KTH Architecture and the Built Environment

Department of Real Estate and Construction Management
Civil Engineering and Urban Management
Architectural Design and Construction Project Management

Thesis no. 146
Master of Science, 30 credits

Visual Planning in Construction
– a study of its use in construction projects

Author:
Linnea Carlsson

Supervisor:
Tina Karrbom
Gustavsson

Stockholm 2012

Master of Science thesis

Title	Visual Planning in construction – a study of its use in the design phase of a construction projects
Authors	Linnea Carlsson
Department	Real Estate and Construction Management
Master Thesis number	146
Supervisor	Tina Karrbom Gustavsson
Keywords	Visual Planning, Visible Planning, construction project management, design phase, design management, communication, commitment, engagement, Lean, meetings.

Abstract

The purpose of this master thesis is to investigate of what use the method Visual Planning can be in the construction industry in general and in the design phase of construction projects in particular.

The investigation and empirical part of the thesis has been based on semi-structured interviews with process developers, design managers and designers from Swedish companies where Visual Planning is used. The interviews have been the base for a comparative case study with the aim of providing an overview of how the method is currently used, interpreted, experienced and perceived in the Swedish construction industry and by its professionals. The master thesis has been made in collaboration with the Swedish consultancy firm Tyréns AB in Stockholm.

The results of the interviews differ on an individual level. The majority of the respondents are however positive and believe in the future of the methods. All respondents stress the lacking documentation, however, as the major difficulty. Several respondents have stressed the difficulties of working in a scattered team due to the analogue format as a shortcoming of the method as well. The biggest benefits stated are the easy accessible overview provided and the clarification of commitments, due to the active participation of the design participants, the analogue format, and the way of mapping of the information process.

It has been found that Visual Planning can be of use as a support in the process of construction project management, since it may facilitate the understanding of how to reach objectives and provide an easy accessible overview of the progress and status of a project. It should however be viewed as a complement to the process of construction project management, and not as a replacement. In conclusion it may facilitate earlier problem solving, since commitment is raised, which in the end facilitates the project to stay within budget as well as to meet the deadline.

Sammanfattning

Syftet med detta examensarbete är att utreda vilken nytta metoden Visuell Planering kan vara av i byggbranschen i allmänhet och projekteringsfasen av byggprojekt i synnerhet.

Undersökningen har baserats på semi-strukturerade intervjuer med processutvecklare, projekteringsledare och projektörer från företag inom den svenska byggsektorn där Visuell Planering används. Intervjuerna har utgjort grunden för en jämförande fallstudie med avseendet att skapa en överblick och insyn i hur metoden i dagsläget används, tolkas och upplevs i den svenska byggbranschen och av yrkesverksamma i branschen. Examensarbetet har genomförts i samarbete med konsultföretaget Tyréns AB i Stockholm.

Intervjuresultaten varierar på individnivå. Majoriteten av intervjupersonerna är dock positiva och tror på metodens framtid. Alla tillfrågade beskriver den låga mängden dokumentation som det största problemet hos metoden. Flera yrkesverksamma beskriver även metodens tillkortakommanden då arbete bedrivs i spridda team. En följd av metodens analoga format. Den genererade lättöverskådliga helhetsbilden och förtydliganden av åtagande och engagemang, som följd av projektmedlemmarnas aktiva deltagande, det analoga formatet och sättet som informationsprocessen kartläggs beskrivs som det största vinsterna.

Det har framkommit att Visuell Planering kan vara av användning och fungera som ett stöd i byggprojektledning, då metoden underlättar förståelse för hur mål ska uppnås och skapar en lättuppfattad bild av ett projekts status och framåtskridande. Metoden bör dock ses som ett komplement i processen av byggprojektledning och projekteringsledning, snarare än en ersättning. Visuell Planering kan slutligen främja problemlösningen i tidigare skeden, då känslan av förpliktelse, åtagande och engagemang höjs, vilket i sin tur skapar bättre möjligheter för projektet att hålla sig inom budget så väl som att möta deadline.

Acknowledgement

The work of this master thesis has been done during four month during the spring of 2012 and started with a meeting at Tyréns in the middle of January, in the very beginning of the new year. At that point, no one, especially not I, knew that my master thesis was to be about Visual Planning. Almost as a coincidence the method Visual Planning were mentioned in passing and I was instantly hooked. The journey has been contradictive, both short and long. Short in time but long in distance. The pace has consequently been high. During the journey I have sometimes found myself becoming my own guinea pig, as I have struggled to be able to see my progress and the status of my work. As I have read and talked to people about the method I have, repeatedly, wished for a whiteboard to attach sticky-notes, documents etc. on.

During these four months many different tracks has been discovered but also been denied further research due to limitations in time and scale. Sidetracks has however led to more understanding and new perspectives, even though they might not have been included in this report. Hence this report represents all as well as just a fraction of the work that has been done during these four months.

I would like to thank Peter Sundström, Cecilia Sundblad and Linus Malm for your enthusiasm in the initial parts of my master thesis, and Tyréns for given me the opportunity to write my master thesis at your company. I have been very well received by everyone that I have met. A special thanks goes out to Anders Grimmer and Jennie Gelting, my supervisors at Tyréns, for your support and our fun discussions at our regular Tuesday meetings. I would also like to thank my supervisor at the Royal Institute of Technology, Tina Karrbom Gustavsson, for your good advice and inspiring questioning but also for the two great last years of my engineering studies. With this in mind, I would also like to thank Örjan Wikforss and Väino Tarandi for your contribution to the master program. Last but not least, several persons have helped me with proofreading, general support and to put things in perspective. I would therefore like to thank Birgitta Carlsson, Emma Carlsson, Mattias Yllén Johansson and Oskar Sirland. You have all been to great support.

Linnea Carlsson
Stockholm May 2012

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1 Introduction

The aim of the introduction is to give the reader an understanding of the background and purpose of the master thesis. The chapter ends with a description of the delimitations and some clarifications.

1.1 Background

1.1.1 The problem

A recurring problem in the construction industry is the tendency of construction projects failing to stay within budget and time. Exceeding budget and postponing finish date is the rule of exception. At the same time, the construction industry generates around 10% of national wealth (gross domestic product) in a typical modern society, which makes it the largest single creator of value in society (Winch, 2010). Efficiency in the industry is of obvious interest. Opinion groups as well as journalists and politicians mean that much more must be built faster and to a lower cost.

In the Swedish governmental surveys "Skärpning Gubbar!" (my English translation, "Sharpen up guys!") and "Sega Gubbar?" (my English translation, "Slothful guys?") from 2002 and 2009 it is stated that the construction industry is falling behind in both quality, productivity and cost development in comparison to other industries. In the survey "Slöseri i byggproject" (my English translation, "Waste in construction projects"), done in 2005, *waste* is stated to represent 30-35% of a total cost of construction projects. This waste is divided into four groups; Errors and controls representing more than 10% of the production cost, Use of resources representing more than 10% of the production cost, Health and security representing 12% of the production cost and Systems and structures representing 5%.

As in all projects the biggest room for influence and changes is found in the beginning and early stages of a construction project. The ability of making changes decreases throughout the progress of the project, at the same time as the costs of making them increases, see Figure 1. Furthermore, the costs of the initial phases of a construction project represent a small portion of the total project cost. The design phase e.g. represents 5% of the total cost (Josephson & Soukkoriipi, 2005).
The ability of solving and, in particular, identifying problems at this stage is of great value.

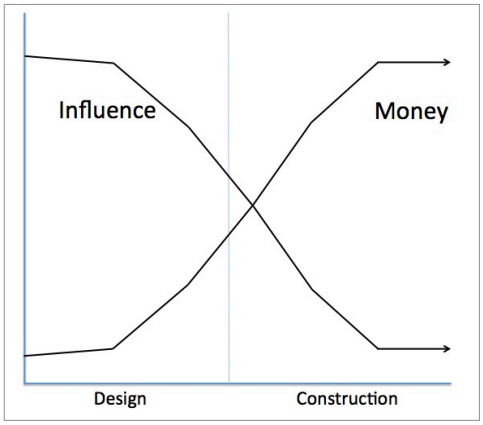


Figure 1. As the ability of making changes decreases the cost of doing them increases. Source: Author's version of Gould & Joyce, Construction project management, 2009.

1.1.2 Attempts for solution

The construction industry has for a longer time turned its head to the manufacturing industry as well as the product development industry. Many of the attempts to improve the internal efficiency have been focused on technology as a solution, such as CAD, FEM (Dalman, 2005) and most recently BIM, Building Information Model/Modelling (Hallberg & Tarandi, 2011; Samuelson, 2010). There is a method, however, called Visual Planning originating from behavioural science, focusing on the human instead of technology. It was successfully implemented at the car manufacturer Toyota in the mid 90's, during the development of the model Prius, shortening their lead-time considerably. The method is claimed to generate e.g. effective communication in development teams and a higher level of engagement (Dalman, 2005).

In 2003, via the Swedish car industry, Visual Planning was introduced to the construction industry in Sweden for the first time. It was tested and claimed to be successful (Dalman, 2005). Used in the design phase of construction projects it is claimed to provide higher quality, which lead to less changes needed to be done during construction. Little has, however, been written about the method in the construction industry since then. Research about the method could be considered poor even in the product development industry.

1.2 Purpose and research question

The purpose of this master thesis is to provide a broader and deeper understanding of and insight into what Visual Planning is and how it can be used to enhance efficiency in the construction industry. The product development industry and the construction industry may have lot in common, but also several conditions and prerequisites that differ. With this in mind, how a method forged in the product development industry can be used in another industry, like that of construction, is of interest. The research seeks therefore answer to the question:

Of what use can Visual Planning be in the construction industry and construction projects?

To answer this question, following sub questions has been investigated: *How is Visual Planning used and interpreted in the construction industry today?* and *How is Visual Planning experienced and perceived in the construction industry today?*

This master thesis has been done in collaboration with the Swedish consultancy firm Tyréns AB. An additional purpose of this master thesis is therefore to introduce the term Visual Planning and to provide a broader insight into of what use Visual Planning can be to Tyréns AB in particular.

1.3 The term Visual Planning

The method Visual Planning is not well known in the construction industry. A short initial description is therefore given.

Visual Planning is a method with the objective of making communication within a team more efficient. It aims to create a common overall picture by making the commitments and obligations of the team visible (Alfredsson, 2011). It has its origin in the Lean concept (Söderberg, 2011), and was developed by Toyota together with Japan Management Association Consultants (JMAC) to shorten Toyota's lead time for the development of new car models as well as to increase the productivity of white-collar workers (Dalman, 2006).

Visual Planning consists of matrix structured boards, where post-its representing activities, deliverables and problems are placed, after individual and time, and a particular type of short meetings, usually only 15 minutes, using the boards as a basis (Alfredsson, 2011). This description is based on its use in the product development industry. The term does not refer to BIM or visualisation tools such as 3D CAD. As the combination of the two words *Visual* and *Planning* indicate it refers to a method of how to visualise planning. By e.g. 3D CAD the planned outcome or result of a project can be visualised, such as a building. Visual Planning aims to visualise the process of getting there.

The term Visible Planning is sometimes also used as a name for this method. This report uses the term Visual Planning. Visual Planning is often referred to as *VP*. This abbreviation will be used in this report.

1.4 Delimitation

The research has been limited to the design phase of a construction project. Benefits, drawbacks and possible usage in other stages of a construction project have consequently not been investigated. Furthermore the research has been focused on the possible usage of the *method* Visual Planning, in accordance to the description above, and not visual measures for planning in general.

1.5 Clarifications

In this report Tyréns AB is referred to as Tyréns, Bjerking AB is referred to as Bjerking, Peab AB is referred to as Peab and Veidekke Entreprenad AB is referred to as Veidekke.

2 Method

In the following chapter, a description of how the research has been executed is given. The path of answering the research question, as well as of developing the research question itself, is presented. Motivation of choices made during the process is also given. The chapter ends with comments concerning research ethics and method criticism.

2.1 Choice of method

To answer the research question presented in paragraph 1.2, a comparative case study of three companies, in the Swedish construction industry, using Visual Planning has been done, based on interviews. The aim of the case study has been to provide an overview of how the method currently is used in the construction industry. The interviews have also been done in order to collect current opinions, experiences and interpretations of the method. A literature study of previous sayings concerning visual methods and Lean as well as construction project management has been done to gain further insight in the method and its origin and the prerequisites in the construction industry. The literature study has been done in parallel with the case study, as a preparation for the interviews but also since the interviews have provided ideas of further required theory studies.

Supervision has been taking place on a regular basis both at the Royal Institute of Technology and Tyréns. Participation in seminars, concerning research and master thesis studies, has also taken place one a number of occasions, which has been a contribution to the research process in whole. The research has been made during a limited time of approximately four months.

2.2 Research approach

Qualitative research has been chosen to answer the research question, since qualitative research is suitable when understanding and insight is desired (Ghauri & Grønhaug, 2010). Qualitative methods are used to gain a holistic view of a research problem. Qualitative methods are also suitable for social and behaviour science and when organisations, groups and individuals are studied.

2.3 Research process

Understanding of the research problem and question has constantly been gained and developed during the period of research. A flexible, evolving and emerging research design is what characterises qualitative research (Merriam, 2009). Analysis and interpretation of data have, by purpose and by default, been done simultaneously with the data collection, which also is typical for qualitative research (Ghauri & Grønhaug, 2010). This process is visualised in Figure 2.

Due to the process presented below, these questions evolved into the current research question presented in paragraph 1.2.

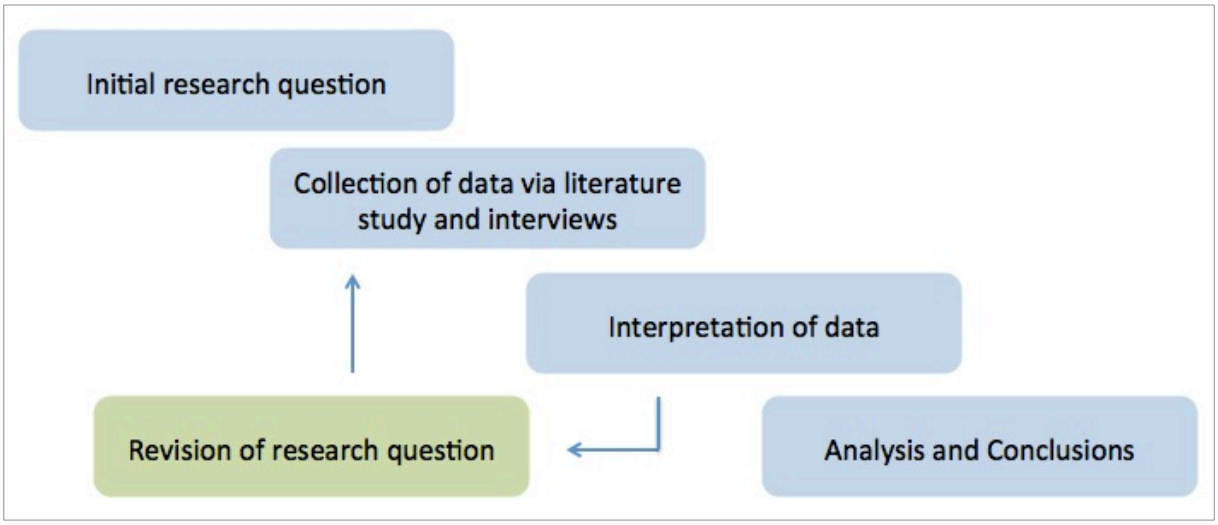


Figure 2. The research process. Source: Made by the author.

2.4 Literature study

To gain an initial insight in the method Visual Planning a literature study has been made. A literature study is a common first step in qualitative research (Ghauri & Grønhaug, 2010). The literature study also enables a comparison of the empirical results with previous research.
An overall objective and purpose of the literature study is to gain knowledge in order to be able to separate what possibilities and benefits as well as constrains and weaknesses that are really gained and originated from the method Visual Planning and what is gained from other external factors not being a part of the method.

2.4.1 Secondary sources

In some parts of the literature study secondary sources have been used. Secondary source, in this case, refers to a reference taken from a source, which in turn refers to another source. Usage of secondary sources is a way of making the research more efficient when time is a lacking parameter. Yet, the use of primary source is to prefer, since the risk of using secondary source is that the original information of the primary source has been misinterpreted. The objective has therefore been to limit the use of secondary sources. However, when secondary sources have been used, they have been of good scientific level (PhD). In the case of a lower level the paragraph does not belong to the focus area of the research, such as in paragraph 3.3.2, where a master thesis report has been used as a secondary source.

2.5 Case study and interviews

A comparative case study of three Swedish companies within the construction industry has been made. The objective of the case study has been to gain knowledge and provide an overview of how Visual Planning currently is used, interpreted as well as experienced and perceived in the Swedish construction industry and by its professionals. The choice of companies has consequently been based on where the method Visual Planning is used today. The case study has been executed via interviews. These interviews have further been used to collect data of how professionals of different positions within the industry experience the method. In total 10 interviews have been made.

Interviews can be made via mail, telephone or in person (Ghauri & Grønhaug, 2010). The majority of the interviews have been made in person. In need of complementary information e-mail has been used as collection method. Three interviews have been executed via telephone, when a date and/or time suitable for the interviewee have not been found. Two interviews have been done via e-mail.

Interviews can be structured, unstructured or semi-structured (Ghauri & Grønhaug, 2010). The interviews made have been of semi-structured nature, which is common in qualitative research. It gives the interviewee freedom to interpret questions and take control over the conversation compared with structured interview, which may rather be referred to as questionnaires, and the interview can be of a more discussion oriented nature. At the same time, semi-structured interviews allows the interviewer to ask some more direct questions as well, in comparison to unstructured interviews (Ghauri & Grønhaug, 2010). The interviews made via mail have, however, had a more structured appearance due to the limitation of such a method.

Two interviews, with a design manager and a designer, have been made at Tyréns. These have however not been a part of the case study. Instead, these have been made to gain more knowledge of the design process and Tyréns way of participating in it at the time of writing.

2.5.1 Choice of interviewees

The interviewees have been of different roles and positions within the construction industry to gain as much of a holistic insight as possible, since different persons with different roles and of different positions have different needs in the design phase.

To gain more knowledge of the method "in theory" two "process developers" has been interviewed. To gain insight in how the method is executed and interpreted in practice four design managers and four designers have been interviewed. All interviewees have had experience from at least one project or assignment where Visual Planning has been used.

2.5.2 Handling, interpretation and analysis of interviews

All interviews, except for the ones performed via e-mail, have been recorded and notes have been taken during them as well. The first three interviews were transcribed. The later interview results were handled direct by notes made during the interviews and complemented by listening to the recordings.

The result of the interviews has, as mentioned, both been used to describe different companies' ways of using Visual Planning as well as individuals' experiences and opinions concerning the method. The presentation of the interview result is divided after the role of which the interviewees belong to.

In the analysis the interview result is put in relation to the interviewees' different backgrounds, the way of which Visual Planning is used at the specific company of which the interviewee belong to as well as theory collected through the literature study. This has been an on-going process during the period of which the interviews were made, which is natural in qualitative research (Ghauri & Grønhaug, 2010).

2.6 Participant observation

The workplace from which the research has been made has mainly been the head office of Tyréns in Stockholm. Due to this, participant observation has been a contribution to the research. Through participant observation insight of approaches, opinions, experiences and attitudes at the company has been gained. Participant observation is an effective way to collect first-hand information in a natural setting. In comparison to interviews, knowledge of what persons actually do and think instead of what they claim to is gained by participant observation (Ghauri & Grønhaug, 2010).

2.7 Research ethics

Even though none of the interviewees has provided information of particular sensitive character or requested to not be mentioned by name it has been chosen to keep them anonymous. The main reason for this is that focus should not be misplace on the individuals per se, but on what they have expressed.

2.8 Method criticism and limitations

All research methods have their drawbacks and limitations. As mentioned, two out of 10 interviews have been made via e-mail. This limits the possibilities of understanding the underlying

reasons of the given answers, since spontaneous attendant questions cannot be made. The risks of misinterpretation of a question are also larger, since the formulation of a question is limited to the written one. A dialog or discussion is not possible. Two interviews were made via telephone. This has also important consequences on the generated dialog compared to interviews made in person, e.g. interpretation of body language is not possible, even though the drawbacks are less compared to interviews made via e-mail.

Since the research has been of an emerging nature, due to that a qualitative research approach has been chosen, the insight of what sort of theory that may be of interest has been an on-going process. Time has however been limited. Due to this, relevant theory found during the later stage of the research period, has not been able to be investigated. In some cases, secondary sources has been used as a solution to this problem.

3 Theoretical framework

This chapter presents theory necessary to explain Visual Planning and is divided into three parts. In Part I theory of project management in general and construction project management in particular is presented. To understand the relationship between the original form of Visual Planning, developed for the product development industry, and the interpretations in the construction industry, the processes in the construction industry are also described. Part II aims to give an overall overview of Visual Planning, what it is and where it has its origin. The reader is also given an introduction and description of the concept Lean as a basis for further understanding of the origin of the components making up Visual Planning. A summary of previous research done of VP is also presented. The last part has focus on important components of VP in particular and methods in general.

3.1 Part I – Project Management and Construction Processes

3.1.1 Construction projects and its participants

A construction project can be described as a circle. It starts with an idea defined by the owner. The designer develops the idea and a constructor produces it. After production the constructor finally turns it over to the owner (Gould & Joyce, 2009).

The owner is the origin of the project. Owners initiate construction projects by stating a need. The owner is often a large organisation or institution, such as a private real estate concern or a public authority, but it may also be a family seeking for a new home (Gould & Joyce, 2009). In other words, the owner can be public or private, big or small. The owner can also be referred to as *the client* (Winch, 2010).

In general, *design professionals* can be divided into architects and engineers. The engineer designs the building systems meanwhile the architect develop the basic concept of the design together with the owner. In infrastructure projects, the engineer is, however, usually leading the design meanwhile the architect rather answers for the aesthetics. Since the building systems consist of a variety of technical systems, structure as well as mechanical, electrical and plumbing system, there is also a variety of engineering disciplines divided per technical area; structural engineers, mechanical engineers, electrical engineers, civil engineers etc. There are different disciplines within the profession of architecture as well, such as building, landscape and interior architects (Gould & Joyce, 2009).

The *constructor* is the professional responsible for the construction activities. Estimators, schedulers and purchasing agents are examples of titles within the constructor profession. This function can also be referred to as the contractor. *Subcontractors* are usually also involved during construction, contributing with expertise in special detailed fields. Tradespeople/blue-collar workers represent the biggest part of the construction personnel. They form the core of the

construction industry and perform the actual work in the field (Gould & Joyce, 2009). *Material* and *equipment suppliers*, last but not least, take, naturally, also part in the construction phase.

These are the general participants presented by Gould and Joyce (2009), but there are several more involved. Regardless of delivery method or sort of project, there will always be some kind of project manager responsible for the overall management. Depending on delivery method, type of project or owner organization the project manager can be an employee of the owner, an external project management consultant or an employee of the contractor (Gould & Joyce, 2009; Ottosson, 2009).

3.1.2 Delivery methods

In which way and at what time these actors are engaged and introduced in the project depends on chosen delivery method. Gould and Joyce (2009) explain that "the term delivery method refers to the owner's approach to organizing the project team that will manage the entire design and construction process" (p. 82). In other words, how the project will be delivered. Different strategies for how to organize the delivery of a project exist due to the need of different ways of managing risks depending on the prerequisites.

The most common delivery methods are *design/bid/build* and *design/build*, but a large numbers of different proven strategies exist as well as combinations of them (Gould & Joyce, 2009). In *design/bid/build* the owners starts by hiring the design professionals. The designers prepare a design and turn back complete contract documents to the owner. The owner continues by hiring a contractor who gets the responsibility to deliver the project in accordance to the contract documents produced by the designers. The contractor can be procured directly or e.g. by a competitive bidding. Choosing *design/build*, the owner hires one firm to be responsible for the performance of both the design and the construction of the project. See relationship in Figure 3.

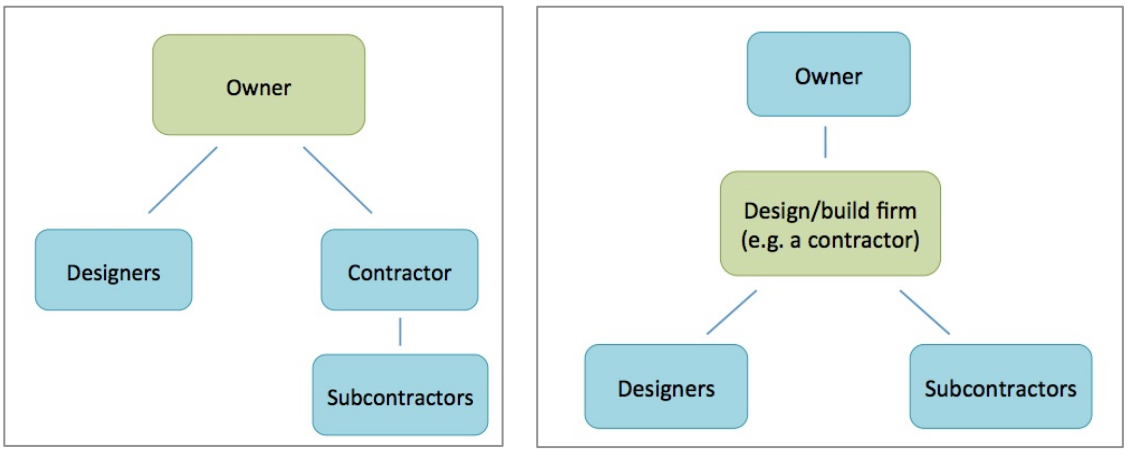


Figure 3. To the left: Design/bid/build. To the right: Design/build. Source: Author's version of Gould & Joyce, Construction project management, 2009.

3.1.3 Phases of construction projects

Regardless of chosen delivery method, a construction project is divided into several different phases; *feasibility study*, *design phase*, *construction phase*, *turn over* and *operation*. The latter is, however, rather a part of the life cycle of a constructed facility than a part of the construction project.

A *feasibility study* is the starting point of a construction project. During the feasibility study the conditions for realisation of the project are investigated, foremost the economical ones. Market demand, budget, schedule and cost of money are forecasted. Cost of money refers to the cost of borrowing money. Many construction projects are financed mainly or partly by borrowed money. During this phase both architects and engineers can be consulted by the owner, to provide early design, constructability and cost advice. The feasibility study functions as a basis for the decision whether to implement the project or not.

If the owner decides to proceed the project moves on to the *design phase*. During the design phase architects and engineers collaborate to establish documents, such as blueprints, that will be used during the following construction phase. Documents established from the design phase also functions as a basis for the schedule and budget of the construction phase. As the name implies the facility is constructed during the *construction phase* (Gould & Joyce, 2009).

Depending on delivery method the appearance of procurement process differs, or at least who is responsible for it. In design/bid/build, procurement of design is done between the feasibility study and the design phase and procurement of construction is done after the design phase but before the construction phase starts. In design/build the owner only go through the procurement process once, before the design. The design/build firm answers then for the necessary procurement of design and subcontractors etc. (Gould & Joyce, 2009).

3.1.4 The Design process

Björk et al. (2006) describes the design phase as "the process where the client's wishes and expectations on a future product or building are developed and transformed to documents after which one produce, construct and operates." (pp. 101, my English translation)

Architects and engineers usually have different approaches to a design challenge. Architects respond to a design task by first identifying the important element of the design. Some may use the physical context as a guideline, or the planned activities in the building. Others may focus on the creation of a unique image. According to Gould and Joyce (2009) the best architects responds to all three aspects. An engineer usually responds to a design challenge in a more objective way than an architect, by breaking down the task in components and the questions to be answered. Both architects and engineers must however think mechanically, technically and creatively (Gould & Joyce, 2009).

The work of the engineers is detailed. This requires well-functioning and efficient communication in the design team. During the design phase adjustments are constantly made to match the dimensional requirements of the facility, which often may result in shifts of the design approach (Gould & Joyce, 2009).

The design phase can be explained by four different sub phases; *programming*, *schematic*, *design development* and *construction documents*. Following description is based on building construction. During *programming* a written description of the requirements of the building is established. This includes needed spaces, required services in those spaces, and the relationships of the functions to be performed in the building. The program can be written by the owner, an architect or an external consultant expert specialised in programming, depending on the owners experience and desire or the complexity of the project. In some cases a constructor may even by hired to take part in the programming due to a need of e.g. constructability advice (Gould & Joyce, 2009).

The phase *schematic design* is first phase of the actual design. The architect develops preliminary floor plans and the visual form of the building. Structural system is also preliminary chosen at this stage. The result of the schematic design is one single design concept.

With the agreed design concept as a basis the *design development* starts. The design will constantly be refined, as it gets more and more detailed. This can also be referred to as the *detailed design*. Large as well as small systems necessary for the function of the building is designed now, such as structural, plumbing, elevator, exterior façade and electrical (Gould & Joyce, 2009).

The final outcome of the design phase is the *construction documents*. These are used for the procurement of construction, and are therefore to be considered as legal documents, but as well as work description for the job in the field. Simultaneously with this process the economic feasibility of the project is tested by using the information established in each stage (Gould & Joyce, 2009).

In short terms, the design phase is characterised by four words, all with *i* as a common first letter; *information*, *interaction*, *integration* and *iteration* (Björk, Johannesson, Malmström, Nilver, Sundquist, et al., 2006).

Information refers to professional knowledge, collection and exchange of information and transformation of gathered information into construction documents.

Interaction refers to cooperation in the design team, with colleagues and authorities.

Integration stands for the coordination needed to achieve the optimal solution for the building or facility.

Iteration refers to the nature of a designer working method, where suggestions are made, reviewed, revised and so on until all parties are satisfied.

3.1.4.1 Factors affecting the design team composition

In general, authorities and other public organisation represent a major part of the clients in construction projects (Winch, 2010). This affects the prerequisites of the procurement of both the design and the construction. The Swedish law of public procurement, LOU, aims to support and ensure competition (www.allego.se). In practice this means that the composition of e.g. a design team can seldom be done in accordance to ones will.

3.1.5 Project management in construction

Project management is a frequently discussed subject in several industries today. Project management can be optimised by "refining of working methods, clarification of roles and simplification of project reporting or visualisation of status by the use of user-friendly project tools" (Tonnquist, 2010, preface, my English translation). Tonnquist (2010) defines a project as a task that is unique, has a time limit and an own budget and requires a temporary organisation. Sebestyén (2006) describes project management as the work task that holds work for a certain project together, which includes planning, organisation, control and leadership.

The purpose of planning is a generated overview over what is to be done and in which order (Tonnquist, 2010). Planning is a way to minimize uncertainty and to create preparedness for possible changes (Sebestyén, 2006). A plan shall be used both as a measurement (yardstick) for the follow up of a project's process, giving the ability to answer the question of "how we are to", but also as a communication tool. Including the persons responsible for executing the plan in the planning process is a way to raise the quality of the plan (Tonnquist, 2010). Planning is usually an on-going process during a project. A too detailed plan can instead of supporting the team lower motivation and confidence.

Tonnquist (2010) states that project offices or rooms is an effective way to gather a team and provides good conditions for efficient teamwork. A project manager shall give the project team members possibility to grow, a feeling of belonging and a willingness to create results. Feedback is tool to generate this. Feedback is also a way to increase self-perception, which is a requirement for the ability of development. Clear objectives and prioritisations are important to enable efficient work and to avoid negative stress. Leadership is to great extent about advising persons. However, the thin line between paying attention and controlling should not to be neglected. The positive feeling of being recognised can easily switch to a negative one by feeling controlled.

According to Winch (2010) construction project management is much about managing information, and in many cases, the lack of information. Construction project organisation

should rather be seen as coalitions due to its temporary nature. A construction project manager must manage the tension between structure and process and therefore place focus rather on flexibility than on productivity.

Winch (2010) describes all projects as an information process system and states: "All organisations are, in essence, information process systems. In order to function they must monitor their environment, take decisions, communicate their intensions and ensure that what they intended to happen does happen" (pp. 6). He compares the construction industry as a service industry with the manufacturing industry. In manufacturing the flow of material is controlled by the flow of information, meanwhile the service industry has been much less interested of managing the flow of information.

The well-known philosophy of continuous planning, often referred to as plan-do-check-act, is according to Ottosson (2009) not only applicable in the construction project as a whole but also in the different phases of the construction project, such as the design.

3.1.6 Communication in construction

Communication is often stated to be the primary cause of project failure (Dainty, Moore & Murray, 2006). What communication truly is is difficult to define, but it may be seen as a fundamental social activity and has been described as a "metaphorical 'pipeline' along which information is transferred from one person to another" (Axley, 1984, in Dainty et al., 2006, pp. 3). The transmitter of the information needs to get feedback that the message has been received, to be sure that communication actually has taken place and that it has successfully been taken place. This means that communication is a two-way process (Dainty et al., 2006).

That importance of communication in construction has been proven by surveys done stating that the average designer uses 40% of his or her time collecting information, 40% of the time to perform his or her actual task and 20% of the time informing and presenting his or her work and performance (Björk et al., 2006). However, communication in construction is problematic due to the nature of project teams in the industry being temporary and inter-disciplinary. The development of a mutual agreed way of communicating is of great importance since people find it difficult to function in the industry otherwise, both on an individual level and on team level (Dainty et al., 2006). Face-to-face communication plays an important role in the construction industry. Meetings represent over 50% of the used methods for communication.

Dainty et al. (2006) suggests that the essence of teambuilding is good communication. Depending on how a team has been developed or evolved the way in which the team members communicate with each other differs. A formally defined team tends to communicate in formal ways meanwhile informally defined teams tend to communicate in more informal ways. A study made

by Loosemore in 1996 show, however, that regardless of the formality of the group, when crises occur, the need of informal communication is crucial.

3.2 Part II – The background of Visual Planning from a product development point of view

3.2.1 "Pulse" – an example of visual planning

The Swedish truck manufacturer Scania is one of many companies that have adopted philosophies and methods from Toyota. In the book "Multiprojektledning – skapa puls i produktutveckling med lean tänkande" (my English translation, "Multi project management – create pulse in product development by lean thinking") Sebestyén (2006) explains the concepts and theories behind a method called "Pulse" and introduces the concepts Pulse meetings and Pulse boards. This method is used e.g. at Scania (Tonnquist, 2010). The following section summarizes Sebestyén's ideas about Pulse.

Pulse meetings are decision meetings where the participants work standing in front of visual planning boards. Pulse meetings are described as "a way of working that visualises information, increases communication, accelerates decision-making and focuses the work process" (pp. 200, my English translation). The visual planning boards, the Pulse boards, are whiteboards consisting of:

1) an image symbolising the objective and vision of a project and what the project shall deliver
2) a network plan consisting of the steps of the path to the project objectives. This network plan describes interim results and delivery points between the members of the project team
3) a summary of possible risks and action plans
4) current problems and disturbances
5) a decision log.

See Figure 4.

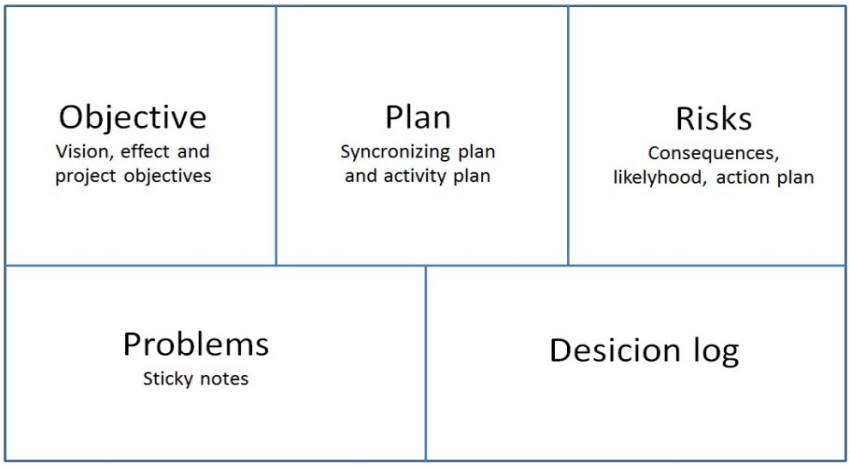


Figure 4. The principle of the Pulse board. Source: Author's translation of Sebestyén, Multiprojektledning – skapa puls i produktutveckling med lean tänkande, 2006.

An essential part of the Pulse meetings is the team members' participation. During the meetings they update the information related and affecting them, by checking off completed activities, fill in missing future activities, status indicate interim results by adding coloured magnets and attaching sticky notes with unsolved problems and gradually compose detailed activity plans together. Detailed delivery and time planes are created by the team together. Current problems and disturbances should always be brought up during the meetings. If the necessary information exists a decision is made immediately. Otherwise, a team member is given the responsibility to collect it to the next meeting. When a problem is solved, the decision is documented in the decision log. If a problem is solved in between two pulse meetings the sticky note shall not be removed until the next meeting. The person attaching the sticky note is also the person removing it.

Pulse meeting shall take place with high frequency, preferably several times a week, and be kept short. Pulse meetings are meetings intended for decision-making not problem solving. The pulse boards are placed in a project room, to enable the team member access to them in between the meetings. The room shall be formed in a way that makes it possible for all team members to stand in front of the boards, giving them the same opportunity to see what is happening on it, how it is changing and gradually evolved through the suggestions and contributions of each member. Pulse meetings are held standing, to avoid that the participants gets to relaxed by sitting in chairs as in regular meetings. It also simplifies good teamwork since there are no tables where participants can mark territory.

The pulse methodology creates interaction between humans, which leads to teamwork, which in turn leads to mutual understanding. Sebestyén stresses that it is not the meetings per se that creates coordination, but the persons participating. The meetings and visual planning boards are means to facilitate communication. By visualising abstract information it becomes concrete communication. All team members have access to one common picture and can actually see what is communicated.

The Pulse methodology is compared to traditional planning methodologies. Shared knowledge and understanding is created by the team members forming project documentation together as a part of the Pulse meetings, compared to the non-active way of using planning documentation, which usually is created to a large extent, in traditional planning methodologies. Pulse enables individual knowledge to become shared knowledge. When a project manager creates a detailed time plan for the participants to follow, the individual is given very little space. Pulse enables individuals to contribute with their knowledge by giving them access to information and decision-making. Taking part of the planning also creates an understanding for how to reach objectives, which makes them less unattainable. In general, that is an essential part of project management, to communicate how goals, objectives and deadlines will be reached.

An important part of the pulse methodology is the function of the team. A gathered team is not only a need originating from the high-frequency meetings. Working in teams requires short lines of communication. To become a well-functional team the team members should be given the possibility of working creatively together. Effective teamwork is not to take part in a meeting a couple of hours from time to time. Instead, traditional meetings favour passivity, territory mindedness and individualism. In addition, during traditional meetings only just a few participants are really active at the same time as the rest are passive and this is not equal to team work.

With the aid of the pulse boards the team is constantly accessed to feedback, feedback that can be seen by all members. Seeking feedback is natural, since feeling belonging to a group is a human need. To be seen and appreciated, especially by people who mean a lot to us, are what motivates us to actions and particular behaviours (Svedberg in Sebestyén, 2006). In between the pulse meetings as well as during them delivered interim results are communicated and one can see his or her, as well as others, contribution to the total team result. Thanks to the level of detailed at the Pulse board, the result of the team members taking part of the planning, they can see the progress in a weekly basis.

Keeping a steady pace in a project is essential in the Pulse methodology. This means to have a high work rate and a retained focus on the, for the client, result and value adding activities. Sebestyén claims that using traditional project management methods such as milestones and toll gates included in the project plan to focus the work and to keep track of time, contrary makes the pace increase when a milestone is approaching but immediately fall back down to a relatively low level afterwards. The Pulse meetings are a way to retain the high pace and focus on the value adding activities, facilitates information flows and communication and secures necessary decisions at the right time.

In the preface Sebestyén writes: "A development project cannot be regarded as a production division with a standardised workflow. The work within development is at times a chaotic creative process that cannot be forecasted in high-defined activities or planned in a Gantt-scheme." (my English translation)

In "Multi project management – create pulse in product development with lean thinking" Sebestyén describes how Pulse can and should be a part of a company's whole organisation. The method is therefore developed in three different levels; product management, portfolio management and project management. The text above is mainly based on the project management level.

3.2.2 Lean and the Toyota Way

In the beginning of the 80s the outlook for the American car industry was poor, meanwhile the Japanese one was on the rise. Managers of the big American car manufacturers choose to blame the situations on unfair and unjust business method by the Japanese (Liker, 2009). However, it stood quickly clear that there was something about Japanese quality and efficiency as the Japanese cars lasted longer and required fewer repairs then the American ones. Toyota was the one standing out the most. They developed new car models both faster and in a more reliable way, without compromising their competiveness regarding prices (Liker, 2009).

Car manufacturers around the world started to realise that they were behind Toyota when it came to high product quality. Researcher from the most prestigious universities in the US started to study what lay behind the success of Toyota and the Toyota Production System (Liker, 2009). The book "The machine that changed the world" by Womak, Jones and Roos was one of the results of the research and introduced the world to the concept "Lean" (Sebestyén, 2006). Lean means to do more with less by working with constant improvements and identification and elimination of waste (www.leanforumbygg.se).

Parts of Lean treat the question of visualization, but also leveling of workloads and standardized tasks and ways of working. Liker (2009) describes Toyota's way of working by 14 principles, which in turn are divided into four groups (see Figure 5). The following section is based on Liker's (2009) description of the Toyota way.

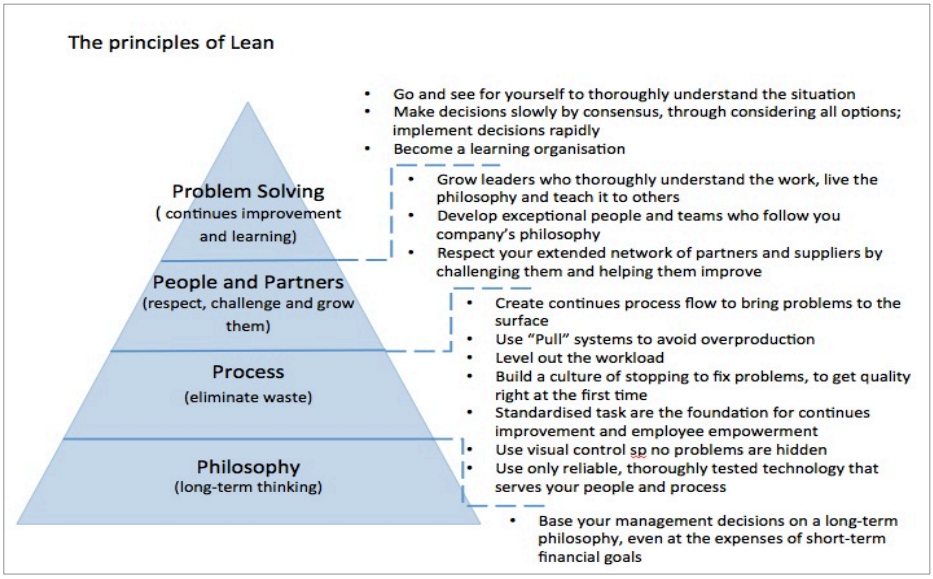


Figure 5. The 14 principles of the Toyota way, divided into groups. Source: Liker, J. K., 2004, The toyota way.

One way of eliminating waste according to the Toyota way is to level out the workload (principle 4). An employee working like a turtle, slowly but consistently, causes less waste than an employee working as a rabbit, rushing away to need a rest later. In accordance to principle 6 (Standardised

task are the foundation for continuous improvement and employee empowering) standardised ways of working are a requirement for constant improvements, as Lean is all about.

Liker stresses that standardization normally is negatively associated. Most people think of standardization as a way of eliminating creativity and not of use in a project orientated organization. These thoughts have its origin in the principals developed by Frederick Taylor, the man behind the scientific management. Meanwhile, Toyota's way of looking at standardization differs. Standardization is not meant for turning the employees into slaves, delivering quantity without quality. By developing ways of working in collaboration with the employees Toyota turn around the application of standardized working methods. Standardized working method shall never be imposed or make work boring or degrading.

On the contrary, standardized working methods shall give the personnel responsibility and the opportunity to innovate their work. Liker stresses that Toyota means that the though that standardization is about finding the scientifically best way of performing a task and standardizing it and make it fixed, is a common mistake. At Toyota, one look at standardization in the absolute opposite way – it is impossible to improve a process before it is standardized. Improvements without a standardized working method only create different versions of a process not a better one. Standardized working method is also the key to quality. At Toyota, standardized working methods are the basis to constant improvements, innovation and the positive development of the employees.

In manufacturing problems can often be hidden, forcing managers to emergency fire fighting, where time is wasted on putting out the fires at the same time as other start. At Toyota it is believed that one should be able to see and determine whether things are at its place or if problems exists. This applies also to conference rooms where planning meetings take place. Is it possible to judge how a project is doing, if it is ahead of schedule or behind? To avoid fire emergences Liker stresses the importance of being able to distinguish deviations just in a glance. This is solved by visual control (principle 7 – Use visual control so no problems are hidden).

Liker defines visual management as "any form of communication devise used in a work environment that makes it possible with one look to see how the work shall be performed and whether that deviates from the standardized way" (pp. 189). The strength of the method lays in the fact that visual measures does not need to be studied to be understood, the meaning is clear immediately, Liker states, and draw parallels to traffic lights and signs.

One of the biggest innovations concerning visual control is the one made in Toyota's product development system. In the beginning of 2000s *obeya* (big room) was introduced, as a part of the development of Toyota Prius. Chief engineers and managers of the most relevant groups involved in a project are gathered in one room (obeya). This room is sometimes referred to as communication center (the military term). In the room there are several visual tools, kept à jour

by the engineers, indicating status for each area instead of traditional time schedules, blue prints, quality information, economical results and other measures how the project is progressing. Everyone and anyone in the project team can review the material. The experiences from using obeya were that decisions were made faster and more accurate. Improved communication, kept direction of objectives, faster collection of information and a stronger team spirit were other effects.

At the same time as many companies celebrate IT as a tool to obtain a paperless office, it is questioned at Toyota. There is no opposition against IT in general, but an approach of that the most suitable means for visual control are the ones to be used. Founders of the philosophies within Toyota emphasize that usually only *one* person sits behind a computer, which results in isolation from teamwork. Pursuant to the Toyota Way, as Liker describes it, visual control, on the other hand, suits the human since it facilitates the use of our senses sight, hearing and touch. According to the Toyota way the best indicators are the ones that we are able to see, hear and feel.

3.2.3 Other sayings about Visual Planning

In a case study of four product development companies using Visual Planning Lindlöf and Söderberg (2011) concludes two types of benefits of the method; communication and coordination. Visual planning facilitates communication through a) the face-to-face communication created via the visual planning meetings and b) through the overview of tasks in the team given by the visualisation on the boards, compared to the possible information overload that often is the result of software-based systems. The combination of the overview provided by the boards and the high frequent meetings, 1-5 times per week, is what provides an ability to coordinate tasks efficiency, Lindlöf and Söderberg (2011) continues. Since the members always update a current picture of the status of the project as well as the members' workload is provided and since the members have to specify their current activities quite often due to the high frequent meetings, potential and real problems surface and can be dealt with earlier.

Some difficulties of the method are, however, also observed. If competences differ a lot in a team the ability of levelling the workload is limited. In some cases, this function can also be interpreted as a control system for the management where the project members are studied, causing reluctance among some people to state planned finish dates and thereby reluctance to provided the information wanted in the method. The analogue format has also been proven to be a limitation. Lindlöf and Söderberg (2011) have found three different difficulties originating from this; difficulties of working with scattered teams, difficulties of tracking causal links between activities and difficulties of saving historical data related to the progress of the project. Söderberg (2011) states furthermore that the analogue format is in some cases met with resistance due to its simplicity and is by some acknowledged as unprofessional.

Visual Planning "is useful for product development teams handling considerable complexity in coordination of their tasks" (Söderberg & Alfredsson, 2011, pp. 1). It is, however, found that in teams without an obvious need of coordination of the members' activities and deliverables on a regular basis, where tasks are more isolated, visual planning is less effective. The size of the team is also a factor to consider. If a team is too small, there is not a sufficient need for a structured communication method. Lindlöf and Söderberg (2011) conclude that a team of 6-12 members is appropriate when using Visual Planning.

Efficient communication is the most mentioned benefit in the rather small amount of previous research done on visual planning, and it correlates with Lindlöf's and Söderberg's findings (Parry & Turner, 2006; Olausson & Berggren, 2010; Morgan and Liker, 2006; Hines et al., 2006, in Lindlöf & Söderberg, 2011). Previous research have e.g. stated that engineers are more involved in the decision-making when using visual methods (Olausson & Berggren, 2010, in Lindlöf & Söderberg, 2011) and that the method may function as a gathering point for the engineers for discussions about current issues and where they can reach a consensus on which next step to take to move forward in the project (Morgan & Liker, 2006, in Lindlöf & Söderberg, 2011).

These aspects are confirmed in the case study. Visual planning makes it easier to know what is going on and is therefore also a rumour killer. Decisions and communication are strengthened by the availability of real time information, in comparison to the often static status of software-based plans. There is also a belief in the analogue format making discussions emerge and people to talk to each other. Project members also listen in a more active way to one another due to the swift pace of the meetings. The swift pace of the meetings, approximately 15 minutes, seems to be an important factor in the method, according to Lindlöf's and Alfredsson's case study. In one team at a company, an hourglass timing each member's presentation is used to make sure that discussions do not become too long and detailed. The members can keep the time that is used as an indicator for a need of a sub meeting after the visual planning meeting, for those members it concerns. In this way, other members' time is not wasted.

At all of the four companies in Lindlöf's and Alfredsson's case study the boards consist of a matrix, where the rows represent the team members and the columns time units, days, week and in some cases even years. Each member presents his or her activities and deliverables that shall be done by him or her on a short-term basis. Crucial problems and absence notes, stating when and why a member was absent, is also presented on the board. This is done by colour-coded sticky notes.

Lindlöf and Söderberg (2011) describe visual planning as a "simple method where activities and deliverables are outlined and illustrated on a physical planning board and discussed at frequent meetings" (pp. 270) and a "rather analogous approach to planning the tasks of product development teams" (pp. 277). They state that research done on lean product development seems to be focused on either knowledge management, how knowledge is captured, transferred

and used or on waste-reduction. Some research has also been done that implies that visualisation supports the transfer of tacit knowledge (Whyte et al., 2088, in Lindlöf & Söderberg, 2011).

Team characteristics, team culture and the role of senior management are three important factors influencing the success of the implementation of Visual Planning in a team (Alfredsson & Söderberg, 2011).

3.3 Part III – Components of Visual Planning and a method in general

3.3.1 Commitment

A committed employee is most commonly described as "one who stays with the organization through thick and thin, attends work regularly, put in a full day, and maybe more, protects company secrets, shares company goals, and so on" (Meyer & Allen, 1997, pp. 3). Several definitions exist though. Meyer & Allen (1997) states however that in general there are two different approaches to the definition of organisational commitment; "a psychological state that a) characterizes the employee's relationships with the organization and b) has implications for the decision to continue membership in the organisation" (Meyer & Allen, 1991, pp. 67, in Meyer & Allen, 1997, pp. 11).

Commitment in general can also be viewed as "a force that binds an individual to a target (social or non-social) and to a course of action of relevance to that target" (Meyer et al., 2006, pp. 666, in Meyer & Maltin, 2010, pp. 325). Meyer & Allen (1997) describes commitment by three components; affective, normative and continuance commitment. Affective commitment to a target has the greatest benefit for that target (Cooper-Hakin & Viswesvaran, 2005; Meyer et al., 2002, in Meyer and Maltin, 2010).

A reason for being committed may be the will of learning new skills and develop as a person by the opportunity to have challenging work and by meet and interact with interesting people. But there might also be a downside for the employee, according to Meyer and Allen (1997), since being committed at work may lead to less time and energy available to invest elsewhere, such in hobbies or the family.

The stereotypical view of commitment is that it is equal to loyalty and willingness to work towards an organisation objectives. Whether that is accurate or not, commitment ensures an organisations ability to trust the employee to do what is right (Meyer & Allen, 1997).
Being committed to something seems to be a natural need among humans (Meyer & Allen, 1997).

3.3.2 Implementation

The word implementation refers to the realisation or performance of e.g. a plan or strategy. The success of a strategy or plan is more depending on the implementation of the strategy than on the formulation of the strategy in itself (Hambrick & Canella, 1989, in Hallersbo and Svahn, 2011). A well formulated plan or strategy, naturally, influences the prerequisites of the implementation but is however not necessarily a guaranty for a successful implementation. The strategy can in itself be outstanding but worthless due to an unsuccessful implementation (Corby et al., 1999, in Hallersbo & Svahn, 2011).

Regardless of what is being implemented, mutual understanding and a consensus is of great importance to function as support for choices needed to be taken during the process. The need of understanding and consensus is often neglected (Whittington, 2002, in Hallersbo & Svahn, 2011). The motivation and commitment among the top management of an organisation is of great importance for an implementation to be successful. The motivation and commitment among the personnel fades easily away if they sense that the support from the management is not whole-heartedly there (Corboy et al., 2007, in Hallersbo & Svahn, 2011; Raps, 2004). The motivation and attitude among the personnel is further also of importance. Superior managers must therefore not presume that their own motivation for and views of the strategy or plan are shared by managers on lower levels within the organization (Raps, 2004).

Several different methods for how strategies can be implemented exists (Roos et al., 2004, in Hallersbo and Svahn, 2011) which all relates to time horizon and the importance of the strategy.

Evolving implementation may be used when the problem is of smaller size and the time horizon long.

Controlled implementation may be used when the problem is of smaller size and the time horizon short.

Step-by-step implementation may be used if the problem is of larger size and the time horizon long. With a longer time horizon effects of the changes made can be analysed which means that additional changes can be made.

Extensive implementation is used when the problem is big and the time horizon short.

4 Empirical findings

In this chapter empirical findings are presented. Examples of Visual Planning in the Swedish construction industry are presented, starting with a description of a pilot project made in 2003. Further, results of interviews done are presented. The chapter starts with a description of Tyréns' operations, to give an insight into the prerequisites and conditions at the company. In some parts of the following text the terms "the traditional way of managing the design" and "traditional meetings" is found. These refers to design meetings, held for several hours approximately once every two weeks, lead by the design manager alone, using the meeting protocol as basis for the meeting structure.

4.1 Tyréns' operations

Tyréns AB is a Swedish consulting firm within the urban and rural development sector (www.tyrens.se). It was founded in 1942 by Sven Tyrén and is owned by the Sven Tyrén Trust, created in 1976. Tyréns has more than 1000 employees and 20 offices in Sweden.
Tyréns competence areas are, among others, urban development, bridges, geotechnical, rock and structural engineering, acoustics, road design and project management. Many of the services are directly linked to the design phase of a construction project and represent the different design disciplines involved in the design. Within the field of project management, services as design management, construction management as well as responsibility of the complete implementation of a project is represented.

4.1.1 Participation in the design phase

Tyréns has very seldom, if ever, responsibility for the whole design, since this is an unusual way of procuring design services. Most clients, or contractor if the delivery method is design/build, procure the design per technical area, in other words per design discipline. Most often, Tyréns is only represented by one discipline in a project. Tyréns' participation in a construction projects varies a lot depending on procured service or discipline. In the following text two examples are described.

4.1.1.1 Design management

In some projects Tyréns answers for the role of managing the design. As the design manager, Tyréns answers for leading design meetings and coordinate the design. The design manager can be introduced in a project at various time of the early phases of the project, sometimes after the schematic design but before the detailed design, sometimes after building permits are acquired, sometimes before zooning has been made. The design manager is also responsible for establishing a time plan for the design.

The final deadline is usually already set by the owner. The overall time plan for the project lay as a basis for the design manager to develop a more detailed time plan for the design in particular. In a conversation with a design manager at Tyréns, it is described how this plan is developed using set delivery deadlines as a basis. A plan of decision deadlines, tollgates, is then generated which in turn generates notification deadlines. Comments are gathered from the designers during e.g. meetings and via e-mails and may result in revisions of the plan.

In general the design manager holds the design meetings once every two weeks, where a responsible assignment manager from each discipline participate. The protocol from last meeting is revised by a review of old questions as well as new. The location of the meeting can vary. The duration of a design meeting can vary a lot, from two hours to four hours.

4.1.1.2 Structural engineering

A common assignment is the responsibility of the structural design. When and how Tyréns' structural engineers get involved in projects differ a lot. Sometimes Tyréns can be assigned to take part in early investigations, which may be a part of a feasibility study of a project. Depending on the outcome and strategy of the client Tyréns responsibility may continue in the design stage, when schematic and system design as well as contract and construction documents are made. In other cases structural engineers from Tyréns may be included in the design even after the schematic design.

In time of writing structural engineers from Tyréns are involved in the design of a new office block in central Stockholm, Project One. Tyréns became a part of the design team in a similar way as the first example described above. The management of the design is procured to another consultant. So are also the other design disciplines. Due to the big size of the assignment Tyréns coordinate their work by a head assignment manager and sub assignment managers. Usually, in smaller projects, only one assignment manager is chosen.

This person is the contact between the design manager and Tyréns own structural engineering team, which are persons from Tyréns structural engineering division chosen to take part in this particular project. The assignment manager belongs to the same discipline as the assignment.

Tyréns plan their assignment using the general design time plan set by the design manager as a basis. The assignment manager answers for the development of this internal plan, even though adjustments can be made in conversation with the team. This plan is jointly reviewed approximately once every two weeks at internal design meetings led by the assignment manager. The assignment managers also take part in design meetings held by the design manager approximately once every two weeks. Interdisciplinary questions are managed at these meetings, which may last for approximately four hours, where each discipline's manager takes part.

4.2 A pilot project

Peab AB is a Swedish construction and engineering company and one of the biggest contractors in Sweden (www.bygg.se). In 2003 and 2004 Peab, as the first actor on the Swedish construction market, carried out a pilot project with the objective to test the method Visual Planning in the construction industry. The pilot project consisted of three different real construction projects. Two of these were delimitated to the design phase. The following section is based on the project report written by Dalman (2005).

In the first sub project the objective was to develop a version of Visual Planning suitable for the design phase. It was a construction project of eight tower blocks where the design phase initially was set to a period of four months, using traditional methods. Experiences existed that the design seldom were completed in time of production start. The design was completed after three month and close to impeccable. In the second sub project the objective was to test the developed method in the design phase. The sub project consisted of an apartment building. The demolishment of an on-site existing building was included in the project. The deadline for the design was initially 10 weeks. The design was ultimately fully completed three to four weeks after production start and included some defects/errors. The common opinion of the designers was, however, that they had been able to develop the design faster than with traditional methods.

Peab describes Visual Planning consisting of two parts; break down of objectives (Barashi) and the actual plan. Barashi is Japanese for splitter or divider (www.translate.google.com). The version developed, though the pilot project, for the design phase consisted of three parts; breakdown of objectives and planning, from activity to individual and project governance.

4.2.1 Sub project 1

The first sub project started with the task of identifying current problems in the design process, to lay the basis of a construction project adjusted version of Visual Planning. This was done through workshops where regional manager, foreman, construction engineers, site manager, business developer and external Visual Planning experts took part. Reasons for project failure and links between them were discussed. It resulted in a meeting agenda and rules of conduct for the meetings (see Figure 6).

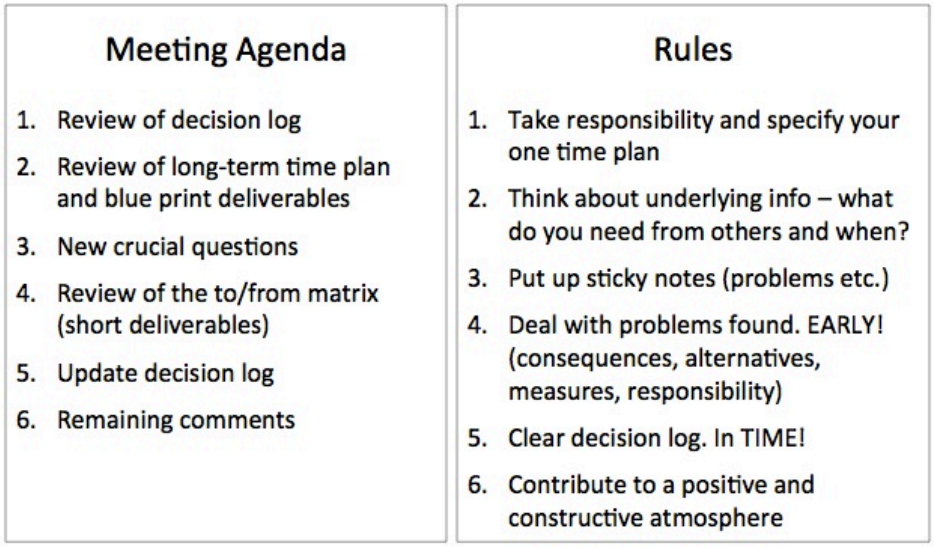


Figure 6. The meeting agenda and rules of conduct. Source: Author's version based on Dalman, Visuell Planering, Projektrapport, 2005.

A time plan was established where design milestones proposed by the building contractor were included. The time plan included each design discipline and time, in weeks. Each designer then decided what sort of information they needed and from whom they needed it in order to meet the requests. This was posted on the time plan through sticky notes (see Figure 7). Questions popping up during the progress of the design phase were managed in a to/from matrix, sorted after designer disciplines (se Figure 7), again using sticky notes.

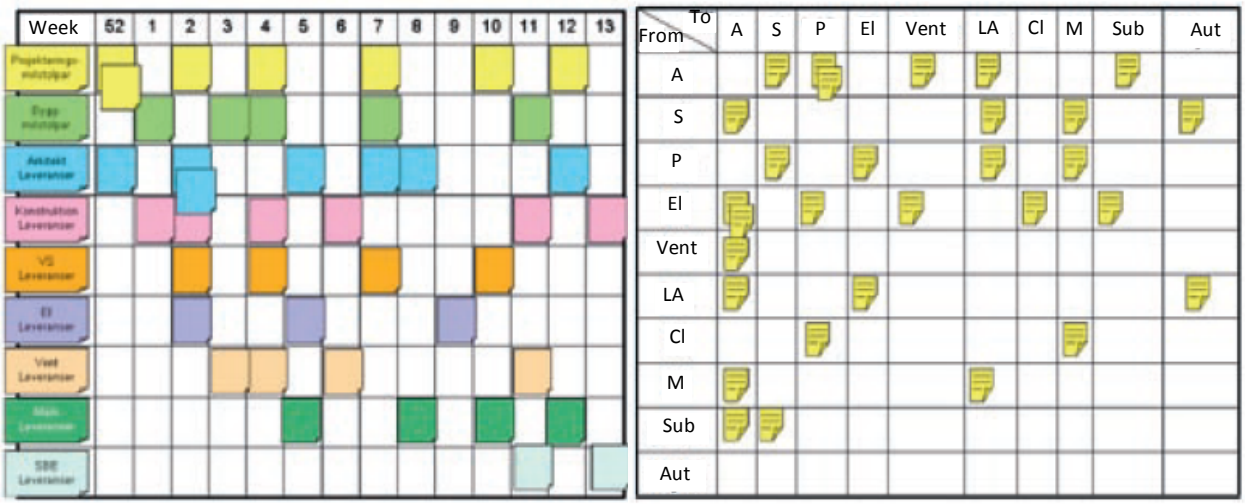


Figure 7. To the left, time plan sorted by design discipline, using colour-coded sticky notes. To the right, To/From matrix for the management of on-going question between different design disciplines. Source: Author's translation of Dalman, Visuell Planering, Projektrapport, 2005.

Questions of important character, able to decelerate the design, were placed on a special board and called "Crucial questions" (see Figure 8). Taken decisions were posted in a decision log (see Figure 8).

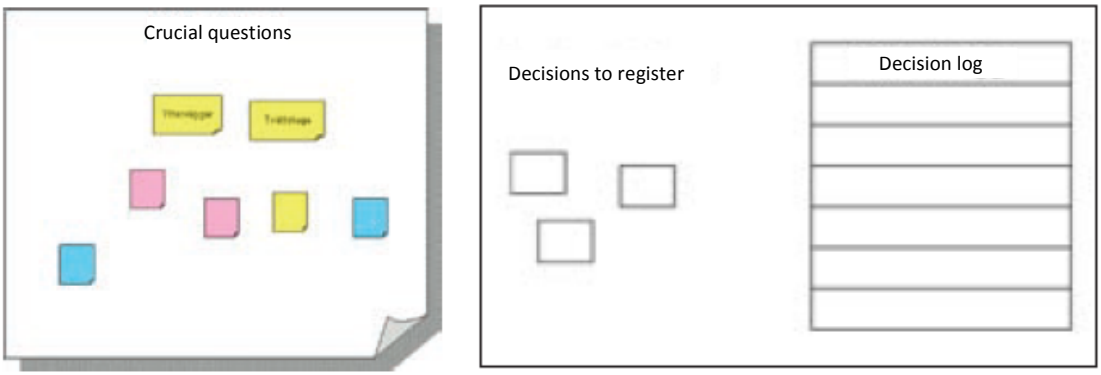


Figure 8. To the left, the board where crucial question was placed. To the right, decision made presented in the decision log. Source: Dalman, Visuell Planering, Projektrapport, 2005.

The decision log was the only document distributed to the design participants. The meetings were held twice a week and restricted to last maximally one hour at a time, which was achieved after a couple of times. Questions risen at the meetings where solved by the concerned designers in smaller meetings afterwards. Possible decisions were announced to the rest of the group and documented at the next meeting.

4.2.2 Sub project 2

The initial time plan for the design, in the second sub project, was developed by the project manager, the architect and the structural engineer. As other design disciplines became involved in the project revisions were made collectively. The meetings were held once a week and planned not to last longer than one hour. This was, however, not fully accomplished. In accordance with the rules of conduct developed in the first sub project detailed design questions were not to be solved during the meetings, but in sub meetings afterwards. This was however not fully accomplished either. This was claimed to be the reason for the exceeded duration of the meetings.

The boards developed in the first sub project were used more or less in the same way as described in former section. Activities, represented by sticky notes, formed the design time plan and were cross-marked after completion but remained on the board. In addition to the tools developed in the first sub project, "Remember notes", such as self-monitoring, were placed next to "crucial questions" and the "decision log". In total, the design time plan, the "crucial questions" board, the to/from matrix and a production time plan were gone through at the meetings.

The to/from matrix made it easier to see who had asked a question and who was to answer it. It also made it possible to see how many question each participant had to deal with. An unofficial protocol was made by the site-manager and distributed between the design members.

The participating designers were interviewed after the completion of the design and all designers claimed to be pleased with the method. The high frequency of meetings was considered to contribute to a higher working pace. The client, who in this case also was the contractor, was, however, a stumbling block and had the most problems keeping up with the high pace. The designers also concluded that the high frequency of meetings decreased their ability to participate in as many projects as usual.

Some participants stressed lack of documentation of how plans and board had been developed and changed over time as well as the reason why, as a shortcoming. Individual notes existed, but could differ a lot and contradict each other due to individual interpretations. The to/from matrix was appreciated for its way of placing pressure on the responsible person, which were interpreted as a factor leading to quicker replies.

4.2.3 Pilot Project conclusions

Peab concluded that the method is suitable to adjust for the construction industry. Clearer interim objectives and the high frequency of meetings are interpreted to make decision-making easier. Problems were identified early and solved in time. According to Peab, participation, consensus and improved communication, in the manner of faster measures, were the key factors for Visual Planning's contribution to the design work. The project report states that understanding of the importance of fellowship to facilitate realisation of planned objectives has been gained and that "the design was considerably improved without an increased input of resources" (Dalman, 2005, pp. 33, my English translation).

4.3 Visual Planning according to the construction industry

10 persons with experience of Visual Planning have been interviewed. All quotes in the following texts have been translated into English from Swedish. The sections on Lean Design®, VDC and Stockholmsarenan are based on, if no other is stated, information given by the interviewees. All interviewees are referred to by abbreviations of their professional position.

Respondent A (PD1) is the CIO, Chief Information Officer, of the consultancy firm Projektengagemang Byggprocesstyrning AB. A company focused on process management in the construction industry with a focus on, among other things, BIM. The respondent was the main developer of Bjerking's concept Lean Design®. This respondent will be referred to as PD1.

Respondent B (PD2) works with R&D questions at the Swedish contractor Peab and was the project manager for the pilot project, implemented by Peab, presented above, and will be referred to as PD2.

Respondent C (DM1) is design manager at Swedish A/E consultancy firm Bjerking AB. The respondent has experience of using Visual Planning in the design phase, mainly though design assignments implemented via Bjerking's own concept Lean Design®. Lean Design® is described and explained further down, later in this text. The respondent will be referred to as DM1.

Respondent D (DM2) is also a design manager at Bjerking AB, with similar experience of Visual Planning as DM 1. The respondent will be referred to as DM2.

Respondent E (DM3) is one of several design managers in the project Stockholmsarenan, a new sport and event arena in the southern parts of Stockholm. The respondent works as a consultant from the consultancy firm Makab for the Swedish contractor Peab in the project. Visual Planning is used for the management of the design in the project. This respondent has no previous experience of Visual Planning. The respondent will be referred to as DM3.

Respondent F (DM4) is a design manager at the Norwegian contractor Veidekke. The respondent has participated in and been responsible for the management of the design in several projects where the concept VDC (Virtual Design and Construction) has been used. VDC is explained and described further down in this text. The respondent will be referred to as DM4.

Respondent G (D1) is a structural engineer and designer at Bjerking. The respondent has been working as a structural engineer for 10 years and has participated in one design assignment at Bjerking where Visual Planning was used. This respondent had heard about Visual Planning before that but not in the construction industry. The respondent will be referred to as D1.

Respondent H (D2) is an architect at Bjerking AB with five years of working experience. The respondent has experience from the same design assignment at Bjerking as D1, where Visual Planning was used. The respondent has also experience from an assignment where Bjerking's digital version of Visual Planning was used. The respondent will be referred to as D2.

Respondent I (D3) is CEO for the consultancy firm Projektengagemang VVS AB and contract manager for Projektengagemang VVS' assignment in the project Stockholmsarenan, which included the design of ventilation, heat and sanitary. Stockholmsarenan is the first project the respondent has taking part in, where Visual Planning is used in the design. The respondent will be referred to as D3.

Respondent J (D4) is an architect and works for the Swedish architectural firm Wingårhds Arkitektkontor AB. The respondent has participated in designs led by Veidekke and have experience from VDC, but also from projects outside of Veidekke where BIM and Visual Planning has been used. The respondent will be referred to as D4.

4.3.1 Lean Design®

The concept, method and service Lean Design® was developed at Bjerking in 2008. The purpose was to adjust the process of how to work in the design to the usage and possibilities of BIM (www.byggindustrin.se). The service means that Bjerking takes full responsibility of the design, all designers are in-house. In Lean Design® the designers work together one or several times a week in a project room, equipped with computers, projector and whiteboards. Sitting together in a project room facilitates spontaneous teamwork and problem solving. The projectors are used for joint reviews of the models. The boards include an objective and delivery board, a question to and from board, a crucial question board and a decision board and used for Visual Planning (see photo in appendix 1).

The design team, including the design manager, starts with developing a plan together, the objective and delivery board, using sticky notes, in similarity with the boards developed in Peab's pilot project. Meetings are set to 30-40 minutes. Each designer goes through his or her own questions. Clarified questions are removed and documented in the decision log, the only resulted documentation of the meetings. The designer bringing up a question determines when the question is fully answered. Via the questions brought up on these meetings, smaller meetings (sub meetings), for problem solving can be arranged (see Figure 9).

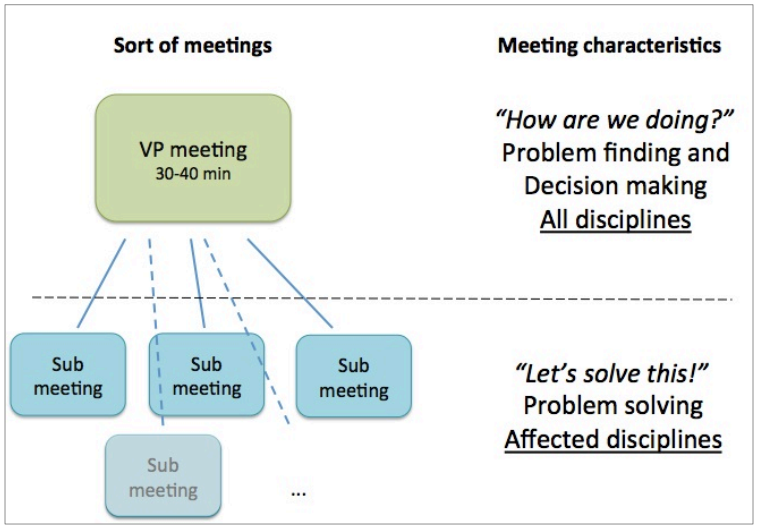


Figure 9. The meeting structure generated by VP. Source: Made by the author.

Recently, Bjerking have stopped using the term Lean Design®, since the concept mainly was based on the use of a special "Bjerking team". Lately focus has switch to development of different ways of using Visual Planning, for enabling usage in any and all projects or design assignments, regardless of the proportion of in-house designers. The assignments in which Lean Design® or Visual Planning has been used have been limited to the ones where DM1 or DM2 have participated as design managers. The documentation has also, in some projects, been complemented by a digital version of the question to and from board, software-based solution developed within Bjerking as a part of the operation system.

4.3.2 VDC

VDC stands for Virtual Design and Construction and is the way Veidekke manages the design in their own developed projects using BIM. Veidekke Bostad AB is a project developer meanwhile Veidekke Entreprenad AB is a contractor. Sometimes Veidekke Entreprenad gets assigned by Veidekke Bostad to deliver Veidekke Bostad's developed project, which means that Veidekke Entreprenad gets the role of a design/build contractor (responsibility of design and construction). Design using VDC means that all design disciplines are gathered once a week to participate in an ICE meeting.

ICE stands for Integrated Concurrent Engineering and is a method developed by NASA. Instead of working disciplinary at separate offices the designers work together in a special room. Questions are brought up, problems solved and designs made at the same time. Several discussions and meetings can take place at the same time between different disciplines. In VDC Veidekke gather the design disciplines once a week for a full day of work. All participants are external, except the design manager and a VDC coordinator. It is important that all participants are decision makers.

The day starts with each participant going through what they have done during the week and what expectation they have for the day. In addition to ICE a question board is used. The board is a matrix of participants and time. Questions are written on sticky notes and placed at the matrix in the box representing the participant requested to deliver an answer and date of when the answer must be delivered. The matrix is, in other words not based on who the requesting person and the answering person is, but on the answering person and at what time the answer shall be delivered (see photo in appendix 1). The sticky notes are colour-coded after who is asking the question. This is also written down on the sticky note.

Each team member also attaches sticky notes with their own planned activities and the planned finish dates for these on the other half of the board. The day continues with a joint review of the 3D model. When this is done, usually after 2-3 hours, individual work follows. After the workday, sticky notes are removed and documented in a digital spreadsheet, decision in a decision log, and general info or decisions in a protocol, by the design manager.

The way Veidekke work with VDC is a development of their own concept MI, which stands for Medarbetarinvolvering (in English, Co-worker Involvement), first developed at Veidekke's operations in Skåne, the most southern parts of Sweden. MI is Veidekke's way of getting all project participants more involved and active in the project. Visual Planning and the use of objective and delivery boards, question boards etc. is one tool in MI. The increasing use of BIM has however led to a development of MI to VDC. VDC may be explained as a combination of MI and BIM. Veidekke has used VDC once in design where the client has not been Veidekke Bostad AB.

4.3.3 VP at Stockholmsarenan

In the project Stockholmsarenan Visual Planning is used in the design. An objective and delivery board, a question to and from board, a crucial question board and a decision log are used (see photos in appendix 1). Assignment managers for each discipline or technical area take part in the meetings, which are held once a week for approximately one hour. When a question of interdisciplinary character is raised, it is written down on two separate sticky notes. One is placed at the question board and one is given to the person responsible for giving an answer.

The meetings start with general information and a review led by the design manager of current sticky notes on the question board, to determine whether they have been clarified or not. When a question is clarified the sticky note is removed from the matrix and placed in the decision log, also on a whiteboard. The decision is documented in a digital spreadsheet and a picture is taken of the decision log of the current meeting. The objective and delivery board is thereafter reviewed. Based on the questions visualized on these meetings smaller working meetings (sub meetings), are created, similarly to Lean Design® (see Figure 9).

At the time when this is being written, the intensity of the design work has decreased since production is in full progress. The Visual Planning meetings are therefor at the moment only held once every two weeks. Initially most designers were located at the project office. This has now changed due to the same reason as the decrease of frequency in meetings. The objective and delivery board has not been used the last year.

4.4 VP according to the process developers

Design of higher quality is a design with fewer errors. PD2 at Peab means that Visual Planning creates this. PD2 states that an objective at Peab is to have reviewed and approved design document before construction start and that VP is a support to create that. According to PD2 the traditional way of managing the design, using protocols, is not always efficient.
PD1 at Projektengagemang Byggprocesstyrning (developer of Bjerking's Lean Design®) defines Visual Planning as a Lean tool. The most interesting part about VP, according to PD1, is that the process is broken down and a puzzle is built together. PD1 stresses that Lean is all about mapping processes.

PD1 draws parallels between a design manager and a musical director. To direct an orchestra the musical director must know all instrumental groups' notes. A design manager can seldom see all notes. PD1 states: *"It's better when the group develop the time plan. That's the big point".* PD1 has encountered the wish and idea of offering a full design service several times. This respondent describes BIM to be a tool facilitating an interdisciplinary way of working, but the process has been missing. This respondent claims that this is where VP comes into play, as a working method and process support.

PD2 stresses the effect that problems are solved earlier when using VP. Fewer problems needed to be managed during production is both time and cost saving, PD2 continues.

PD1 explains typical parts of VP as the use of a project room with boards (object and delivery board, question board etc.). In the concept Lean Design®, which PD1 developed at Bjerking, they wanted to sit together working, not only during meetings. This respondent points out the importance of human communication. The respondent describes when working according to VP, the first step is to go through the objectives to establish common base values. The respondent gives an example: *"If you, as a group, shall cut a tree, you have to first agree upon what a beautiful tree is. Otherwise you can't do it."*

PD1 stresses that participation, involvement, and a common set of base value creates understanding for the process and other team members' work. PD2 also agrees upon the importance of participation and involvement and that VP is based on physical presence and active participation. A design member cannot sit quiet and listen in VP. PD1 also stresses the effect of the designers stating themselves what they need and when they can deliver.

"I believe that all individuals function in that way. If you have said it or promised it yourself, you stand by it. That's what this is about. When you, yourself, have stated when you can deliver and what information you need. You have been given the chance to do that. You endorse it then. I believe that is a psychological affect of this, not only that participation is created, but that you've actually given a promise."

At first sight, PD1 could agree with sceptical persons. PD1 believes that most people initially think working with sticky notes sounds trivial and silly. Adjusting to a system may also be a hurdle. VP planning suits individuals that are system organized. Sitting together, as in Lean Design®, can also be difficult. Some individuals may feel they are out of their comfort zone. PD2 stresses the process of change as the biggest difficulty. Otherwise, the respondent stresses the simplicity of the system and that VP facilitates the design for all participants.

"The key factor is understanding. When they understand, they see the benefits and commits to the process. You can't push it and have no one understanding why. Then it won't work. That is very important."

PD2 mention that all design disciplines are informed of the conditions and planned way of working in advance. They can decline. But PD2 stresses that people in general are positive. Some misses regular protocols, but this is also an effect of the change management, PD2 continues. Actors that do not participate in the team, but still have a need of following the work, may miss the protocols. Sub reports can then be a solution.

According to PD2 VP can be used in all projects. This respondent believes however that the effect is bigger the more complex a project is. PD1 stresses the use of VP as a way of working with constant improvement, e.g. by writing the cause of an issue on the back of a clarified sticky note. The value of working according to a method is another insight the respondent has had. When a method exists, it may always be improved. That is not possible without a method. The

respondent compares the construction industry with Ford's original way of manufacturing cars. At Ford the most important thing was never to stop the assembly line. This results in a never-learning industry.

PD1 shares PD2's experience, that no one claims VP to be bad after having tried it. The later respondent describes a general wish of digitalization, but believes that it would ruin the essentials of the method. A benefit would be the filter and seek abilities, but the stepping forward of each participant is important. You can easily see the effects of changes in the planning. PD2 agrees.

"You shouldn't hide behind a computer. One should be present in a physical way. It makes you take bigger responsibility for your actions. […]. *One of the biggest advantages is that you use all your senses. I, at least, prefer to stand up and work. Instead of reading a protocol."*

PD1 describes VP as a process where all your senses are used. It has an effect on the learning process. The respondent believes, however, that western culture focuses on finding the tools, when implementing Lean, e.g. implementing the boards, but misses the cultural part of it. The respondent claims that it is not all about the boards. We take the tools, but do not understand that it is a culture.

4.5 VP according to the design managers

"I see only benefits."
DM1

According to DM1 and DM2 at Bjerking the biggest benefit of Visual Planning is the generated engagement and control. A higher level of clarity is created by formulating issues into question placed at the question to and from board. It is easy to see who has asked the question and who is supposed to give an answer. Issues do not get stuck and left behind or forgotten as in a traditional protocol.

DM1 describes Visual Planning as the use of an objective- and delivery board, question to and from board, crucial question etc. They stress that VP is much more efficient than traditional design meetings, since a designer may have five minutes of value creating time in three hours in traditional design meetings. Using the VP meetings for setting up smaller sub meetings is also a benefit. It is easier to define that e.g. the architect and the structural engineer must meet and discuss the issue. When the designer get more involved and dedicated it is easier to get everyone to have their say, which in turn make issues reach the surface earlier. Problem solving can start earlier.

This is something DM4 at Veidekke agrees with. DM4 also stresses the effect that one cannot hide when using VP. The respondent claims that VDC not necessarily shorten the design phase but contributes to a design of higher quality and less errors. The more error-free design, the better tender documents, the easier it is to stay within budget during production. DM4 continues by stressing the effect of a more active designer. When one brings up what they need from each other clarity of what is needed to be done is generated, which is not always generated in the traditional management of the design.

It is however important to be well prepared for the meetings. Sitting together as in VDC also simplify question asking. The structure generated by VP, how the need of sub meetings easily is identified is something that DM3 at Stockholmsarenan also stresses as a gain. DM3 explains how details are not dealt with in the VP meetings, which he sees as an advantage.

The decision log as the only documentation is something positive according to DM1 and DM2. This is probably one of the biggest benefits according to DM3. DM3 explains it in the quote bellow.

"In such a big project as this [Stockholmsarenan (author's note)]*, according to my point of view, traditional design meetings would never work. The protocols would be several hundred pages long. No one would have the strength to go through it.* […]. *Visual planning in a project like this is, according to me, absolutely necessary. You can't have the traditional meetings, it takes far too much time."*

The documentation is however very important, DM3 continues. DM4 agrees with him. DM4 stresses that some of the designers, which the respondent has worked with, have expressed especially the lack of historical documentation explaining the development of boards' appearances as a problem. The only documentation available of this is usually individual notes, which may have been written in contradicting ways. Thus the team members lack a common view of the reasons for the boards' appearances.

The involvement and participation, to solve problems together lead to better planning according to DM2 and DM1. The objective and delivery plan is one example. It can be difficult to know what information each designer need from whom and when. Planning the design alone as a design manager, it is easy to forget pieces. DM1 stresses how this is the overall objective with Visual Planning.

DM4 explains how the job around putting up sticky notes is not always easy and sometimes design participants do not feel comfortable doing it. Partly since they also have to formulate their own responsibilities. DM1 shares this experience. But DM1 stresses however also the effect of doing it. If one has been active and participated in the decision-making and planning, one is more eager to follow it. The involvement and participation may also help quiet persons according to DM1, in comparison to regular meetings where positivity is favoured. DM1 and DM2 share the experience of being much more passive as design managers in VP meetings, compared to

regular design meetings. In regular design meetings everything evolves around them, in VP meetings the designers are given a much bigger role.

Despite the problems stated by DM4, DM4 states that no one has ever said that they are not willing to work as in VDC again. Suggestions of improvement have been given however. Some designers have experienced the time at Veidekke's office as inefficient. DM4 stresses the importance of the working environment and access to each designer's virtual home office. DM4 states furthermore the importance of the client participating and being given the chance to work and understand the method. Production shall also be represented in some way. DM3 agrees. It is a prerequisite and the point of the method, that every actor is represented.

According to DM1 and DM2, everyone that they have worked with has been positive. Initially some may be sceptical, but as soon as they understand the method, everyone is usually positive. Naturally, it is easier for them if everyone is from within Bjerking. DM2 has however developed a digital version to solve the access problem. The more participant there are from Bjerking, the better are the conditions for effective collaboration however. They continue by stressing the fact of not being able to handpick participants.

When working with external designers the need of documentation increases. Parts of the boards can however be used in projects where VP is not used. DM2 has e.g. in some design management assignments, where all designers have been external, used a digital version of the question to and from matrix. In these assignments, design meetings may have been held only every third week, but DM2 have filled in the matrix by communication via e-mail in between the meetings.

DM2 and DM1 state a belief of the ability of using VP in all sorts of project, and all sorts of planning. Size of the design team only increases the requirement of good leadership and governing. VP is suitable in the design phase since so many issues are managed in this stage of a construction project. DM1 continues by claiming that errors in the design is the biggest error factor during construction, in general representing 26% of all error costs of the construction.

DM2 and DM1 also believe that the method will spread fast. They work with external designers and so does Peab and others. The structural design department at Bjerking is thinking of starting to use the method for their internal planning and management. DM3 thinks that VP may not always be necessary and compares it with 3D design. It simplifies but is not a must. In a smaller project VP will not have the same impact, DM3 says. DM4 believes in the use of Visual Planning and expresses a belief in the possibilities of scaling the method. DM2 expresses, however, an insight in the time needed to implement Lean in an organisation.

DM4 expresses a belief in the importance of the physical activity of writing and attaching sticky notes, compared to the alternative of the design manager only recording the questions directly in a digital spreadsheet. The physical activity is what creates the participation and involvement. DM1 agrees and points out the impact of involvement:

"You shouldn't underestimate the usage of the sticky notes, to physically take a step forward to the board and to writing by hand. … One may think it's trivial, but it is the step… You could use just a digital spreadsheet and sit around a meeting desk the whole group together, but then you're back working as in a traditional design meeting. To participate in an active way and self-contribute, that's what's important. … VP is an effective way to create that."

4.6 VP according to the designers

D3 at Projektengagemang VVS finds Visual Planning contributing to shorter and much more efficient meetings. Meetings that usually could last for four hours, takes only one hour in the project Stockholmsarenan where D3 take part and where VP is used. D3 describes VP as "*a way of activating the participants in a good way and a visual way of 'sending questions' to each other, as well as a way of making the meetings more efficient*". D3 thinks the method has been effective, especially in the schematic design. It has not been as effective in the later parts of the design process though. This respondent claims, however, that this is due to the smaller amount of questions and issues in the later phases.

When D4 describes VDC and its benefits, the main focus is on BIM and the enabled 3D visualisations. However, according to him, the purpose of the question and work matrix used in VDC is to ensure that questions and issues are not left behind as well as given to the right person. This facilitates D4's work. The number of sub meetings (C-meetings) increases due to the method, but the length of the design meetings is shortened. DM4 feels that the method generates clearer decisions in comparison to traditional design meetings but that it at the same time requires more of the procurement of designers and contractors.

D3 believes that VP can be used in all projects, regardless of delivery form, as long as the design manager and all the participants follow through with the process during the whole project. D4 agrees and says:

"I see no limitations, and in larger projects where design meetings tend to turn into problem solving meetings prolonging the meetings, the benefits are even bigger".

D3 stresses however the vulnerability in the documentation but also the benefits, such as generated time savings and commitment, by saying:

"The disadvantage with the VP method is that the documentation partly suffers. The method is developed for an internal way of working at Toyota, where everyone is working 'wearing the same hat'. What may cause troubles is if an error occurs that requires that one goes back to trace whose fault it is. It can be difficult to sort out errors since the traceability is difficult and the questions extremely briefly formulated. […]. *The biggest benefit is the time aspect and the involvement"*

The designers' experiences differ a lot though. D1 thinks it is difficult to explain or describe Visual Planning. This respondent says that by describing what deliverables is needed to be exchange in the project team, the question of how to move on in a project is quickly sorted out. D1 laughs and states *"the use of a whole lot of sticky notes"* as short description of the method. D1 claims that the meetings got longer and less efficient. Failing documentation is the biggest issue:

"*The VP meetings took much longer time than traditional design meetings do. It was quite inefficient. It did not exist any protocols in any way, one had no idea of what was decided.* […]. *Decisions made by the contractor, which we were directly affected by and depending on, were not documented anywhere. It was not positive at all."*

D1 further describes that the meetings were held once a week and took 2,5-3 hours in the project where VP was used. A project room, such as described in the text about Lean Design®, was used. The design manager reviewed the matrix meanwhile some designer continued with their own work in front of their computers. Technical and detailed questions were often discussed during the meetings. No decision log was used, or at least not distributed to the designers, according to D1.

D2 explains the use of VP in this project in a similar way but stresses that the meetings using the boards as basis lasted for half an hour up to an hour, and were then followed but more detailed discussions for 1-2 hours. Since everyone sits together one can easily choose level of participation. D2 agrees however with D1 about the failing documentation and emphasizes the importance of traceability. This applies, as well, to the project where the digital version of the question to and from matrix was used.

D1 was initially very positive to the method as D1 was introduced to it through a workshop, an exercise where the participators created a time plan, but feels the opposite way after the finished assignment and stresses that *"it is a worse way of working… at least the way we did it"*. D1 says however that it may be easier to be passive and just "slide" as a designer in traditional meetings, meanwhile VP add more responsibility on the designers. D1 believes that a well-experienced design manager and some kind of decision log is crucial for the effectiveness of the method. D2 agrees and says:

"As long as you can't free text search in the documentation [digital "question to and from", (author's note)]*, in my opinion, VP is not that good in any project. Regardless of the size of a project the ability of having control over which decisions that are made is always required."*

D2 thinks however that VP can be effective in any project if that is managed and that, in the end, the more senses we use the overall picture becomes clearer and more common.

5 Analysis

In this chapter similarities as well as differences in the interview result are analysed and discussed. The aim of the chapter is to combine this discussion with the presented theory.

5.1 Interpretations in the construction industry vs. the product development industry

The general interpretation of Visual Planning in the construction industries is similar to the product development industry's interpretation in many ways. The boards in Peab's pilot project consisted and illustrated the same kind of information as in the Pulse methodology (Sebestyén, 2006) and the cases presented by Lindlöf and Söderberg (2011). Rules, such as that only the person attaching a sticky note is the one allowed erasing it and stating it as finished, is also a component shared by the two industries. The question to and from board seem however to be an addition to the method done in the construction industry. This might be an effect of a lower level of informal problem solving due to the nature of more scattered teams in the construction industry.

The meetings are in general longer in the construction industry, 30-60 min, than in the product development industry, 20 min in accordance to Lindlöf and Söderberg (2011), and not held as frequently, once a week compared to several times a week. The different interpretations within the construction industry, at least the studied examples, have also many similarities with one another. Most of them seem to have taken inspiration from Peab's version, since they use the same boards. Veidekke's version of VP in VDC deviates slightly however, since they have combined the objective and delivery board with the question to and from board. In several cases Visual Planning is in the construction industry used as a component in companies' own-developed standardized working method for projects where BIM is used.

All studied companies have complemented the method by documentation in some kind of digital format. In all cases, the companies using VP have either had responsibility for several technical areas, design disciplines, in the design or responsibility for several phases of the project in general (Lean Design® – several design disciplines, Stockholmsarenan and Veidekke/VDC – design management and construction).

5.2 Difficulties and hurdles

A recurring problem, according to the interviews, is the low level of documentation and absence of traditional protocols. Both designers, design managers and developer express this. The

developers and design managers express the problem as something they caught up from some design participants rather than a self-experienced problem.

One designer, DM1, put great emphasis on the impact of lower level of documentation. Several designers agree and stress that it is difficult to trace the origin of an error. The required brief formulations of the question could also be a problem. This designer experienced that it caused confusion and lack of evidential proves in later discussions and disagreements. Another designer explains the reason of this disadvantage originating from the initial purpose of the development of Visual Planning. The method was developed for the internal way of working at Toyota, which means that all parties are "sitting under the same umbrella". This is seldom the fact in the construction industry. In the project where DM1 has experience from, the client's way of participating in the work seems to have had a great impact.

Talking to DM4, the low level of documentation does not seem to be such a big problem. On the other hand the projects where they use VDC and VP are design/build projects, where they themselves answer for the construction. In this case, even the client can be seen as internal, Veidekke Bostad AB, the project developer, which means that the parties are in a greater extent "under the same umbrella". One could think that this would not be a problem in the Lean Design® concept as well, since the purpose of the concept is to have one actor answering for the whole design. But neither the client nor the contractor is "under the same umbrella" in this case.

When DM4 stresses that the lack of documentation may lead to disagreements due to different interpretations of e.g. decisions and a lack of a common overall picture, I find this very interesting. The purpose and one of the biggest benefits of Visual Planning stressed has been the generated common overall picture. Components of the method have been claimed, both by Sebestyén (2006) and Lindlöf and Söderberg (2011) and several of the interviewees, to generate a common overall picture and understanding, at the same time it is being stated that other parts generated the opposite.

Another paradox is the statement of the hurdle of the necessity of adapting to a system when working with Visual Planning and that the participants may found this disturbing. A frequently stated benefit of VP is the participation of the team members leading to a higher level of involvement and engagement. Instead of just following a set plan, the team members are involved and given the chance to participate in the planning, which results in a feeling of not being forced to adapt to something already determined. Nevertheless the choice of using a method such as VP demands participants to follow a system and therefore to adapt, and this is what some claims to possibly be a hurdle. However, according to Liker (2009) the use of standardised working methods shall not be seen as a way of controlling employees but the opposite way around and a prerequisite for continuous improvements, which is also mentioned by PD1. An agreed way of communication, which could be compared to standardised working method, is also stressed as a necessity by Dainty et al. (2006).

The fact that interpretations and experiences of the method in some cases differ a lot can be a hurdle. Most interviewees express a belief in the method. DM2 and DM1 think it will spread fast since they experience that all participants in the end appreciate the method and more and more designer will be introduced to it since many of the actors using VP are working with external designers. PD2 also emphasises the simplicity of the method and that it generates benefits for all participants. Still, some of the interviewees have stressed bad experiences of Visual Planning. But if opinions and experience varies in such a great extent, what message about the method will be spread?

The belief of the method spreading fast is based on the appreciation of the participants and people being introduced to it. With a bad experience, regardless of reason, that person will not recommend the method. As PD2 points out, the understanding for the method is a crucial factor for the success of the method, which also correlates to implementation theory (Whittington, 2002, in Hallersbo & Svahn, 2011). This is probably also one reason for the variety of views. The more background knowledge of the purpose and the basis of the method, the more positive is the interpretation.

The developers are in general very optimistic. Working with development questions, at any company, probably implies a positive approach to change. Optimism among the developers is therefore natural. The design managers have also in general a more positive view of the method than the interviewed designers. Several of the interviewed design managers have a great interest in methodology, process etc. in general. Several of them know a lot about Lean. One design manager stands out however. That respondent was positive but not as visionary as some of the others. This person has also less experience of the method and its background.

5.3 Opposite effects

D1 expresses a bad experience of Visual Planning as a method. Even though difficulties and shortcomings are expressed by most of the interviewees, they found the method in general positive and no one expresses such disbelief as D1.
What is interesting with D1's described experiences is that they are the total opposite to the claimed and, by many other interviewees, experienced effects, se following quote.

"*The VP meetings took much longer time than traditional design meetings do. It was quite inefficient. It did not exist any protocols in any way, one had no idea of what was decided.* […]. *Decisions made by the contractor, which we were directly affected by and depending on, were not documented anywhere. It was not positive at all."*

The poor documentation has been brought up both in previous research done in the product development industry and by the other interviewees but no one expresses such failure of the

method due to this shortcoming. D1 also describes the method to generate longer and less efficient meetings, the opposite to what otherwise is said and written about the method. How can D1 experiences differ from theory and other interviewees?

5.3.1 Lack of documentation

First of all, no decision log was distributed. The decision log as documentation alone, may be experienced as a too low level of documentation. If it is removed, no documentation is left at all. Whether the decision concerns crucial questions or bagatelles the need of having it documented is obvious. There may not even be disagreements about what has been decided, just that no one remembers. A digital version of the question to and from board existed, but this could only help the designers to remember current issues.

D1 and D2, who have experience from the same project, both emphasise difficulties and disagreements with the contractor (the project was a partnering project). For example, the contractor often changed conditions and earlier made decisions. The design team had problem meeting these changes since much of their work had already been done, using previous condition as a basis. Or, to meet them, a lot of their previous work was wasted. D1 states that they (the design team) could however, due to the lack of documentation not show and explain this to the contractor. The source of this problem is not the lack of documentation and the method Visual Planning per se, but the actions of the contractor. The importance of consensus about how to work is obvious in this case. However, the shortcomings of the method are in cases like this proven to become critical.

5.3.2 Longer and less effective meetings

According to D1 Visual Planning resulted in three hours long design meetings. Detailed discussions took place frequently and D2 describes the opposite relationship of the meeting structure as the one described in Figure 8, in paragraph 4.3.1.. It seems like the effect of the method generated a more problem solving oriented meeting. This is even stated by D1. D1 expresses a belief of meetings with focus on problem finding to generate sub meetings for problem solving, but that this way of working is according to the traditional way and Visual Planning generates the opposite.

On the other hand, D2 describes the meetings in a slightly different way. This person states that the meetings using the boards took half an hour up to one hour and were followed by more detailed discussions where the designer could choose whether to participate or not, depending on the relevance of the discussion to them. In other words, one could say that the VP meetings took half an hour up to one hour, in similarity to other interviewees' descriptions, and were followed by smaller sub meetings intended for problem solving. The problem might then have been that this was not done in a clear way, since the sub meetings were held in the same room, with the

same persons in it, directly following the main meeting. Despite the experienced more passive role of the design manager generated by Visual Planning, the demands on the leadership of design manager does not decrease, as at first sight could be expected. In opposite, they seem to increase.

Another interesting thing in D1's story is the designers' way of participating in the meetings. D1 stresses an advantage of Lean Design® being the possibility to continue working with the computer during the meeting. Many of the designers sat, in other words, in front of their computers during the meetings. The active participation has been a recurring strength of the method and an important ingredient (Sebestyén, 2006; Liker, 2009), and discussed further in following paragraph.

Due to mentioned reasons above the implementation of the method seems to have been the reason for failure in this particular project, rather than the method in it self, in accordance to implementation theory (Hambrick & Canella, 1989, Corby et al., 1999, Whittington, 2002, in Hallersbo & Svahn, 2011).

5.4 The positive effects and the basis for them

Most respondents, however, seem to agree which factors in Visual Planning that affects the design process positively compared to the traditional way of managing the design, in other words, which factors that contribute most to the efficiency of VP.

Several persons stress the effect of the design members' participation. The breakdown of objectives and the setup of a common time plan do not change the deadlines. That is seldom possible, and probably not the purpose either, but it visualise what is required of the participants towards each other. Some may claim that this is done in the traditional way of managing the design as well, but perhaps VP makes it clearer.

The breakdown of the objectives into delivery and notification points may not be that distinguishing but the fact that the designers have participated and developed this information and therefor also the plan might be. Several interviewees emphasize the effect of the participants, by themselves, expressing what they shall deliver as well as what they need. In general, the clarification of commitments can be divided into three different areas: The commitment of delivering what one has said in the joint time plan (the objective and delivery board), the commitment of delivering the information requested in a certain question (the question to and from board) and the commitment to seek the information and answers one has expressed is needed (the question to and from board).

The last part is maybe the most important. Not only will a person responsible for delivering an answer to a question become more willing to do that, but responsibility is also placed on the information seeking person. As PD2 expresses it, *"you can't hide"*. Giving lack of information at the right time as a reason for not being able to meet a deadline is common, according to both design managers at Tyréns as well as the interviewees. This is exactly what the effects of Visual Planning might work out. This applies as well for the time management. One cannot say "Two weeks? I can't be done in two weeks", when that person has participated in the work of developing the time plan.

By the compilation of the objective and delivery board a time plan adapted rather to the internal (within the design team) information delivery deadlines than drawing and document deliverables is generated. The drawing and document delivery points are naturally the basis and the starting point information to define the information delivery points. However, when planning the delivery of information one is automatically also mapping the working process and in Visual Planning it is also made visible. It is very much about HOW an objective, goals, deadlines etc. is reached, instead of just only WHAT and WHEN. The question HOW is probably often a part of the traditional way of managing the design but since the design manager primarily single-handed answers it, it is not answered, illustrated, visualised or communicated to the designers.

When it is not illustrated and an active part of the actual plan it will also be harder for the design manager to follow up its progress. This can both be related to Sebestyén's (2006) thoughts about project management as well as Winch's (2011) thoughts about management of construction projects. Sebestyén stresses the need of communicating how to reach goals and deadlines since they may seem unrealistic and unreachable otherwise. Winch states that management of construction projects can be seen as the management of an information process.

5.5 An analogue method

The analogue format seems to have a central role in the benefits of Visual Planning. Sitting behind a computer is an inactive action and a way of isolation from teamwork (Liker, 2009), meanwhile the participation as a part of the VP meetings generates commitment. The overview is also facilitated by the analogue format, in comparison to the software-based systems where information overload may be an effect (Lindlöf & Söderberg, 2011). In other words, the benefits found through interviews made in this report as well as the ones concluded by others (Lindlöf & Söderberg, 2011) are to a great extent related to the analogue format.

The difficulties found in the construction industry, e.g. lack of historical documentation, as well as in the product development industry (working with scattered teams, saving historical data and scepticism) (Lindlöf & Söderberg, 2011; Söderberg, 2011) seem however also to be an effect of the analogue format.

Thus the analogue format is underlying both the strengths and the weaknesses of the method. The difficulties and shortcoming cannot be managed by digitalisation the method without risking losing the benefits.

5.6 Further comparison with previous research

Experiences stated by the interviewees correlate in general in great extent to the ones seen in the product development industry (Lindlöf & Söderberg, 2011). Clarification of commitments within the design team as an effect of active participation is however raised to a larger extend by the interviewees then in previous research at the same time as the low level of documentation seems to be even a bigger limitation/difficulty in the construction industry. The reason for this is not shown in the empirical finding or presented theory. It could be due to the differences of the industries; in construction the design members are less often "sitting under the same umbrella" which may make commitment harder to achieve and documentation is of higher importance.

6 Conclusions

The main purpose of this chapter is to present an answer to the research question. Additional conclusions and insights gained during the process of research are also presented. Finally, recommendations to Tyréns are presented.

6.1 Research question and answer

Of what use can Visual Planning be in the construction industry and construction projects?

Visual Planning can be of use as a support in the process of construction project management. It can be used to facilitate the understanding of how to reach objectives and the generation of an easy accessible overview of the progress and status of a project. Used as a way of creating a meeting structure it enables waste of the project participants' team to become as limited as possible. It may also be used as a way of making the most out of participants' previous knowledge. The method may also be a way to create a clearer and stronger feeling of commitment in a project team. Together it may facilitate earlier problem solving, which equals lower changing costs, better basis, such as construction documents, for construction, which in turn equals lower construction costs and more accurate tenders.

The more parts and components used of the method the more can be gained. The full version may not be used in all construction projects. The method can however always be scaled up and down. Components and principles can always be used.

The method can however be difficult to use in scattered team, which is a usual feature of a design team in construction projects, and may also fail to generate sufficient documentation. Visual Planning should therefore be seen as a complement to traditional ways of managing the design, rather than a replacement. The method seems to be easiest to implement when one actor has responsibility for several technical areas, design disciplines, or several phases of the project in whole.

Awareness, knowledge and understanding for the method, what it may provide but also what it will not provide is essential, especially to be able to complement it with the right tools. This is not only essential for the success of the method in a particular project or company but for the future of the method in general. Without knowledge of the method, failure due to poor implementation may easily be mistaken for lacks and shortcomings of the method itself.

The fact that opinions, experiences and interpretations partly differ in the construction industry indicates that the method is not yet fully developed. In some ways, it might not ever be, since *one* way does not exist. It could be viewed as that in every organisation the process of developing the method will and must take place. But pursuant to Lean principles, is not this the actual point and moreover, the benefit of using a method? That it may continuously be improved.

6.2 Visual vs. Visible

As an effect of this research, an additional reflection has been made, concerning the fact that two names of the studied method exist. During this research it has been found that one of the major benefits and effects of Visual Planning is not only that is makes planning visual, but visible. This has made me reconsider the name Visual Planning in comparison to Visible Planning. The word visible refers to another, for the method interesting, word; viewable (compare with Swedish words such as *synlig, sebar, synbar*). Visible Planning seems in some ways therefor to be a more appropriate name and would also eliminate the confusion surrounding Visual Planning as it is often mistaking to be a name for visualization tools such as BIM and 3D CAD.

6.3 Recommendations

The best conditions for implementing Visual Planning in the design of construction projects seems to be when responsibility is held for several technical areas or project phases. Given the assignment structure, the suitability of the method for internal management of assignment, such as structural engineering assignment, could be interesting to investigate. In such case all team members, the structural engineers at Tyréns involved in the assignment, are "sitting under the same umbrella". However, the need of coordination is not as big as in the total design team, and it may therefore not be of use to such great extent.

A digital version does not seem to be an effective alternative. Yet, it may be a complement supporting the weak parts of the method. Concerning the documentation problem, it may even be stressed that the method *should* be complemented by digital tools. This research has shown that there is a usage of the method in assignments of design management character (where all designers are external). The studied examples have, however, all belonged to design/build projects, project where the responsibility of design management is seldom given to a consultant.

Finally, the conclusion of the importance of awareness, knowledge and understanding cannot be overrated. As already stated, knowing what is desired to achieve as well as what will not be achieved through Visual Planning in itself is of great importance for the implementation, to in turn be able to complement with the management of the design with the right tools. Appropriate method for implementation would be step-by-step implementation, since it provides an ability to analyse consequences and implications.

7 Possibilities for further research

During the research process issues have been encountered, which have not been within the limitations of the studied field of this master thesis and therefor not further investigated. They are therefore presented in this chapter as possible areas for further research.

This master thesis has studied the use and interpretation of Visual Planning in the construction industry. Little research in this area has been done previously.

The question of how to implement a method such as Visual Planning has not been the focus of this master thesis. Further research concerning this area may therefore be of interest.

Visual methods have by some researchers been claimed to facilitate knowledge sharing and management. This has been commented in this master thesis, but not investigated. It may therefore be of interest to investigate how Visual Planning can be of use to transfer knowledge in a team, company or the industry in whole.

Studied examples in this research have shown that Visual Planning is recurrently used in projects where BIM, Building Information Modelling, has been of use. The question of how Visual Planning supports in particular BIM projects may be of interest.

The formation of a team has implications on to what extent Visual Planning can be used. A studied example had embedded the role of ”total designer” in the way of working with Visual Planning. One consultant taking full responsibility is uncommon in the industry, but might be beneficial. The possibilities of working more in that direction, by e.g. “broad” assignments and partnering between consultants, as well as what is possible to gain from it and which actor that in such a case would be, may be an area to further investigate. Furthermore, whether today’s structure favours or disfavours the clients, the designers or the contractors respectively construction projects and the industry as a whole.

8 References

8.1 Literature

Socialdepartementet Byggkommissionen, 2002. *Skärpning gubbar! Om konkurrensen, kvaliteten, kostnaderna och kompentensen i byggsektorn: Betänkande av Byggkommissionen*. Stockholm (SOU 2002:115).

Statskontoret, 2009. *Sega gubbar? En uppföljning av byggkommissionens betänkande skärpning gubbar*. Stockholm (SOU 2009:6).

ALFREDSON, L. 2011. Visualisera mera! – förbättra teamets kommunikation genom att planera visuellt (my English translation: Visulise more! – improve the communication of the team by planning visualy), *Management of Technology*, No. 2, pp. 3-4.

ALFREDSSON, L., & SÖDERBERG, B., 2011. Challenges of implementing lean principles in product development – the case of Visual Planning. Proceeding from *the 18th EurOMA Conference 2011*. Cambridge, United Kingdom.

BJÖRK, F., JOHANNNESSON, G. etc., 2006. *Tekniken i samhällsbyggnadsprocessen* in *Samhällsbyggnadsprocessen* (my English translation: *Technology for the processes of the built environment*). Chapter in course compendium, Department of Civil engineering and Architectural Engineering, Royal Institute of Technology, Stockholm.

DAINTY, A., MOORE, D. & MURRAY, M., 2006. *Communication in construction: theory and practice*. London: Taylor & Francis.

DALMAN, C., 2005. Visuell planering. Peab Projektrapport, Sollentuna.

DALMAN, C., 2006. Visuell Planering för byggbranschen (my English translation: Visual Planning for the construction industry), *Väg och vattenbyggaren,* No. 2, pp. 44-46.

GHAURI, P. N., & GRØNHAUG, K., 2010. *Research methods in business studies*. 4th edition. Harlow: Pearson Education.

GOULD, F. & JOYCE, N., 2009. *Construction Project Management*. 3th edition. New Jersey: Pearson Education, Inc.

HALLBERG, D. & TARANDI, V., 2011. On the use of open bim and 4d visualisation in a predictive life cycle management system for construction works, *IT con*, Vol. 16, pp. 445-466.

HALLERSBO, C., & SVAHN, R., 2011. *Framgångsfaktorer vid strategiimplementering – exemplet grönt byggande, Skanska* (English titel: *Success factors in strategy implementation, example of green construction, Skanska*). Master thesis, Industrial technology and management, Royal Institute of Technology, Stockholm.

JOSEPHSON, P-E. & SAUKKORIIPI, L., 2005. Slöseri i byggprojekt – behov av förändrat synsätt (my English translation: Waste in construction projects – a need of a changed approach). FoU-Väst Rapport 0507, Sveriges Byggindustrier, Göteborg.

LIKER, J. K., 2009. *The Toyota Way – lean för världsklass*. Malmö: Liber.
(original edition: LIKER, J. K., 2004. *The Toyota Way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.)

LINDLÖF, L. & SÖDERBERG, B., 2011. Pros and cons of lean visual planning: experiences from four product development organisations, *International Journal of Technology Intelligence and Planning,* Vol. 7, No. 3, pp. 269-279.

MERRIAM, S. B., 2009. *Qualitative research: a guide to design and implementation*. 2nd edition. San Francisco: John Wiley and Sons, Inc.

MEYER, J. P. & ALLEN, N. J., 1997. *Commitment in the workplace.* Thousand Oaks: SAGE Publication Inc.

MEYER, J. P., & MALTIN, E. R., 2010. Employee commitment and well-being: a critical review, theoretical framwork and reserach agenda. *Journal of Vocational Behavior*, Vol. 77, No. 2, pp. 323-337.

OTTOSSON, H., 2009. *Vad, när, hur och av vem – praktisk projektledning inom bygg-, anläggnings- och fastighetsbranschen* (my English translation: *What, when, how and by whom – practical project management for the construction and real estate industry*). Stockholm: Svensk Byggtjänst

RAPS, A., 2004. Implementing strategy. *Strategic Finance*, No 4, pp. 49-53.

SAMUELSSON, O., 2010. *IT-innovationer i svenska bygg- och fastighetssektorn – en studie av förekomst och utveckling av IT under ett decennium* (my English translation: *IT-inovations in the Swedish construction and real estate industry – a study of occurence and development of IT during a decade*). Doctural thesis, Department of Management and Organisation, Hanken School of Economics, Helsingfors.

SEBESTYÉN, U., 2006. *Multiprojektledning – skapa puls i produktutveckling med lean tänkande* (my English translation: *Multi project management – create pulse in product development by lean thinking*). Rönninge: Parmatur.

SÖDERBERG, B., 2011. Lean i praktiken – hur får man visuell planing att fungera i utvecklingsteam? (my English translation: Lean practically – how does one make visual planning effective in development team?), *Management of Technology*, No. 4, pp. 3-4.

SÖDERBERG, B. & ALFREDSSON, L., 2011. Lean visual planning and product development complexity: Facilitating information processing capability. Proceedings from *the 18th International Product Development Conference "Innovate through design"*. June 5-7, Delft, Netherlands.

TONNQUIST, B., 2010. *Projektledning*. 3rd edition. Stockholm: Bonnier Utbildning. (Available in English: TONNQUIST, B., 2008. *Project management: A guide to the theory and practice of project, program and portfolio management, and business change*. Stockholm: Bonnier Utbildning)

WINCH, G. M., 2010. *Managing Construction Projects*. 2nd edition. West Sussex: John and Wiley & Sons Ltd / Blackwell Publishing Ltd.

8.2 Web pages

LOU - lagen om offentlig upphandling (the law of public procurment), www.allego.se, http://www.allego.se/Content-Web-Page/5d3e0aee-5f31-46ae-a60c-677d5ce82874/lou-och-luf.aspx, Accessed: 2012-03-27

50 största byggföretagen 2010 (50 largest construction companies 2010), www.bygg.org http://www.bygg.org/nyhetsarkiv/50-storsta-byggforetagen-2010__2115, Accessed: 2012-03-20

Ny process ska ge äkta lean (my English translation: New process will generate true lean), www.byggindustrin.se
http://www.byggindustrin.com/teknik/ny-process-ska-ge-akta-bim__5763,
Accessed: 2012-02-29.

Vad är lean? (What is lean?), www.leanforumbygg.se,
http://www.leanforumbygg.se/default.asp, Accessed: 2012-03-01

About Tyréns, www.tyrens.se
http://www.tyrens.se/en/About-Tyrens/, Accessed: 2012-03-20

VDC/BIM – för ett mer interaktivt byggande (VDC/BIM – for more interactive construction), www.veidekke.se
http://www.veidekke.se/om_veidekke/vardeskapande_samspel/medarebtarinvolvering/article66795.ece, Accessed: 2012-03-20

9 Appendix

Appendix 1: Photos of Visual Planning

Appendix 1: Support questions for interviews

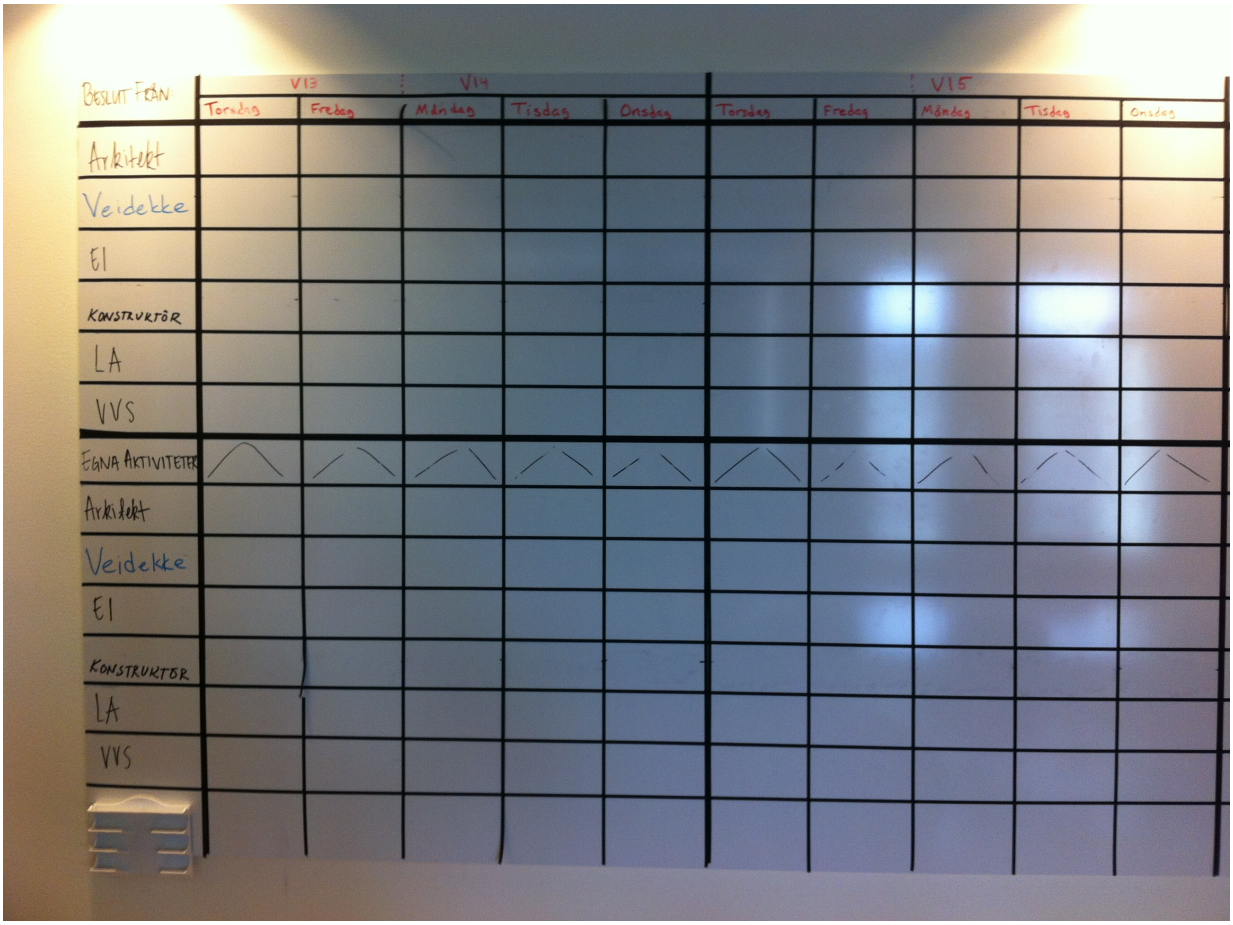
Appendix 1 – Photos of Visual Planning

Lean Design®

The objective and delivery board at Bjerking. Columns representing time in weeks and rows representing the design disciplines.

VDC

Matrix at Veidekke for questions and requested deliverables (the upper part) and planned work and activities (the lower part). Columns are representing time in workdays and rows are representing each design discipline.



VP at Stockholmsarenan

Objective and delivery board. Columns representing time in weeks and rows representing design disciplines and the actors involved in or effected by the design.

Question to and from board to the left, where columns represents the actor requested to deliver an answer and the rows the actor in need of the answer, and decision log to the right, made up by the clarified sticky-notes.

Continuation of decision log to the left and crucial questions to the right. No crucial questions existed at the time when the photo was taken.

The VP room.

Appendix 2 – Support questions for interviews

Interviews

Introductive questions
Who are you – Title/Role:
Personal background – education, ”road” to VP
With what sort of background experience of VP do you answer following questions? How many projects?

The company version
Briefly, how would you describe … way of working with VP?
In detail – how do you work?
Frequency and length of the meetings?
VP room?
Colour-coded sticky-notes?
Standing meetings?
Meeting structure/agenda?
The usage of the board during the meetings?

Definition VP
What is VP according to you? How would you describe/explain it to someone who has never heard about it?
In what way does it differ from the ”traditional way”?
Do you reckon that there exists a universal way of working with/using VP?
How does it affect you as a design manager/ designer? How do you experience it?

When, where, how
When should/can VP be used? When is it of use/suitable?
Does VP require any special condition?
Are any demands set on the project?

Experiences and differences then and now
Construction or Design?
Delivery form? Design/build or design/bid/build?
What is most effective?
What have you or the organisation learned? Has any changes been made?
Changed approach or view of VP?
Is the method effective in long term?

Comparison with theory
”Gathered team, overbridging competences, one project/person” – how does this relate to the nature of construction projects and the design phase.”

Opinions
Advantages, disadvantages, benefits, drawbacks, possibilities, problems?
Possibilities for the future – new technology, digital VP?
What is the most essential?
What makes the difference?
If all parts are not able to be implemented, is any part more important than another?
Is this the best way of working?