It is in some textbooks (REF) referred to as a positivistic method, but today GTM goes way beyond this position (Charmaz, 2000; Morse, 2009), illustrated in titles like *Situational Analysis – Grounded Theory After the Postmodern Turn* (Clarke, 2005) and *Constructing Grounded Theory* (Charmaz, 2006).

> Grounded theory is a way of thinking about data – processes of conceptualization – of theorizing from data, so that the end result is a theory that the scientist produces from data collected by interviewing and observing everyday life (Morse, 2009, p. 18).

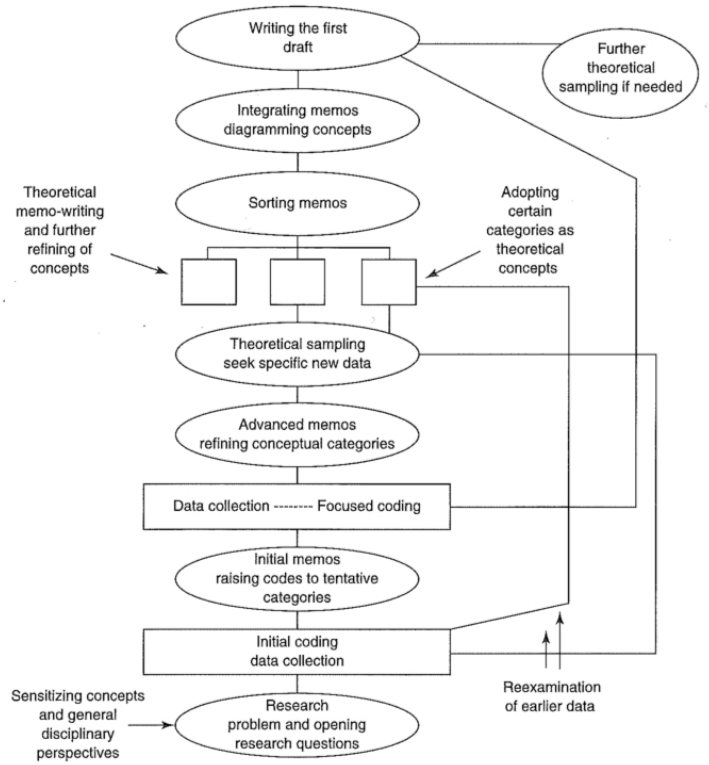


Illustration 14: The Grounded Theory Process[24]

GTM is explicit about how theory is built from data and how this is a recurring process of data collection, coding and writing memos, aiming at theories to understand the worlds we study (Charmaz, 2006, p. 10).

This study is not a GTM study, but draws on elements from this methodological approach, especially on the ongoing interpretation relative to new data and new literature review related to the recurring processes of data collection, coding and writing memos.

Back to the question on how this ongoing challenge and going in circles is part of any theoretical dialogues? This thesis draws on the legacies from ANT, AR and others, all emphasizing the cyclic actions for approaching research, testing our understanding and systematic interpretations of what is happening.

[24] (Charmaz, 2006, p. 11)

4.6 What can be Learned from a Single Case?

This study is based on a single case. Case studies are widely used (Stake, 2000, p. 435) and yet often mistrusted in that they supposedly lead only to non-verifiable and unreliable conclusions (Flyvbjerg, 1991, p. 137; Yin, 1981, p. 97). Not very tempting presented this way, but as many things supposed, these statements are worth to challenge in greater details.

Case studies may be viewed as a choice on what to study and not a methodological choice. On complex, situated and contemporary phenomena the boundaries between the phenomena studied and the context are not clearly evident. Thus a case study may be seen as an extension of experience and that "the methods of qualitative case study are largely the methods of disciplining personal and particularized experience" (Stake, 2000, p. 449). Another perspective is a more methodological approach and a design similar in several cases for making generalizations based on comparative analysis of data (Yin, 1981). A shared paradox is the search for particularity in a case versus the search for generalizability. If you want the one you are supposed to lose the other! Both perspectives lead back to a single case as something more non-verifiable and unreliable versus the ideal of the context independent of general knowledge. The first perspective solves this by using case studies as a sort of extension of experience, implying a kind of lower theoretical ambitions, and the second perspective takes away the particular by using a similar design in several cases.

A single case as something non-verifiable and unreliable per definition is based on a set of misconceptions, especially related to our understanding of contextual knowledge relative to general knowledge, where contextual knowledge is seen as less solid and valuable (Flyvbjerg, 1991, p. 137). But this can also be seen the other way. We can see contextual knowledge not only as good as general knowledge, but that all knowledge in the study of man and society are contextual some way or other (Flyvbjerg, 1991, chap. 8).

The discussion on contextual knowledge introduces a new look at innovation discussed in the theory chapter and some of the threads from the methodological discussions so far on scientific knowledge and facts. Scientific facts have always been seen as pure facts. The Merriam-Webster on-line dictionary defines it as "knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method." In other words, once a fact is established as valid, it is generally accepted as the truth, and has become

universal through the *scientific method*. The validity is supposed to transport itself everywhere without effort (Law & Mol, 2000); like diffusion as a mechanism of transportation. Being universal will also logically remove the need for challenging the facts, adapting it to local contexts or situations; when its first established, the facts are universal, period. I will argue that the linear models of innovation builds on this understanding, like that of much practice of innovation and industrial change; once developed the implementation is supposed to transport itself with or without little effort. In linear innovation thinking complexity is not a major issue the same way as contextual and situational elements become of little interest.

Over the last decades however both the understanding of science and the universal understanding of facts have been challenged. Latour says, "Universality or order is not the rule but the exceptions" (Latour, 1997, p. 49).

Facts have been localized (Law & Mol, 2000) in the meaning part of the people, structures and materiality creating it, and the research process has become contextual (Latour, 1981, p. 56). Science is viewed as a collective action, and information, or facts, about nature are the outcome of this collective action (Latour, 1979; 1987). The point is that facts are constructed and it takes work to establish and maintain them, illustrated in the case of the double helix form of the DNA assembled in the Cavendish laboratory at Cambridge in 1951 (Latour, 1987). There will be a resistance to change present in any organization. This new understanding of scientific facts and how they are established also changes the focus. Central now is the focus on action and because the facts are constructed to observe the scientists at work and find out what they do—and not what they say—becomes important. This is also important because when first established as a fact the discoveries/innovations are difficult to understand and deconstruct; a black box is created that no longer is discussed and challenged (Latour, 1979; 1987). But facts are not only challenged as constructions of a group of people, but also heavily situated in the laboratories and the devices/apparatuses: science has become "regionalized" instead of universal. With regional status the whole logic of universalism fails. Now it is not only possible but also essential to question how facts are spread and transported (Law & Mol, 2000). Now the facts are situated in the context (Latour, 1981, p. 56), the people and the apparatuses that constructed them, and any transportation of facts should also include the context, a social and technical mess, for the facts to be valid the old way. Since that is impossible, the facts are no longer to be understood as immutable, but as

changing as they spread/are transported. The changing is not a problem for the transportation; it is the changing/lack of rigidity that make the transportation possible. This lack of rigidity is the background for the metaphors follow the circulations discussed in more details earlier, used as an approach to understanding experiences.

One example illustrating the importance of fluidity is McDonalds.

> " …frequently cited as the gold standard for global uniformity, reveals impressive variations as it moves from one site to the next. If it is successful it is not because the formula is rigid. It is precisely because it can change shape" (Law & Mol, 2000, p. 10)

The discussions so far challenge the initial question on what can be learned from a single case. It is not so much about defending the single case anymore. It is more about how we can learn something of *general* interest and significance. It is also doubly interesting because it links back to the discussions on irreductions in the start of this chapter. Lewin (Lewin, 1935, chap. 1) related the conflict to two modes of thought and the metaphor of Aristotelian and Galilean physics discussed earlier. Related to our discussions on learning from a single case and contextual or non-contextual knowledge switching from an Aristotelian to a Galilean mode would mean deemphasizing different categories, classifications or boxes to put everything in giving them properties based on the box it is put into. It also means deemphasizing the idea of any governing structures and inner essence like that of the *Norwegian cooperation model* (Hernes, 2006). It would also mean emphasizing the complexity, the dynamics and situated processes in an industrial project.

In a Galilean mode both causation and generalization take a different form. This way knowledge may be both contextual and of general interest and significance. Geertz and Foucault—two very different thinkers—discussed earlier that both build their analysis on contextual knowledge (Flyvbjerg, 1991, p. 152). The specific as a point of departure does not stop the analysis to have general interest beyond the Balinese cock fight (Geertz, 1973b, chap. 15) or the development of European prisons (Foucault, 1979).

In many ways the table is turned, where the argument is no longer that it is possible to use a single case to describe the specific, but that it is dangerous not to do it.

It may be wise not to take as a whole the rationalization of society or of culture, but to analyze such a process in several fields, each with reference to a fundamental experience: madness, illness, death, crime, sexuality and so forth. I think that the word rationalization is dangerous. What we have to do is analyze specific rationalities rather than always invoking the progress of rationalization in general (Foucault, 1983, p. 210).

4.7 Metaphors

I have used both my own and borrowed metaphors ranging from rugby matches to zebras on the savanna.

A legitimate question would be if rugby or falling stones could contribute to our knowledge on innovation processes in an industrial project. Or more precise why use metaphors and not general statements, theories and models?

I will start to answer the question by turning the attention to general statements, theories and models. These are all anchored in the idea of the context independent, universal and general, or if you like the Aristotelian mode discussed earlier. In a Galilean mode of contextual knowledge this idea is challenged.

To elaborate on this challenge I will draw the attention to the cyclic approach to research discussed earlier and the action-reflection cycle (Lewin, 1946b). The action-reflection cycle can be read as a general statement and is so embedded in action research practice that it is in danger of becoming an unchallenged procedure, method or template. This would be a misunderstanding of the intentions behind the cycle. It should be seen as a teaching device stressing the participative interpretative practice introduced by AR at that time (McTaggart, 1997). The same challenges and possible misunderstandings are attached to models like that of the grounded theory process (Illustration 14). The order and logic of the model is not a description of what the actual work will look like but a model stressing certain aspects of the road from experience to theory. The misunderstanding of the action reflection cycle is an example that illustrates how general statements and models easy become the reality and not a device for stressing certain elements.

A metaphor, and especially a metaphor with few similarities, avoids these misunderstandings. It is difficult to interpret a rugby match as a Lean'ish project, falling stones as part of the reality in a factory or a zebra as an actor in a project. At the same time the metaphor contributes knowledge stressing certain elements of the work, without the dangers of mixing the model with reality. I will argue that metaphors this way may be seen as the Galilean counterpart of the general statement theories and models of the Aristotelian mode of science but without the dangers of being misunderstood as the reality.

4.8 How do we Know that it is Valid?

From the earlier discussions on regional versus universal knowledge and Aristotelian versus Galilean mode concepts, the idea of the context independent, universal and general is replaced by the contextual and knowledge as embedded and entangled in the people, structures and materiality. S*cientific method* as an objective way to establish universal *scientific facts* is thus no longer applicable. The same way positivist credibility and validity (Greenwood & Levin, 2007, pp. 66-70) loose any meaning in the sense that there is no one simple objective method or any context independent general knowledge. But the basic questions we tried to solve by these and related terms are still around:

Why should we trust the findings from this study? How do we know the findings are valid? Or stated operationally, will the thesis stand up to outside assessment?

I will start to elaborate on three concepts used to address the questions raised: validity, reliability and generalizability. The meaning of these concepts is different depending on the viewpoint (Illustration 15).

TABLE 3.6 *Perspectives on validity, reliability and generalizability*

	Viewpoint		
	Positivist	**Relativist**	**Constructionist**
Validity	Do the measures correspond closely to reality?	Have a sufficient number of perspectives been included?	Does the study clearly gain access to the experiences of those in the research setting.
Reliability	Will the measures yield the same results on other occasions?	Will similar observations be reached by other observers?	Is there transparency in how sense was made from the raw data?
Generalizability	To what extent does the study confirm or contradict existing findings in the same field?	What is the probability that patterns observed in the sample will be repeated in the general population?	Do the concepts and constructs derived from this study have any relevance to other settings?

Illustration 15: Perspectives on Validity, Reliability and Generalizability[25]

[25] (Easterby-Smith, Thorpe, & Lowe, 2002, p. 53)

Validity, reliability and generalizability in a constructionist viewpoint thus becomes linked to how the study gives the reader access to the experiences, the processes from data to meaning, and if the study has any relevance to other settings (Easterby-Smith et al., 2002, p. 53). But this is a generic description arguing for the contextual, and even thou it points in a direction, it fails to give an answer to the questions raised. More contexts, people, structures and materiality are needed.

Trustworthiness (Guba & Lincoln, 1989, pp. 233-236) and *validity* (Heron, 1996, chap. 8-9) are related terms used in action research that may be linked to the action-reflection cycle (Lewin, 1946b) and the co-generative action research model (Greenwood & Levin, 2007, p. 94) discussed earlier. Cycles of inquiry, reflections and actions together with the local stakeholders become the means to achieve trustworthiness and quality, in the way the local stakeholders themselves take part in the discussions on how the study gain access to the experiences and practice. Solving the local practical problem together with the stakeholders surfaces again, and introduces *workability* (Greenwood & Levin, 2007, pp. 63-64) as "the ultimate measure of credibility and validity" (Martin, 2000, p. 70). *Did the solutions work?* becomes the important question related to validity.

In this study, and my quest to try to answer the questions raised on the quality of the findings and research, I focused on *workability* and *transparency*—in both experiences and construction of meaning—and *relevance* in drawing on the discourses presented.

Workability becomes linked to validity. Reflections and actions together with local stakeholders both on practical and in some part theoretical issues as described in the context chapter become the core processes to achieve workability. Does the practice, and thus theory, work?

Transparency becomes linked to trustworthiness and reliability. Transparency contributes to the trustworthiness of the thesis in the way it makes explicit the road from participation in the project, by raw data to findings and discussions. Use of open sources and comments from the local stakeholders as discussed earlier, become the means to achieve the transparency both in describing the experiences and the construction of meaning in the analysis chapter.

Relevance becomes linked to generalizability. Outside interest and the impact of the project on the

outside world becomes the approach to assess the relevance of the project and work, and if the analysis has general interest beyond the factory.

To go back to the beginning: *How do we know the study, and the findings, gain access to experiences of those in the research setting?*

The answer to this question is embedded and entangled in both the theoretical and methodological discussions in the thesis; in the way theory is seen as entangled and extended in practices. The answer to gain access to the experiences is in the strategy of following the actors in action and focusing on what is done and the work practices assembled. It is part of working together with the local stakeholders, both in solving the local problems and in the theoretical reflections.

The findings are thus the result of more than two years of a long production improvement project in a factory, a result of the continuous work and contributions from a manifold of actors, including the researcher working as development partner and project leader. The idea was to gain insight into how the new way to do production assembled in the factory, being there as a *friendly outsider* when the changes took place. This made it possible to establish *thick descriptions* of the events taking place, not based on the researcher alone, but as part of solving the problem with the local stakeholders. This way the findings are part of a process of cycles of inquiry, reflections and actions together with the local stakeholders (*those in the research setting*).

The validity may also be linked to how the project contributed to solve the local problems together with the local stakeholders, establishing a new way to do production in the factory that improved both quality and efficiency. The solutions assembled together in many ways *worked*; both as a strategy of collaboration and participation in the way we did production, and according to economical key figures, as described in the context chapter.

The next question is: *Is there transparency in how sense was made from the raw data?*

As introduced in the Sources of data chapter, the strategic choice of involving the local stakeholders implies transparencies and the use of open sources of data where possible. For us to discuss and reflect on our practices we need access to the same data. The sources of data are thus the official

and published meeting summaries and reports from the project. All summaries and reports were open for discussion, comments and corrections before approval (in practice also later), and available for everyone on the company intranet. So to answer the first part: Yes, there are full transparencies regarding the sources of data.

The theoretical perspective and stand practiced in this thesis focuses on the ways the relations establish and assemble the actors; in other words, the practices and events that make something. The events establish the relations between actors and the explanation is part of this description (Latour, 1996; Law, 2008), the focus will be the stories about how the relations assemble or not. To make sense from the raw data is thus about describing how people, structures and materiality connect, un-connect and re-connect, and thus assemble, abandon and re-assemble the project. To give the reader access to the process from data to meaning is this way about to give the reader access to the thick descriptions describing how, as illustrated in the actors/actor-networks of the quality system, the project team and the four-color silkscreen printer in the Analysis chapter.

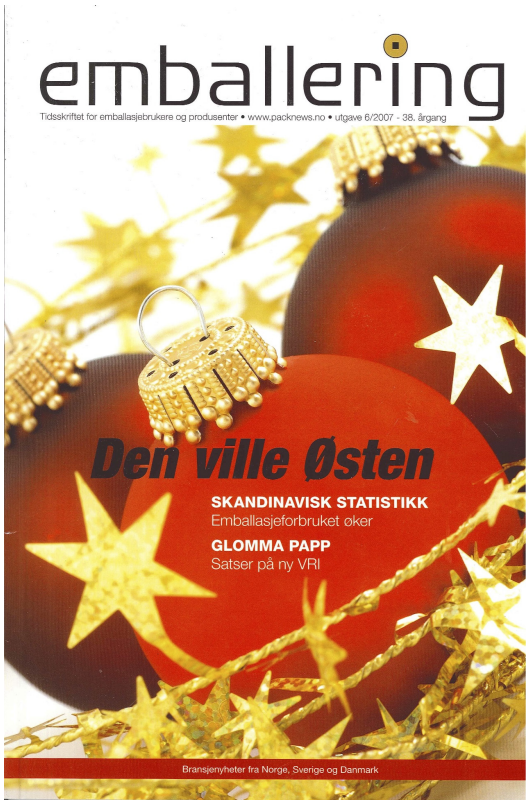
The third question is: *Do the concepts and constructs derived have any relevance for other settings?*

To answer and elaborate on this question on relevance, I will use three examples from different viewpoints: The company viewpoint, the industry viewpoint and the official Norway as seen in the Skattefunn scheme.

The company found the project and the findings so relevant that a new project involving everyone soon came on the agenda. As introduced early this was a factory project on production improvements. From the beginning the project in practice broke the organizational borders of the factory, and included outside actors. Elements of practices assembled in the project, like that of vertical and horizontal integration in development projects, were soon copied elsewhere in the company, and a plan for making this a company project involving everyone in the company is in the works.

The major industry journal found the project and the findings so relevant that they granted two feature articles on the work. The industry journal became interested in the zero-defects project when it was brought up in a discussion on a different project in the fall of 2007. The local production

improvement project based on approaches, tools and methods known as Lean, was assessed as so relevant for the industry that it was granted a full article in the December, 2007 edition of Emballering (Nordberg, 2007). One year later the same journalist participated in the Kick-off conference, and wrote a new feature article in the December 2008 edition of Pack News (Nordberg, 2008). Those of us in the project interpreted this as recognition of the work we contributed and the relevance of the practices established.



Front page Emballering 6/2007

Front page PackNews 6/2008

Illustration 16: Industrial journals front pages covering the project

Also the official Norway as seen in the Skattefunn regime found the project and findings so relevant that they decided to grant funding to it under the Skattefunn scheme, described in the Context chapter. We in the project team interpreted this as further recognition of the work contributed and

the relevance of the practices and findings from the project.

> To be eligible for support under the SkatteFUNN scheme, a project must demonstrate innovation potential. There must be clearly defined objectives and milestones, and a detailed budget and funding plan must be presented. The project must be designed to generate new knowledge, information or experience, or to implement findings from industrial R&D to develop new or improved products, services or production methods (The Research Council of Norway, 2010, p. 2).

To sum up the third question: yes, the practices, concepts and constructs have relevance in other settings outside the project. The relevance in these settings is of course most connected to the practices and the effects of the work, and less connected to the theoretical explicit concepts and constructs seen in the dualities, paradoxes and processes identified. But at the same the time I will argue that the study challenges the mythical image of Lean. Lean is presented as a precarious and complex practice of paradoxes, conflicting ideas and different origins. The Lean project is presented as a socially and materially embedded collective enterprise.

5 Analysis

The Lean'ish way to do production became a reality as the result of the contributions from a wide set of actors. Together the people and materiality in the factory made up a web of relations that produced or assembled an understanding and a practice that became the Lean'ish project. The web of relations includes computer systems, hardware, literature, groups, conferences, people and structures (Illustration 17).

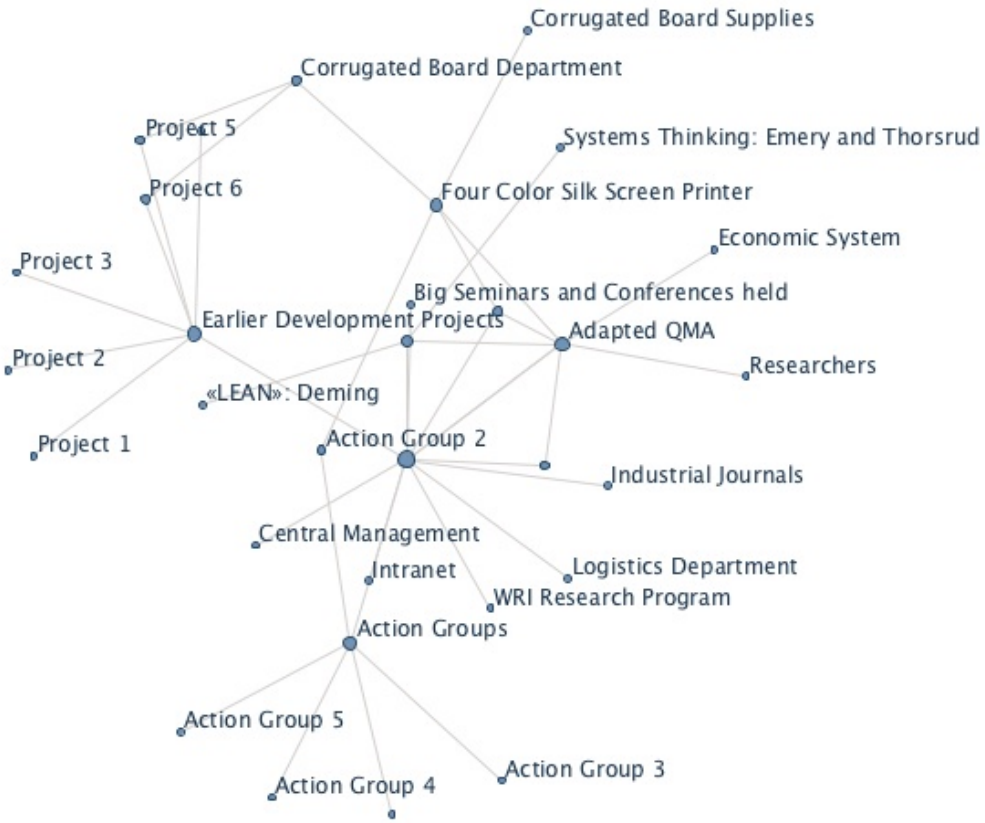


Illustration 17: The Lean'ish Actor-Network

The purpose with this and the other Actor-Network diagrams is to illustrate the many different actors and connections in what was to become the actor-network of the project. The actor-network diagrams are not analytical, but pedagogical in the way they illustrate the heterogeneity discussed in more detail in the analysis. The analytical discussions of these networks are part of the analysis and

the stories about how the relations assemble or not.

The analysis identifies how technology functions as a biased actor in the network and not as a neutral artifact. It further describes how the project became embedded and entangled in the people and materiality of the factory. This way it was not about implementing something from the outside, but developing something from the inside. The analysis also shows how materiality and people shape each other and create success or failure. This way the analysis introduces a wide set of paradoxes and multiplicities that challenge the simple models and dichotomies established in Lean-literature. Multiplicities become part of both the understanding and the practices making up the Lean'ish project.

5.1 The Local Challenge

Since the Display department was established in 1984, it has been competitive and economically sound. But over the last years things began to change and there have been many challenges such as financial deficits, workplace issues, product quality and waste. Many of these challenges are interrelated and may also be challenged and discussed in more detail, but the overall picture is clear: the department had a situation that if continued could turn into a major problem.

There were no big controversies or events taking place in the department so the obvious question to ask is why these problems now? There is of course no one single and simple answer to the question. But one thing is sure, and that is that "things" have changed. For example, the products from the department went from an almost autonomous position, in many cases only a nice shelf in bright colors with a logo, to an integrated part of a total marketing matrix including new visual designs, TV and media marketing and branding of new products.

This change from something autonomous to part of an integrated marketing plan has at least three major implications. First, that timing has become extremely important. TV and media marketing are expensive and therefore often have to be limited to a short period. The display products in the total marketing plan have to be in place in the right time: not too early and not too late. Second, there are many more individuals that work together and have a say on the display products. That could be the customer representative, the economists, the hired marketing people, the visual designers, the subcontractors, the local sales department, construction and production and more. The challenges on communication between all these parties have increased exponentially and with that the likelihood for misunderstandings. A consequence is that the time from when all the materials and parameters are in place to when the products are expected to be delivered are reduced. More time is used to straighten out misunderstandings and errors especially in the underlying materials. Third increased quality and less tolerance for divergences are demanded both on printing and construction. Many colors and complex constructions have become the rule and the earlier one color shelves with a poster are now history.

These three implications introduce two competing challenges. First, that there is less room for errors because of the reduced time window available and the time for a second try or a rerun has diminished. Second, that the complexities part of production have increased both in the number of

people involved and in the products themselves. In other words, the potential for defects has increased at the same time as the room for errors has decreased.

These new challenges establish a new demand on production. This new demand has several implications on the people, the materiality and the procedures in the factory. One implication is that the old technology (the one color silkscreen printing machine) is no longer efficient because the products will have to be printed several times with different colors. A second implication is an increased demand of a skilled and trained workforce because there are no easy jobs anymore. A third implication is the reduced possibilities for the local manager to control and supervise every task and thus imply a change in the role of the production manager. The challenges introduced put the factory in a situation where the people, the technologies and the way to do production all have to change to face a different reality.

The department was in many ways organized according to the old way with a hierarchical organization and hegemonic structures as indicated in the established job fractionization in the factory and not least in the wage plan differencing between roles and rewards on the basis of the individual. But at the same time it was not a place of hegemonic practice. The local production manager involved the employees in the day-to-day management contributing to a flexible and informal practice illustrated in the results from the *Organizational Culture Assessment Instrument Survey* (Cameron & Quinn, 2006, chap. 2) run in the factory during the autumn of 2007.

> The survey shows the clan culture to be the dominant culture in the factory. This culture is characterized as a friendly workplace where people give much of themselves - almost like an extended family. The leaders have the roles of tutors/mentors and the organization is held together by loyalty to each other and tradition. The organization emphasizes the long-term benefits of investing in human resources and success is defined by being responsive to customers and concern for people. Team work, participation and consensus are key issues (The Half-year report December 2007 – part 5).

This illustrates how the existing approach to production was in many ways an established black box; it was “the way we do it here.” At the same time the new reality challenged the established black box in the factory as seen in the changes demanded and the tensions around reaching budgets,

workplace issues, product quality and waste, among others. In many ways we were in a situation where the black box of production was challenged, both in the focus on autonomous groups and participation, the system perspective and in the zero-defects approach to production assembling. Many elements were already in motion as described in the informal and flexible practice already established, but elements like the individual focus and job fractionization part of the way to do production, the lack of a system perspective on production and not least to make these embedded and entangled in the people and materiality still remained. The black box was thus still not opened or replaced by the assembly of a new dominating black box or way to do production.

To use a metaphor from biology: the habitat that production lived in had changed. The structures, methods, technologies, and the way of doing things that made us competitive in the old habitat were not adapted to the new. We were in many ways like the classic example of the white moth sitting on the now black (from pollution) tree in industrial England; we had lost our precious camouflage and become easy prey.

Illustration 18: The White Moth on the Black Three[26]

The problem of the department, in the perspective of the theoretical stand taken, was not just about implementing a given methodology like a flavor of Lean or the newest fad. Nor was it to have faith

[26] http://www.museumofhoaxes.com/hoax/photo_database/image/the_peppered_moth/

in the “structural help” like that of the Norwegian cooperation model. It was rather about assembling a team of individuals, structures, relations, technologies and methods—or more precisely, the way we do production in all its aspects—better adapted to the new habitat.

5.2 The Local Way

How was it possible for the department to make the changes necessary? How were they able to assemble a new way to do production? Or to continue the biology metaphor, how were they able to assemble a new way to do production in all its aspects in the factory better adapted to the new habitat? At Østfold Innovation Network[27] November 2009 meeting the company's quality manager presented some of the results from the project.

First, they were able to make the changes necessary. The project was accredited to:

- *Simplify the quality system and reduce the numbers of documents*
- *Reduce dramatically the complaints/cost on corrugated boards*
- *Stop errors early in the process (increasing the proportion of reported discrepancies)*
- *Identify the organization before production as source to more than 80% of the errors*
- *Improve flow of production - reducing overtime by 30%*
- *Establish a more accurate and transparent order planning*
- *Improve work conditions with less wear and stress on employees*
- *Implement a working logistics for supplies and products*
- *Establish involvement and participation in practical work*

As discussed in the introduction a lot is written and explored about management in the Lean literature. In this study I will focus on the hidden or forgotten actors, especially the interrelations between the actors making up the project network. I will focus on actors like the quality system, the project team, the silkscreen printer and most how these and others actors together assemble a dynamic network or team better adapted to the new habitat.

27 Østfold Innovation Network vision is to contribute to value creation in Østfold through close cooperation with industry, higher education and research institutes and the public by developing an innovation network and a meeting place for people.

5.2.1 The Quality System

First I want to focus on the adapted quality system. The quality system is usually seen as an important but neutral part or artifact in the company. I will bring it forward as an example illustrating how a piece of software/technology functions as a biased actor and not a neutral artifact alone. This way the quality system goes from something neutral and thus hidden and forgotten to an actor taking part in the assembly and reassembly of the way to do production.

The data establish the adapted quality system as a hub connecting other actors in the assembly of the new way to do production. The adapted quality system embeds the work of for example the project team and the literature chosen in the electronic documents and this way makes the inscribed experts mobile as part of the system. This way the quality system turns procedures and schemes into emissaries bringing the experts into the daily practice and thus both strengthening and aligning the network. The data also reveal the "strange" relationship between resistance and support where one does not rule out the other. This is a relationship linked to the existence of alternative actor-networks turning both support and resistance to something beyond individual acceptance or rejection to include practices, structures and technologies.

THE INTRODUCTION OF A NEW UNDERSTANDING OF THE QUALITY SYSTEM
As described in the context chapter the quality system (QMS) got an important role in the project. It became the major official source of data on the progress of the project, but it also became a symbol of the change from the old way of doing production. None of these roles were naturally given or passively acquired; they were an effect of the contributions from many actors over a long time.

> The inclusion of the quality system was introduced. Both the practice of reporting divergences and complaints along the lines of what is done in production of corrugated boards and improvements of procedures and knowledge of procedures is important to include (From the PTM #3 Summary).

We decided to include the QMS in the project in the Project Team Meeting (PTM) #3 on October 10, 2007. It was not until PTM #25 on November 19, 2008 that the hardware and training were in place and the adapted system operative. Clearly our intentions and understanding developed in this period, but the ambition of a different QMS was in place almost from the beginning, as illustrated in

the meeting summary cited. As the time gap indicates the obstacles were many as was the resistance to the changes. At the same time it was a project with strong support from the top management, the production manager and the trade union. This blend of resistance and support was experienced as a paradox at the time and a source of much frustration. This paradox will be elaborated in more details later.

The Lean rhetoric of "flow and waste" and not least the continuous improvements work introduced (Kaizen) put the role of the QMS on the agenda. It became essential to know the details and facts behind the waste in order to develop measures to address the problems in a systematic way. What kind of waste did we identify? Where did we register it? Where did it originate? What measures could we take? With Kaizen as a starting point and a wide definition of waste, it implied from both ideological and practical reasons discussed in the theory chapter a user driven QMS. No one manager has the time, practice or knowledge to address waste in all its forms as understood in our approach. It was obvious for us to establish a user driven QMS to get the details and facts needed in our Lean'ish approach and new way to do production. The experiences from the *Efficiency project on production of corrugated boards*, an earlier development project lead by one of the researchers in another department in the company, contributed to establish the approach and the idea of a user driven QMS. What was not discussed was the way of participation proposed earlier in the introduction of precarious Lean.

In the old way of doing production the QMS had quite an irrelevant and insignificant role as seen from the shop floor and a user driven perspective because it was isolated from the operators in production. They had no access to the system, there was no hardware available on the shop floor, and no training in the use of the system. It was in fact not part of the way to do production. Both the way we introduced the QMS in the project described earlier and our later actions in the project resonate with this understanding: the QMS as something new to the factory to fill an empty place.

In retrospect the picture is somewhat different. Yes, seen from a user driven perspective it can be argued that the QMS was not a part of the way to do production. But it can be argued that this is not what the QMS is about. The company and the factory had a working, well-established QMS and procedures for the use of it. It was an electronic system supplemented with a hardcopy system where complaints and divergences were reported on paper and handed in to the production

manager. The production manager did a quality check and registered the data in the electronic system. This way it was very much part of the way to do production and the task and role sharing in the factory. The established QMS was used as a tool to set major economic differences between departments on supplies of cardboards, but not used as a tool for local development. This is illustrated in the ratio of divergences versus complaints (about 1:1 in 2007). In a zero-defects perspective the number should be at least 3:1, a higher ratio the better indicating an approach to production that identifies and stops the defects before they end up as complaints and economic losses. In this understanding the established QMS represented and inscribed the hierarchical and hegemonic practice up to now part of the way to do production.

The discussions so far establish both the old and adapted QMS as an inscription device, but for two different practices. This way it also implies the coexistence of multiple rationalities, discourses or actor-networks in the factory. The duality of the resistance and support experienced thus becomes important to understand the contributions.

The first resistance met were the internal rules on not giving operators access to the QMS. The rules and procedures were clear in a way, but at the same time there had been a development project on production efficiency in a different department that had been allowed to bypass the procedures and grant the operators access to hardware and training in the QMS. That project had improved the efficiency significantly in the department in question and left a door open for us to use.

In the project team meeting #3 on October 10, 2007 it was decided to include the QMS in the project and to start the process of redesigning the databases to better reflect the actual challenges when making it a central tool in local development of production. The arguments for this approach were first the need for more information and facts on waste in production. Second the Lean'ish position taken was based on participation and a system perspective, and third the experiences from the efficiency project in the other department. The redesign included a new access regime that allowed operators to access the system, new or improved procedures and new fields and categories to increase the diagnostic/system/network features of the system. New roles were created to establish a new workflow where not everything goes to the manager but directly to the operators responsible.

In parallel and as a part of the work in the PTM's #5-9, the pitfalls identified in the QMS became the main indicator on progress and success of the later measures taken (Table 3). The role of the QMS became the source of data of progress on the project and success started to develop.

Case	Decision
4	1. Statistical indicators NN presented what data we today can extract from the QMS (the most important indicator pointed out during the process on pitfalls). It is possible to extract both complaints and divergences in detail (with cause). NN takes responsibility for the practicalities so that we can have a continuous overview. If everything goes according to the plan, it will in the short term, be an increase in divergences and a decline in complaints (defects will be caught by ourselves and not the customer).

Table 3: PTM #9 Summary Case 4

This change in approach to production was not isolated to "paper work" only as in reporting the problems in the quality systems but included emphasis on practice and how to react on quality issues including the authority to stop production. The latter challenge is illustrated in the decision on making it a formal pitfall to work on (Table 4). The possible pitfall identified was not respecting or supporting the decisions taken by the operators when reporting divergences and either stopping or suggesting to stop production.

Case	Decision
4	Pitfalls q) "Attitudes" towards actions to stop production/products Description: A pitfall if no response to reporting divergences/stop of production. Important to see that something happens when you report. That it has an impact.

Table 4: PTM #7 Summary Case 4q

As described earlier in the context chapter the Dialogue Conference on April 7 2008 marked the start of development of measures and activities based on broad participation on the earlier identified pitfalls like that of Group 4 (Table 5).

#	Pitfall	Indicators	Ideas
4	Description: Not the required quality between the various processes (0-defects approach). Do we process and manage (transport/ process/store) products that should not be passed on in the process?	Divergences QMS Complaints/waste	Link to a waste project? Map all parts of production

Table 5: Dialogue Conference Report on Pitfall 4

Based on the pitfall the group of nine from the Display department, the trade union started the work on interpretation and localization of the pitfall and development of measures (Table 6).

Pitfall (split in parts)	Description of measure	Comments
Production scheme	Training and knowledge about production practice	
Quality on card board	(Covered by group 2)	
Staff/work schedule	New approach to plan manning (maximum production times known)	
Internal divergences	Own terminal for operators that enable them to report divergences direct Follow-up and feedback	Use experiences from efficiency project

Table 6: Dialogue Conference Report on Measures Group 4

The group made explicit features of the new QMS earlier that only implied like that of a dedicated computer terminal for the operators and access directly to the electronic system and not indirect by hard copies seldom used. This way the operators became part of the official source of data on the progress of the project and illustrated a new way to approach the QMS. The legitimacy and significance related to this work were supported by the choice of this system to become the main indicator on the progress related to all pitfalls. This proposal was accepted by the steering committee. The work continued in a designated task team originating from the conference to take

up the work on solving the funding, finding practical solutions and establishing a training regime. In June 2008 the internal funding and infrastructure was in place (Table 7).

Case	Decision
2	Group 4: User driven QMS The allocated funds for the equipment are in place. Room and equipment for training (hands-on) are in place.

Table 7: PTM #18 Summary Case 2

The second resistance was technological. The project team was informed by the ICT support that the present network infrastructure made it impossible to use the system because the bandwidth was inadequate for our use. The location of the factory and the network infrastructure further made it impossible to increase the bandwidth to the level required. But since we already had a working connection to the production manager the bandwidth argument was challenged and after much back and forth a solution was established based on our local needs and not a general access to all the intranet services. The user driven QMS initiated autumn 2007 and made explicit in spring 2008 became part of the way we do production in autumn 2008 (Table 8).

Case	Decision
3	Group 4: The hardware is in place. Training of all employees at the department is completed and the use of QMA and AS400 is in progress. Evaluation and possible follow-up of training remains

Table 8: PTM #25 Summary Case 3

Now the main users in the QMS were the ones doing the different tasks in production. The operators wrote and updated the procedures (Illustration 9), filed divergences and complaints, responded to divergences and complaints in compliance with the thinking and approach to production assembled in our project. The actual change of practice and not only rhetoric is illustrated in the results from the project including reducing the numbers of procedures to those needed, increasing the ratio of divergences versus complaints, identifying the sources of defects and more. This changes resulted in hard results like the dramatic reduction in the cost linked to

complaints on card boards, stopping the defects early in production, reduction in use of overtime because of better quality and less defects, and less wear and stress on employees because of a more accurate and transparent order planning.

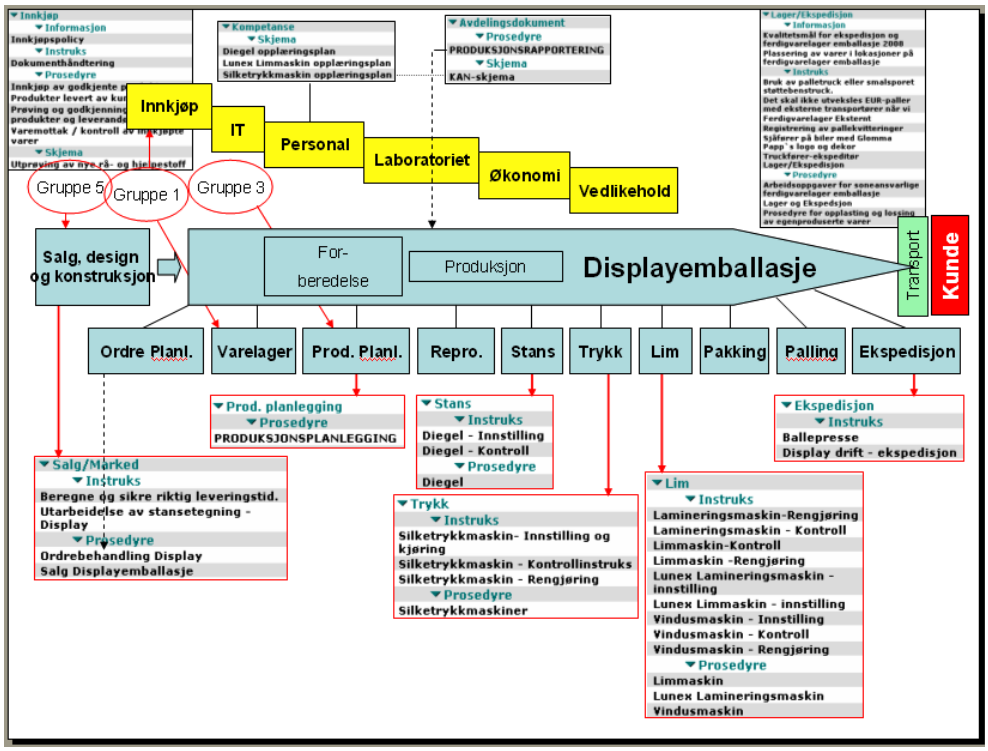


Illustration 19: Procedures and Instructions Overview November 2008 (in Norwegian)

Why this focus on the operators and a user driven QMS? The initial QMS and practice gave a simple, static and sequential picture of something not at all like the dynamic organization and processes it was meant to represent (Kirkebak, 2000, p. 55). The one actually doing the different tasks did not have direct access to the system. This could be because of limited access to the computer system, no hardware easy available at the shop floor or lack of skills and training, all true in our case. As a consequence the main users of the QMS were management that had access to the system, the hardware available and training in using it. Despite the obvious shortcomings it worked in many ways well within the earlier habitat, but when the environment changed more dramatically like in our case the shortcomings got significant. The existing QMS was thus unable to contribute to a zero-defects approach in the factory illustrated in the Kaizen methodology. With the changing

habitat, including shorter time limits, more people involved, higher quality and complexity demanded, another way to do production in all its aspects is demanded, including a new position to fill for the QMS for both ideological and practical reasons discussed.

Relations

The adapted QMS includes several important features when seen in context with other actors and aspects of the network. From being a rather isolated system of little practical relevance and significance for production, the new QMS became a hub connecting different actors and thus one of the more important actors closely linked to other parts of the network. This central position in the network was not planned from the start, but it became of increased importance as the understanding in the project group and the network of actors developed. By the quality manager (the one responsible for the development of the new QMS and a member of the project team) it became linked to the project team. By the redesign of the databases and the training regime it became linked to the operators (as individuals and as a group) as the new users of the system. By the agreed upon set of project indicators it became linked to the researchers and steering committee and economic system of the company. By the rewritten procedures and electronic schemes/templates for complaints and divergences it became linked to the zero-defects approach initially brought forward by the project team and the basic literature (Deming, 1986; F. E. Emery, 1981; Thorsrud & F. E. Emery, 1970).

Network relationships diagram

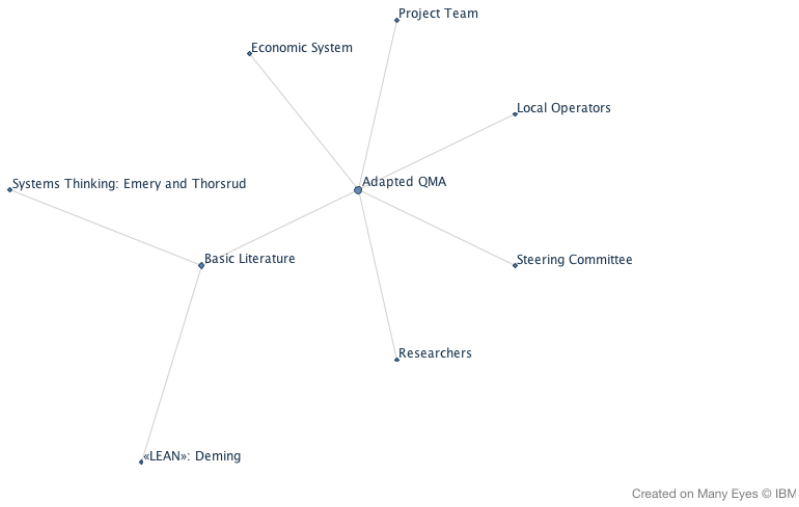


Illustration 20: The QMS Network Diagram

How did the new QMS contribute to the assembly, development and existence of the project?
One contribution was to make it possible for other actors to contribute (Illustration 10). This was done in the redesign of procedures and the electronic schemes, templates and workflow for handling the procedures and divergences and complaints described. The zero-defects approach and the work of the project team and basic literature became embedded in the electronic documents in the new QMS and thus inscribed in the daily practice. By aligning and distributing the work of others the new QMS achieved compliance, and got the different actors in line with the main ideas by creating a contextual envelope for production including literature and earlier projects.

Along another axis, the adapted QMA became the source of indicators/parameters for how well the project evolved. This way the ideas of zero-defects approach got entangled in the numbers reporting back to the steering committee and part of the economic system. What earlier would not count in this context as progress now became marks of successes.

What can be learned from the new QMS?
One important lesson is that of embedding, entangling and *inscribing* (Latour, 1988, p. 83) the main ideas and approach in technology in daily use like the new QMS. This made the "experts" mobile as embedded in the electronic documents and contributed to compliance by aligning the different actors in the team. But for the new QMS and the inscriptions to become an actor of importance it

demanded other actors such as computers, IT network and a technological infrastructure. It demanded technology to be accessible and useful for the operators. The old way of a single computer at the local manager's office would not make the electronic documents into important elements. Teamed up with new computers linked to the local network and with the right software installed we got a powerful mix. But without skilled and trained people to use the computers to access the inscriptions and to translate them into practice no work was done. The training regime therefore proved important as the last part of the new QMS blend of inscriptions, technology and skilled people that contributed so much work to establish the zero-defect approach in the department. This lesson illustrates the manifold of actions and work contributed to establish the adapted QMS as an important actor. It is nothing like the adoption of a list of ideas associated with implementing Lean discussed earlier.

Another lesson learned is that of the "strange" relationship between resistance and support. This project had rock solid top management, middle management and trade union support in the company. At the same time the obstacles were many as was the resistance discussed in the analysis and best illustrated in the long time it took to establish the new QMS and quality practice. In a situation like this it is easy speculate on who is to blame. But in retrospect this was not about that at all, it was about a much stronger and more serious opponent. It was not about trying to convince a person or a group. My findings suggest that the stronghold of the resistance was the old QMS with allies embedded in the way to do production and inscribed in technology and practices established like that of job fractionization and hegemonic structures found in the established task and role sharing in the factory. The factory was this way not a *tabula rasa,* an empty place for us to transfer our new QMS and related practices. The landscape was already full of actors assembling a strong network and our biggest error was to treat it as empty and virgin. It was like trying to teach kids about force and momentum in physics not taking into account all the conceptions about these and related phenomena already in the heads of the kids. We met resistance from the already established framework and practice, and from the project perspective it seemed like misconceptions. Neither the factory nor the kids are a *tabula rasa*. We better take that into account when trying to introduce a competing conceptual framework and practice even if the space seems empty. This lesson on resistance and support illustrates how it is no longer about top-down or bottom-up support discussed earlier on how to relate to and understand the "implementation of Lean." It is about the way to do production and the materiality and the people part of these practices. We have to

anticipate a multiplicity of rationalities, discourses or actor-networks sharing the same space in the factory.

Processes

As discussed the new QMS became a hub in the assembled network node of actors and an important and critical actor in the network bringing otherwise isolated actors into the network. But how do we explain or understand this position?

First, in the way the adapted QMS produced and interrelated what we could think of as *emissaries* (Law, 1986, pp. 251-254) aligning the network found in the procedures and schemes, the technological infrastructure and trained people discussed earlier. This way the emissaries inscribed the new way to do production and made the QMS become an apparatus that transformed our way to do production into electronic documents and procedures (an *inscription device* (Latour, 1979, p. 51)). I call them emissaries because they acted as agents sent on a mission to represent the project and together made it possible for the project's ideas to *circulate* (Latour, 1999b, p. 20) and thus become mobile and at the same time in compliance with the Lean'ish thinking.

Second, in the way the adapted QMS assembled in the presence of and in competition with the already established practices of the old QMS. The metaphor of learning and misconceptions are used to illustrate the resistance in the factory and the presence of an alternative actor-network. A resistance not based on rational individuals to be convinced, but on practices inscribed in the way to do production and organize the work, and thus a much stronger opponent.

5.2.2 The Project Team

Second I want to focus on the project team because it represents a break with the top-down approach associated with many Lean projects where a person or a small group drives the project (Morgan, 2005, p. 115). This way the project team was an actor and not a place for the diffusion or adoption of a universal Lean thinking. It was the starting place for the assembly of something Lean'ish in the factory. The project team also illustrates the way the relations come together and assemble the project. The project team is an example on how these relations develop during a project (Law, 2008), how ideas develop and how actors gain strength and influence through *alliances* with others (Harman, 2009, p. 15).

The data show the project team as an *obligatory passage point* (Callon, 1986, pp. 203-206) aligning other actors contributing to the assembly of the project. In this way the project team contributed to holding the project together as it was embedded and entangled in the people, structures and materiality of the factory. First as part of the project team, later as part of the factory and company. The data also introduce the duality in the growth of the project and the understanding of what it was all about. The analysis this way challenges Lean as something to implement and replace it with something that is part of the people, structures and materiality and that changes as these elements change. Finally the data show the paradox of how the significance and relevance of the project is inversely proportional with the coherence in the way we understand the project. The greater strength and legitimacy to take actions the more multiplicities present on what to do. *Translations* (Latour, 2005, p. 108) enable the ideas to *circulate* (Latour, 1999a, p. 71) and thus lose some properties and gain other. The translations this way act as the glue (Harman, 2009, p. 15) holding the project together, but at the same time introduce tensions that may break it.

THE ASSEMBLY AND GROWTH OF A PROJECT AND AN IDEA

As described in the context chapter we made a choice of vertical and horizontal integration in the forums including the project team with representatives from the involved departments and different levels in the organization as part of the same team. The project team this way included production personnel, production manager, sales personnel, sales manager, quality manager, procurement and logistics. The initial rationale was not based on explicit actor-network thinking or design but more an implication of the structural requirements and perspectives of the research program described in the context chapter.

The project team was at the same time an intentional design and a response to the failures to deliver what is promised in many Lean projects. This design was motivated by both the initial challenges linked to the changing habitat and our preliminary understanding of Lean and how to optimize processes and systems rather than job fractionization (Deming, 1986; Morgan, 2005).

Part 1: The Lean'ish project and the project team

The reflection log from the first informal meeting on June 19, 2007 reads, "*None omitted.*" A "slogan" that in many ways represents a break with the small group approach and set the standards for the work to come and the purpose communicated both in the company and public. But few actors were committed and few relationships established, and thus we had a very fragile network.

> "*The purpose of this project is that we will work smarter, not run faster."* (Nordberg, 2008, p. 64)

It was a group of people not familiar either in personal or professional life that met on September 5, 2007 for the first team meeting. The meeting summary shows that some from management had taken part in the first informal meeting about the possibilities of a Lean project in June 19 2007. The participant list shows that most from the factory had taken part in the first plenary presentation August 22 2007 in the factory introducing the project and Lean philosophy and approach to production. Some also had professional relations in the organization as members of the same department or in direct contact in the production line, but as a group we were unfamiliar and had little knowledge about the other members' roles and skills in any detail. In the PTM #1 September 2007 the issue was to establish a project map based on the mandate established in the informal meeting, but even more important to start to get to know each other and try establish the team and begin the assembly of the project. In the beginning the whole network was fragile with few actors and few relational bindings established.

The reflection log September 12, 2007 reads: "*Will be a challenge to recruit people* (to the project team)," which showed a worry about meeting the ambitious plans on broad participation and the resources available. As shown in the project timeline in the context chapter the project team decided to have regular meetings approximately every fourteen days. The hours the participants gave (we

reported 2,445 in house hours on development in 2008 to the Research Council of Norway Skattefunn scheme) to the meetings alone indicate the importance and significance given to the work. In line with the systems thinking and our preliminary understanding of Lean, the process mapping was carried out in collaboration between the different members in PTM #2-5 September – November 2007.

In PTM #2 September 19 2007 a member of the project team suggested that the expert, the one responsible according to the organizational map and role given on the process studied, should do the work and present it for the group as an alternative to the collaborative.

> "- *Then we don't have to spend an hour on each process.*
> *- We can take a specific order and tells us about the practice of it. We go through the production.*
> *- Not to disagree, but that we all sit here now and talk about it and discuss it, and that all really have understood what we actually do has been really all right. That it is not something that comes ready-made.*" (Transcript from PTM #2 September 19 2007)

Several members of the project team emphasized the importance of knowing the what, why and how emerging from the collaborative approach as essential. This indicates a shift from focus on individual tasks and responsibilities and towards a focus on processes and systems. An understanding of the *team* as an actor with ambitions of a shared understanding and not a group of individuals *alone* started to emerge. This also indicates that the other participants were viewed as so significant and the work so relevant that the participants were willing to prioritize time on this work and build relations with the others. The discussions in general and the mapping with all its detailed know-how assembled the project team in many ways.

The core of the project, the local Lean approach labeled zero-defects, was unresolved at start up. Yes, Deming (1986) and the new approach to quality and production and the link to the NDP and Lean were already introduced. Our understanding had a direction but was still general and superficial:

> The goal is to achieve 0-defects delivery to external customers. It means that our internal

> procedures should detect defects before products leave the factory. We provide enormously expensive products, and complaints will have severe economic consequences. We simply can not afford to make mistakes (Nordberg, 2007, p. 58).

Our understanding of Lean began to develop and take form as part of the process mapping between September and November, 2007. This practical first *translation* (Callon, 1986; Latour, 1997) and materialization of Lean is embedded in the five prioritized pitfalls identified by the project team and presented at the steering committee in December 2007 (Table 9).

#	***Pitfall***
1	*Time used to control others work ("waste"),*
2	*Not satisfactory quality on corrugated board supplies*
3	*Errors related to production planning*
4	*Too little "flow" in production*
5	*To misinterpret/not understand customer needs in sale.*

Table 9: Status Report December 2007 Identified Pitfalls

A Lean'ish approach unique to the factory started to assemble focusing on the goal of smoothing production by removing waste, by systems-thinking and a new understanding of quality. It was unique because the situated elements such as the problems with the corrugated boards, and local technologies and infrastructures, as well as unique people were embedded in the project. Through these activities and the ongoing challenges, reflections and discussions on the production processes in the project team went from slogans and something general to become a practical venture in how we do production in the factory.

In this first autumn the project and the Lean'ish understanding thus went from something vague and in part unresolved to a committed group and a shared understanding of a Lean'ish approach embedded in the project team, the structures and materiality part of the project team.

Part 2: The Lean'ish project and the factory

In January 2008 it was essential to both strengthen and anchor the project in the company to be able

to do the actions necessary. We had to strengthen the local significance and local relevance of the project. The first step was to assemble a preliminary and material understanding of Lean and to establish the project team as a unit discussed above and embedded in the pitfalls. The second step was to try to bring it out in the factory and get everyone involved. The Dialogue Conference on April 7, 2008, the Kick-off Conference on September 16, 2008 and the designated Task teams were central activities. These three activities illustrate the growth of the project from the project team to a large part of the employees in the involved departments and services (Illustration 21).

Participants in the zero-errors project

D= participant, L = Leader

		Role in the project								
Name	Department	Steering committee	Project Team	Task Team 1	Task Team 2	Task Team 3	Task Team 4	Task Team 5	Kick off 16/9-08	Notes
NN	Display Production								x	
NN	Display Production								x	
NN	Display Sales							D	x	
NN	Display Production								x	
NN	Order office					D			x	
NN	Sales	D	D			D			x	
NN	Display Sales		D					L	x	
NN	Display Production								x	
NN	Display Production		D	D				D	x	
NN	Display Production					D			x	
NN	Display Production								x	
NN	Researcher		L						x	
NN	Procurement								x	
NN	Corrugated Board				L					
NN	Display Production								x	
NN	Economy					D			x	
NN	Display Production		D	L			D		x	
NN	Display Production								x	
NN	Display Sales								x	
NN	Display Sales								x	
NN	Display Production								x	
NN	Display Production								x	
NN	Display Production								x	
NN	Display Production								x	
NN	Corrugated Board				D				x	
NN	Human resources									
NN	Managing Director	D								
NN	Display Sales								x	
NN	Manager Quality		D		D		D		x	
NN	Researcher		D		D				x	
NN	ICT			D						
NN	Display Production								x	
NN	Display Production								x	
NN	Display Sales							D	x	
NN	Procurement		D	D					x	
NN	Display Production								x	
NN	Display Production								x	
NN	Manager Packaging	D					L			
NN	Display Production								x	
NN	Display Production				D				x	
NN	Logistics		D			L			x	
NN	Display Sales							D	x	
NN	ICT						D		x	
NN	Display Production								x	
NN	Trade Union	D							x	
Antall:	45	4	9	4	5	5	4	5	40	

Illustration 21: Participant List Conference September 2008

In the Dialogue Conference April 7, 2008 the work began on the measures to address the pitfalls we selected, for example the new QMS discussed earlier. Heterogeneous groups worked on the pitfalls identified and a set of rough prioritized measures was presented in plenary as described in the context chapter and in the conference report. The work continued the next months in the designated Task teams that developed operational measures. This work represents in sum a continuation of the practical and localized development and *translations* of Lean going beyond the project team because new elements of understanding, new challenges, new technology and new people were

introduced to and entangled in the project. The *translations* enabled the Lean'ish understanding to *circulate* but it also meant losing some properties and gaining other. This continuation is illustrated in the example with the new QMS discussed earlier and how the Task team #4 went from a pitfall on quality to a measure on a dedicated terminal for the operators and change in the practice of the QMS.

The new actors also included the managing director and the trade union representative that together opened the conference and also took part in the discussions and work in the groups. These two actors became highly visible in the conference and were especially important in the early work of gaining legitimacy of the project. It now became impossible to ignore the project without also challenging the representatives of the two most important power structures in the company. But as the analysis of the QMS shows, the relationship between support and resistance is not straightforward and will be further elaborated in the Discussions chapter. Anyway, at the time of the conference, the legitimacy given proved important in the efforts to build significance.

In 2008 the project went from the project team to the whole factory. This way the project gained strength and significance in the company just by the sheer numbers involved. In this period the project also became even more embedded and entangled in practices in the way to do production by the work in the task teams. This way the project got anchored in the organization and more relevant for the one involved being part of the new way to do production. But at the same time the shared understanding got challenged. Now it involved about fifty people, where some were well familiar with all the processes and others familiar with only parts and bits. Therefore the increased strength and relevance introduced a challenge on our shared understanding of the project and LEAN.

Part 3: The Lean'ish project beyond the factory walls

In parallel with the work in part 2 a third part representing the growth of the project beyond the company became introduced. Where the second step was intentional and planned the third step just happened more by coincidence than strategy. The articles in the industrial journals, discussed briefly in the methods chapter, are important in the way the project turned out. This way the project gained more strength, but the growth beyond the factory and the company also introduced tensions as seen in the multiplicities of understandings present.

"*He is very clear that the project stands and falls with a broad commitment from the employees.*
- The project involves everyone involved in the process, both the production lines on display here at the department Tune, and at the main factory. Identifying of the pitfalls, definition of measures and selection of solutions all coming from below, he said." (Nordberg, 2008, p. 64)

"Zero-*defects philosophy is to increase employees' awareness to make the necessary operations in the most optimal and easiest way, she states.*

She does not think that there is something new at Glomma Papp to delegate responsibility, but realizes that she may be perceived as subjective here.
- Changes in an organization must include all and cannot be something I alone "invent". In that case I have no faith in that it will succeed. Moreover, it is the individual employee who best know their own process, she says." (Nordberg, 2008, p. 66)

Broad involvement and participation become both official and explicit in the articles and thus seemingly self evident and obvious to everyone involved and not a source of any controversy. But as the citing indicates there exists a variation in how to interpret participation and collaboration present in the project similar to that discussed in the two stories of Lean earlier. The articles also gave further legitimacy to the work because it proved the work to be of general interest not only regional (as part of the research program) but also national and Nordic.

Part 1 to 3: Reflections

Why this focus on the alternative broad project team and the growth and assembly of the project and our understanding of Lean? As discussed earlier the top-down approach is associated with many Lean projects where a person or a small group drives the project. In my experience a team in Lean projects is often centered on the "experts," usually hired consultants with general knowledge in one or more flavors of Lean. The consultants are then linked up to management and establish a small and effective group of experts with authority to make changes and in line with the thinking of top down management (support #1 reason for failure) (Rubrich, 2004). One consequence of this thinking is that the Lean project faces the threat of being isolated and thus loses any significance

and relevance in the company and inevitably fails to deliver what is promised. In the Lean context an archetype is a project promising to bring the company into the 21st century of Lean management, ending in a low ambition *translation* of 5S. A *translation* represented with a shop floor of yellow lines marking the place for everything but with few real changes in how we do things. The isolated approach is thus unable to contribute to the assembly of a strong, relevant and sustainable project necessary to establish a new way of doing production in the factory. With the initial challenges linked to the changing habitat and our preliminary understanding of Lean another way to organize the work and a different strategy of actions is demanded, a way that includes a strategy of broad participation and involvement and the assembly of a project of significance and relevance in the factory.

Relations

There are several important features associated with the project team the way it turned out in practice. From risking being a rather isolated group of little practical relevance for production, the project team defined the zero-defects ambition and the challenges met for all actors and thus became an *obligatory passage point* in the network (OPP) (Callon, 1986, pp. 203-206) (Illustration 11). This way the quality manager links it to the new QMS. The local manager and the representative link it to the operators from the operators. The director links it to the central management and the steering committee. It becomes linked to the WRI research program by the researchers. Several members in the team link it to a line of earlier development projects (six years of different development projects). The logistics manager links it to the logistics department. It becomes linked to the intranet by the meeting summaries, reports and documents published. It becomes linked to the basic literature like that of Deming (1986) and socio-technical systems thinking (Emery, 1981; Thorsrud & Emery, 1970) by the workshops held in the project team. It becomes linked to the big seminars and conferences held. The articles initiated and published linked it to the industrial journals.

The project team also initiated or created actors that later contributed to project. Not only with the creation of a group of people like the task teams but also by initiating events like the dialogue conference and the articles in the industrial journals which became important actors in the work to assemble the project. The project team literally took part in *assembling* not only the network of actors but also actors themselves (Illustration 22).

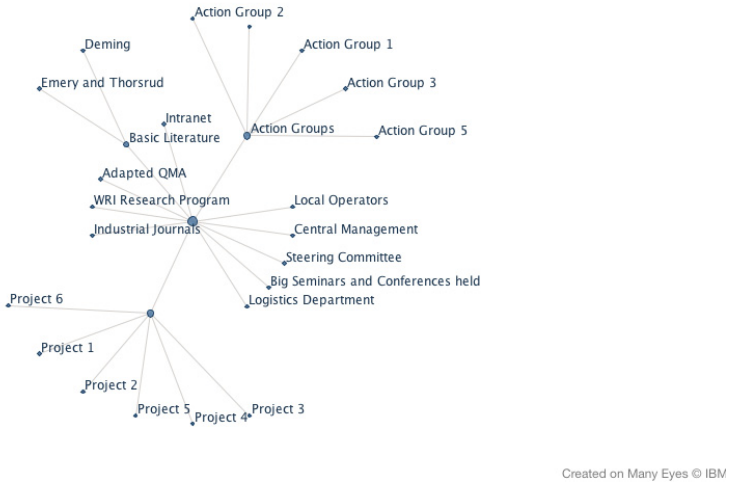


Illustration 22: The Project Team Network Diagram

How did the project team contribute to the assembly, development and existence of the project?

The discussions on the assembly and growth of the project show how one contribution was to entangle, enmesh and embed the project in the materiality. First in the project team itself then in the factory, company and beyond. This is illustrated by the way the project team contributed to make important actors like the managing director and the trade union representative, earlier projects, the dialogue conference and others become part of the network (Illustration 21). In this way the project team established a significant alliance and was difficult to challenge. This strategy represents something very different from the small group of experts discussed earlier. It was no longer about diffusion of an idea established somewhere else; it was about including people, structures and materiality in the assembly of a new way to do production.

The second contribution is related with the first but from a somewhat different perspective. That is in the way the assembly and growth of the project was reflected in our understanding of Lean as shown in the analysis of the Project team. This is illustrated in the way our understanding went from embedded in the pitfalls to finally entangled and enmeshed in the materiality of the factory and company. The project team's contributions are linked to creating forums like the dialogue conference and thus explicitly open up for a new way to think about Lean. The project team

contributed to an understanding of Lean relevant in both the factory and the company beyond the project team.

Third, the project team contributed to *sustainability*. Because the relations in the project turned out to be dynamic and in many cases fragile, they broke and we had to renew and establish new relations continuously as illustrated in the challenges of the summer of 2008. The project team contributed to renewing and renegotiating the relations with the actors as the OPP in the network and thus took the role as the stabilizer in the project. This contribution include that of introducing new actors, new challenges and new technologies as part of the project growing from the project team to the factory and beyond. This way Lean is not so much about a philosophy or culture as the assembly and reassembly of a way to do production that becomes part of the people, materiality and structures in the factory.

What can be learned from the project team?

One important lesson is that of the duality of the growth of the network with the creation of meaning as part of the agencies. This is illustrated in the way our idea and understanding of Lean grew from slogans like zero-defects to an approach to doing production as new actors were introduced and the network grew from the project team to be embedded and entangled in the technologies, structures and people in the factory, the company and beyond.

This growth and duality is also an example of the precariousness and unpredictable nature of the project. It is precarious and unpredictable because the understanding of Lean is continuously negotiated between the different actors. As new actors enroll, our understanding becomes challenged. It is difficult if not impossible to define beforehand the final result. Our understanding becomes dynamic and unpredictable and will have to be maintained and nurtured to stay alive.

The Project team shows the assembly of an alliance of actors establishing significance (strength in numbers), relevance (local structures, people and technologies embedded in the understanding) and legitimacy (related to power structures). But this growth also illustrates the paradox of how the increased significance in the number of actors, and the increased relevance in the way our understanding is embedded in the materiality introduce a less coherent reality in the way we understand central concepts like participation. We will have to anticipate multiplicities of logics,

rationalities and discourses sharing the same space in the factory. Tensions will be a natural consequence of these multiplicities. Creating room for and handling this heterogeneity of understandings and preconceptions in the factory replaces the struggle for a shared understanding found in many development projects.

Processes

The main findings related to the project team are the way our understanding of Lean became part of the changing materiality as the network grew—illustrated in the way the ideas *circulated* in the factory (A. Cussins, 1992; C. Cussins, 1996; Latour, 1999a; Law & Mol, 2000). It was thus not about an order following a line of command from the project team to every one involved in production unaltered or unchallenged. The orders were *translated* in the *circulation* along the chain of actors and thus losing some properties and gaining others making the orders relevant in the local materiality, creating variations and not coherence in the network as seen for example in the concept of participation. The *translations* may thus be seen as the glue (Harman, 2009, p. 15) linking the different actors together just because it adjusted the understanding to local conditions and thus made it relevant. But also the paradox in how the same process of translation created tensions that may break the relation or the whole web of relations (Callon, 1986).

> "*... translation is always insecure, a process susceptible to failure. Disorder – or other orders – are only precariously kept at bay*" (Law, 2008, p. 145)

Why is it insecure? *Translations* are always insecure because to translate a word is to find its equivalent. But since no two words mean exactly the same all *translations* may lead to tensions and misunderstandings (Law, 2008, p. 144). The process of *translation* thus become a process without a given result or security.

Translations introduce tensions as part of the process of establishing significance and relevance in the project. The project team produced interrelated *negotiators* that in some ways handled these tensions. *Negotiators* were the heterogeneous task teams, the dialogue conference, the kick-off conference, the open project archive and electronic boards that all become actors in the network. But also tensions were eased as people able to build relationships and bridge differences like the production manager in when taking part in changing the way we did production.

> Any such coherence, if it happens at all, is a momentary achievement. The logic is Serres-like: most of the time and for most purposes practices produce chronic multiplicity. They may dovetail together, but equally they may be held apart, contradict, or include one another in complex ways (Law, 2008, p. 152).

It is important to note that this paradox does not have a solution. Yes of course we may have coherence at a given time in the project, but this must be seen as a temporary phenomena and not the rule. The role of the negotiators is not about establishing a shared understanding or consistent approach everywhere in the factory but more about creating room for variations and handling the tensions.

5.2.3 The Four-color Silkscreen Printer

Third, I want to focus on the four-color silkscreen printer because it emphasizes the non-human actors in the team and especially the relationship between these actors that define and shape one another (Law, 2008, p. 146). It is also an example of how relations between non-human actors assemble.

The data establish the four-color silkscreen printer as an actor that interacts, shapes and is shaped by people and technologies in the factory. The printer also expands the network both in time and space, making elements located elsewhere and historical elements part of the assembly of the project in the factory. The reshaped printer also contributed legitimacy to the project by the increased quality of production with drastically reduced waste and thus greatly improved efficiency, value creation and work quality. The printer is no more a neutral actor but an actor that shapes and takes part in how the Lean project assembled. The data also reveal the unpredictable and un-deterministic part of the project making Lean a precarious venture in the factory. The interactive shaping and reshaping of technologies in this way became an important process of the alliance making up the project.

THE SHAPING AND RESHAPING OF TECHNOLOGY

About a year before the zero-errors project a new four-color silkscreen printer replaced the one color printer. The rationale was the demand for more complex products described to the changing habitat. As it turned out the new printer had a lower curvature tolerance border than the earlier one and the amount of waste was raised to a problematic level with all the implications involved discussed earlier. Seen in retrospect the new technology thus made us even less adapted to the changing habitat than the old. The easy way out would be to buy flat corrugated boards. This was not a solution for several reasons. First, our supplies on corrugated board were from an internal supplier, and second that the problems with curved boards are an industry problem and not a local problem. The problems had to be faced including the assembly of a new way to handle these dynamic challenges including people, technology and supplies.

The problems with the corrugated board quality and the consequences on production were identified as one of five prioritized pitfalls: "*2) Not satisfactory quality on corrugated board supplies"* discussed earlier. A heterogeneous group including representatives (including the team leader) from the supplier (the corrugated board department) started the work on developing measures in the

Dialogue Conference April 7 2008. The preliminary measures developed were presented and included in the official report (Table 10).

Pitfall (elements)	**Measures**	**Task team**	**Comments**
Not satisfactory quality on corrugated board supplies	*Establish inter-disciplinary group*	*Production Corrugated board department Laboratory Mechanical department Silk screen printer operators from Display department*	*Approach the pitfall from different perspectives to establish the best possible overview*
	Technical issues tests - heat - glue application - glue recipe - line speed	*Corrugated board department*	
	Technical improvements - Improved process control - maintenance schedules	*Corrugated board department*	*Link to already initiated project?*
	End product tests - cooling of boards - carving machine with air - systematic feedback from end user (silk screen printer operators)	*Corrugated board department Display department*	

Table 10: Preliminary Measures from Dialogue Conference 2008

The suggested inter-disciplinary group was established as Task team #2 and started the work. In the Kick-off conference on September 16 2008 the task team presented the status included in the official conference report.

Number of meetings: 1 (but the pitfall have been discussed and test productions have ben run)

Note:
The work on the pitfall was already initiated before the VRI project was started. It is now a part of the zero-errors project. There have been some challenges regarding traceability and systematics in the work (complex and difficult processes)

Issue/Pitfall:
Warp means technical printing complications in the silkscreen printer. At milder curvatures the problems can be addressed with technological adaptions and follow-ups. These issues mean however increased waste and decreased line speed.

#	Measure	Milestone	Status today
1	Discussed the problems with paper and technology suppliers.		OK
2	Completed test production with a focus on alternative media type (250 g/m2) and optimal moisture profile, the development of temperature and moisture in the pallet material and registration of the climatic conditions in storage at the Display department.	September 2007	OK
3	Completed test production with emphasize on technical issues and alternative paper supplies (assistance from paper supplier).	August 2008	OK (no conclusion drawn)
4	Completed second test production with emphasize on technical issues and alternative paper supplies (assistance from paper supplier).	September 2008	OK (no conclusion drawn)
5	Define shared quality criteria Display and Corrugated board departments.		

6	*Assess completed test productions.*		
7	*Testing with alternative paper media.*		
8	*Process technical testing: Glue, heat, line speed, etc.*		
9	*Machine technical testing: Process control and maintenance.*		
10	*Testing end product meintenance on corrugated board.*		

Table 11: Status report from task team #2 at Kick-off September 16 2008

It is clear from the report presented that the progress is slow and the activities few especially regarding the inter-disciplinary approach. The lack of results and activities were noted in the official conference report.

> "*But as the assessment survey indicate, the project is in a phase where one must "provide the goods". This is particularly evident for the work in Task team #2: The quality problems on corrugated boards. The work started regardless of the zero-errors project and has subsequently become part of the project. We have not yet managed to solve the problem and we must take actions methodical and practical. As one participant points out in relation to this pitfall: "the seriousness of the zero-errors project fades seen in relation to this work""*

The quality issues on corrugated boards become a threat to the whole project, even if the lack of progress and results were a result of a totally different project. Our new and effective four-color silkscreen printer was shaped into a source of problems. The threat was real and added to the worries stated in the June 4 2008 PTM #17 official summary.

> "*Is zero-errors no longer interesting? Do we prioritize different? Can be a threat to the project if this continues. Have the interest cooled so much that we have to either restart it again or maybe wait? A dangerous signal to the grass root, as key persons do not have time. At the same time we have to accept that there is much to do and that it is not possible to attend.*"

In PTM #23 October 8 2008, increased focus was put on task team #2 and the measures presented on the conference were replaced by a new report and action plan presented to the project team September 25 2008. This plan included an increased focus on systematic processing of the feedback

from the operators on the silk screen printer, internship from the corrugated board department on the silk screen printer following the test productions done in cooperation with and assistance from external technical suppliers and specialists. In PTM #24 November 5, 2008 the task team reported major progress and a possible end to the pitfall.

> "*Task team 2: Planned measures, documents on traceability of BM and silk screen printing machines are available. These measures include lowered line speed, less heat and covering the boards before delivery and have produced very positive results. The team may have found the solution and will submit a status report.*"

In the same meeting it was reported that the project was accepted for funding from Skattefunn. The threats to the project were in many ways removed. A major problem was solved and approval and legitimacy was given as part of the Skattefunn funding discussed earlier. The threats hanging over the project over the last months had evaporated. The critical issues and little progress were thus turned to success and results significant for the whole project due the new combination of glue, heat, supplies and line speed as presented in the End of project conference and the Official evaluation report dated June 4, 2009 (numbers on savings removed).

> "*TEAM #2*
>
> *Pitfall:*
>
> - *Quality issues on corrugated boards that lead to problems with screen printing and other operations in the Display department (low efficiency, a lot of waste, ...)*
>
> *Activities:*
>
> - *Technical test productions completed*
> - *Supply test productions completed*
> - *Storage tests completed*
>
> *Results / Potential:*
>
> - *The measures a success. Must be followed up in practice and over time (basic data).*
> - *Now flat and stable boards are supplied to the Display department (a procedure that seems to work). Must be verified and quality assessed.*
> - *Use less steam (lower temperature, ...) on the corrugated board machine*
> - *We estimate 30% improved efficiency (better line speed, less disruptions, ...*

continuous operations on the silk screen printer).

- *In advance of deliveries and less use of overtime.*
- *Employee satisfaction, less error correction and problems.*
- *Remains to follow up a batch where it went wrong (not following procedure) and evaluation.*
- *Annual complaints from the Display department can be reduced to zero. Alone, this is a potential savings equal to a (significant number) (a factor of 8 for indirect costs).*"

The corrugated boards this way made amends. Our new four-color silk screen printer which was a source of problems earlier became a solution with improved boards and new and improved strategy for handling problems.

Why this focus on a piece of technology and a specific supply like the corrugated boards? Quality problems related to corrugated boards are an industry problem. Common problems are issues like warps where boards exhibit a curvature that causes difficulties in converting and printing operations (Kirwan, 2005). These problems have a complex causal relationship involving temperature, moisture, glue, time and more and most producers have to handle these challenges continuously. In the factory these problems accelerated because of the new four-color silkscreen printer introduced. The earlier project (not including the Display department or part of the zero-errors project) on solving the quality problems on corrugated boards had few results and slow progress. This pared with the implications the whole production a new approach to production would have to assemble a new way of handling these problems.

Relations

There are several important features associated with the silkscreen printer and the way it transformed and changed in relation with the corrugated boards especially. This is illustrated by the way the local quality problems on corrugated boards shaped the silk screen printer with the implications of the whole production and thus became both an implicit reason for the project; in many ways it was the biggest threat to the project and also what turned out to be one of the main contributors. The technologies and supplies are no more neutral actors but actors that shape and take part in how the Lean project assembled.

As the data show the silkscreen printer heavily depended on the supplies of corrugated boards. It became linked to the corrugated board department in the joint work in the task team, the internship and the collaboration on solving the quality problems. It also became linked to earlier development projects and ideas when including these as part of the zero-errors project. The network expanded both in time (by the earlier projects), geographical (the corrugated board department is located 6 km distance from the Display department) and organizational (a separate organizational unit).

Last it reinforced the relations to the local operators and the action team as part of the work on the improvements and the adapted QMA and economic system as the key indicator on progress and numbers.

Network relationships diagram

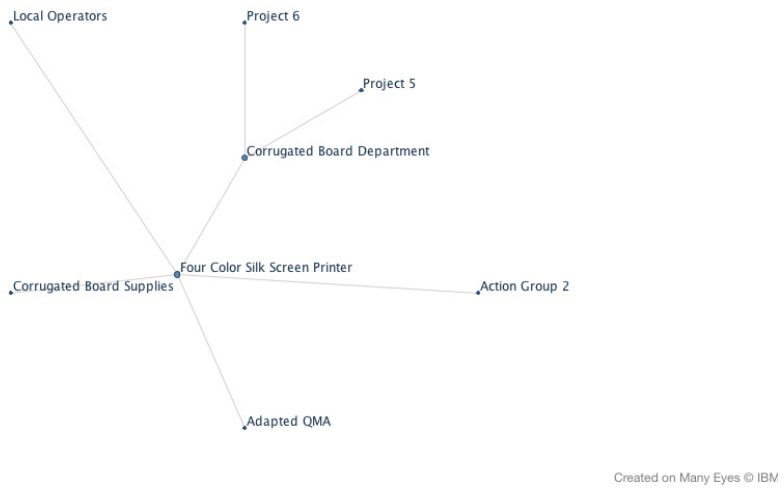


Illustration 23: The Four-Color Silkscreen Printer Network Diagram

How did the Silkscreen printer contribute to the assembly, development and existence of the project?

The main contribution was to produce results in a format, like improved numbers on complaints and efficiency, which embedded the project success in the official graphs and statistics of the factory. The project depended on showing progress and results, not only as abstract concepts of

collaboration and broad participation but as numbers in the economic system and the quality system, numbers like that of divergences and complaints in the quality system and not least in efficiency and value creation due to improvements in use of overtime, position to deliver, scrap and errors in general.

Second the silk screen printer contributed in the way it became the rationale for the increased focus on the interaction between technology, supplies and people as described in the heterogeneous task team, the internship and the new approach to handle the old problems on quality issues.

What can be learned from the Silkscreen printer?

The first lesson is the old socio-technical fact that technology cannot be handled isolated from the people and infrastructures it is supposed to be a part of (Trist & Bamforth, 1951). Or stated in other words, technology is never neutral (Latour, 2002, p. 32). This is illustrated in the experiences with the new four-color silkscreen printer that in an early phase became a threat to the department due to increased waste and the complications it caused in production.

The second lesson is in the way the outside and inside thinking breaks. The best example is how an outside element like that of the supply of corrugated boards not only influence but also shape the results inside the department. The network thinking alternative exemplified in linking the work in the different departments, workstations and activities produced the results needed.

The third lesson is how the silkscreen printer became an actor taking part in the assembly of the project. It shows how a technological artifact is not only biased, but how it can interact with other technology like that shown in the relation between the corrugated boards and the silkscreen printer.

The fourth lesson is the unpredictable and un-deterministic characteristics of the silkscreen printer. This is illustrated by the way nobody knew when or if we would find the solution to the problems with waste in the silkscreen printer. It could have been earlier or it could have been much later. Lucky for us it happened in time for the project to survive. Six months later and maybe the whole project would have been trashed.

Processes

The interactive shaping and reshaping of technologies are identified as the important processes of the development of the alliance making up the project. This is illustrated in the way the different actors came together and interacted and thus shaped the silk screen printer, corrugated boards, the task team, the operators and the procedures and in our case held them together in a way that contributed to the project. The argument is that technologies act. It is not only people that shape technology but also technology that shapes technology as well as people. It is this way not about a single one-way process but an interactive process.

The silkscreen printer network produced an interrelated what we could call *sculptors* that *shaped* also the technological elements. The way the corrugated boards *shaped* the silkscreen printer into a contributor is one example. The way the printer itself *shaped* the supplier on corrugated boards is a second example. The supplier on corrugated boards changed from an isolated outsider to an integrated part of production, illustrated in how the supplier now took part in the task team and organized for internship at the silkscreen printer.

6 Discussions

The analysis introduces a set of threads and findings still open that need to be discussed further.

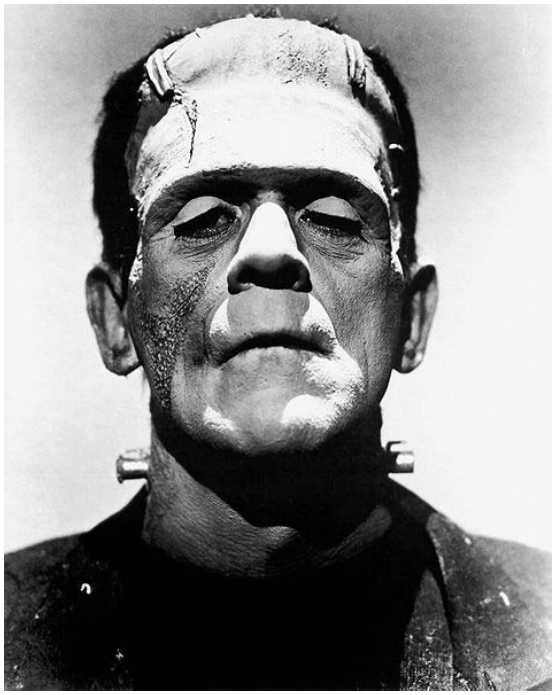


Illustration 24: Frankenstein[28]

The findings suggest that the Lean'ish project is anything but a singular product brought in from the outside. The Lean'ish project is made up of odd bits and parts – a bit like a factory Frankenstein (Illustration 24). This way the project is not a product of a single mad professor but a product of a heterogeneous and manifold group of actors creating a multifaceted being.

In this discussion I open the black box of Lean as introduced in the problem statement and the basic rationale for the approach chosen. Second I elaborate on some of the dualities and paradoxes introduced in the analysis and opening of the black box. Third I answer the research questions posed before I reflect on the metaphor proposed. Finally I discuss some practical implications from the findings and suggestions for further research.

[28] http://commons.wikimedia.org/wiki/File:Frankenstein%27s_monster_%28Boris_Karloff%29.jpg

6.1 Opening the Lean Black Box

The problem statement introduced the failure to deliver what is promised, and what I define as a conflict with and neglect of the materiality and the processes in the organization. As stated earlier I want to challenge the mythical image of Lean. I want to challenge the image where Lean is treated as one thing, as a single entity and product for us to implement in the company. Or in other words, Lean as an established black box.

So far I have used the word black box quite loosely about something treated as a well-established fact and truth, and thus something unproblematic. The origin of the word is in engineering where for example a complex part of an electric circuit is literally replaced by a black box with two terminals. The black box hides the messy contents from view and replaces all the details with the relationship between the voltage and current at its terminals (Nilsson, 2008, p. 59). We no longer need to worry about all the content and detailed elements inside because they together act as one predictable unit.

I have deliberately postponed any tighter definition because I wanted to first explore the inside of the black box and the different elements entangled and enmeshed in our understanding of Lean. The analysis this way draws an image of many parts and elements of assembling the Lean project. At the same time the literature review draws the image of Lean as an approach that holds these parts together as a unit, implying that we don't have to worry about the inside.

> "*When many elements are made to act as one, this is what I now will call a black box.*" (Latour, 1987, p. 131)

I will use Latour's words as my own in the understanding of the black box. In some ways it goes beyond what I called a well-established fact and something unproblematic to also imply something treated as not only a unit but also a predictable entity.

Lean as a black box can thus be challenged in the two implications suggested:

- The *universal singularity* of Lean
- Lean as a product to *implement*

The findings from the analysis draw an image of a precarious process, where different kinds of actors took part in the assembly and reassembly of what I have labeled as something Lean. The moment we went beyond the rhetoric of flow, waste and participation and toward practice, the local footprints in our Lean'ish approach become obvious. As the analysis shows Lean became entangled and enmeshed in a web of materiality, structures and people. Our understanding of Lean thus becomes an effect of this material web and nothing like any universal singularity. These local footprints are visible in the pitfalls identified and not least in the measures and practices established as part of the project.

As stated above the findings draw an image of a precarious process where different kind of actors took part. The analysis also shows a process where the product that was supposed to be implemented developed in parallel with the growth of the project network. This way the final solutions in many ways were undetermined. We did not have any ready-made product to *implement* or put in effect in the factory and thus the "product" metaphor loses any meaning. The phrases "implementing Lean" or "installing Lean" become like asking the carpenter to build a house without any further discussions or details on if it is supposed to be an office building, a kindergarten, a cabin or a villa. You can end up with almost anything.

6.1.1 What Did it Look Like When We Took the Time and Effort to Open the Black Box?

The starting point was that we do not understand what is actually going on when introducing these new methods like that of the mythical Lean with the Japanese labels and exotic examples. The problem statement thus challenges our understanding of what's happening. What do we miss? What escapes the mesh? What is inside this black box?

The analysis on the assembly of Lean in the factory opened the black box. Some of the findings from inside the black box are:

- The existence of both human and non-human actors, illustrated in the production manager, the silk screen printer, the project team and the articles in the industrial journals all contributing to the assembly and well-being of the project.
- The materiality in the assembly of Lean and how technology, infrastructure, events and people are entangled and enmeshed in a web, illustrated in the assembly of the new QMS.

- The way technology may inscribe a practice like that illustrated in old QMS as part of the alternative actor-network working as an inscription device on the old way of role sharing.
- An understanding of Lean developing with the changing materiality of the growing network illustrated in how our understanding developed going beyond the project team to include the whole factory.
- A network of actors that define and shape one another illustrated in the changes taking place in the interaction between the four-color silkscreen printer, the corrugated boards and the involved operators in the two departments.
- The precariousness in the processes and dependency of actors to take their part in the assembly and reassembly of the project, illustrated in the challenges the summer 2008 when the contributions to the reassembly of the project dipped for a period.
- The presence of competing or alternative actor-networks part of the factory, illustrated in the challenges when trying to establish the new QMS.
- A variety and in some cases incoherence in the understanding of the project illustrated in the conflicting understandings of participation shown in the industrial journal articles.
- The ability of the network to extend itself in time and space by embedding and translating distant actors, illustrated in how earlier company projects in the company and literature become part of the project.

These findings bring us as far away from Lean as a single entity and product for us to implement in the company as it is possible to get. Lean goes from something from the outside that we implement to something we, the actors, assemble from the inside. The findings emphasize the image of Lean as a process of materiality, precariousness, dualities and paradoxes very different from the clean and mechanical black box of Lean. One contribution of opening the black box of Lean is thus to add reality (Latour, 1999a) to our Lean'ish practice in the factory. Not as anything pale, neutral, universal, non-contextual and mechanical, but on the contrary as a world of dedicated individuals and real people, with know-how and skills which are then part of an interaction with biased technologies and machines with their own contributions and history in the factory. This draws an image of Lean connected to all the parts of the way to do production.

6.2 Dualities Introduced

The findings and our discussions so far introduce a new and very different image of Lean. They draw an image of Lean as a process of materiality, precariousness, dualities and paradoxes. The materiality and precariousness are discussed in detail earlier, but now I will elaborate some more on the dualities and paradoxes in the project.

Opening the Lean black box challenges our initial beliefs about Lean as a single entity for us to implement, contributes new understanding of a Lean'ish project in practice and not least contributes new knowledge on how that something assembled. The challenge is highlighted in the way old dichotomies become part of the same space and multiplicities in the findings.

These dualities and paradoxes include:

- The duality found in the parallel growth of the project with the development of our understanding of what the project is about.
- The relationship between resistance and support experienced in the project.
- The paradox of the translation process as both the glue and the source of tension.
- The duality found in the assembly of the increasing significance and relevance and the increasing incoherence in the understanding of what we are doing.
- The dichotomies of old and new, far and near, small and large, inside and outside that come together in the project.

The duality found in the parallel growth of the project and the development of our understanding of what the project is about

This duality is noted several times already because it illustrates very clearly how our understanding is linked to the materiality it is a part of. It does matter if we are talking about the Lean project in the materiality of only the project team, the factory, in another department or in the company as it is described in the analysis.

The duality challenges the universal singularity of Lean. The arguments for the materiality and against the universalism are strong in the analysis and best illustrated in the way our understanding of Lean developed in the different phases in the project representing the changing materiality. It also implies that every time we change the materiality, as for example when including a new

department, new technologies or new people, we also change our understanding of what we are doing.

The duality not only challenges universalism as noted but also how our understanding changes as we go from the "controlled" arena of the pilot or in our case the project team phase 1. The findings are thus not only challenging universalism as so but also the "transfer" of "best practice" within the company. Lean this way not only becomes regional but local. This way we take two steps on the road away from universal singularity.

The relationship between resistance and support experienced in the project

As discussed earlier top management support is on top of the success checklist in many Lean projects, and this was in place in our project, too. We had support from the local production manager, the quality manager, and the trade union representative as well as the operators in the factory. But at the same time, as discussed in the analysis of the new QMS, we experienced strong resistance in the long time and all the work it took to establish the new quality practice.

In the analysis it is argued that the resistance was not about individuals trying to "sabotage" the project but about the presence of another actor-network, embedded and entangled in the materiality of the factory. It was an actor-network in many ways like the one we were trying to assemble. The factory was thus not a *tabula rasa*, but full of actors already making up a network. To make it even more challenging this "other" thinking was inscribed in many of the structures and technologies in the factory, like those associated with the idea of job fractionization found in the established task and role sharing in the factory. It was not about convincing individuals with rational or emotional arguments but about challenging the technologies, practices and the way we do production. It was thus not only about assembling Lean in an empty room, but about assembling something stronger, better, more significant and relevant than that already present.

The analysis and discussions of the assembly of the new QMS bring forward the strange relationship between resistance and support. Not as an individual "problem" (even if that could be a part of the challenge of course), but as an effect of another actor-network present in the factory. This way it is not anymore about either support or resistance, but both at the same time. We will have to anticipate resistance also in the presence of strong support as in our case. This

acknowledgement links resistance to technologies, practice and the materiality and explains the "strange" example of someone supporting the project at the same time being part of a practice that resists the project, showed in the analysis of the new QMS.

The paradox of the translation process as both the glue and the source of tension

The analysis of the project team introduces the process of translation as the glue in the project linking the different actors together in the network because of the local relevance established among the different actors. But the process of translation is also seen as the source of tensions that may break the network because of the differences and variations introduced in this process.

Translation as a theoretical concept is part of the way ideas *circulate* in the network. The translations are thus the cause for the changing meaning of Lean as the ideas circulate. As with the example of McDonalds introduced earlier the translations are not the problem, but the opposite, they are the reason for the success. Translations create relevance for the actors and thus the glue metaphor. Translations this way face two challenges. If the variations in the translations are too small we will lose the local relevance and the rationale for contributing to the network. Any shared understanding in the literal meaning is thus the last thing we want because that would mean that the project had less local relevance. At the same time if the variations in the translations are too big, we will lose the relationship to the other actors and that of being part of the same project. It leaves us with not too much and not too little, and not too predictable.

The translation processes may thus produce two contradictory results. This duality or paradox emphasizes the precariousness in Lean as shown in the analysis. This precariousness is not about poor planning or preparations but a part of the changes in practice and the complexities in the processes involved, as illustrated in the translation process. The precariousness is further emphasized, as the translations are part of the continuous assembly and reassembly of the project. A translation that in one moment of time will contribute work to the assembly of the project may in another break the relation because the materiality has changed. Translation is thus not only precarious in the outcome of the process but also a dynamic process.

The duality found in the assembly of the increasing significance and relevance and the increasing incoherence in the understanding of what we are doing

This duality is in a way a continuation of the discussions on translations as a precarious process that may produce what seems like contradictory results. But now the focus is not the process as such but how the increased significance and relevance also produced an increase in incoherence.

What do I mean? Significance or strength is seen as a result of the number of actors and relations in the network assembling the project (Harman, 2009; Latour, 1996). In this perspective the project established a greater significance going beyond the project team and into the factory and other departments in the company. We experienced increased significance and greater strength and impact on the way we did production, like the ability to change procedures, establish new infrastructure and change criteria for success discussed. But at the same time we experienced increased tensions and incoherencies on what we were doing, like how to understand participation in the industrial journal articles.

More contributing actors beyond the project team led to stronger and more significant factory results. But it also resulted in an increasing diversity and heterogeneity in the translations as they represent a broader and more diverse materiality. This way the increasing significance also creates tensions and incoherencies. The incoherencies challenged the project as one project and not a family of more or less interrelated projects. One consequence of this duality is that the greater the strength and impact to do something, the less sure we became on what it was all about.

The dichotomies of old and new, far and near, small and large, inside and outside that come together in the project

Setting up a venture to change the way to do production is a big challenge. This is illustrated in the efforts and work contributed, the time it took to establish the new way and not least the manifold of actors. The venture in the factory this way introduced actors both old as in Thorsrud, Deming and the NDP and as new as the latest technology in silkscreen printers; from as far away as in the Kaizen methodology and as near as in the operators from the local town of Sarpsborg; as small as in the task team of four persons and as large as in the Lean literature; as inside as in the local production manager and as outside as in the research program VRI. This way what we usually think of as dichotomies came together. But how can the project at the same time include both old and new, far and near, small and large and outside and inside?

I will turn this question around. Are there any reasons for why it shouldn't? Why should for example geographical distance have an impact? Who has decided that geographical proximity is of importance and interest in this project? Latour talks about the tyranny of the geographers in the assumption of distance as something important and far and near as a dichotomy.

> "*I can be one meter away from someone in the next telephone booth, and be nevertheless more closely connected to my mother 6000 miles away*" (Latour, 1996, p. 3)

The metaphor of Latour tells us that distance is not necessarily a universal structure of importance. The same goes for the logic that separates old and new, small and large and inside and outside – who decides that these are dichotomies that may not be handled within the same theoretical framework? The concept of network in the way it is used in this study does not make any such assumptions. Everyone and everything contributing to the assembly of the project is an actor and thus part of the network. All presupposed properties are rejected, and they are treated within the same theoretical framework.

This way the dichotomies introduced are seen as constructed paradoxes representing something very different from this study. They are presuppositions imposed on us. If we stay to our heterogeneous relations including all kinds of actors the paradoxes are less paradoxical.

6.3 Back to the Research Questions

How does the analysis, findings and discussions so far relate to the research question posed?

- *How did the new way to do production assemble (and reassemble) in the factory?*

What I mean by "how" is an understanding of both the processes and how the processes ended up in the assembly of the new approach to do production. This analytical understanding of "how" developed in the theoretical discussions and practices part of the project and also implies contributions from several different elements without any strong simple accounts of causality.

The research question can be divided into four more specific questions:

1. *Who and what contributed to the assembly of the new way to do production?*
2. *How did they contribute to the assembly of the project?*
3. *How was the assembly of the project challenged?*
4. *Through what processes did the actor-network affect the assembly of the project?*

Who and what contributed to the assembly of the new way to do production?
A dynamic network of heterogeneous actors entangled and enmeshed in the materiality and history of the factory, contributed to the assembly of the new way to do production. This heterogeneity and materiality was not a problem, but what made the project relevant and significant, or in other words what made the project a reality?

The network of actors identified in the analysis contributing to the assembly of the new way to do production is large (Illustration 16). The list includes (see the analysis for a complete account of the actors introduced) articles, books, several groups, individuals, technologies, software, a conference and historical projects and events (Table 14).

Node	**Actor**
The new QMS	The book *Out of the crisis* by Deming
The new QMS	The *PackNews* and *Emballering* journals

The new QMS	The *QMA software* installation
The project team	The heterogeneous group in *The project team*
The project team	The heterogeneous groups in *The task teams*
The project team	The local production manager *NN*
The silk screen printer	The four color silk screen printer *Svecia*
The project team	The *dialogue conference*
The silk screen printer	Earlier development project like the *Efficiency project in corrugated boards*
The silk screen printer	The group of the local production operators

Table 12: Some Actors Part of the Project

The findings this way introduce a variety of actors as both human and nonhuman, old and new, near and far and small and large. It is also difficult to pick out the most important actor, including that of a list of top ten because it is the web of actors that in the analysis is credited with the effects experienced, and not the single contributions.

Opening the Lean black box and thus opening up for the complexities introduces a web of actors that made the new way to do production a reality. The image drawn in the findings represents something very different from that of the black box of Lean and the universal singularity and clean methods for us to install or implement. It is no longer about installing a ready-made solution. It is not only about the assembly, but the continuous reassembly of both the network of actors and the understanding as the project developed. The universal is replaced by materiality, precariousness and the dynamic.

What does it mean? It means that we are left with a dynamic network of heterogeneous actors entangled and enmeshed in the materiality, people and history of the factory. This heterogeneity and materiality are not the problem but what made the project relevant and significant, or in other words what made the project a reality.

This network also introduces the variation in how we understand the project in the network. This

multiplicity of understandings is also the strength because of the relevance created locally, but it is also a challenge in the way that we work together after what we can think of as slightly different plans.

How did they contribute to the assembly of the project?

The different actors contributed with odd bits and parts that together made up the project. This way the heterogeneous group of actors contributed work creating a multifaceted "monster," where the bits and parts making up the monster represented the parallel understandings present in the factory.

The contributions identified in the analysis include (see the analysis for a complete account of the contributions introduced: inscribing the project in technology in daily use; establishing indicators; entangling and enmeshing (continuously) the project and our understanding of it in the factory (OPP); and not least producing valid economic results (Table 13).

Actor	Contribution
The new QMS	*Inscribing* actors in the project into technology in daily use, and thus make it possible for them to contribute despite any gap in time or location within a conceptual envelope.
The book *Out of the crisis* by Deming	One example of the result of *inscribing* is how elements from this book and the concepts of quality and autonomy become embedded in the procedures in the new QMS. This way this literature contributed every time a procedure was evoked despite the fact that the author is dead and the experiences and cases are from Japan.
The project team	The project team contributed to make important actors like the managing director and the trade union representative, earlier projects, the dialogue conference and others, some even created by the team itself, become part of the network (Illustration 11). This way the project team entangled, enmeshed and embedded the project in the materiality.
The silkscreen printer	The silkscreen printer contributed in establishing results in

	the “valid” economical format and embed the project success in the official graphs and statistics of the factory. In numbers like that of divergences and complaints in the quality system and not least in efficiency and value creation due to improvements in use of overtime, position to deliver, scrap and errors in general.

Table 13: Actors and Contributions

The actors contributed with odd bits and parts that introduced a heterogeneity of work, both as part of establishing structures (like the new procedures, work flow and indicators), introducing new artifacts/actors (like the computer terminal and the four-color silkscreen printer), contributing to establish a new understanding of the way to do production (like that going on in the project team and the dialogue conference) and shaping and reshaping of technologies and systems (like the corrugated boards and four color silk screen printer interaction).

These and the other contributions to the assembly of the project represent something very different from the black box of Lean. It is no longer about everyone working in a complete consensus after a common plan. As introduced in the discussions on who and what contributed earlier, we worked together after what we can think of as slightly different plans. The universal as in a company wide consensus is replaced by variations because of local translations.

What does it mean? It means that the project is made up of odd bits and parts – a bit like a factory Frankenstein. But not as a product of a single mad professor but of a heterogeneous and manifold group of actors contributing work creating a multifaceted “monster,” where the bits and parts making up the monster represent the parallel understandings present in the factory. As the mad professor loved Frankenstein (Latour, 2002) we too loved our Lean’ish creation. And maybe just because of the many actors and the many contributions and renegotiations, the Lean’ish creation turned out to be something else than a monster as seen in the assembly of the new practice described in this study.

How was the assembly of the project challenged?

The project was challenged by the presence of a parallel way of doing production found in the

factory. It means that if the project fails it is thus not because it is *killed* but because it is *abandoned* by the individuals, technologies and structures in the factory. The biggest challenge identified in the analysis is thus not so much an outside enemy like a person or event, as the lack of contributions and commitment. This is best illustrated in the challenges the summer 2008 when the contributions to the continuous reassembly of the project dipped.

The question implied is then what stopped the potential someone or something to contribute to the assembly of the project? Translation as a process to establish local relevance has been identified in the analysis as an important part of the assembly of the project. Rephrasing the question according to this specification would then look something like: What challenged us in being part of the project to create local relevance? There are several answers to the question, but maybe the most obvious answer is that the potential actors don't see the rationale in being part of the project. An illustration can be the curved boards discussed earlier. From initially being isolated from the silkscreen printer and the problems there and with a production goal in quantities produced, the whole business of curvature was not anything of much interest. There were some issues on complaints, but these were not enough to seriously challenge the way to do production. When the producers of the corrugated boards gradually became involved and entangled with both the people and technology in the other department as in visiting operators, the new quality system and the dialogue conference the curvature and the curved boards grew to become also a local problem to be taken seriously. A rationale for change was established and this way also the foundation for later contributions such as the development of practices to produce boards fit for the silkscreen printer.

The curved boards example illustrates the presence of an existing, parallel and rational way of doing production in the factory and how this practice is a challenge because it stops the actors involved from contributing to our project. The effects of the presence of such a parallel understanding and network are illustrated in the time it took to establish the new QMS. As shown in the findings the "niche" was already occupied by the old QMS embedded in both technology and many other elements of how we do production. The old practice does not leave that niche without resistance. The example also emphasizes technology as not neutral artifacts but biased actors in our practice and thus the "strange" relationship between support and resistance discussed earlier.

What does it mean? It means that if the project fails it is not because it is *killed,* but because it is

abandoned by the individuals, technologies and structures in the factory (Latour, 2002, s. 10). The resistance is in this way a passive and not an active process.

Through what processes did the actor-network affect the assembly of the project?
The analysis introduces four processes: inscriptions; resistance; translations; and shaping (and reshaping). These processes are seen as effects of the network of actors and explain the way the odd bits and parts of the project assembled in the project. The four processes identified in the findings are examples of how the relations assembled or not, that gave birth to the new practice and way of doing production seen in the factory.

The first process identified is that of *inscription*. How technology like the new QMS become an inscription device producing *emissaries* sent on a mission to represent the project not in person but as part of the device.

The second process identified is that of *resistance*. A resistance like that opposing the QMS not based on rational individuals but on practices inscribed in the way of doing production and organizing the work. The metaphor of learning and misconceptions are used to illustrate the resistance in the factory and the presence of an alternative actor-network.

The third process is that of *translation*. Translation is important because it explains both the growth of the network and the development of our understanding of what we were doing illustrated in the work of the project team. As shown in the analysis translation may be seen as both the glue and the reason for tensions in the network. Glue because it gave the project local relevance and thus also significance. Tensions because although the translations created local relevance they also created a more incoherent understanding of what we were doing. If the incoherencies became too large the actor-network could break. The translation also introduces the dualities found in the growth of the project and the development of our understanding in parallel with increasing incoherence.

The forth process is that of *shaping* and *reshaping*. This process explains the way different elements interact and mutually shape and reshape each other like that of the silk screen printer and the corrugated boards. As the example illustrates, this includes technology and supplies and not human actors alone. Actors both shape and are shaped by other actors.

The findings in this way introduce a set of processes. These processes are seen as effects of the network of actors and explain the way the odd bits and parts of the project assemble in this project. They are also precarious, un-deterministic and dynamic as illustrated in the dualities, paradoxes and strangeness discussed earlier.

The explanations given by the processes are thus not about simple accounts of causality in the form: "condition B is a cause of outcome C," known for example from the macro models discussed earlier. In that the condition, that is the Norwegian combination of laws, regulations and deep structures, would be seen as the cause for the outcome of high value creation in Norway. This way a few elements of what make up the work life are identified as the cause. This study represents something very different. The processes introduced in the findings are seen as effects of the network and not the effects of isolated elements. This way when I talk about the processes explaining the way the project assembled it is a narrative on how the relations assemble or not assemble to explain how the project came to life. The processes identified are about those relations.

The findings represent something very different from that of the black box of Lean. The black box basically represents a mechanical understanding where the singular Lean is the cause of outcomes like efficiency and flow. The findings represent the opposite: a precarious, un-deterministic and dynamic network of actors setting up a project where the processes are seen as effects of the network, and not because of a single condition or event.

What does it mean? It means that the focus is shifted from the single event or action towards the interactions. It is not about if Kaizen is the best way to establish autonomous groups or if dialogue conferences contribute to increased participation. It is about building an awareness and sensitivity toward the complex ventures where Kaizen methodology and Dialogue conferences may be a part, but where the effects are results of the interaction of actors and not the single actor. The four processes identified in the findings are thus examples of how the relations assembled that gave birth to the new practice and way of doing production in the factory.

6.4 Back to the Metaphor

So far I have linked the findings and analysis back to the basic rationale, the problem statement and the research questions. Now I will try to link the findings and analysis back to the metaphor introduced to understand the project, that of a game of rugby.

In this metaphor, our understanding and practice of Lean is the ball and the different actors are the players. First, the findings establish a variety of different actors in the network based on the fact that they have contributed to the assembly of the project. Second, the findings establish how resistance should be anticipated as it is embedded in the technologies, practices and the established way to do production in the factory. Third, the findings establish that no single actor alone will secure a project like ours. Not even top management support will guarantee success, because it's not about the best consultant or best manager, it is about the best network. Fourth, the project illustrates how you will have to play until the game is over. A great dialogue conference or kick-off alone will not change the way to do production alone. Fifth, the findings show how unforeseen things happen, like the example with the new four-color silkscreen printer introducing a lot of problems due to the lower curvature tolerances on corrugated boards. The assembly of Lean production is a precarious process. Finally as every supporter knows: the best team doesn't always win.

The metaphor gives us a conceptual view for handling the complexity, materiality and the precariousness of the Lean project. This way the metaphor identifies five elements related to practices described:

- Work
- Resistance
- Team-play
- Stamina
- Precariousness

The metaphor introduces concepts and ways of looking at the Lean project very far away from the Lean black box. Seen in retrospect the metaphor this way catches many of the practicalities introduced in the project and positions the project relative to the Lean black box. But at the same time it leaves out the developing and changing understanding of what we were doing. The ball metaphor misses out on the parallel growth of the project and the understanding. It misses out

duality in the increasing significance and increasing incoherence. These latter paradoxes are in many ways the core of the project and if forgotten make the metaphor of little practical use because it ends up as just another exotic story and black box.

But as a teaching device stressing the contrast between Lean as a unit and a product for us to develop, versus Lean as a multifaceted product that is the result of the people and materiality in the factory, it works. The message is that Lean is not something we adopt it is something we construct. The metaphor should thus not be used as a definition of practice, a quest that will have to fail because of the complexities involved. The metaphor should be used as an introduction to Lean as something from the inside of the factory, and contribute to establish a self-awareness and sensitivity towards the multiplicities of doing production.

6.5 Some Practical Implications

The dualities of practice and theory are established in the Introduction chapter. The rationale is to make the research more significant and relevant for the local actors, and the research more theoretically sensitive. Theory and practice are seen as two faces of the same, and theory is embedded and extended in the practices.

The findings and discussions so far introduce several practical implications that both illustrate and extend the theoretical discussions. In this chapter I will highlight some of the implications introduced with special emphasis on what can be learned from the project relative to the practice in the factory.

The first implication is that of technologies and artifacts like the quality system, the four-color silkscreen printer and the curved boards as biased actors and not neutral things. The findings describe how these elements both contribute to and challenge the assembly of the project. They are part of the web of humans, technologies and materiality making up the project and not any outside or irrelevant element of a disembodied Lean. This new understanding of technology puts them in focus as part of the materiality in the project. Planning any new changes should then include these non-human actors based on an understanding that they are not neutral but biased actors. The needs, desires and preferences of the non-human actors must be taken into account, like the case of the cardboards and the four-color silkscreen printer. The non-human actors are part of our way of doing production and must also be part of the change processes introduced and strategies planned. This way if we want to change some part of our way of doing production we should then also change the involved technologies, software, procedures and structures related. The same way if we introduce any new technology or artifact, we must check out how it complies with our way to do production.

Second, seeing technologies and artifacts as biased actors also gives birth to a new understanding of resistance met in the project. As illustrated in the assembly of the new QMS resistance this becomes a passive and not an active process. The practical implications are seen as part of introducing the new way to do production and not least in how to make it stick. As part of the new way to do production this understanding presents the existence of alternative practices already part of the materiality in the factory. That can be in the way the work is organized, the procedures established, the economical scorecard in the company and embedded in technologies and software in use. To

establish something new is not about establishing something on a *tabula rasa* but the opposite, to establish something in parallel and competition with something already in place. To establish something new is then about recruiting allies in the people and materiality of the factory. This way it also becomes easier to build on and not compete with local knowledge, know-how, machines and experiences in the factory as they are seen as possible allies. The commitment and contribution from the actors is the key to establish the way to do production. The same way the project cannot live without the commitment and contributions of those who have created it. It means that if the project fails it is because the individuals, technologies and structures in the factory abandon it.

The third implication is from the dualities and paradoxes discussed earlier. These dualities and paradoxes not only challenge basic facts about how to understand a project like the one in this study, but emphasize the precariousness and indeterminism found in the project. The project network is a precarious, dynamic and in many ways un-deterministic construction. This precariousness is not a problem but the means to establish the relations in the factory with a variety of understandings present that together assemble and reassemble the project network with local relevance and significance. The more connected Lean becomes the stronger and more significant. Instead of raising the flag of universalism and the ideal of the non-contextual we should raise the flag of materiality and the idea of being part of the people, technologies, machines and structures of the factory to be successful.

The fourth implication is that of the project team as an obligatory passage point (OPP). The early objectives formed by the project team brought other actors like the quality system and the Deming literature into the story. This way the project team not only roughly defines the identities of those actors, but also makes itself indispensable and thus an OPP. The findings describe how the project team this way contributed to hold the project together, aligning, or more precisely translating, other actors' interests, problems and goals to fit that of the alliance of actors, as understood in the project team (Illustration 12). The project team had to continuously prove the relevance of the project, because the other actors identities and goals were developing as the project moved forward. This way the design of the project team became extremely important to handle the many different relations of the precarious alliance. In the factory project the success is linked to the horizontal and vertical integration in the project team, and the presence of a wide and heterogeneous group of people and skills.

6.6 Suggestions for Further Research

There are many possible ways of extending what is done in this thesis. The findings can be challenged and extended in new cases. The data can be used to identify and construct new actors or processes, or in other ways be used to explore new subjects. But the findings can also be used to explore actors, events and contributions more vaguely illustrated in this thesis. I see the first two approaches as important and something I will likely push for later, but also trivial in a way in that it is quite obviously something to do. In this section I will therefore elaborate on the last approach, to pursue elements more vaguely identified, and that relate to new discourses going beyond initial focus. A few examples are provided in this section.

6.6.1 What is a Company?

The findings illustrate how the actor-network extends beyond the organizational charts of the company in the assembly of the new way to do production. The actor-network this way not only extends beyond the company as a legal entity, but it also extends in time and space as discussed in the findings. There are thus no longer any inside or outside, any borders in the actor-network, that corresponds with the company as a legal entity.

The findings this way challenge what we understand with the company. If the company as synonymous with the legal entity does not make sense, what then makes sense? Or, what is a company in this perspective?

A quick search in my computer dictionary comes up with an interesting (but unintended?) contribution.

> company |ˈkəmpənē|
>
> noun (pl. -nies)
>
> 1 a commercial business: a shipping company | [in names] the Ford Motor Company | [as adj.] a company director.
>
> 2 the fact or condition of being with another or others, esp. in a way that provides friendship and enjoyment: I could do with some company.
>
> • a person or people seen as a source of such friendship and enjoyment : she is excellent company.
>
> • the person or group of people whose society someone is currently sharing : he was

silent among such distinguished company.

• a visiting person or group of people : I'm expecting company.

3 a number of individuals gathered together, esp. for a particular purpose: the mayor addressed the assembled company.

• a body of soldiers, esp. the smallest subdivision of an infantry battalion, typically commanded by a major or captain : the troops of C Company.

• a group of actors, singers, or dancers who perform together : a touring opera company.

The first entry is the same as our findings challenged, but the other two findings are more interesting. The second entry introduces the relational as the essence of the company, (the) company as *the fact of being with another or others*. It also introduces the company as something dynamic and precarious, (the) company as something *currently*. The third entry introduces the rational, the company as a network of people *gathered together for a purpose*.

This short exercise illustrates how extending our definition beyond the company as the legal entity replaces the passive and sterile in the legal entity, with something engaging and alive, a *company of brothers in arms* and a *touring opera*. This extension of the company introduces something much closer to the working unit part of the Lean'ish project.

One suggestion for further research is to contribute to the assembly of a new understanding of what a company is. A model that makes sense, and corresponds better with the tasks, like that of assembling and reassembling new ways to do production, associated with the company. A new way of understanding the company based on the company as something beyond the legal entity, will also challenge and contribute to the discourses on regional innovation systems and the practices of innovation strategies.

6.6.2 Technologies of Control

ANT assumes all actors are equal, and no assumptions are made either about humans or non-humans. It is about how the relations establish and this way assemble the project. At the same time authority in practice, if not in words, has been identified and discussed as part of the existing and competing actor-network present in the factory, for example as part of the practice of job fractionization and hegemonic structures found in the established task and role sharing in the

factory. ANT is basically silent on authority, but since authority is linked to the competing actor-network of hegemony, it can be said to reflect the linear thinking, and thus this silence becomes a problem. As an AR-venture some structures are set to contribute to participation and collaboration as a reaction to linear and authority-driven processes, but still with a low voice. The issue has not been resolved or discussed in much detail. The existence of what we could call the linear network in the factory emphasizes the importance of discussing this issue in more detail.

The existence of practices and actor-networks in parallel in the factory, illustrated in the relationship between support and resistance discussed earlier, link up to and extend discourses on rationality and technologies of control (Bauman, 1989; Foucault, 1979; Lysgaard, 1981). When introducing a new way to do production we also impose ideologies and rationalities on the workplace. This way rationality is also an ideology and a technology of control. That is not necessarily wrong, especially not in an AR-venture with ideological preferences, but the problems arrive when we handle the methods, the technologies and the artifacts as neutral and separated from rationality. One suggestion for further research will be to study these embodiments of rationality and technologies of control. This issue may be controversial in the factory because people in industry are often not interested in ideology. But this statement may be turned upside down and argued that they are highly ideological precisely because they think they are not. How? Because when not interested they become easily subjected to ideological controls like that found in methodologies and new approaches to do production, precisely because they fundamentally lack self-awareness of their own operations. The findings in this study establish these methodologies and approaches as biased and ideological actors introducing a new rationality. The next step will be a further exploration of the practices of rationalities and technologies of control in a Lean'ish project.

6.6.3 Semiotics of Things

The literature review and theory chapter emphasized the absence of people and materiality in linear models of innovation, as part of Lean'ish practices. Where are the people? Where are the technologies and machines? Where is the materiality?

In discourses like socio-technical systems thinking and others, the technologies become part of the social processes in the factories. Technologies this way become social entities constructed through human actions (Levin, 1997). In ANT technologies and materiality are introduced as actors the same ways as humans. This way the semiotics is extended to include nature, technology and

context, or if you will, the semiotics of things! One consequence of this is that we lose the distinction between representation and things (Latour, 1980); the neutrinos of DNA (Latour, 1988) for example, become at the same time real (the DNA), human (as in social) and semiotic (meaning) entities. This way they become the natural object (the fact), the actor in the network, and part of creating the meaning at the same time, or what is known as part of the *counter Copernican revolution* (Latour, 1997).

The analysis identified how technology functioned as a biased actor and not a neutral artifact alone, and the descriptions of the quality system and the four-color silkscreen printer in the analysis remind us of, and highlight, the *semiotic* character of things (Latour, 1997, p. 52). These objects became actors that contributed to both the assembly of the project, and the assembly of the understanding and practices part of the project. In other words, these things took part in creating the meaning in the project.

The way things take part in creating the meaning is an element in this thesis, but it is not the focus. I suggest a closer look at how things, like a four-color silkscreen printer, contribute not only as a social entity, but also in the assembly of meaning and the processes that explain these effects of the network. This knowledge contributes to our awareness and sensibility towards the materiality part of the assembly of meaning in an industrial project.

7 Appendix

7.1 List of research data

Official Meeting summaries from the project team:

#	Date	Issue
1	05.09.2007	Establishing a project road map
2	19.09.2007	Process mapping part 1
3	10.10.2007	Process mapping part 2
4	31.10.2007	Process mapping part 3
5	14.11.2007	Summary process mapping and preparing organizational culture survey
6	28.11.2007	Identification of pitfalls from process mapping
7	05.12.2007	Pitfalls and indicators
8	13.12.2007	Prioritization of pitfalls
9	09.01.2008	Planning development of actions
10	23.01.2008	Work on the QMS and planning Dialogue conference
11	20.02.2008	Planning Dialogue conference
12	27.02.2008	Planning Dialogue conference and company visits
13	12.03.2008	Preparing group organization and work on pitfalls
14	01.04.2008	Workshop for project team and group leaders
15	16.04.2008	Evaluation of Dialogue conference report draft and prioritization of measures/actions and action teams
16	07.05.2008	Planning action teams and further work on measures
17	04.06.2008	Status from the action teams
18	18.06.2008	Status from the action teams
19	13.08.2008	Planning Kick-off for implementation of measures

		developed on selected pitfalls
20	27.08.2008	Status from action teams and detail planning Kick-off
21	10.09.2008	Status from action teams and final planning Kick-off
22	16.09.2008	Evaluation Kick-off (earlier same day)
23	08.10.2008	Evaluation of Kick-off report (development of measures) and follow-up and support to the action teams now set for implementing the measures developed
24	05.11.2008	Status from implementation teams and QMS reports
25	19.11.2008	Status from implementation teams
26	03.12.2008	Status from implementation teams and evaluation of project posters
27	17.12.2008	Final adjustment of progress report and presentation/discussion of “the Toyota way” and problem solving
28	14.01.2009	Status from implementation teams
29	28.01.2009	Status from implementation teams and starting to round up the project
30	25.02.2009	Status on remaining tasks and start-up of project evaluation
31	13.05.2009	Project evaluation report discussed and Project round up conference planned

Project reports:

#	Date	Issue
1	20.12.2007	Half year report december 2007 (identification of pitfalls and organizational culture)
2	07.05.2008	Report from Dialogue conference (measures)

3	08.10.2008	Report from Kick-off Implementation of measures
5	17.12.2008	Half year report December 2008 (implementation of measures)
6	04.06.2009	Final assessment report (for round up conference)

Presentations and articles from the project:

#	Date	Issue
	19.06.2007	Presentation of LEAN in the management group
	22.08.2008	Presentation of the project, LEAN philosophy and approach to production and preliminary project map
1	01.12.2007	Article in the industrial journal "Emballering"
2	12.03.2008	Slides for electronic information boards in the factory
3	01.04.2008	Workshop presentation for group leaders on Dialogue conference (later)
4	12.06.2008	Info folder attached to summer paycheck
5	14.11.2008	Presentation QMA Workshop for operators
6	01.12.2008	Article in the industrial journal Packnews (former Emballering)
7	17.12.2008	Presentation "The Toyota way" for the project team
8	18.05.2009	Presentation evaluation report snapshot for the quality team (management) at the company

7.2 Timelines

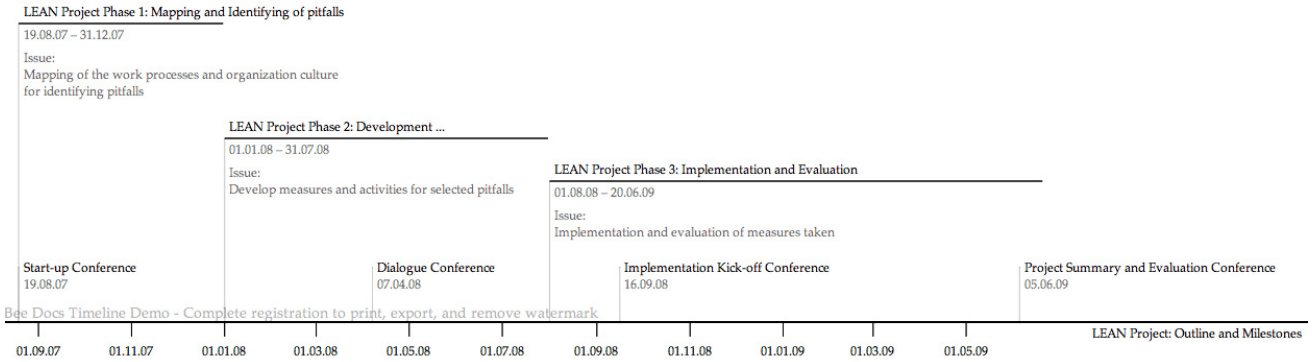


Illustration 25: Project Phase 1-3 (LARGE)

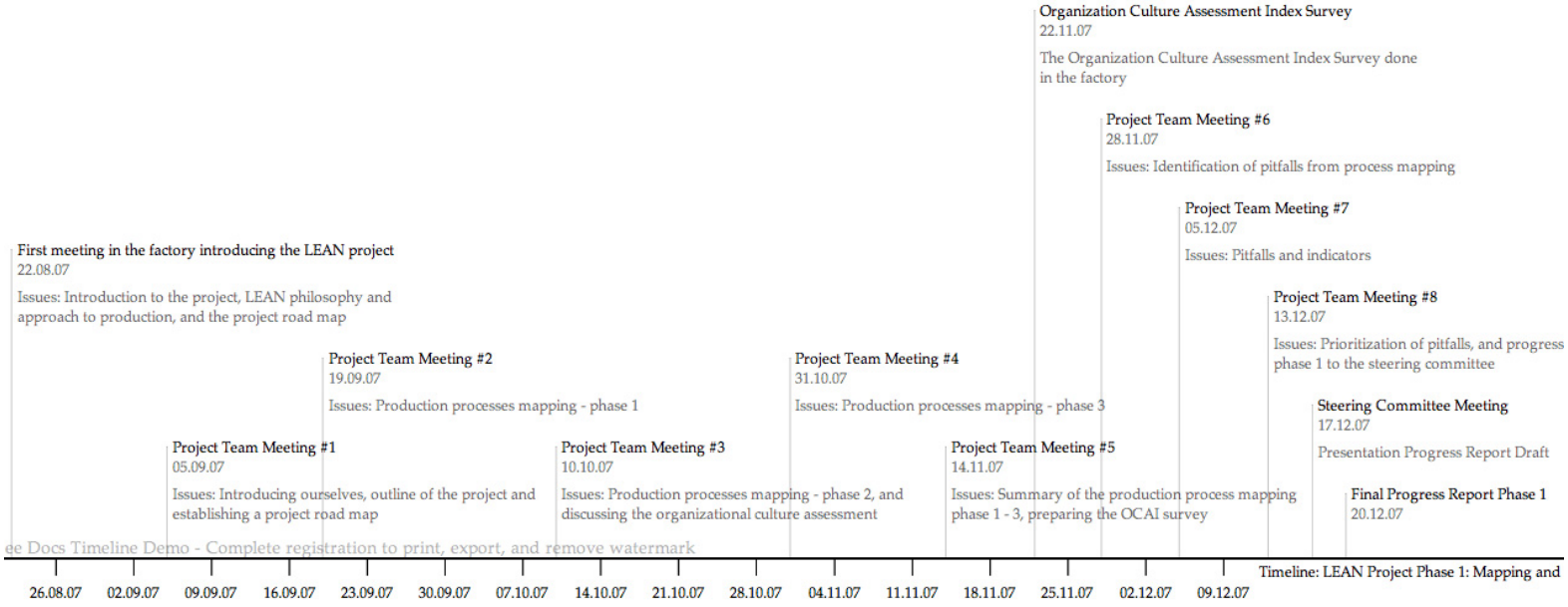


Illustration 26: Project Phase 1 (LARGE)

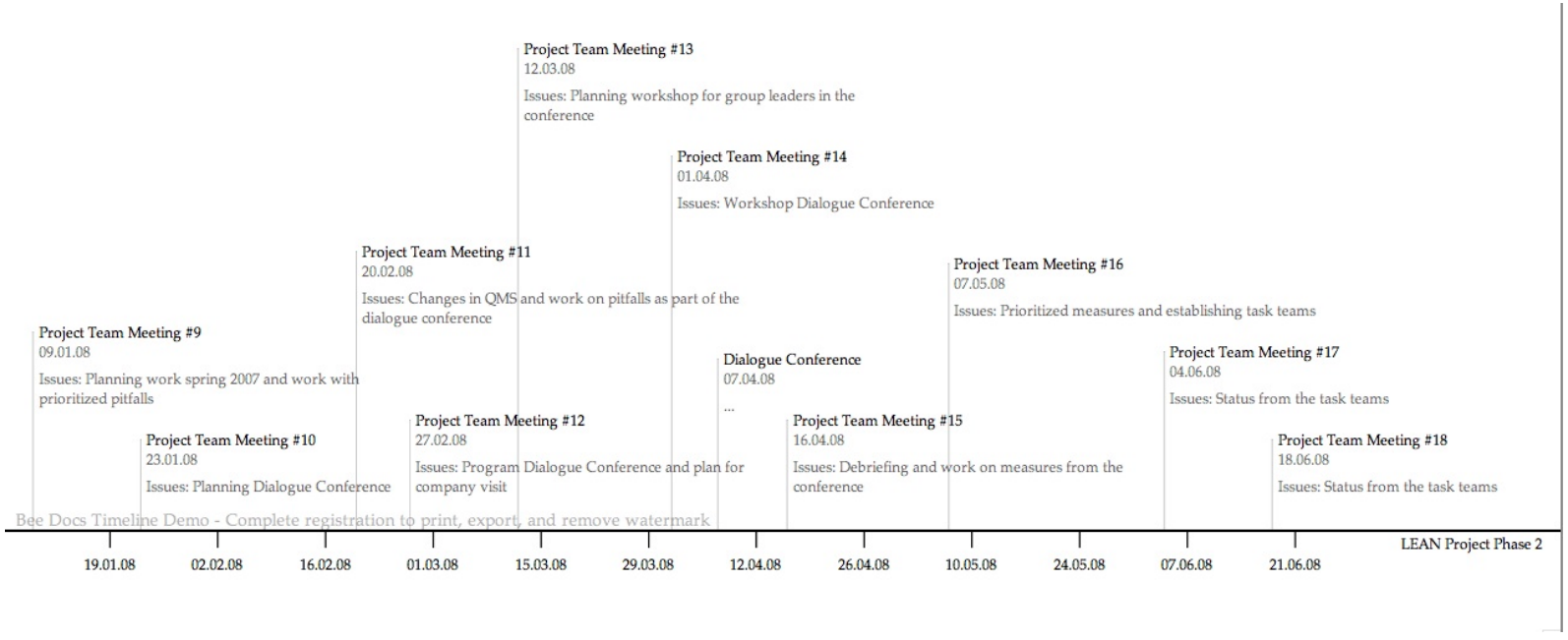


Illustration 27: Project Phase 2 (LARGE)

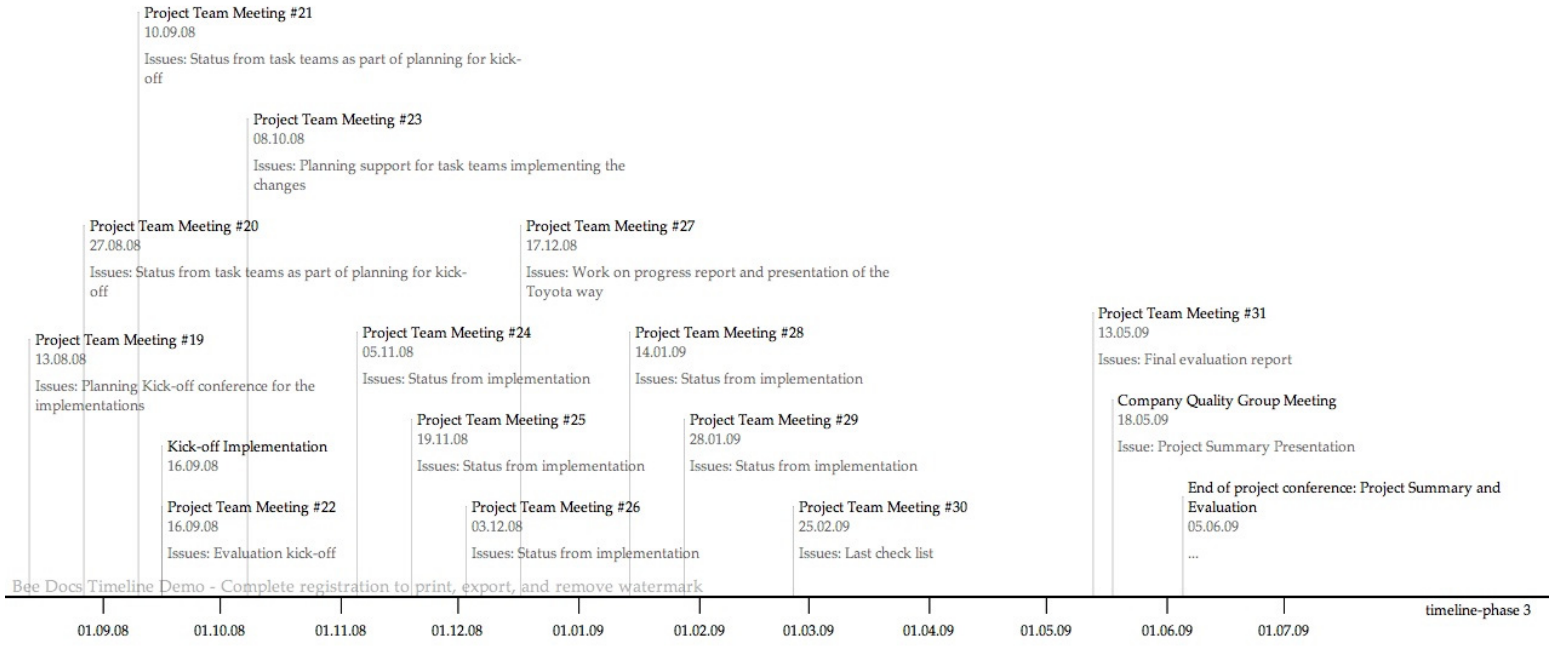


Illustration 28: Project Phase 3 (LARGE)

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