

A CONTINGENCY APPROACH TO THE CO-LOCATION OF DESIGN TEAM MEMBERS

THE CASE OF THE NORDIC CONSTRUCTION COMPANY

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ABSTRACT

Title: A CONTINGENCY APPROACH TO THE CO-LOCATION OF DESIGN TEAM MEMBERS - THE CASE OF THE NORDIC CONSTRUCTION COMPANY

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Background: A “Big Room”, a way of organizing design team members through integration, can be found as one of the tools in the “Lean management” philosophy that made Toyota as a car Manufacturer successful. NCC, one of the largest construction companies in the northern European construction industry, is developing their own Big Room concept under the name of NCC Project Studio to improve building design results.

Purpose: Describe and analyze the current use of NCC Project Studio, and propose recommendations for improvements to the design team constellations. Of particular importance are the issues of who to involve in the NCC Project Studio, how, and to what extent, during the design phase.

Method: The study has been conducted using case study methodology. Empirical material was collected in both a longitudinal and cross-sectional manner and was presented after thematic analysis. The empirical material was contrasted against primarily theory of lean construction before recommendations for NCC were provided.

Conclusion: Improvements of the NCC Project Studio concept are threefold. First, NCC is recommended to involve a larger number of designers and customers in the everyday work within the Project Studio. Second, the strategic process of working within the Studio, is recommended to include a more precise and validated business plan in the early stages. Third, for the operational process, implementing the Last Planner system is recommended.

Key words: Lean Construction, Big Room, Co-location, Socio-technical System, Contingency Theory

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LIST OF ACRONYMS

BIM	Building Information Modelling
CST	Complex Systems Theory
IFOA	Integrated Form of Agreement
IPD	Integrated Project Delivery
LCI	Lean Construction Institute
NCC	The Nordic Construction Company
NCC PS	NCC Project Studio
PDCA	Plan, Do, Check, Act
P²SL	Project Production System's Laboratory
STS	Socio-technical System
TPS	Toyota Production System
VDC	Virtual Design in Construction

A. BACKGROUND

In this chapter the reader will be introduced to the background information that has been important for defining the purpose of this thesis. It will also give the reader an idea of what the thesis author has found particularly important before starting his own investigation. The chapter starts with a broad, general, description of the background to be followed by a more thesis specific background in the end of the chapter.

A.a. General background

During the years 2012 and 2013, investments in the Swedish construction industry grew faster than investments in the national goods and services sectors overall. Investments in 2014 and 2015 are also indicating a strong growth in the domestic construction industry the years to follow (Finansdepartementet, 2014). In total, investments in construction account for about nine percent of the Swedish GDP (Sveriges Byggindustrier, 2013). This is why it is of interest, not only for the market incumbent profit-maximizing firms, but also for the society at large, that the locked in capital provides long term cost-effective returns.

Productivity improvements in the Swedish construction industry are, according to some theorists, measured incorrectly and has therefore been underestimated (Lind & Song, 2012). However, invalidating macroeconomic reports is a rather defensive, reactionary type of research. Business history suggests that a protectionist, rear-view, perspective has a tendency of failing to allocate resources and technology to efficiently match the needs of the end-customer. This is something “the big three” US auto manufacturers came to realize after having been overtaken by foreign competition in the second half of the 20th century. Toyota, the Japanese auto manufacturer (today the largest in the world), is the role model organization for what is known as “Lean production” and had an annual net profit margin 8.3 times higher than the industry average in March 2003 (Liker, 2004). To be explicit, valuable initiatives will pose questions of how we will do things better, and looking at the ones best in the class could be one way of doing this.

One of the core principles that built the success of Toyota in the 20th century is the continuous development of partnerships (American Institute of Architects, 2007; Liker, 2004). Manufacturing companies in general find themselves in an increasingly complex network of suppliers, customers and other stakeholders. Construction companies in particular typically operate in an ever-changing production setting with different production schedules each day. Under shareholder pressure, the most intuitive way of reacting to this

complexity is by local optimization – all firms for themselves. Construction project participants have traditionally been transferring risks to others to the greatest extent possible, leading to more adversarial relationships instead of partnerships (Larson, 1997).

Whether or not we measure productivity correctly, studies of the construction industry suggest that construction project costs can be cut to half the current and the time from ideation to fulfillment can be cut to a fourth (Josephson, 2013).

Assuming that construction productivity is not meeting its full potential; one reason for this could be that the industry has had a relatively easy time to defend itself against globalization, a facilitator of hyper competition in many other industries. Segerstedt and Olofsson (2010) argue ***“The construction industry is local. Governmental subsidies, national and local regulations and culture have essentially protected the construction industry from global competition.”*** (p. 348).

Additionally, one does not simply construct buildings of different types in countries with the best factor economies for the specific niche. Or more explicitly, there are no clear scale economies utilized in construction globally where some specialists focus on a certain building type and other specialists focus on other, just to distribute them across the oceans. Today it seems bizarre. On the other hand, in the first half of the 1900s, not many thought that it would be cheaper to buy a car which parts had been shipped across the world before the first user could take it for a ride.

This is not to say that the globalization hasn't had any impact in construction. The industry has for a long time relied on temporary workers migrating across national borders to fulfill labor demand (Rosewarne, 2013).

Conceptually, projects – the setting under which construction work is performed – seems to be a setting that would be suitable for change, something that should make the assumed performance gap easier to bridge. Lewin (1947) argues that the first step in a change process is the unfreezing, the breaking down of organizational structures, before change can be made. This first step is usually confronted by strong resistance from the organization due to factors such as fear. Interestingly, unfreezing is in many aspects done continuously in construction as the manufacturing plant is re-located and re-built for each new product release. In addition, construction projects typically involve many different specialists, and by moving human resources between projects, efficient practices should spread easily between organizations and

projects. Still, industry clients find attitudinal¹ and industrial² barriers to be critical hinders for change in the current business climate (Vennström & Eriksson, 2010).

For the purpose of overcoming the instinct of local optimization, short term profit-maximization, and adversary, a new management philosophy building upon the Toyota Production System (TPS) principles described e.g. by Womack, Jones, and Roos (2007) is under development for project management in general, and construction in particular. This is known as the theory of “Lean Construction”.

A.b. Lean construction

That lean manufacturing concepts have the potential to become a paradigm shift within construction was first proposed by Koskela (1992). He states *“Construction has traditionally tried to improve competitiveness by making conversions incrementally more efficient. But judging from the manufacturing experience, construction could realize dramatic improvements simply by identifying and eliminating non conversion (non-value adding) activities. In other words, actual construction should be viewed as flow processes (consisting of both waste and conversion activities), not just conversion processes”* (p. i). Koskela further argues that early adoption of this philosophy offers opportunities for competitive advantage.

In contrast to when it was first to be implemented by Toyota, the lean management philosophy has already proven itself to be a perspective that can provide improvements in multiple contexts. Empirical examples of results from utilizing the new paradigm within construction management are also gaining in numbers (see Tommelein, Ballard, & Lee, 2011).

Matt Petermann, currently digital practice manager for a large design and architectural firm, states that lean design³, as part of the theory of lean construction, is to try and recreate the master builder⁴ but in a modern context. Today, it is inarguable that construction projects are too complex for a single master builder to possess all the knowledge needed to support the decision making throughout the project duration.

¹ Types of attitudinal barriers are short-term focus, adversarial attitudes, lack of ethics and morals and focus on projects instead of processes.

² Types of industrial barriers are traditional organization of the construction process, conservative industry culture, industry structure and traditional production processes

³ Design, as defined in this thesis, refers not only to the aesthetic-, but also the functional design for purpose of proper use. Aesthetic design is, in this thesis, generally paired with the architectural design.

⁴ A single entity responsible for carrying out a full construction project (design and construction), commonly used in the first half of the 20th century.

Fragmentation of the master builder role has occurred in two dimensions – the dimension of time (project design *or* project production phase) and the dimension of subject expertise (mechanical, electrical, interior or landscaping, etcetera) (Yates & Battersby, 2003). All the expert knowledge is to be synthesized. In his era, the master builder did not have to call his left half of the brain to a meeting with the intention to synchronize it with the right half. Particularly, when the master builder had decided what was going to be built, most of the time he had already thought of how he was going to execute the work planned as he was also in charge of the construction phase (Yates & Battersby, 2003).

Utilizing lean design or Target Value Design (TVD⁵) is a way of aligning customer value with efficient production technology and to move design efforts to an earlier point in time where the feasible design space is bigger and costs of design changes are smaller, also known as the “MacLeamy Curve” (American Institute of Architects, 2007). TVD can further be described as the intersection between the five components (1) Production system design, (2) Co-location, (3) Collaboration, (4) Set-based design, and (5) Target costing (Nguyen, Lostuvali, & Tommelein, 2009).

A.b.a. The Big Room

Co-location, the second of these components, will be in focus in this thesis study. More precisely, the co-location of team members into a physical space called a “Big Room”.

Big room is the direct translation of the Japanese word ‘Obeya’. Liker (2004) names the creation of the Big Room as ***“One of the most important results of the Prius project from an organizational design perspective...”*** (p.55). A Big Room serves two purposes; information management and quick decision making. In the Big Room the cross-functional design team work together almost daily with the help of visual tools to assist their decision making (Liker, 2004).

Khanzode, Fischer, and Reed (2008, p. 10) describe the Big Room as used by Project Production Systems Laboratory (P²SL⁶) member DPR Construction⁷: ***“It is our experience that detailers must work side-by-side in one “Big Room” to model and coordinate their designs to meet the***

⁵ TVD is an adaption of the Target Costing concept used in manufacturing industries (Zimina et al. 2012).

⁶ P²SL is dedicated to developing and deploying knowledge tools for management of project production systems. P²SL is inspired by the accomplishments of the Toyota Production System. (P²SL, 2014)

⁷ DPR is a construction company from the US that: “will do for the Construction Industry what Toyota did for the Auto Industry” (DPR, 2014) when it comes to quality and innovation.

coordination schedule. Although we cannot precisely say by how much, this shortens the overall time for modeling and coordination and is more economical in the end for all concerned parties because the detailers won't need to wait for postings to see what others are doing which greatly reduces wasted detailing efforts."

Further, Khanzode et al. (2008) point out that the one party, in the project studied, that opted out of working in the Big Room also came to induce many issues when their work was to be coordinated with the rest of the design team. The project participants therefore concluded that everyone shall be working side by side in the same Big Room from there on.

A.c. NCC and the Big Room concept

The Nordic Construction Company (NCC) is one of the leading construction- and property development companies in the northern European region. The company operates within the residential, building, heavy civil, roads, and the industrial construction industry sectors. The company also provides raw materials for construction production, such as aggregates and asphalt. The major geographies of operation are the Nordic countries but the company can also be found in Germany, Russia, and the Baltic countries (NCC, 2014).

NCC, and particularly the company's construction division, has under the last few years been developing their own Big Room concept under the name of "NCC Project Studio" (NCC PS) for collaboration and quality improvement (NCC, 2014). It is the company's understanding that the increased transparency between project participants through the physical co-location of project participants will help mitigating wasteful delays and incur costly rework and iteration. The concept is also meant to conjoin the separation between product and process design through early involvement of production management.

In this thesis we study the use of NCC PS within NCC Construction Sweden AB, a corporate division contribute to one third of the corporate revenue. In the Nordic countries NCC Construction⁸ accounts for more than two thirds of the corporate employee count 2013 (average 18 175) (NCC, 2014).

⁸ NCC Construction regularly acts as a main contractor. This means that usually NCC holds the prime (main) contract of a construction project to the project owner. Further the general contractor usually procures large portions of the work to be done by a diverse set of specialist companies, called subcontractors. The contracts are known as subcontracts and can thereby be seen as the first tier of suppliers for the main contractor.

Generally, construction work is engineered to order, meaning that the building is designed, engineered, and built to specifications only after the order has been received.

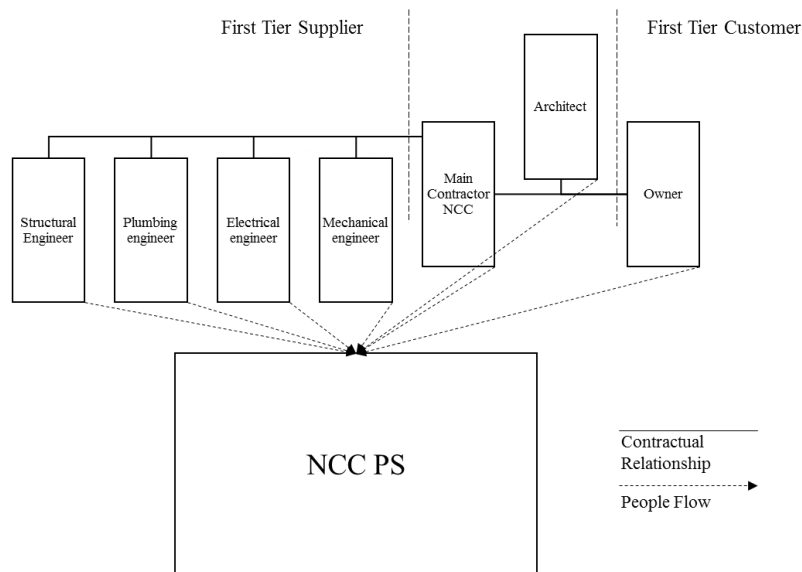


Figure A—1 Schematic of the idea behind NCC PS. N.B. the contractual setup is merely an example, many different setups are common.

In NCC PS, the main contractor NCC, sub-contractors⁹ responsible for designing different functionalities of the building, and the owner¹⁰ is gathered for coordinating the team’s work using different visual aids and planning tools. The founding principle is visualized in Figure A—1.

Naturally, as this is a new concept for the company, investigations for finding which team members should be part of this process at different stages, how, and to what extent, is still lacking.

⁹ As can be seen in Figure A—1, the main contractor holds the main (prime) contract against the owner. This contract is generally divided into work-structures where the most part is, in turn, sub-contracted out to specialists of different kinds. These can be seen as the first tier suppliers in Figure A—1. The sub-contractors can, in turn, sub-contract their work creating a second tier of suppliers for the main contractor.

¹⁰ The owner is on the buying side of the main (prime) contract, as seen in Figure A—1. Largely, the owner will supply the financial needs for project fulfillment and be the player interlinking the end-customers (building users) to the project team.

B. PURPOSE

In this chapter, the purpose, scope, and delimitations of the study are described. The motivation of the choice of purpose is given describing the takeaways that is aimed for target readers as addressed by the author.

The purpose of the thesis is the following:

Describe and analyze the current use of NCC PS, and propose recommendations for improvements to the design team constellations. Of particular importance are the issues of who to involve in the NCC Project Studio, how, and to what extent, during the design phase¹¹.

The conceptual visualization of the thesis scope is found in Figure B—1. As can be seen, the scope is limited to the implementation of the Big Room concept within the organizational standards of NCC design practice.

B.a. Motivation of study purpose, contributions to target reader groups

As mentioned in the background chapter, pro-active studies for improved industry efficiency are assumed to be more useful than rear-view, defensive, protectionist studies.

There are three main groups that are being targeted as readers of this report. First and foremost is the host organization, NCC, which was the initiator of the study. Second, the community of lean construction theorists for an in-depth study of the concepts proposed¹². Third, fellow Industrial

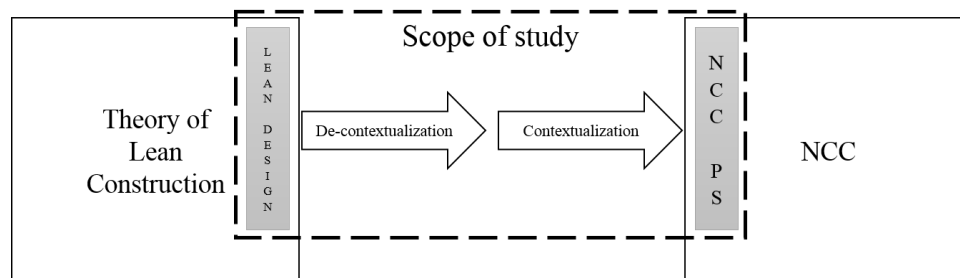


Figure B—1 Conceptual scope of the study

¹¹ In Swedish terminology the design phase is known as “Projekteringsfasen”.

¹² Generalization of the study results and recommendations to other organizations should be done with caution. That other organizations can use the holistic view used in the report for comparative purposes is nevertheless intended.

Engineering students are targeted for an in-depth case study in an industry not so commonly analyzed within the community of industrial engineers.

To begin with, hopefully, NCC will perceive the study as a description of their every-day operations from an outside-in perspective and see the recommendations as a holistic decision aid material. The aim is to help the company in their path moving forward with NCC Project Studio. NCC has initiated an attempt to implement a methodology taken from theories of lean construction to change their operations; the study aims to positively influence the company's development in this matter.

Furthermore, the community of lean construction theorists will hopefully perceive the study as an unbiased, deep, and transparent study to complement conceptual descriptions provided and commonly discussed. It is the author's belief that a case study of the kind performed can help to identify and to understand areas for further clarification, justification or theoretical development.

Finally, the author perceives industrial engineers and civil engineers in everyday situations to overemphasize the differences between the two scientific areas. The choice of study object and choice of theoretic framework aim at bridging the perceived gap.

B.b. Delimitations

Firstly, this thesis will not focus on the development of computer aided design methods and the technology for such that are being developed and increasingly used in building design.

It is, nonetheless, the firm belief of the author of this thesis that increased use of building information modelling (BIM) and lean design (even lean construction) practices have operated as pairwise facilitators. BIM is by the National BIM Standard project committee defined as '*.../ a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle, defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder*' (NBIMS-US, 2014). The author's belief is strengthened by the research performed e.g.; Sacks, Koskela, Dave, and Owen (2010); Tjell (2010); Uddin and Khanzode (2013).

However, as Smith and Tardif (2009) states, the idea of BIM, and the demand for such technology, dates back a very long time. The most basic functionality of a BIM, to model information from different stakeholders in a

central database with a virtual (near-) reality user interface is certainly is not a revolutionary idea, technology just had to catch up with market demand.

Secondly, neither is the thesis' main target reader the industry incumbents of "small construction"¹³ for which presumptions as stated in the background section (such as complex supply network structures and high uncertainty due to small series of production) are less distinctive. NCC is one of the largest construction contractors in the Nordic region and the industry will be viewed from a perspective that represents a majority of their turnover (Figure C—1, p. 15) driving large and medium sized construction projects.

This is not to say that the company's smallest construction projects are not of great importance. The author's belief is that the small projects performed by NCC are important for customer understanding in local markets. The discussion of market position is not part of the thesis scope, however.

Thirdly, the systems interacting with, and influencing, the unit of study will not be analyzed at length. Analysis of external consequences of the recommended actions will thereby be limited. The reason for this is the already holistic approach taken through a systems perspective which will be further described in D.a. Socio-technical Systems Theory on page 23.

¹³ Small sized construction projects such as small reconstruction projects, small housing projects, etc. with approximate contract value of \$1 million or less.

C. METHOD

In this chapter it is described how the research has been conducted¹⁴. The chapter starts with a brief summary of how the study was performed. Thereafter the choice of study methodology is motivated. The method used for reducing the qualitative (non-numeric) data set will be given before we describe what kind of results that can be expected from using the methodology. Lastly, the author will provide criticism of his choice of method that is found important to the reader to take into account when deeming the study results.

C.a. Object of study

The object studied is design teams utilizing NCC Project Studio, including both the team members located in the Big Room and the team members that work remotely. The latter are design team members that belong to the team doing design work but that are not present in the Big Room on a continuous basis. The object will be studied using case study methodology.

C.b. Research process summary

The study started with a longitudinal¹⁵ pre-study of one construction project using NCC PS. The pre-study was followed up with a cross-sectional study phase for which information has been gathered from two other construction projects.

Primary data has been collected using semi-structured interviews and observations. Secondary data (such as internal and public documents) have been collected throughout the study.

¹⁴ Readers with limited academic background and interest can skip the chapter to ease the thesis' coherence.

¹⁵ Longitudinal (as used in this thesis) means that it spans the time dimension and that data is collected at different points in time.

Table 1 Schedule for data collection, Full day observation (O), Interview (I). (The longitudinal dimension is found horizontally and the cross-sectional dimension vertically)

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Phase																		
Longitudinal Pre-study	X	X	X	X	X	X	X	X	X	X								
Interview guide formulation										X	X	X						
Cross sectional phase									X	X	X	X	X	X	X	X	X	X
Project #																		
Project 1	O		O				O	O		O			I					
Project 2									O					I		I		
Project 3																		I
Month	March		April				May				June				July			

The timeline for the data collection process can be seen in Table 1. Literature was studied throughout the research project. Moreover, a two day conference on lean design in Chicago, USA, was partaken. The interview guide, as an instrument for the cross-sectional¹⁶ phase, was formed after the author had better understood the study object in the pre-study.

The transcribed interview material was reduced using thematic analysis before the empirical findings were analyzed against theory, and recommendations were given.

C.c. Thesis assumptions

Two assumptions are fundamental for understanding the choice of study methodology.

Firstly, the author assumes (based on the description given by the manager of NCC Project Studio implementation) that the concept of NCC Project Studio originates from the theory of Lean Construction as described in F.b Lean Construction starting on page 50¹⁷.

Also, the author assumes that if the company is to fulfill the initial goal of introducing the NCC Project Studio working methodology, discrepancies against the theoretical framework that the methodology originates from are unfavorable for successful implementation.

Because of these two assumptions, as well as the fact that NCC Project Studio as a concept is still in its early days (in a company historic perspective), the study performed will approach the study object without prejudgment of

¹⁶ Cross-sectional (as used in this thesis) means that the time dimension was not spanned, but data was collected spanning other dimensions. In this case, the dimensions of geography and company hierarchy.

¹⁷ During the study, this assumption came to be supported by interactions with all actors asked in the matter.

the current state of the implementation process. The aim is to get close to the study object and let empirics be contrasted against theory that is found particularly applicable to the system state as found.

C.d. Motivation for choice of methodology

Motivating the choice of a case study approach is its strengths when studying contemporary events where the researcher's possibility to manipulate the unit of study is low (Yin, 2014). These are found to be major advantages for the study purpose as NCC is currently working with a change in the product design operations across different geographies. Therefore the researcher has chosen to take on a largely passive role with the aim of assisting the current change managers with information and advice for their actions moving forward.

Another reason why the case study design is found to be of particular use in this thesis project was that, when dealing with organizations, boundaries between phenomenon (in this case the success of change initiative) and context are not always apparent (Yin, 2014). Bryman (1997) describes it as the qualitative researcher's quest of taking a holistic, contextual perspective. Contextual aspects of the study object came to be of particular interest for further research after the first study phase, the pre-study.

C.d.a. Motivation of longitudinal pre-study

Despite the strict advise by e.g. Yin (2014) that field contacts should not be established at an early stage when conducting case studies, observations started in the very beginning of the thesis project.

Worth noting regarding this aspect is that before the study started, the researcher took a class on Lean Construction and studied literature extensively on the subject area without necessarily judging what parts of the theory that would be in focus of the thesis. Rather, the study object was approached with a broad theoretical background of lean construction without preconceptions of what theory that was going to be of particular importance for NCC PS at this point in time. This was to minimize the risk of bias in the observations that started the study.

The main reason why field interaction was established early was that the longitudinal data set would be larger and thereby contain more useful data. Also, a basic understanding of the routines within a NCC PS was found important to generate early on as this understanding would determine the quality of the cross-sectional interviews.

The early field interaction has analogies with the lean concept "Genchi Gunbutsu", meaning that the manager ought to go to the source to find the facts to make correct decisions (Liker, 2004). Bryman (1997)

describes a similar issue that he calls the dilemma for qualitative researchers. He says that researchers must engage in literature long before the study starts, leading to the inability of seeing the world in an unbiased way and overseeing details important to the actors studied. This dilemma was largely avoided with the early interaction.

C.d.b. Motivation of choice of study object

The choice of case company was given as the thesis project was initiated by NCC. Denscombe (2009) describes the situation. If the study is in part of (or fully) ordered from an external actor, the choice of case is in fact *not a choice at all*.

Generally, it is recommended to utilize strategic sampling for case studies (see Bryman & Bell, 2011; Denscombe, 2009; Flyvbjerg, 2006). Strategic samples (or strategic choices of study objects) are chosen on the basis that they will give particular insights to the matter studied, and the choice made can therefore be argued to be better than another choice for one reason or another. This sampling method is clearly distinct from statistical, random, sampling where the sample(s) studied is supposed to be *representative* for the overall studied population and thereby show as little differences to other choices as possible.

If a strategic choice of study object would have been made for this project, a member company the Project Production Systems Laboratory¹⁸ (P2SL), and their design teams, would have been a natural choice. Often times the P2SL member companies are role models in their implementation of lean construction ideas. The researcher could, for example, ask him- or herself ‘What Big Room design team constellations at role model company XYZ work most effectively?’ This type of research question inhibits a number of uneasy presumptions, however.

Either it could presume that the true answer is thought to already be out there and thereby the answer can be found and observed. This is found highly unlikely. Or, it could also presume that the researcher would need to point to different variables that influence the effectiveness and rule out all other thinkable variables, deeming them less important. After the important variables have been established, measurement of each and their respective impacts on the effectiveness would have to be performed.

The latter of these would give the study design strong similarities with an “experiment study”. In an experiment, the researcher does in fact have a possibility to influence the setting studied. This is one of the strongest distinctions between an experiment and a case study (Yin, 2014). Definitely,

¹⁸ See description of P2SL in “A.b.a The Big Room”, p.4

the experiment study would be a valid and easily defensible choice of study methodology for the study purpose. The two major reasons why an experiment was not performed was the lacking time and resources for the type of study and that the risk of deeming variables of actual importance unimportant was found to be too high.

However, the purpose of this study is not to exemplify how implementation has worked elsewhere –rather to provide insights of what can be done to make an ongoing implementation attempt successful. It is intended that the very choice of making a non-strategic choice should provide analytical insights *different* from the ones found when study objects are chosen due to reasons such as being close to- or under the very supervision of theorists themselves (like P2SL companies).

Lean construction theorists have been criticized for being overly optimistic and to generally assume that lean construction is a ‘good thing’ with theory building that could be found evangelical or ‘guru-like’. Further critical voices has also been raised that the established theorists oversee many failed implementation attempts both within manufacturing in general and construction in particular (Green, 1999). The object of study for this case study is intentionally non-strategically chosen and will be studied holistically in order to answer to this type of criticism. It is by the author understood that an evangelical perception of the theory is disadvantageous for the implementation efforts pursued world-wide and the depth of study is done to exemplify the vast spectrum of propositions that can be derived from viewing a system through a ‘lean lens’.

The choice of construction projects to study within NCC was done on the basis of strategic sampling, however. All construction projects that were studied were contacted after NCC managers referred the project design teams as being in the forefront of advancement in using NCC PS methodology. If one could argue that some NCC PS design teams are closer to the managerial goal¹⁹ of how to use a NCC PS – the projects studied are thought to represent the ‘internal best practice’ design teams, closest to this goal. Analysis will therefore use the logics of Flyvbjerg (2006, p. 230) ***“If it is not valid for this case, then it is not valid for any (or only few) cases”***. Or, translated to the thesis settings: ‘If it isn’t valid for the studied NCC PS design teams, then it isn’t valid for any (or only few) NCC PS design teams’. This is not to be confused with the type of study and the object of study which is NCC PS design teams (more general). Due to the strategized sampling, the case study

¹⁹ The author does not generally want to use the term of ‘end goals’ and ‘lean-ness’ which by default are prone to steer managerial efforts away from thinking of a never ending pursuit of continuous improvements. In lean construction, there is no ‘end goal’.

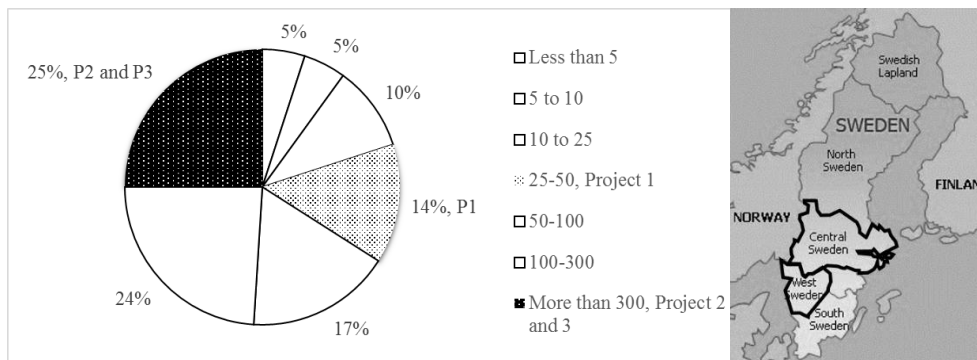


Figure C—1 Information about studied construction projects. Project sizes in comparison to NCC construction projects overall measured by MSEK contract value 2013 (left) and geographies represented in the study (right).

has a higher internal validity (generalizable within NCC PS design teams throughout NCC).

Another factor that positively affects the internal validity of the study is that the chosen construction projects for study were located in different geographies in Sweden and are of different size (see Figure C—1). Information grounded in all studied projects is thought to be highly likely to be found in other NCC projects due to the diversity of studied projects.

C.e. Data collection methods

The main sources of data are drawn from three modes in a company cross-sectional²⁰ manner. The ability to triangulate – cross check – data taken from different sources and with different methods is one of the major strengths of the case study design (Denscombe, 2009). The cross-checking ability was used to the extent possible within given constraints in time and resources. The three data collection modes are interviews, observations and document studies. The three are described further below.

C.e.a. Observations

The series of passive observations that begun in the very start of the research project served not only the purpose of forming an interview guide, but also for triangulation purposes and to get an understanding of industry practice and language used within construction design. The observations were

²⁰ Cross-sectional in the sense that the dimension of time is left out of the analysis. Interviewees are chosen across the organization structure, geographically and organization structure hierarchically.

kept strictly passive due to the desire to keep the observations as close to the realistic scenario as possible. The observer effect (also known as the Hawthorne effect) – that actors change their behavior when they are being watched – was mitigated by the observer arriving early and leaving late – thereby becoming part of the environment and by keeping the study purpose camouflaged (Denscombe, 2009).

C.e.b. Semi-structured interviews

Secondly, semi-structured interviews were held. The interviews were deliberately held open with short, non-leading, open ended, questions that were followed up with questions that deliberately had the same formatting to sustain high internal reliability²¹ (Hjerm, Lindgren, & Nilsson, 2014). The interview guide used in all interviews is found in K. QUESTIONNAIRE, p. VI. In the beginning of the interview, the interviewees were informed of the importance of using their own words and elaborate freely on each subject brought up. All interviews were held in similar settings, namely in private meeting rooms, at the interviewees' respective office²².

All interviews utilized the same interview guide with 19 questions, but the interviews tended to get longer each time²³. One reason for this could be that the researcher's knowledge developed over time and more detailed follow up questions were found to be of the researcher's interest. The interviewees were key personnel in their respective instance of NCC PS and their construction industry experience ranged from 6 to 28 years of practice.

All interviews were recorded using two recording devices on smart phones for replaying the interview in order to manually transcribe the full length interview within three days after the interview, when the memory of e.g. irony and gestures was still fresh.

C.e.c. Document studies

Finally, document studies have been performed. The documents are taken both from public- and company internal records, facilitated by the access to the company's intranet. Documents, as evidentiary sources, have been used with precaution due to the inability to check the validity of the material as a researcher. That the researcher himself generally does not know how the data he uses has been collected or analyzed – secondary data sources are generally less reliable than primary.

²¹ Internal reliability, as used in this thesis, means that the data is drawn from an objective instrument of measure.

²² In some cases a production site office.

²³ The interviews were 27, 45, 88 and 112 minutes long respectively.

Therefore, when using documents as data, the document's author was always identified and both the purpose and the target audience of the publication was critically studied to increase the reliability (Denscombe, 2009). Document studies were used almost single-handedly for triangulation purposes of already collected primary data, if not for giving brief descriptions of construction projects and the organization studied.

C.f. Thematic analysis for data reduction of transcribed interviews

To arrive in only a few quotes to represent all the information as provided by – the sometimes lengthy – interviews, a thematic analysis was performed. Thematic analysis is a widely used analytical method for qualitative²⁴ analysis. *'Thematic analysis is a method for identifying, analysing, and reporting patterns (themes) within data. It minimally organises and describes your data set in (rich) detail'* (Braun & Clarke, 2006, p. 6).

More specifically, the thematic analysis conducted was of theory driven form meaning that theory of some sort continually influenced the interpretation of the interview material. Some ideas of how the coding of data were already made clear before the coding began. *'In contrast [to non-theory driven analysis such as grounded theory], a theoretical thematic analysis would tend to be driven by the researcher's theoretical or analytic interest in the area, and is thus more explicitly analyst-driven. This form of thematic analysis tends to provide less a rich description of the data overall, and more a detailed analysis of some aspect of the data'* (Braun & Clarke, 2006, p. 12, emphasis added). The theory of interest, driving the analysis, is found in chapter F. THEORETICAL FRAMEWORK.

Theory can also be found in chapter D. EMPIRICAL FRAMEWORK but this framework has not been chosen for the researcher's theoretical interest per se. The framework is largely a description of the author's view of a design team as a system and was used to structure the findings for increased readability. The framework will be introduced in C.f.a Empirical framework introduction.

The thematic data analysis was performed in eight process steps. It was done to reduce the (large) amount of qualitative data to a comprehensive, and compact, format. The result of the analysis was a reduction of more than 40 000 words of transcribed interview material to about 24, representative, extracts. The extracts, as stated in the thesis report, have been backed up by narrative for ease of understanding context and meaning of the quotations cited. The narrative was continuously checked against the underlying data to

²⁴ Qualitative analysis, in contrast quantitative, analyze non-quantifiable data.

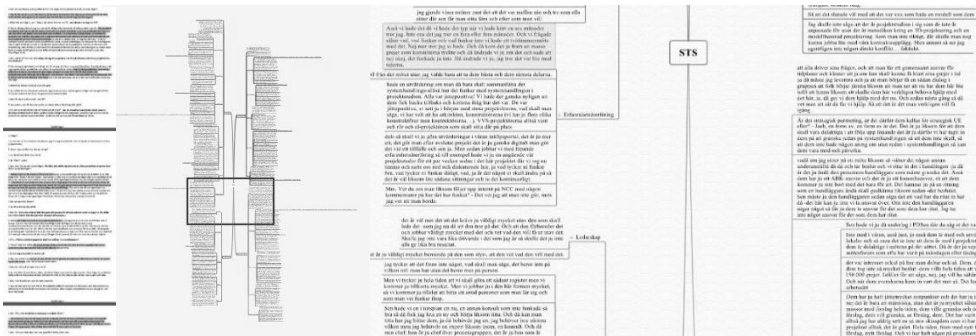


Figure C—2 Highlighted interview transcripts (left), Mind map used for thematic grouping (Middle and Right)

reduce the risks of misquotations and loss of context. The author’s interface against the data in different stages of the data reduction process can be seen in Figure C—2.

Starting off, important statements were highlighted in the finished transcripts, as can be seen in the leftmost picture in the figure. The highlighted statements were highlighted for fulfilling at least one of two main conditions. Either the statement was closely connected to another interviewee’s standpoint in the discussed issue (confirming or rejecting the other), or the statement was particularly important to the interviewee as being revisited by the interviewee on numerous occasions throughout the interview.

A so called ‘mind map’ was then drawn after classifying each extract into one of four themes. The mind map can be seen in Figure C—2 and was used as a tool for easing the process of further finding patterns within the interview data. As Braun and Clarke (2006) describes, thematic analysis is better performed when patterns are found within the whole data set. For example, if two interviewees have similar standpoints in some matter, a pattern should be highlighted, regardless of where in the interview transcripts the standpoints were found. The similarities better be found regardless if the standpoints can be found close to each other within the interview transcripts, or if they were expressed as answers on the same question, or not. The mind map helped grouping extracts of similar (or opposing) nature together within the first order themes.

How the interview data reduction was done, in detail, is summarized in Table 2. Clearly, an analytical framework was used, and was needed for the type of analysis performed. The description of the analytical framework will now be introduced but will be better understood after reading D. EMPIRICAL FRAMEWORK.

Table 2 Interview data reduction process, adapted from Jacobsson and Roth (2014) and Braun and Clarke (2006)

Process Step	Description of the analytical process	Data size
1 Familiarizing with the data	Transcription of interviews, reading, rereading, and identification of initial ideas.	> 40 000 words
2 Generating initial codes	Initial ideas (both from observations and interviews) were found to be well fitted within the STS framework by Kast and Rosenzweig (1979). Therefore, the framework and codes were adopted.	
3 Initial data reduction	Highlighting of extracts, see Figure C—2, found to be revelatory to the interviewee's position in relation to identified themes and the study's research question. Extracts were kept long, including context if not clear. Particularly, extracts that supported or contradicted other respondents' were highlighted. Highlighted were also extracts that were revisited repeatedly in response to different questions and answers emphasized by the interviewee.	> 7000 words, 120 extracts ²⁵
4 Searching for themes	Based on codes, categorization of reduced data.	
5 Mapping the data	All extracts were mapped onto a digitally generated "mind map", see Figure C—2, where second order themes were grouped together and relatedness of responses were visualized.	
6 Reviewing themes	The extracts were found to fit the framework well, and only ten percent of initially highlighted extracts were not categorized by second order.	
7 Defining and naming themes	First order themes adopted from Kast and Rosenzweig (1979), second order themes (or groups) were generated inductively (by correspondence or opposition between interviewees' standpoints) and were named after the full mapping was finished.	
8 Producing the report	Refining analysis, selection of compelling extract examples, the framework was used as the structure for reporting the findings	< 2500 words

²⁵ The correlation factor (Pearson's rho) between interview length (in minutes) and number of extracts highlighted from each interviewee is .922. This means that the correspondence between the lengths of the interviews correspond well with the interviewee's representation in the report.

C.f.a. Empirical framework introduction

The empirical framework used to structure the empirical findings (and to outline chapter E. EMPIRICAL FINDINGS) is taken from systems- and contingency theory. Contingency theory can be described by the notion that there is no one best way of managing in all situations. Emphasis, in contingency theory, is put on the characteristics of a specific organization and in order to drive a change program in that organization, one must consider the set of conditions in that particular setting (Brown & Harvey, 2011). Kast and Rosenzweig (1972) argue that there is no cookbook solution to management success. The contingency- and systems view provide a more thorough understanding of complex situations and therefore increases the likelihood of appropriate action.

A system (in this case study, the design team) is built up by subsystems but contrarily to the reductionist²⁶ view, clear dependences bind the subsystems together and they influence each other in a number of ways.

The STS approach builds upon the idea that a system is made up of five subsystems and a supra-system surrounding it. All sub-systems interact with and influence each other. In this thesis, four of the subsystems will be in focus. Those are the ‘Goals and Values’, ‘Technical’, ‘Psychosocial’ and ‘Structural’ sub-systems of an NCC PS. The remaining sub-system is the centered ‘Managerial’ subsystem, and it is the thesis author’s intention to support the actors within this sub-system. To fulfill the thesis purpose and to address the intended reader groups, the STS approach was found particularly applicable. A greater understanding of the interacting subsystems will give the manager a better understanding of appropriate action, on all levels. The supra-system will not be thoroughly investigated and it is part of the study delimitations (see B.b Delimitations p. 8).

The subsystems, and how they interact, will be further elaborated on in chapter D. EMPIRICAL FRAMEWORK. Hanisch and Wald (2012) point out that contingency theory has been popular in organization theory since the 1950s but only lately (last few years) more commonly applied to settings of project management organizations (as in this study). According to Brown and Harvey (2011) the STS approach is considered one of the most sophisticated techniques for practicing organizational development with substantial expertise and effort needed for implementation. Analysis in this thesis will not be done with the level of expertise and effort that this suggests but rather use the framework to include different aspects of the data studied and to structure the findings in writing.

²⁶ For an explanation of reductionism, see D.a.a Structural sub-system, p. 24.

C.g. Choice of theoretical framework

The theoretical framework in chapter F. THEORETICAL FRAMEWORK (beginning on page 48) will first describe Lean as a concept. The conceptual view will be presented mainly through a description of the Toyota Production System (TPS), popularly known as ‘The Toyota Way’. After the general introduction of TPS, theory of the philosophy and concepts applied in construction follows. Thereafter a review on cultural aspects of lean implementation is given.

C.g.a. Motivation of the choice of theory

As earlier depicted in C.c Thesis assumptions, the thesis rests upon the assumption that a gap between theoretic descriptions and the practice observed is disadvantageous.

Moreover, the author found it most important that the most central theoretical concepts are of the greatest importance. This is why it is a given that the Toyota Production System, and the concepts that has come to form a Lean Production system were to be described. The author finds the TPS to be the core and origin of Lean Construction. If the foundation is not properly engineered, nor will the building occupants perceive the system – much like building a house.

After the TPS has been introduced, the most important parts of the theory of Lean Construction are chosen based on what has been found in the case material. Theory of Lean Construction is, by the author, perceived to be young and because of this the theory grows in diverse dimensions. The youth of the theory also makes a critical mindset important when choosing within the theory. Basically, the author has tried to reference the most cited Lean Construction theorists and cross-check the choices against the core concepts of Lean for inconsistency.

Because the theory to be implemented has been successfully implemented in other cultural settings, the assumption that culture would not influence the chance of success seem to be a too risky assumption. Therefore, theory around Swedish culture and its ability to take on Lean systems are briefly described.

C.h. Form of results

Bryman (1997) points to the fact that the results of a qualitative study are of idiographic nature. Idiographic results means that the results are contextually bound, both by time and setting (see C.i. Critique of methodology below).

Due to the holistic, in depth, type of research performed this is found to be particularly true in this study. Eisenhardt and Graebner (2007) argue

that theory building from cases is less generalizable, due to the fact that the fewer the instances (cases) studied, the lower the risk is that the theory does not comply with the findings. Certainly, this is true also for this study. For example, compared to a survey study, the findings are less generalizable. Still, the thesis purpose is of a particularizing nature, not a generalizing.

C.i. Critique of methodology

As a reminder, the unit of study is the full design team, including the team members working remotely, outside the NCC Project Studio. To get more reliable results, interviews with design team members outside the host company NCC would therefore have been highly desirable for more reliable results. As conclusions will be drawn, assuming the opinions for remote team members (members outside the NCC PS physical space) it is clear that these assumptions would be strengthened by empirical data on their actual standpoints. This means, for example, that the assumption that increased interaction between team participants would be helpful and well perceived by these team members doesn't necessarily have to be true.

Because of this, further studies, to bridge this gap in reliability has been proposed (see I.a Proposed future areas of study on page 78).

As the study is performed in Sweden only, and on NCC projects of medium to large size, generalization outside these settings shall be done with caution.

D. EMPIRICAL FRAMEWORK

In this chapter, the framework used as a basis for presenting the empirical findings is described. The chapter's purpose is to describe what aspects of the diverse data set that has been taken into consideration. The chapter starts with an overview, thereafter the history of the framework is presented. Finally, the author gives his view on the applicability of the framework to this thesis.

D.a. Socio-technical Systems Theory

As the framework for coding the empirical findings, the considered design teams have been viewed as an open socio-technical system, see Figure D—1. The STS view, as used in this paper, is an application of the contingency approach, to emphasize that *“there is no one best way of managing in all situations”* (Brown & Harvey, 2011, p. 41), and that situational factors have impact on the results of interventions.

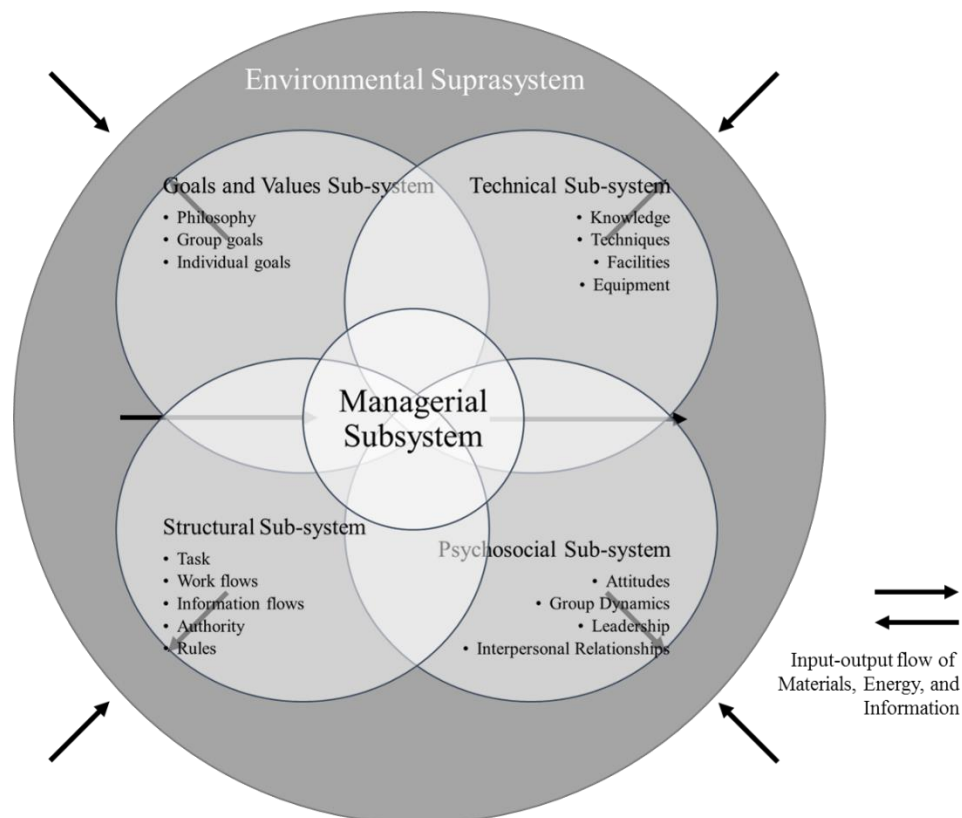


Figure D—1 The socio-technical system, adapted by Naoum (2001) and Kast and Rosenzweig (1979)

The STS view was first utilized in the British mining industry, where the traditional “short wall” method was superior to what had been designed to be the technically superior “long wall” method. Managers could not understand why the breakdown of masonry work forming a long wall, utilizing economies of scale, was underperforming the traditional short wall method where short wall sections were built in sequence. Only when the psychosocial aspects of the new methodology were analyzed, managers found their answer. Each mason was expected to work more independently in the new setting. From breaking down the closely knit bonds of the team structure used when building the short wall, the long wall method induced a greater level absenteeism and the end result was lower productivity (see Trist & Bamforth, 1951).

As earlier depicted in C.f.a Empirical framework introduction on page 20, the thesis empirical findings will focus on the four subsystems surrounding the managerial. Those are the ‘Goals and Values’, ‘Technical’, ‘Psychosocial’ and ‘Structural’ sub-systems of an NCC PS.

Naoum (2001) states that the subsystems have been added to the view of an organization over time, as organizational theory has evolved.

First, the managerial and structural subsystems were in focus. Theories were formed on how to set up principles for dividing and coordinating work (structural subsystem), and how to set (and subsequently operationalize) goals fitting the needs of the environment (managerial subsystem).

Second, the psychosocial subsystem, emphasizing interpersonal relations and behavioral patterns was added to the view as behavioral scientists stressed the importance of group dynamics and motivation.

Third, management scientists highlighted the knowledge and techniques needed for operational efficiency (technical subsystem). All schools tended to do this in a rather narrow-minded fashion leaving external systems aside whereas the systems view and other modern applications have come to take a holistic approach including all subsystems *and the environment* in their view of the organization (Naoum, 2001).

The history that laid ground for the STS view will now be reviewed for the purpose of placing the thesis analysis in a business historical setting. Hopefully, it will also provide a deeper understanding of each subsystem’s importance and meaning.

D.a.a. Structural sub-system

As stated above, structures were the initial focus in the view of an organization. Organizations were *analyzed*. Analysis – the word – means ***‘the division of a physical or abstract whole into its constituent parts to examine***

or determine their relationship or value' (Dictionary.com, 2014a). The antonym is synthesis, meaning putting together. Typical for the analysis of organizations at this point in time was not only to divide them into pieces, but also that it was done in a reductionist way. Simplified, *'[reductionism] in philosophy, [is] a view that asserts that entities of a given kind are collections or combinations of entities of a simpler or more basic kind or that expressions denoting such entities are definable in terms of expressions denoting the more basic entities. Thus, the ideas that physical bodies are collections of atoms or that thoughts are combinations of sense impressions are forms of reductionism'* (Dictionary.com, 2014b). Reductionist analysis have for a long been the typical approach in natural sciences such as physics and chemistry where atoms form molecules, atoms consist of nucleons and electrons and nucleons are formed by quarks. Maybe this is why this early management school came to be named (classical) scientific management; the smaller the part of the organization analyzed – the greater understanding of the whole was expected and an optimization of the whole was expected.

Typical names mentioned to be representative of the reductionist mindset used in scientific management are Frederick W. Taylor and Alfred P. Sloan. Taylor laid the grounds in his book "Principles of Scientific Management" (see Taylor, 1911) to what later was referred to as 'Taylorism'. Sloan, manager and president at General Motors in the 1920s and 1930s, is considered to be a pioneer when it comes to applying Taylor's ideas (Dale, 1956). Sometimes, people refer to the mass production technology utilized in the Ford factories in the production of Ford model T early in the 20th century – but the similarities between the two is most probably coincidental. Charles E. Sorensen, principal at Ford, claims that *'No one at Ford – not Mr. Ford, Couzens, Flanders, Wills, Pete Martin, nor I – was acquainted with the theories of the "father of scientific management," Frederick W. Taylor. /.../ To my mind this /.../ should forever dispose of the legend that Taylor's ideas had any influence at Ford.'* (Sorensen, 1956, p.41). Nonetheless, the school that has come to be named "Fordism" as used by Ford at the time was also focusing on the structural subsystem of the organization and there are clear similarities in how management of work was supposed to be carried out.

D.a.b. Psychosocial sub-system

The human relations movement came as a response to scientific management and was largely a criticism of the de-humanization of workers that classical Scientific Management had come to be known for.

The Hawthorne effect, earlier referred to in section C.e.a 'Observations' on page 15, originated at this time. Experiments at the Hawthorne Western Electric Company in Chicago on the effect of worker

productivity by variations in lighting, compensation and breaks all came to have positive effect – no matter what change was made (Calhoun, 2002a). The conclusion was that mere attention and engagement by managers on the working conditions came to have a positive effect. Up to this point, economic compensation had been seen as the major, if not the only, reason for increased effort. The experiments, carried out in mid 1920s, laid ground for the movement that particularly was influenced by Elton Mayo (Calhoun, 2002a).

Mayo had seen that in most factories visited, the social and emotional needs of workers had been overseen and the working conditions contra-stimulated the workers and resulted in lower productivity. His solution to this was the reversal of the extreme labor division that had come from the reductionist mindset. By introduction of team working conditions and workplace counselling this was counter-acted (Calhoun, 2002b).

Calhoun (2002b) claims that the human relations movement lost ground in the mid-20th century but that major themes of resemblance can be seen in the 1980s Japanese models of workplace organization.

That the theorists of classical scientific management, i.e. Taylorism, were actually as dehumanizing as some of the later theorists say, is not undebated. Chandler (1965) for example, points to the fact that the theoretical contributions of Taylor were never fully realized in any system until the critique came. Still, many of Taylor's concepts had become standards in the administrative practice of many organizations at that time.

D.a.c. Technological sub-system

In the wake of the human relations movement, many managers, and studies on management, shifted focus to what has become popularly referred to as the scientific-technological revolution. Despite the hesitation to refer to the interests at this time as a revolution in its true meaning, few would argue that technology – as it is being referred in this thesis – was slowly developed and overseen at the time in history.

Most soviet theorists covering the subject of the scientific-technological revolution²⁷ agree that the shift in mindset started somewhere around the forties in the west, and fifties in the Soviet Union and that this shift was a worldwide phenomenon (Hoffmann, 1978). Differences can be found however, on the perspective whether the scientific-technological revolution was a shift in the view on technology only, or on the workings of society as a whole. Some argue that the essence of the time lies in the breakthroughs in the use of new materials, energy sources and the transfer from labor works to automated production processes (Hoffmann, 1978). Some argue that the

²⁷ In Russian known as *nauchno-tekhlicheskia revolutsiia*

scientific-technological revolution was just part of a much bigger movement, where job satisfaction, leisure, interpersonal relations, education, etc. was part (Hoffmann, 1978).

D.b. The Toyota Production System versus contingency theory

Some readers might ask themselves; how is a ‘one-stop-shop-solution’ such as the Toyota Production System different from the contingency view? Wouldn’t it be perfectly contradictory saying that there is no one best solution for every organization and still propose that a Swedish construction company is to learn from a Japanese car manufacturer?

Koskela (1992) points out that the tools that have been developed by lean practitioners are for many what lean is all about. Lean practitioners and theorists themselves often times say that the tools are nothing without the system thinking behind it. Koskela (1992) describes it as a philosophy, Yates and Battersby (2003) and Naylor, Naim, and Berry (1999) describe it as a new paradigm.

Hoss and Schwengber ten Caten (2013) argue that the socio-technical systems approach has the same goals as lean, but that the STS approach is more inclusionary, taking more aspects into consideration. They imply, thereby, that lean theory lacks coverage of some part of a production system and the systems that surround it. This view of lean is not shared by the author of this thesis. It is understandable that when lean is seen only as a set of tools, the socio-technical systems view of the organization would inhere a perspective that would be lean critical.

Hoss and Schwengber ten Caten (2013) has much in common with the view represented in Green (1999). The latter says that non-humane worker settings is a common attribute in lean production setting. However, non-humane worker settings contradict many of the fundamental principles of lean, such as continuous improvement and utilization of trusted technology (see “Lean Production”, p. 48). His argumentation has much in common with the one of Hoss and Schwengber ten Caten (2013) as both seem build their argumentation on a very narrow sample of literature.

That managerial actions proposed by lean theory *are* compatible with the systems view of the organization is argued by Saurin, Rooke, and Koskela (2013), having reviewed literature on Complex Systems Theory (CST) and theory of Lean Production. They also argue that lean practitioners can learn from theory of complex systems in numerous ways. For example, CST can help the manager understand the importance of slack in the system for safety reasons, it can give a broader perspective on control procedures that can adapt

to different levels of variability in the system, or it can help to stress the need for development of resilience²⁸ skills of a worker.

Saurin et al. (2013) also make an argument of the applicability of CST to control factors hindering the successful implementation of lean production systems. A select few of the control factors are to control for manager inability to conduct implementation processes. Control for hierarchical structures suppressing “low-level” inputs. Controls for the inability to foresee how lean works better if it is implemented throughout the whole organization. The latter is an iteration of the synergetic effect as described by Shah and Ward (2007), F.a. Lean Production, p. 48.

D.b.a. Thesis author’s view on the Socio-technical system

The history behind the socio-technical systems view, as a synthesis of different managerial science movements through time – and their interdependencies – may seem like an old analytical framework to use as of today. The reason why the history is given is simply to indicate how the author does not emphasize any of the sub-systems as being superior to the other, but rather takes the standpoint that different sub-systems are important in different settings, depending on the context.

It is also the thesis author’s standpoint that the framework provide a holistic approach to the empirics of the case studied, and that the framework will function as an objective tool out of which the analysis will come without bias. Further, it is believed that lean theory²⁹, due to its multifaceted areas of application and implication, is fully conformed to the holistic, systems view, approach.

²⁸ The term resilience is used to describe a system’s ability to adjust their functioning prior to, during, or following, changes to a system and is recognized as a central part of CST.

²⁹ That lean is a ‘theory’ is in itself debatable and depends on the definition of theory. The thesis author does not see lean as a theory but rather as a set of descriptions of managerial perspectives in varied contexts that commonly can be derived to the same set of principles.

E. EMPIRICAL FINDINGS

The empirical material has been reduced in accordance to the methodology described and will be presented narratively interspersed with quotes in accordance to the model described in the preceding chapter. Pictures and sketches are taken in NCC Project Studios. Quotes have been corrected to written language and translated from Swedish to English. The narrative will follow the framework as presented in the preceding chapter. As earlier described, there will be clear overlaps between the areas described in the outline below as a result of the sub-system interdependencies.

E.a. Sub-systems overview

In Figure E—1, a diagram of the number of extracts chosen from each interview is shown. For example, in interview three, almost half the extracts chosen for its importance were classified as being opinionating the structural sub-system of the interviewee's Project Studio.

The analytical significance of the diagram is limited. Certainly, the absolute time spent discussing each subject area is influenced by the researcher and his interview guide. However, it is the author's understanding that in comparison in between interviews, the frequency of subject area

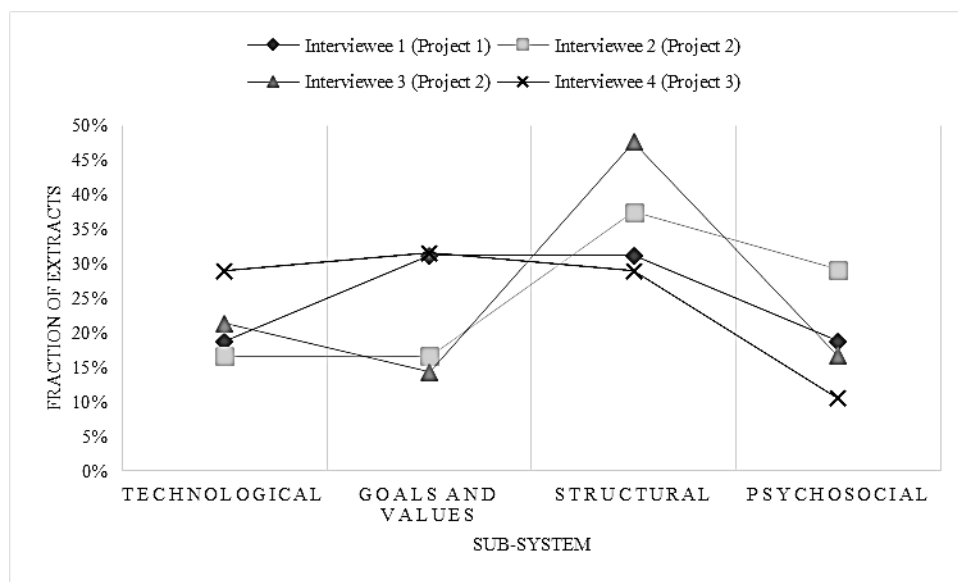


Figure E—1 Quantitative representation of themes for the reduced data (120 extracts). The fractions represent how many of each interviewee's quotes that were classified into one sub-system or another.

revisits give insight in what each interviewee finds particularly important. All interviewees were given the same questions and similar interview settings.

It is clear that interviewee 2 and 3, representing the same project, revisited the area of goals and values less frequently than the other two interviewees. It can also be seen that the structural sub-system was the major area of interest for interviewee 2 and 3. Interestingly, the areas of interest for interviewee 2 and 3, members of the same design team, generally correspond well.

Interviewee 4 paid relatively little attention to, and effort discussing, the psychosocial sub-system, while the other sub-systems were given largely the same attention.

E.b. Structural sub-system

The common denominator of NCC PS at the projects visited is a physical space where meetings are held with key design team members. Key personnel generally consist of design lead(s) from NCC, consultants hired by the main system sub-contractors, and the architect. Usually, an owner³⁰ representative is present as well. A schematic of the setup can be seen in Figure A—1, page 6.

Activities generally follow a (somewhat flexible) schedule as can be seen in Table 3. Clearly, there are different numbers of “NCC PS-days” each week for the different projects. In all project studios there is a focus on having time for meetings. The schedules correspond with the perspective given during observations, namely that not much time is left for individual work. Generally the day is seen as an opportunity to coordinate the schedules of a wide range of experts with different interests.

Table 3 Project Studio schedules for studied projects (M is short for meeting)

	Project 1	Project 2				Project 3		
	Thursday	Odd Wed	Odd Thu	Even Wed	Even Thu	Wed	Thu	Fri
9:00	Design M	Design M	Free Time	MEP M	BREEAM M			
10:00	Design M	Design M	Free Time	MEP M	BREEAM M	VDC M	Structural M	Sub-system M
11:00	Visual Planning	Lunch	Lunch	Lunch	Lunch	VDC M	Structural M	Sub-system M
12:00	Lunch	Pull Planning	VDC M	Structural/Ski	Free Time	Lunch	Lunch	Lunch
13:00	Visual Planning	Pull Planning	VDC M	Structural/Ski	Free Time	Design M	Sub-system M	Sub-system M
14:00	M if Needed	Free M Time	Free M Time	Free M Time	Free Time	Free Time	Sub-system M	Sub-system M
15:00						Design M	Sub-system M	Sub-system M

³⁰ The owner is the first tier customer of the main contractor.

E.b.a. The architect function and meetings

The architect is responsible for aesthetic design. The architect has the largest number of team members in all three projects studied. These work for the head architect from their office (if not called in to the PS for special reasons), in Project 3 approximately 15 full time architects supported the head architect, working from the architect company's home office. In Project 1, there was only one supporting the architect, 'detailing' at the home office.

The head architect is expressed to be the project team member who knows the most about the others' needs, and the head architect is the busiest actor in a PS. It was, by far, the most active design team participant (apart from the design lead) observed in Project 1. No data supported that this was not the case in the other projects studied. It could be that this was due to reasons of seniority; it could also be that the architect has a connection to the project owner that is seemingly different from other design team engineers and consultants.

A career as an architect seems aimed at an end where the person still has a high project involvement, in fact increasing project involvement and authority over time. This differs from the design lead role, for example. The design lead generally has less experience than the head architect³¹.

The career path also gives the architect a growing network of project owners over time, easing the architect's ability to be early involved in projects in the industry. Many times the architect is hired before the main contractor has been decided upon.

The head architect sits in meetings more than 75 percent of the scheduled time in the PS³².

E.b.b. Information distributing administrators

The same setup as used by the architectural function is used for other expert groups, such as the mechanical engineer for example. The design specialists representing different disciplines are commonly referred to as 'consultants'. There is generally only one (sometimes two) consultant(s) that is called into the PS to represent their discipline. This person is contractually stipulated to make decisions for their respective companies. In the contract, all projects also had a financial penalty clause tied to absence from the PS.

³¹ The design leads of the projects studied had less than five years' experience.

³² 97 percent of observed time in Project 1 (counting group scheduling activities), 75 percent in Project 2 and "more or less all sub-meetings" Project 3

Project 2: ‘We wouldn’t host the whole design team but most of them have rather large organizations at home who perform the actual drawing work. Then there is someone from each discipline who are here, one responsible, so to speak’^a

Interviewees agree that when there is *no dependence on others*, there is no reason to sit in the project studio to do work. There are many areas where this is true, such as when heights of certain installations have been designated beforehand and when a room in the building is dedicated for one discipline, such as an electrical room for example.

Clearly, there is hierarchy in the organization structure. Within the PS the target is to decide and divide work in between expert groups. The divided and decided work will then be carried out elsewhere, by others.

Project 3: ‘They would probably only be disturbed by sitting with a hundred others – we already solved everything for them... Then they had their own meetings, between consultants, because they had to’^b

E.b.c. The design lead role

All interviewees agree that the design lead has the overall responsibility of leading the work in the NCC PS. Interviewees also shared the understanding that this responsibility could be shared with other team members, if it was the right person (see E.c.a. Leadership and personality, p. 37).

Particularly, division of responsibility was prominent in Project 3 which had a formalized organization chart of the structure that had earlier been agreed upon. Each design sub-system had a designated meeting time (see Table 3) and each had a designated sub-system leader who drove the sub-system work ahead. Division of responsibility was much less common during the observed sessions in Project 1. At most, discussions concerning one point in the meeting agenda was led by the architect or a consultant, on the design lead’s initiative.

In Project 2, the design lead was getting increasingly confident in delegating authority and responsibility to others.

Project 2: [In another project] it was a little less. One could be well-informed about every single detail. Now, I have to trust them to coordinate themselves. I sit in the design meeting and divide tasks of how they should coordinate during the day. Before, I could sit down with everyone and pull the strings, but now I have to trust the others.^c

For larger projects (2 and 3), the design lead was assisted by a junior design lead whose main responsibility was to help out with administrative issues and coordination.

The interviews show that it is also the design lead's responsibility to make sure that the team members don't wander off on sidetracks but stay within the contract scope. The design lead in Project 2 had sat the design team down to tell them the importance of their deliveries and who delivers what.

From observations of Project 1, the design lead is perceived to be the node in the most part of all the discussions regarding the building design. Not only is it the design lead's responsibility to pull the design work out of designers and to order design work. It is also within the responsibility of the design lead to pull information out of the owner's representative so that the end customer can continuously influence design choices made.

At the same time as the design lead is responsible for the information flows through the design team, it also seems like this person is mainly responsible for the NCC PS methodology compliance. Other individuals seem responsible only for their area of expertise, not for the development and utilization of NCC PS as a concept.

Project 2: 'A lot is demanded of the one that is responsible to lead it, me in this case. That I believe in it. The leader has to prepare a lot and to work a lot with it and needs to know what he or she wants to get out of it. If my drive was not as high as it is, the same results would not be provided at all.'^d

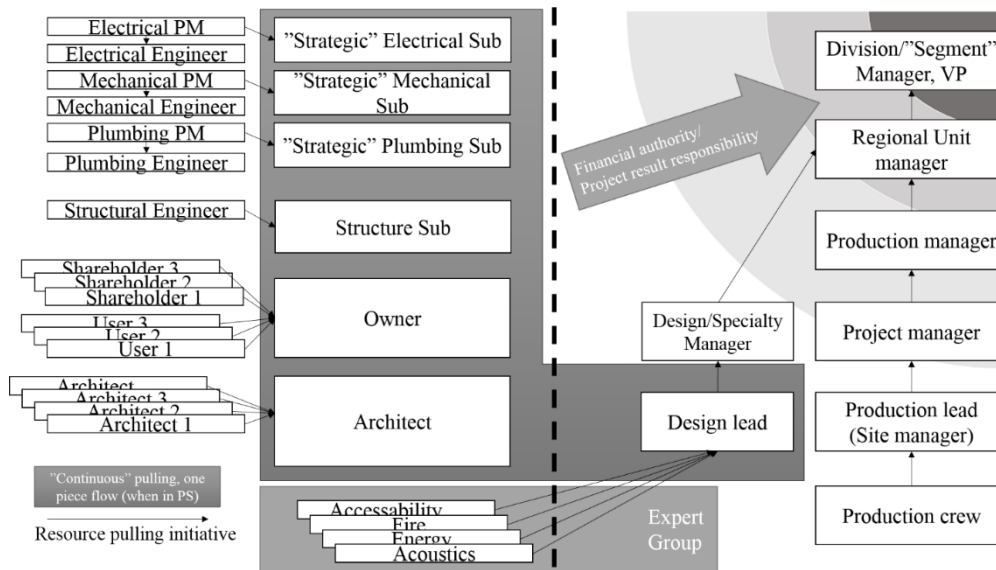


Figure E—2 Scheme of current state information flows. Sub is short for sub-contractor and the organizations for the sub-contractors do differ. For further understanding of the person depicted, see E.b.b. Information distributing administrators on page 31.

The design lead also has to balance budgetary goals and resources in different forms as provided by the company. Observations and interviews resulted in the scheme of the supply chain of information and other resources as seen in Figure E—2.

Seemingly, all the flows depicted need to pass through the design lead.

E.b.d. The design process

In Project 1, the allowable cost for the project was still not agreed upon after the initially planned production starting date had passed. In project 2 it was realized after the system design³³ stage that much more rentable area was needed, when all numbers were added together. Both projects initiated extensive cost reduction phases where (earlier agreed upon) decisions were invalidated in order to overcome the budgetary issues.

³³ Systemhandling using Swedish construction terminology.

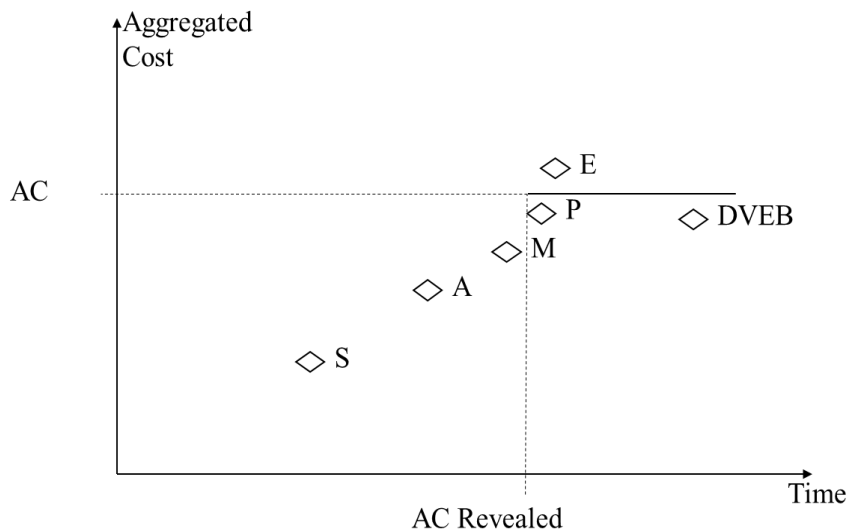


Figure E—3 Schematic of the design budget development over time in the PS (not in scale). (M – Mechanical, E – Electrical, P – Plumbing, A - Architectural, S – Structural, DVEB – De-value-engineered budget, AC – Allowable Cost

Project 2: ‘it is uncommon that we can scope the full project from the start /.../ in this type of reviews, xxx discusses resources. You meet and discuss, can we deliver according to plan, do we need more- or do we, in fact, want to cut resources? Have not received the required? For example, if we thought that we were to get a certain amount of renters at this point, and it looks like we won’t, then we will have to cut the pace’

After Project 1 observations, the author drew a schematic of how the project budget develops over time, this can be seen in Figure E—3. The process is generally similar in the other projects studied. The design specialists from different disciplines finish their design work, in large clusters, sequentially over time, handing their results to the others for their add-ons. At some point in time, the owner representative reveals his budgetary constraint. After this, the taken design decision up to that point needs revision to meet the goal.

Project 3 was led by NCC after the systems design – in order to develop construction documents – and further led the production stage. Many system design changes came to be worked into the design at the owner’s initiative after the point in time when NCC took over. In Project 1 and 2

project managers continuously kept changing the pace for which work could carry on.

E.b.e. Continuous improvement initiatives

All projects had, at one point or another during the design phase, initiated attempts to discuss improvements of their PS' setup with the design team involved. All interviewees had a positive impression of the experience feedback sessions³⁴ held.

The head architect in Project 1 proposed a workstation for his team member working in his home office so that she could sit in the PS and draw.

Project 3: 'We had it [experience feedback session] when we had been working for six months or so. Not quite that long, actually. We asked them: 'what works well, and what can be improved?' We had a two hour meeting regarding this – no; actually I think it was more than that. During that meeting, many things the consultants had been thinking were brought up. Then we changed those, I think there were some things about the working hours.'^f

The PS working hours of Project 3 changed as a result of the feedback session so that representatives were allowed to leave earlier and to arrive later than originally stipulated in the contractual time penalty clause.

The working hours are one of the major changes in the NCC PS concept to the traditional product design working conditions. In the contracts between NCC and the design representatives clearly stipulated working hours when representatives should be in the Project Studio are defined. The purpose of the contractual penalty clause for absence is to ease communication between information holders and representatives asking for information.

At first, when asking the interviewees about continuous improvement initiatives, the impression is given that it is done continuously. However, to get information on the outcomes of these initiatives and their documented occurrences have been complicated.

Project 2: 'It was only one action point in the design meeting protocol, I can print it out for you but I didn't document that meeting – I just chose to put the best and the worst experiences in the protocol.'^g

³⁴ NCC uses the Swedish expression 'Erfarenhetsåterföring'

E.c. Psychosocial sub-system

E.c.a. Leadership and personality

The design lead generally takes on the responsibility to keep the consultants' spirits up at the same time as the status quo is challenged. This calls for specific personality traits. All impressions given, from observations of- and interviews with the design leads, indicate that they have a sociable, flexible and humble personality.

The design lead does not perceive the consultants to take ownership of the group spirit if not encouraged to do so.

Project 3: 'I do not encourage everyone to do this because I do not think everyone has the right personality for it. We have been working hard to get this through and to keep the social aspects alive at the same time. That everyone dares to speak out and that all involved are able team workers'^h

The interviewees also agree that there are clear differences in personalities on the market for design professionals. The team work aspect is perceived crucial to the working climate and there is no good way to get ahold of the right consultants but through the referral of professionals whose judgment you personally find trustworthy.

The faith in corporate standard evaluation tools and corporate supplier database material is low and perceived as unreliable.

Project 2: 'In the supplier management system, one has to rate [the suppliers]. It will be a red, yellow or green smiley, depending on the judging made. We do not really have that with the consultants but we have the list at our boss' office so that it is possible to know who have been working with whom. Then it is just to give them a call and ask, it is the same really. In reality it is impossible to use the supplier management system anyway. You will have to go and ask someone who you trust.'ⁱ

E.c.b. Seniority

By observations and interviews made, seniority apprehend two dimensions in the construction industry. Generally, seniority (1) grows with the number of projects partaken and thereby the number of special cases that

the professional has been exposed to. It could also be seen as (2) the physical age of the person.

In the PS sessions observed, seniority was of great importance. Many times, details with small impact on the overall project result but with high technical or aesthetical complexity are discussed. Often times, the same technical issue is discussed on numerous occasions during the meeting, iterating the same arguments. Often times, the decisions were made based on the argument that it is how it has always been done.

Project 2: ‘One cannot be too much of a beginner to sit in a Project Studio. One has to master his or her discipline which you are there to represent.’^j /.../ one cannot fall back too much in discussions with others. My experience is that when beginners enter, they do not really want to enter into conflict – so to speak.’^k

‘Beginners’, as the opposite of consultants having high seniority, are generally kept outside design meetings. Beginners are commonly situated at the designers’ own office spaces drawing, or ‘detailing’, in computer aided design software. Beginners are fed with decisions made to update each discipline’s model from the meetings as held in the project studio. More than one person representing each discipline in the PS is generally not seen an option due to the risk of double work.

In Project 3 it was different. According to the interviewee more responsibility was given to team members with less seniority.

Project 3: ‘Senior team members are more used to shooting from the hip and just keep going, so to speak. They say: ‘It’s just like it always is’ and I think: ‘Oh! It is?’ Then – on the next meeting – ‘Oh, right! That was expected from me’... Yes, if you would have had that in a Gantt chart that you checked each week, it wouldn’t have been a surprise. /.../ I think juniors are much better at seeing that’^l

Finally, there is no doubt that the technological evolution has accelerated lately and has become a clear indicator of seniority. Generally, the faith in computer aided design methods decrease with the level of seniority. Senior designers rely heavily on manual calculations and theoretical derivation, this is particularly prominent when discussing building functions design.

Project 3: ‘When he [a senior consultant] sits in meetings, he takes out his calculator from 1974. Then he sits there and thrums on it and all of a sudden he is like: “Yes, that will work. We can do that. /.../ He does not want to use software or models...”’^m

E.d. Technological sub-system

E.d.a. Geographic location and layout

As can be seen in the sketches from two project studios, Figure E—4, the layout of the physical space is left much flexible. In the leftmost sketch all project studio work took place in one and the same room. It was a smaller design team and the chairs, as provided by NCC, were generally occupied only at one of the two tables. No workstations were provided in the Project Studio for Project 1. The one room, likewise the Project Studio, was used as a meeting room basically at all times.

Project 1: ‘One could hope for a better physical space than the one we are provided – one with more space surrounding it... We have been thinking about how to best dispose of the space in a Project Studio, and in my mind, it would have been best to lay it out surrounding an office landscape. In the landscape there could be room also for external personnel. But then, we are not there yet.’ⁿ

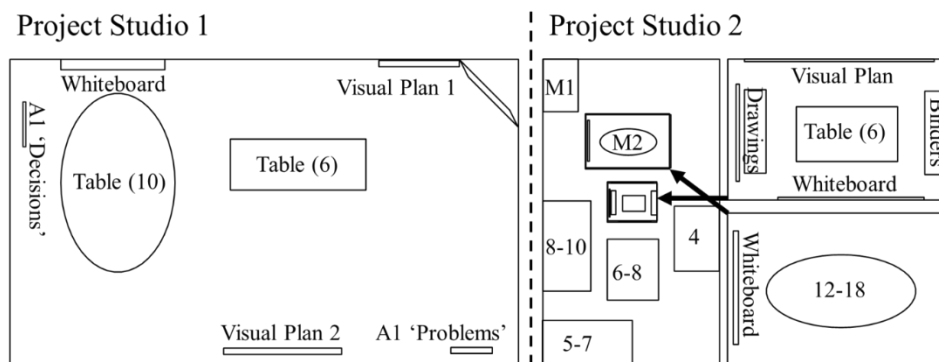


Figure E—4 Sketch Drawings of the layouts of the studios. Studio PS1 (Left), Locale PS2 (Middle), Meeting Room PS2 (Top Right), Visual Room PS2 (VR, Bottom Right). NB: sketches are not in scale and numbers (representing seats at table or number of workstations) are approximations, M is short for meeting room.



Figure E—5 NCC headquarters’ Project Studio, Workstations (Left, Right), Meeting Room (Middle)

Workstations were, however, provided in the Project Studio for Project 2. In this project, the design team participants generally had meetings during the two Project Studio days but then utilized the space as a node for collaboration in between remote offices afterwards.

When meetings were over in Project 2, communication in between the administrators (see Information distributing administrators, p. 31) of each discipline took place. The administrators reported what had been decided in the various meetings – back to the representatives at their respective offices.

Worth noting was that for Project 2, the physical space had been changed two times as the project team grew in numbers and a larger space was needed. At first, in the program design stage, the physical space was only a small room where few wanted to spend more time than necessary. After this, a designated space at the corporate headquarters (Figure E—5), single-purposely for NCC Project Studio had opened. This was the second physical space used. After this, there was a second move, to the final establishment seen in Figure E—4.

Project 2: ‘Before I entered the project (in the program design) everyone sat in an old basement. Everything in there was quite shabby and dark. It was in NCC’s old education spaces by a loading dock and it was a little room. The consultants and designers weren’t really motivated to sit there and they barely did. /.../ No-one wanted to sit there. You went to the meeting and coordinated in between for 15 minutes afterwards. That was why I gave everything I had so that we could move into the new space in the HQ.’³⁰

E.d.b. Visual planning

All projects utilized ‘visual planning’, although under different names. In all projects all design team members responsible for work



Figure E—6 Visual planning schedules. From the left: Project 1, Project 2, and Project 3 (demounted from wall)

participated in the planning, mostly in a consensus driven atmosphere. Team members generally spoke up at once if something seemed wrong. In some aspects, the way the planning was done differed as well.

Both projects observed had in common that the visual planning session involved at least one representative from each design discipline. The planning session started with every team member writing their upcoming activities on post it notes. Thereafter, the post-it notes were put in a logical order, and each representative was responsible for putting his or her own notes in between the others'. Often times, discussions about the trustworthiness of the plan started already during the stage when the notes were put on the board.

In Project 3, according to the interviewee, the design schedule was built in a 'right-to-left' manner, starting with the activities furthest in the future. So called milestones built the initial schedule structure, and activities closest to the milestones were asked for first. Each of these activities then asked for prerequisite activities to be finished when they needed to start. This way, a tree of commitments was built 'backwards' in the time dimension to the current date.

Observations of the scheduling activities in Project 1 and 2 differed from the one described to be used in Project 3. In these two projects, the scheduling was carried out in a 'left-to-right' kind of manner. Scheduling started at today's date, pushing as many activities as possible into the schedule from time zero, no time can be 'wasted'. Thereafter, scheduling the succeeding activities as soon as the current was thought to be finished. The network of commitments was thereby driven by the resource availability and an end date (or schedule milestones) was given first after the scheduling was done.

Pictures of the schedules, resulting from the visual planning sessions at different projects can be seen in Figure E—6.

In none of the observed sessions, time was given to follow up on activities that had been carried out so far, nor the ones that had not been carried out to plan either for that matter.

E.d.c. Other visual tools

Despite being questioned, none of the interviewees thought that more equipment in the Project Studio would be very helpful. However, interviewees from all projects indicated that the equipment and technology that was already supplied to their respective studios needed to function well or better.

Project 3: ‘Yes, we even had a smart board that we used. /.../ it was good to have one, but I think that we used it too seldom. /.../ we could use it in work meetings and such. /.../ we drew directly on the model, saved a screen shot and sent it along with the meeting protocol or something. We used it a little in the beginning but it is as it is with new technology. Not everyone feel confident in using it and it takes a while to boot it and so on...’^p

Moreover, education in how the supplied equipment was supposed to be used was commonly asked for.

Project 3: ‘That has to be it, exactly! Maybe it would be good to spend more time to educate the ones involved in the systems that we are asked to use. For example, every time we start a new project with a new owner, we always have a new document management system. We have the PDS and you talk about ‘Byggnet’ and there are probably 100 different systems. Every time they are different. More education would be really useful, I mean, we took a class on the PDS, but more of that! More time should be set aside for such things.’^q

Also, terminology and common definitions used in the NCC PS were not always clear.

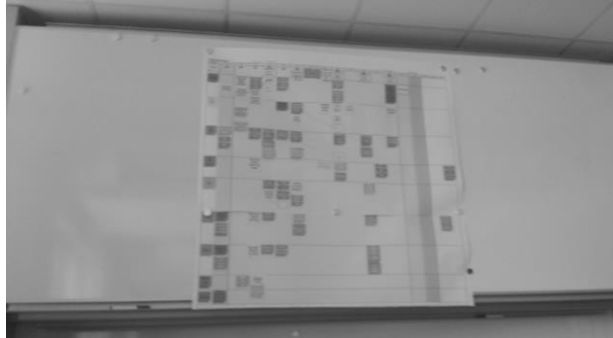


Figure E—7 In the PS for Project 2, the Visual Plan was manually digitalized into Excel using Excel's 'comment' function before being printed and put on the whiteboard.

Project 3: 'There is so much terminology; Project Studio, the visual room, Big Room... I mean, what is project studio? What is a Big Room? What is the visual room, and so on? We called this, the large room, this is the Big Room. And then we call it the visual room, where we visualize as much as possible. If you walk into the Big Room, everything is there, we said. We had the drawing room with drawings and we had the Big Room where everyone was allowed to enter when there wasn't a meeting. In there we had posted all the meeting protocols, all questions, everything, including the schedule. We had visualized it in there so to speak, even a senior colleague understands that.'

Some of the new ways of working has also induced unconventional procedures for documentation. In Project 2, the schedule made collaboratively was digitalized by making digital post-it notes in Microsoft Excel using the software's commenting function (see Figure E—7). The excel sheet was thereafter sent to the scheduling participants. Sometimes, it was also printed on a large sheet of paper to be put on the wall.

E.d.d. E-mail, telephone and protocols

Clearly, it is important that the design lead, being the main responsible for all information flows (see E.b.c The design lead role) communicates effectively and clearly. In Project 3, a web-driven system that made questions shortcut between team members (not having to go through the design lead) had been set up and worked well, when used correctly. Each team member in

need of information from another logged the question in an online database. The question updated a two-dimensional matrix on a TV screen visualizing which team members that were 'behind' and 'before' the others.

Without exception, the interviewees found the need for documentation and communication using different digital media extensive, in some cases the bureaucracy was found overwhelming, however.

Project 3: 'What we had done was that we had visited other project studios, interviewed them and looked how they had been working. The biggest issue was that the design leads in other large projects only sat in meetings, wrote out meeting protocols fair and answered e-mail. So that was our highest priority really, we will only have one protocol to write and that is the design meeting protocol and we will not sit and e-mail each other. I think it went well!'⁸

It seems, the communication attempts are not always well received. In Project 1, the design team did not seem to appreciate the documentation and protocols that they were provided.

Project 1: 'I have been thinking of the complexity with protocols. There are many protocols /.../ you spend much time and effort on the documents and then barely anyone look at them. I don't know. It is a real puzzle.'⁹

Much information needed to be transferred to (and from) the NCC PS. This is clear given the setup of Information distributing administrators as described on page 31. Every decision that was to be incorporated into the three-dimensional building model had to be transferred from the various meetings to the one drawing or detailing. Generally, the ones detailing were found in outside the NCC PS. Also, the one detailing cannot expect an answer to a question until his or her administrator has posed the question in the correct NCC PS meeting.

E.d.e. Virtual design

As seen in B.b. Delimitations on page 8, enablers in the form of Virtual Design environments, through the utilization of computer aided design software, is outside the thesis scope. A short note will be given on this matter anyway, due to its close relationship to the system's technological performance.

Project 3: 'It ended in that xxx had a model they kept alive and changed it in accordance with the information that yyy provided.'^u

Both observations and interviews contradict what can be read in NCC's annual report of 2013: '*NCC has extensive experience in the utilization of virtual construction, VDC, in more than 600 projects and is thereby industry leading, not only in the Nordic Countries, but also globally*' (NCC, 2014, p. 21).

E.e. Goals and Values sub-system

E.e.a. Problem orientation

The common way design work is done is in a reactive fashion. Seemingly, something is always late, or needs to be done as soon as possible so that something else won't run the risk of being late.

Work being carried out is largely of problem solving kind. This is due to the habit of not looking ahead until a problem occurs. Commonly, the problems take on the form of design detail questions. Keep going in full speed of design until some detail appear problematic, maybe it is a collision between the ventilation and the sprinkler system, maybe a wall needs to be moved for a room to fit something new.

Largely, the reasoning behind this way of working seems to be cost driven. If we always have problems to solve, there is no risk of sitting idle. All interviewees also share the understanding that the building design is 'somewhere out there to be found', that once all questions have been given an answer, the building design is finished.

Most likely, this way of working was due to the stage of design for which most of the observations were made. Most strategic questions, except for financing and resource needs, had already been finally decided upon.

Project 2: 'What do I want to get out of the sessions on Wednesday and Thursday? What questions exactly do I want answered? I mean that is the routine of the meetings. You look at the unanswered questions – which ones of these do I want answered.'^v

E.e.b. Corporate goals

Much like the confusion with regards to the terminology around NCC PS (see E.d.c Other visual tools), there sometimes seem to be a gap in the communication between the corporate mission and how this translates to the everyday design work for the NCC PS design teams.

Project 2: ‘It does not feel like there is a very clear goal. I miss clear directives of what we should focus on. Right now it is very much up to the projects to decide and choose and we really do not have the knowledge for it, it is not in our focus so it gets left behind. I believe that we could get more out of it if the goals were clearer /../ I sometimes feel like there is no clear vision from the company – this is what we are going to do! And this is where we will be in five years! It is quite hard for each project to set this kind of goals really...’”

Not only is there a setup that eliminates ‘slack’, projects also seem to be held responsible for strategic goal setting.

E.e.c. Rewards and penalties

In the contracts, no rewards for deliveries above expectations are stipulated. Despite this, penalties of different kind are common. As mentioned before, penalties are tied to team members’ presence in the Project Studio for example.

How penalties will be deemed, and on what grounds are not always clear.

Project 3: ‘I believe that we had some penalties tied to the contract. If they do not deliver – the penalty would apply. But, it is hard to judge of course – when do they not deliver, what do we compare against? /../ rewards systems are not used as we do with penalties. Rewards can be a pat on the back and someone telling you “Good job!” And I think we have done this a lot. I mean, through praise you grow as a person and you think it is fun to go to work.’^x

E.e.d. Customer goals

In Project 3, the owner was not commonly taking part of the everyday work in the Project Studio. A meeting between NCC and their clients were held on separate days, aside the PS.

Project 3: ‘They [the owner] are not part of our Project Studio. Well, they use our spaces but they are not part of the project studio work, participating in the work that way. There are separate forums for communication with the owners and they have been on days the project studio participants are not present.’

Also, observations of Project 1 witnessed that the project owner and the main contractor did not share the view on budgetary constraints earlier agreed. Significant delays in the start of production was caused by this misalignment.

As can be seen in Figure E—1, on page 29, the interviewees from Project 1 and Project 3 both put the most focus on questions around goals and values. In comparison, both representatives of Project 2 put little emphasis on the aspects regarding goals and values.

F. THEORETICAL FRAMEWORK

In this chapter, the theoretical framework to be used for further analysis through comparison to the empirical findings will be described. First, lean as a concept is introduced, and theory around lean construction theory follows. Thereafter a review on cultural aspects of lean implementation is given. The chapter's purpose is to give an overview of the theory used when comparing to the case data. Further readings on the references are highly recommended for a more in depth understanding.

F.a. Lean Production

The Toyota Production System (TPS), the very foundation of lean, can be summarized in 14 principles, hierarchically structured into five “Ps” (Liker, 2004).³⁵

To begin with, the first P is a fundamental part of the system. It is a *long term philosophy* and it is also the first principle. Long term results will always come to defeat short term goals, even financially sound (Liker, 2004).

Secondly, *sound processes will produce desired results*. With this P, it is clear that TPS is a process oriented system. Adhering to this principle are seven principles, (1) to create process flow surfacing problems, (2) utilize “pull” systems to avoid overproduction, (3) level the workload, (4) stop to fix problems (do it right the first time), (5) standardize tasks, (6) use visual controls, (7) use only reliable technology (Liker, 2004).

Tied to the orientation around processes is also the often cited pursuit of waste elimination. “Waste” is known as everything created that does not add value to the customer – also known as non-value-adding-activities. Important to remember, however, is that waste elimination is not equal to lean implementation, something that is a common misunderstanding (Liker, 2004).

Thirdly, two ‘Ps’ are of equal hierarchy, namely *people and partners*. With ‘people’, the people inside the organization (employees) are meant, and for people two principles are found. (1) To grow your leaders to a thorough understanding of their work and to live the philosophy, and (2) to develop exceptional team members. Organization externally, the principle reads that your extended network of partners will develop by your challenges and your help for them to improve (Liker, 2004).

³⁵ For the convenience of the reader, the theory around the TPS system has been significantly shortened, but keeps a complete review due to the interdependencies in between the principles. To get a better (or an actual) understanding, reading Liker (2004) is strongly encouraged.

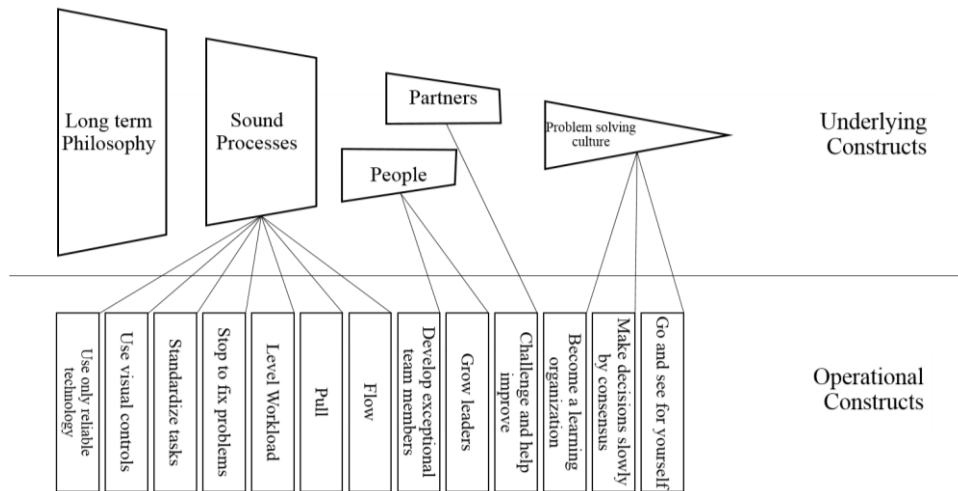


Figure F—1 The Toyota Production System principles (Liker, 2004)

Finally, the system is crowned with a (*root*) *problem solving* culture. The three principles that synthesize this “P” are (1) go and see for yourself [genchi gunbutsu], (2) make decisions slowly by consensus and (3) become a learning organization by reflection [hansei] and continuous improvement [kaizen] (Liker, 2004). All principles can be seen in Figure F—1.

Shah and Ward (2007) try to answer the question “what is lean?” by complementing the theory of lean as a philosophy by characterizing lean by ten distinct dimensions of the system. These can serve as an operational

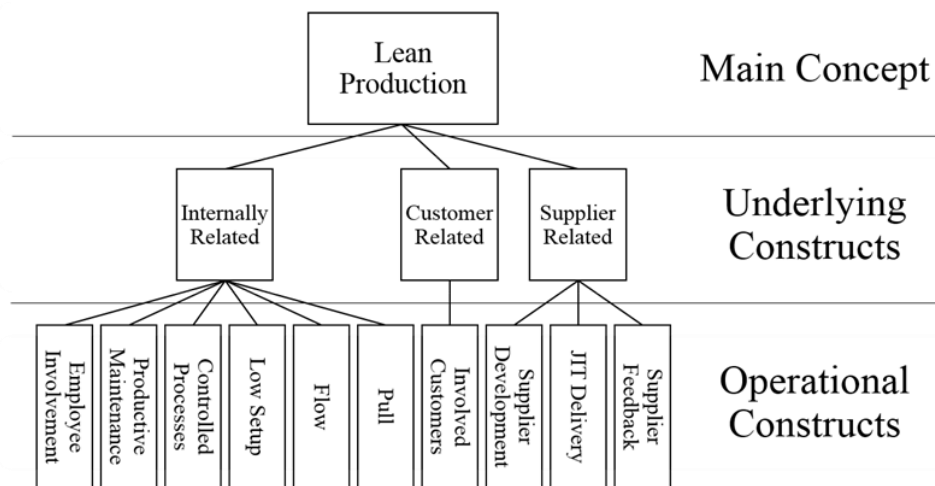


Figure F—2 Ten distinct dimensions of a lean system (adapted from Shah & Ward, 2007, p.799)

measure of “leanness” and are tools stemming from the historical roots in TPS. This can be seen in Figure F—2. All dimensions are shown to be positively correlated, meaning that they support each other (synergize). This, according to Shah and Ward (2007), constitutes evidence that a lean production system has an “integrated nature”.

F.b. Lean Construction

From the concepts found to drive improvements at Toyota, a group of production system researchers, originally based in California, USA, started to develop a theory adapted to the construction industry. A much referred to theorization of their works is what is known as the Lean Project Delivery System (LPDS) and its fundamentals are found in e.g. Ballard, Tommelein, Koskela, and Howell (2002); Koskela, Howell, Ballard, and Tommelein (2002).

The LPDS is a conceptual view of a construction project over time and the project is broken down into phases. In this regard, the LPDS is not different from the traditional view of a project. One of LPDS’ major differences compared to traditional project delivery is the view on the *interrelationships* between the project phases. A phase in the LPDS always have interconnecting activities with its successor and predecessor. This prevents the project participants from ‘silo thinking’ where once a task is performed, it is ‘thrown over the wall’ to the customer of the task (e.g. the designer to the production manager or the structural engineer to the electrical engineer).

The LPDS is designed to promote ‘flow’ and ‘value [generation]’ by involvement of downstream actors in decision making, deferment of decision making, alignment of participant interests, and sizing and location of buffers to absorb supply chain variation (that cannot yet be eliminated) (Koskela et al., 2002). The flow and value mindset adds to the ‘transformation’ goal of a project, where something (input) shall be turned into something else (output). If only the transformation goal is given attention, the building can be broken down to its constituent pieces, and the transformation needed for each piece can be summed to the whole *independently*, - much like the mindset reductionist view earlier described (see D.a.a Structural sub-system p. 24). In the TFV³⁶ view, the interrelationships of phases (and their processes) are just as important as the activities alone (Koskela, 1992).

³⁶ Together, the ‘Transformation’, ‘Flow’ and ‘Value’ goals are popularly referenced as TFV goals.

F.b.a. Design in the Lean Project Delivery System

As one phase in the LPDS there is Lean Design. Naturally, the activities during the design phase are distinct to the activities following the design. These differences are well described by Ballard (2000b, p. 2): ***'designing of product and/or process can be likened to producing a recipe, which is then used to prepare the meal. This is the ancient distinction between thinking and acting, planning and doing. One operates in the world of thought; the other in the material world.'*** Ballard (2000b) continues arguing for three other distinctions between designing and making, namely the quality criteria, the value of variability, and meaning of iteration.

Firstly, *quality in design is experienced by realization of purpose*, - does the recipe fit what we will use it for? This is different from the quality criteria of making – quality in making is determined by the conformance to design specifications (Ballard, 2000b).

Secondly, *variability of design is something positive*, variability of making is something negative. If variability in design was not needed, the design process would be non-value adding, as it would be perfectly predictable (Ballard, 2000b).

Lastly, *iteration in design can be positive*. Draft sketches, and temporary problem solutions, can many times be value adding for visualizing design problems or design alternatives. Iteration in making is called rework and is per definition wasteful (Ballard, 2000b). Positive iteration in design, can be likened by a good conversation where each participant leaves with a better understanding of the situation, and is facilitated by the organization of design personnel in cross functional teams (Ballard, 2000b).

The design phase in LPDS intersects with the project definition phase, the predecessor. Before design can start, the client will have to form, *and validate*, a business plan which ultimately will answer the question ***“If we could have facilities X (means) within applicable constraints, and if use of facilities X would enable us to achieve objectives Y (ends), would we do it?”*** (Ballard, 2008, p. 8). Constraints are *parameters*. This means that constraints will *not* be part of design variation; usually they involve cost, time, location and regulatory information. Costs are usually a centered concern. To determine reliable cost estimates, the market is used in different ways, benchmarking against buildings already constructed is common practice.

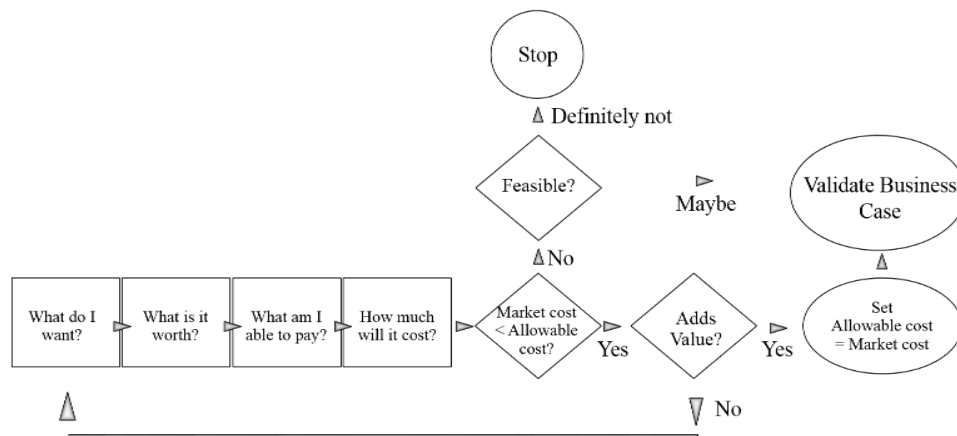


Figure F—3 How to validate the business case (adapted from Ballard, 2012)

The business plan will inhibit risk, as a result from different assumptions that has to be made. If the risks are high (resting on many highly unreliable assumptions), the client shall form the project team early to help validate the plan. If the risk level is low, and the plan can be easily validated, the design stage can start (Ballard, 2008). A schematic of this process can be seen in Figure F—3.

Given a validated business plan, the team with the client as an active team member can be formed (if not already formed in the validation stage). The one, most important, condition for hiring the design team is that it will be done on the basis of being most likely to fulfill the business plan. This contrasts the traditional approach, breaking the work down into pieces just to contract each piece for the lowest price quote, under strictly stipulated.

The first step of the design process (beginning when the business plan has been validated) is target setting (Ballard, 2008). This is when the importance of the formed business plan comes alive. It is simply impossible to design to purpose, if the purpose is unknown. Targets will be so called yet-goals. Yet-goals are thought to challenge the traditional goal-setting assumptions where the goals are seen to be of either-or-nature, and the concept originates from when Toyota was to develop their own luxury car, to compete with Mercedes and BMW. Liker (2004) names that the Lexus was designed to bring a fast and smooth ride, yet have a low fuel consumption. Traditionally, either function will be prioritized, or aesthetics, for example. But the target setting in LPDS is setting yet-goals for all priorities important

for the client and the end user. Goals for function, yet-goals for aesthetics (of traditionally contradictory nature³⁷) will be set.

The contract structure recommended to use by the American Institute of Architects (AIA), when delivering a lean construction project under LPDS is the Integrated Form of Agreement (IFOA) as part of the Integrated Project Delivery (IPD). In AIA's working definition of IPD from 2014 they argue *'The owner's "business case" defines the need for and the requirements of a capital project. The ultimate goal for an owner is to complete a project to meet very specific business goals within very specific constraints. Typically these constraints, at the highest level, are budget, schedule and a level of quality required to support operations, all within a predictable level of risk. Generally speaking, the industry suggests that the owner can expect to optimize any two of the three constraints but not all three; Integrated Project Delivery enables optimizing all three.'* (American Institute of Architects, 2014, p.5). Within this statement, the three LPDS components of (1) customer business case validation, (2) project constraint definition and (3) yet goal setting can be found.

When yet-goals have been set, the design system can be stressed for high performance using one of two alternative methods. Either the target cost is set lower than the benchmark used in the business plan (the same for less), or the project scope is set greater than the benchmark (more for the same) (Ballard, 2008). It is important to remember that this last step of the target setting is an experiment, and shall be done with caution. It cannot be done if the business case already comprise high risk assumptions.

³⁷ See Liker (2004) for the TPS view of the concept.

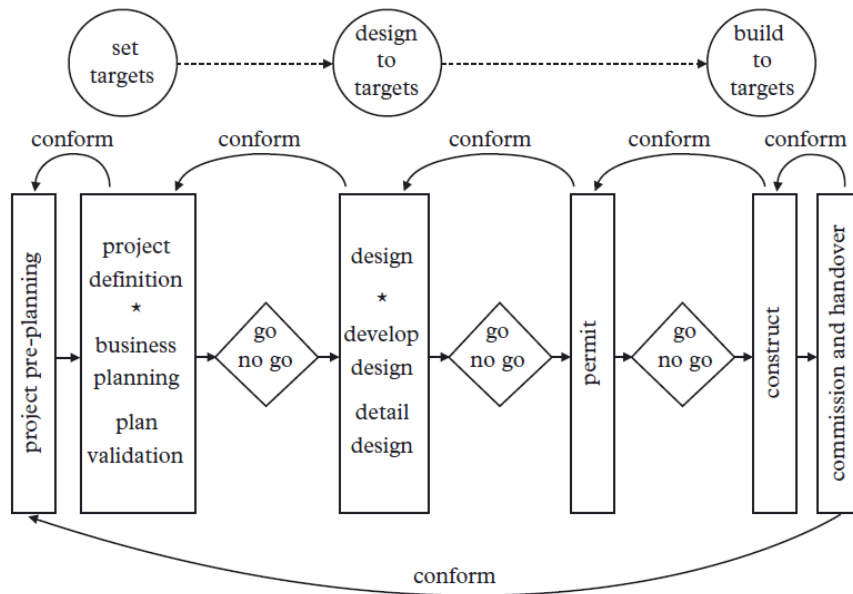


Figure F—4 Target value design process scheme (Zimina, Ballard, & Pasquire, 2012)

There are two more steps in the design phase as described in the LPDS, design development and detailed design. In the development stage, all key players³⁸ shall be part of the team from the outset. The reason for this is to avoid that new criteria (or preferences) for choosing design alternatives are introduced when new team players are added, and co-location of the team is for facilitation of collaboration (Ballard, 2008). In the detailing stage, the uses of design are identified, and a preparation for permit-gratification is done. A visualization of the process is given in Figure F—4.

F.b.b. The Last Planner system

Also part of the LPDS is the Last Planner System. It has been such a common part of implementing lean construction systems that it has sometimes been found synonymous with Lean Construction. Also, Koskela et al. (2002, p. 223) says that to start their first lean construction project ***“Most companies start with pilot implementation of the Last Planner System. This system is designed to assure the reliable release of work from one station to the next. It is not uncommon for those leading this effort to come to the startling realization of the power of this idea, as in ‘This reliability stuff is really important’.”***

³⁸ Ballard (2008) names architects, engineers, general contractors, specialty contractors, regulatory agencies, and perhaps even suppliers.

The Last Planner system is a system for production control that was formed with the purpose of making planning more reliable and to change the project management mindset as found, driven by after-the-fact variance, to a pro-active mindset.

In the end of the 20th century, it was recognized that merely 35 to 65 percent of the planned construction activities were finished in accordance to plan, and that planning could be improved only by minimizing the number of defect tasks (tasks that could not start or continue due to one reason or another). The last planner is a person or a set of people in the project who commits to work, taking assignments from the schedule. The system works as a screening mechanism between what should be done and what actually will be committed to, screening defect activities out of a schedule by asking oneself what *can* actually be done before setting the plan to action. The principle is shown in Figure F—5.

Defect activities are scheduled activities that given the information of the current state, cannot be carried out according to plan. Defect activities shall, when using the Last Planner system be systematically rescheduled to a proper time, given the new information about the system. Ballard (2000a) further argues that the Last Planner System of production control is particularly appropriate for design, due to the value-generating nature.

A project can be seen as a network of commitments. The structural engineer commits on sizing the structural beams of the façade so that the architect can size the glass partitions to be placed within. Because of this network of commitments, reliability of commitments is crucial. The more complex the project is, the more commitments generally have to be made between project participants. If commitments cannot be trusted, the network fails, and so does the project.

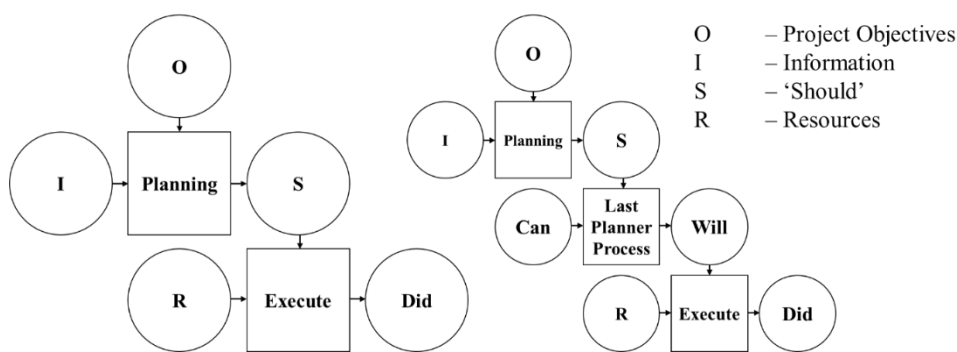


Figure F—5 The last planner is a screening mechanism to recognize and to take actions against defective activities based on the current state of the production system (adapted from Ballard, 2000a).

The last planner system of production control is also a pull system. Pull systems distinguish themselves against other work flow regulatory systems, push systems, primarily in one way – through the feedback of the system state for deciding the amount of work released to the system. Push systems do not take the current state of the production system into account when deciding whether new information or new material into it. Pull systems do just that; depending on the current state of the system, different amounts of work is allowed to enter the system. In traditional line production, this commonly applied as a maximum Work in Progress (WIP) cap, or maximum capacity.

The term of pull is easiest understood by thinking of the end customer asking for a product³⁹. This demand trickles upstream the supply chain through a network of derived demand requests. Resources needed to satisfy the end customer needs are thereby “pulled” into the system leaving requests that are not derived from end customer demand unrequested. *‘In factory systems, pull may be derivative ultimately from customer orders. In construction, pull is ultimately derivative from target completion dates, but specifically applies to the internal customer of each process.’* (Ballard, 2000a, p.2-4). The term ‘internal customer’ refers to the aforementioned network of commitments that synthesize the project. For each process, there is a succeeding activity, or a project participant that rely on the outcome of the process. This is in fact the same participant that asked for its completion in the first place – all the way back to the end customer asking for a facility to satisfy his or her means. Ballard and Howell (2003, p.7) describe it: *“A pull technique is based on working from a target completion date backwards, which causes tasks to be defined and sequenced so that their completion releases work; i.e., achieves a handoff. A rule of “pulling” is to only do work that releases work - requested by someone else. Following that rule reduces the waste of overproduction, one of Ohno's seven types of waste⁴⁰.”*

³⁹ Even though the feedback of system state is what really defines a pull system from another setup. Not the end customer pulling mechanism.

⁴⁰ Ohno’s seven types of wastes is yet another concept set that are typically found fundamental in lean theory. They are defects, over-production, waiting, transportation, movement of people, inappropriate processing, unnecessary inventory. Discussed is also an eighth waste under the name of “underutilized creativity”.

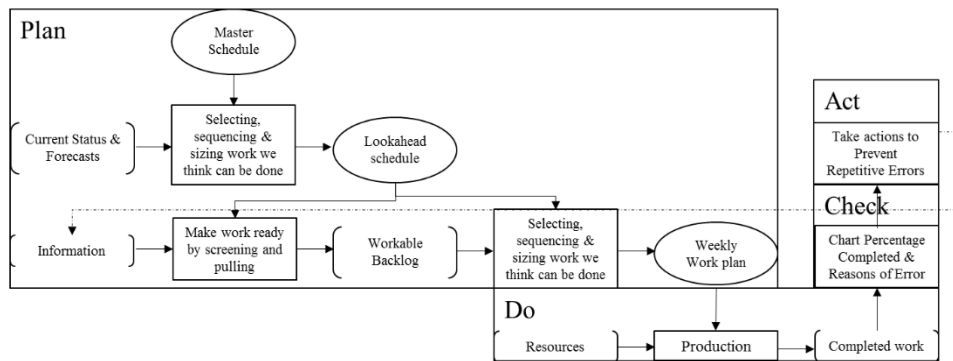


Figure F—6 The last planner system. Actions are represented with rectangles, outputs with circles and information resources are within brackets. Adapted from (Ballard, 2000a). Added by the author is the PDCA cycle, first mentioned by Shewhart and Deming (1939), to highlight the systematic iteration for continuous improvement that is built into the Last Planner system.

The Last Planner System was originally charted as seen in Figure F—6. In fact, there are three types of schedules used in the Last Planner system, ‘Master’, ‘Lookahead’ and ‘Weekly work’. The two latter schedules have been screened from defect activities following the model as seen in Figure F—5.

Within the master schedule, milestones are kept, *only*, and they are kept to make sure that time constraints given by the goal-setting phase of the project are kept (see F.b.a Design in the Lean Project Delivery System). Taking the milestones from the Master Schedule, accompanied with information of the current system state, sequencing and sizing of work will be done. The current state information incorporated into the look-ahead schedule makes it different from a schedule produced at the goal-setting stage of a project (where the master schedule will be worked out). Using information of the current state for future scheduling is called feed forwarding and the principle to follow proposed by Hamzeh et al. (2008) can be seen in Figure F—7. Whilst an activity is within the sliding time window of the look-ahead schedule, they are continuously broken down into pieces and prerequisite work for the planned activities is done to remove all constraints needed to perform the planned activity on time. Pre-requisite work in design settings could be gathering of information, financing, or human resources with specialist expertise.

Using the information in the look-ahead schedule, weekly work plans will be produced for each week. Up to entering the weekly work plan, activities (defined as small packages of work) *can* be rescheduled using new information given by the system state. Certainly, the goal is to use the look-ahead plan to make activities ready to start when they were first thought to.

However, if information is given that the activity better be re-scheduled, why shouldn't it? In the weekly work plan – more or less a task list for the ongoing week – all activities have undergone numerous quality controls. Because of this, the weekly work plan should contain nothing but sound activities – only activities the design team think can be done.

Each party responsible for carrying out activities will have a weekly work plan. In the beginning of each week the responsible party commits to the planned activities for the upcoming week. By committing to the activities the planning enters the execution stage, leaving the planning stage. It could be argued that the activity leaves the state of thought to the state of action. In Figure F—6, the thesis author has highlighted this difference with the use of the PDCA-cycle. The PDCA cycle is a popular tool for continuous improvement, the top principle of the Toyota Production System as seen in Figure F—1.

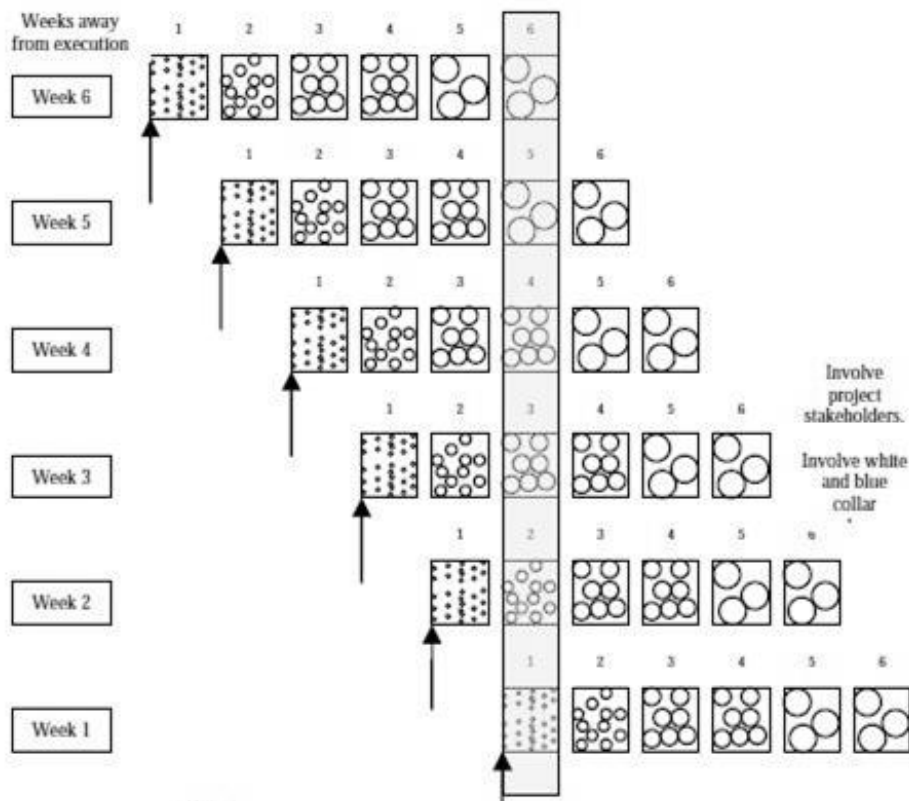


Figure F—7 The "sliding" look-ahead window where activities are continuously broken down as they are getting closer to the time of execution. The example shows a six week look-ahead plan but the time window can be changed depending on the project settings. Adopted from Hamzeh, Ballard, and Tommelein (2008).

After each week, the design team will follow up on the team results. This is done by measuring how many of the committed activities that have been properly carried out. For the activities that were not carried out correctly, analysis will be done to find errors. The error causes will be corrected for the future activities.

The last two steps clearly resemble the last two steps of the PDCA cycle, namely check, and act. In its original form, Shewhart and Deming (1939) proposed that instead of acting in a process linearly, activities' results shall be studied and the study results should be fed back to the next iteration. We call this phenomenon feed backing and is common practice in many systems. Within the Last Planner system the PDCA cycle is built in, systematically, through the cause analysis of error and to the errors' adhering corrective actions. See, again, Figure F—6.

F.b.c. Lean construction critique

Voices have been raised that theorists within the lean construction sphere are highly selective in their empirical filtering of evidence. Green (1999) states clearly that theory of lean construction is extremely one-sided. He argues that ***“Increased management control is legitimized as management through customer responsiveness. Muda is to be eliminated. Karoshi is the price to be paid. Rather than providing a step forward to the future, the concept of lean construction may well provide a step backwards to the past.”*** (p. 136). Karoshi is a term used for sudden deaths and severe stress from overwork, clearly not an ideal goal. Criticism certainly is appreciated despite that such a linear relationship between customer responsiveness and “Karoshi” falls a bit on its own argumentation of one-sidedness and the lacking robustness. Particularly as no examples were taken from the lean *construction* industry itself.

F.c. Organizational and national culture

For the sake of taking national-contextual aspects into account for an implementation process, national culture can be considered. Particularly this can be of interest when one wants to make assumptions of how a system works when being ‘exported’ from one country to another – as in the case of taking the TPS to Sweden.

Certainly, culture does not have geographic boundaries (like countries do) and subcultures do exist within nations – not only geographically clustered but clustered by many different criteria on different levels (Hofstede, 1995; Nakata, 2009), therefore all of Sweden cannot be expected to react the same way to interventions. Culture is usually different in organization, despite their otherwise highly similar traits. For example, this is

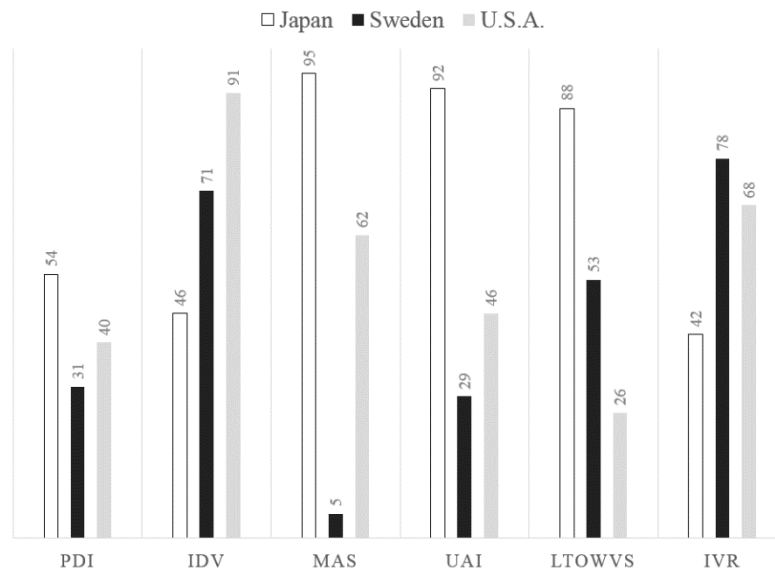


Figure F—8 Hofstede's cultural dimensions of Japan, Sweden, and the U.S.A. (Hofstede, Hofstede, & Minkov, 2010)

known for the many who have applied for multiple jobs at once being able to compare. This aside, the national culture can sometimes provide explanations or at least spur discussions that can be helpful. Additionally, in regards to construction culture, Brochner, Josephson, and Kadefors (2002) argue that the subculture (of Swedish construction) resonates well with the national.

The works of Geert Hofstede's are commonly referred in discussions of cross cultural differences since the 1980s (Nakata, 2009). Hofstede provides the data of his own research free for other researchers to use, but clearly advise the caution of usage for the ones unfamiliar with the concepts. For one, the five "dimensions" that Hofstede has operationalized to show the differences are not dimensions as we know them in physics or natural sciences. It is for example hopeless to answer the question of how many cultural dimensions there are. Also, just like in many social science constructs, the absolute value of a measure has no direct meaning. Meaning is found only when comparing two measures (or countries' values of a dimension) against each other.

In Figure F—8, the national cultural dimensions that are found interesting for this thesis are visualized. The most significant differences are found between Sweden and the two others when it comes to the "Masculinity" (MAS) dimension, and Japan and the two other countries when it comes to Uncertainty avoidance (UAI). Less substantial difference, but still worth noting, is the Japanese long term orientation followed by Sweden and lastly USA (Hofstede et al., 2010).

The masculinity index indicates that the country has a competitive culture if the score is high, and consensus oriented if the score is low. Sweden, being the most “feminine” country in the entire study, has a preference for cooperation and caring for the weak, while Japan (and to some extent USA) compliment assertive behaviors and material rewards for success. Important, in this study, is that *‘At 95, Japan is one of the most masculine societies in the world. However, in combination with their mild collectivism, you do not see assertive and competitive individual behaviors which we often associate with masculine culture. What you see is a severe competition between groups.’* (Hofstede et al., 2010)

Uncertainty avoidance is clearer cut. A country whose UAI is high is more likely to develop systems where the ambiguous or uncertainty of outcomes are suppressed – and the dimension suggests whether the country simply let things happen or are they trying to control the future? Clearly, Japan is less comfortable in dealing with uncertainty than the two other countries. Lastly, long term orientation can also be referred to as level of pragmatism. High scorers, such as Japan, encourage societal change and modern education efforts while low scoring countries, such as USA (relatively) rather hold on to current traditions and norms (Hofstede et al., 2010).

F.c.a. Culture and Lean Applicability

In a recent, large scale, study Kull, Yan, Liu, and Wacker (2014) show that culture can moderate the success of lean manufacturing practices. Contrary to their beliefs, a high level of future orientation and a high level of performance orientation were both *negative* moderators of lean manufacturing success. High uncertainty avoidance was (as hypothesized) a facilitator for success, just like a low level of assertiveness (Kull et al., 2014).

G. ANALYSIS

In the discussion section, empirical findings will be contrasted against the theoretic framework to give light to differences and similarities between the theoretic view of Lean Construction and NCC Project Studio. The same structure as can be found in E. EMPIRICAL FINDINGS will be used to ease for the reader to validate the analysis against the empirical material. Again, clear overlaps between the sub-systems can be seen. The analysis provides the foundation for chapter H. RECOMMENDATIONS.

G.a. Author's comment on the choice of analyzed material

Not all the material presented in E. EMPIRICAL FINDINGS will be analyzed within this chapter. The author has chosen the most important material to highlight in order to defend the recommendations in the next chapter.

The empirical material not highlighted within this chapter is not thought to contradict the analysis made, rather the opposite. It was kept in this report to provide opportunity for reader cross-validation and further personal analysis of the same data set.

G.b. Structural sub-system

G.b.a. Organization structural setup

From the empirical study made we can conclude that NCC Project Studio is a physical space where meetings are held with specialist 'administrators', representing different functional needs of the design such as aesthetics, abrasion resistance or supply of electricity. The administrators feed information back and forth between the Project Studio and remote offices. Within the remote offices, 'detailers' perform the actual drawing works and calculations needed that is too time consuming to be done within the meeting settings. The settings are firmly structured with penalties tied to the administrators' presence and detailed schedules have been agreed upon to regulate when attendants are to discuss what.

The current setup contradicts the people and partners' principles of the Toyota Production System (see F.a Lean Production, p.48). Really, the partners and people principles are very similar. They tell us to build teams and empower team players. Team players are needed to deliver prime end customer value with low systematic waste; the system does not depend on where company boundaries are found within the system. In order to grow your leaders, employees and partners there is reason to believe that the partners have to meet, and each employee's work needs to be set into context.

Today, the context is found within the studio, where only a select few are allowed space.

In order for a ‘detailer’ to get prerequisite work done, or to get information of the owner’s preference, information about this request literally has to be carried by the administrator to the right meeting, where another administrator has to pick up the request, and only in the best case, the answer can be delivered during the same meeting. If the design team is large, the probability that the answer can be provided by another, remotely working, detailer, is much higher than the chance that it could be answered by the administrator. Thereby, the detailer normally has to wait at least 2 weeks to get his question answered.

The process can be short-circuited, however. If the detailer cannot stand the two week minimum lead times, he or she could send an e-mail or call the person in possession of the answer, given that he or she knows who has the information. If this is unknown, the e-mail can also be sent to the human node of the design team (the design lead) or a meeting can be arranged between detailers remotely.

A schematic of how the Project Studio is functioning today and how it would function in a Lean context can be seen in Figure G—1.

To the left, the setup of today has been modeled. It has strong similarities with a hub-and-spoke system commonly seen in the aviation industry. Airlines set up hubs, carrying large passenger flows in between them before the final destinations (spokes) can be connected. For the airline industry, there are economies of scale telling us why this has to be, for design teams there are not.

The inconsistency between the people and partners’ principles of the Toyota Production System, and the current organizational structural setup, has made the author propose a new structural setup of the team as can be seen

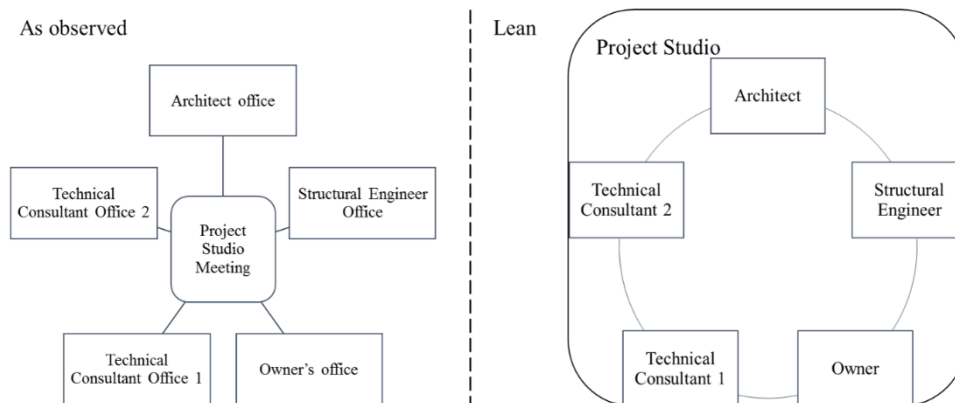


Figure G—1 The current perception of the organizational structural setup of the NCC PS today (left), and an 'Integrated', lean, setup (right).

in H.a New organization structural setup of the NCC Project Studio design team. This setup is thought to resemble the Lean setup modeled in the right half of Figure G—1.

G.b.b. Design process in a strategic perspective

From the empirical study made we can conclude that work within the NCC PS is not oriented around standardized processes on the operational level. This will be further elaborated on in section G.e.b Operational design process, the use of ‘Visual planning’ versus the Last Planner System, below. On the strategic level, a process does exist, however. Design project phases built by milestones can be recognized.

Work in the project studio is oriented around problems and particularly to solve already recognized problems, working full speed until hitting a road block. In the strategic process, a major roadblock is generally run straight into. This is when the project owner reveals the budgetary constraint that the team has always unknowingly headed against.

At the point in time when the owner reveals this budget, the owner makes the budget lower than what the current estimates are. Naturally, at this point in time it would seem counterproductive to introduce system ‘slack’ by raising the budgetary constraint from the current estimates. When the owner lets the team know that what is done so far is not up to par, this is when a reactive working habit, oriented around problems, is fostered from the top down in the system. At this point, there cannot be a long term philosophy. Rather, from this point in time and onwards, all work rest on the assumption that something was wrong in the earlier made decisions and this, multi-dimensional equation, will have to be solved.

The strategic process currently followed contradicts the process, partners, and long term philosophy principles of the Toyota production system.

Let us say, instead, that a process like the one described by the LPDS would be used. The LPDS project starts off by designing what is success, for what purpose are we going to use the building, and thereby – what costs can we allow the building to incur? More or less, the LPDS sets out to establish what does our customer value? And what can we allow this value to cost?

Before the business case has been validated (using the scheme seen in Figure F—3 on page 52) design work cannot start. In order to fulfill the business case, the owner will form the team that has the best chance of fulfilling the set goals early on. The team will also help the owner validate the business case made. This way, there is a long term philosophy. There are also partnering concepts, through the team formation based on competence

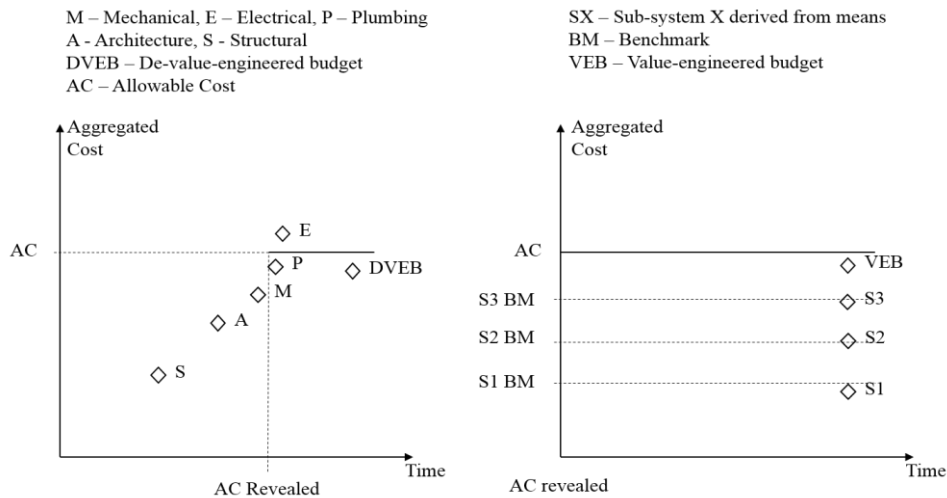


Figure G—2 Schematic drawings of the estimated project budgets over time. Today's budgetary development (left) as earlier depicted, and the one thought to be formed using the Target Value Design process as proposed by the LPDS (right).

and earlier experience. And clearly, there is a strategic process (see Figure F—4, on page 54) that can be further broken down into sub-processes.

The development of the projects budgetary estimation over time during the design stage using the LPDS in comparison to the current setup is illustrated schematically in Figure G—2. The figure is highly schematic, but the most fundamental aspect that it is thought to highlight is the difference of clear goals from day one onwards. An overarching budgetary goal that can be broken down into smaller yet-goals that can be continuously benchmarked against. With the process proposed, the risk will be smaller that at one point in time, the whole team realizes that they are totally off track and need to revise all earlier decisions. Within the new process, it is also easily understood that trust between the owner and the design team members is crucial. At day one, after business case validation, the supplier will know the financial power of the customer (project owner) – knowledge that can be easily abused.

To bridge the perceived gap between the lean principles of TPS and the theoretical descriptions of lean construction, a new design process is proposed by the author and can be seen in H.b. Proposed new strategic process of design on page 73.

G.c. Psychosocial sub-system

Psychosocially, it seems that the new setting that NCC Project Studio bring, has already started to shape in the attitudes of design team members who are allowed space within. This could be a reason why corporate standard

supplier evaluation tools no longer seem reliable. The personality that works better in an integrated system differs from the personality that bloom in the segregated, internally competitive, system where every company fights for their own good.

In Sweden we are not prone to walk on each other's' toes (see F.c Organizational and national culture on page 59). Thereby, to structure for a consensus driven atmosphere is standard practice in Sweden. Most probably, this cultural aspect is one reason why the meeting-oriented working methodology is seen in the Project Studios today. It is a structure where schedules fill up quickly in order to discuss decisions with team members and customers. Interestingly, as seen in F.c.a Culture and Lean Applicability on page 61, the consensus seeking culture correlates positively with the success of lean systems. Because of this, wouldn't it be against lean principles to restructure from the meeting-driven structure found in today's practice to what has been proposed in H.a New organization structural setup of the NCC Project Studio design team on page 71?

The answer to this is no. In the new structural setup the atmosphere won't be less driven by consensus. In fact, consensus driven meetings will still be held (in Sweden, we will not have to worry about this, it is in the cultural code) and, in addition, the new structure is thought to induce an increased level of consensus, only less formally structured.

Two design practice fundamentals as described in F.b.a Design in the Lean Project Delivery System on page 51 are supported by the proposed new structural setup.

Firstly, remember that iteration can be something positive when design decisions are made. In today's hub-and-spoke system, information lead times are too long for design iterations through draft sketches or innovative solutions' testing. To make three or four detailing iterations takes too long for most ideas to be tested. This is different in the team organizational structure recommended.

Secondly, remember that variability is to strive for within the recipe-making design phase of a project. If design would have no variability, it would be perfectly predictable and then – it would also be superfluous. Variability is dampened by the practice of 'this is how we have always done things' rulings on decisions today as described in E.c.b Seniority on page 37. In the same section, we can read that beginners are not thought to fight for their own discipline as much as their senior colleagues. Entering into conflict to defend your own specialist area is further seen as something positive.

Generally, what the team dynamics of today sanction is inability for iteration, low variability, and local optimization where each team member fights for his or her own good. Using a schematic figure similar to the one in Figure G—1, the local optimization is visualized in Figure G—3.

This is not to say that standing up for your discipline is wrong, of course this is part of the purpose of being a specialist having superior knowledge. It is the specialist's job to make sure that the team utilizes this. But, when the 'war meeting' is the one, and only, point of connection between the team members' organizations, not much space is left for the consensus to be driven toward shared values.

Within the new proposed structure in H.a New organization structural setup of the NCC Project Studio design team and through utilization of the new process in H.b Proposed new strategic process of design it will be easier for all design team participants to find their common goals. And in order for the system to sustain in the long term, this common goal will be to deliver end customer value.

G.d. Goals and values sub-system

The interviewee of Project 3 spent a lot of effort discussing the goals and values of the design team. The impression was given that the customer was not always involved in the decisions made.

Part of the operational constructs of a lean is the customer involvement in the upstream decision making. It has to be made sure that the design team ultimately works for the best of the customer and not for themselves. Every team members' goals shall be aligned with the project owners, this is how trust will be built for long term success.

Owners will continuously provide input if the team members seem to have misunderstood the project objective. In order to make this possible, the new design process on the strategic level as described in H.b Proposed new

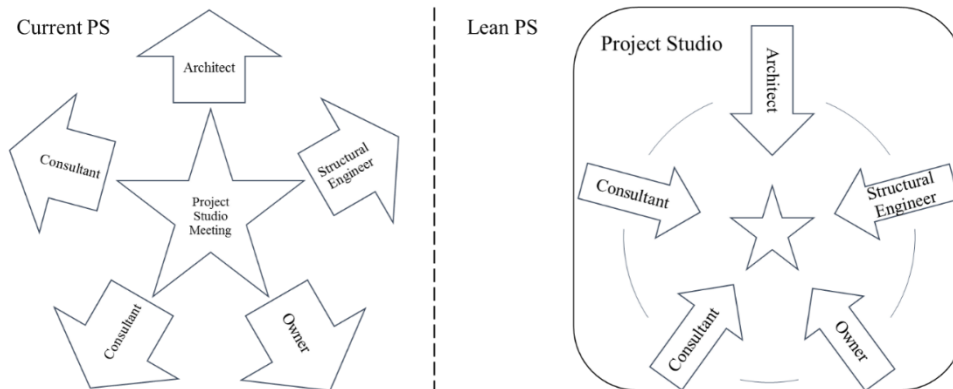


Figure G—3 How different actors pulling in different directions makes the system locally optimize (left). The integrated system (right) is designed to easier find the global optimum through shared values. The optimum customer value (purpose of design) is found in the center and the star represents the set of probable design outcomes.

strategic process of design on page 73 should be utilized – otherwise the design team does not know what design success is, nor the purpose of the design. Continual owner representation will also be required for their involvement. This is part of the new organization structural setup recommended in the following chapter.

For NCC internally, corporate goals are not always clear for the decentralized project teams as seen in E.e.b Corporate goals on page 45. The new structural setup is thought to bring financial power closer to the value adding processes and it will naturally bring a flatter corporate structure were leaders are grown within their job descriptions instead of moving upwards in the organization hierarchy.

The decentralization of corporate resources is actually required to carry out the recommended structural change, financially. If the full design team is to be co-located in one physical space, this physical space will have to fit all the needs of the team both technologically, but also when it comes to size and location. The physical space and its location is clearly important to the design teams (see E.d.a Geographic location and layout, p. 39).

Would it be that the financial authority is too far from the value adding activities (in this case the design work being performed) it could easily be thought that this new design facility is only cost driving when offices are already provided for each design team individual elsewhere. This type of reasoning, on the other hand, only rectifies the view of each company for themselves and moves the focus away from the design project as unit that ultimately drives value creation – not every company for themselves.

This way the new structural setup is thought to bring a flatter corporate structure within NCC through the decentralization of corporate resources to the business unit project teams.

G.e. Technological sub-system

G.e.a. Underutilization of visual tools and mailbox overflows

With the current setup, where most work is oriented around problem solving (and discussions thereof) in meetings – visual tools such as smart boards are not surprisingly underutilized. The actual work where problems are solved is usually carried out remotely.

The detailers, that draw using computer aided design software, would most probably be more inclined to use a smart board when communicating in between each other than the administrators would. The latter generally fill their schedules with information gathering and distributing activities within the hub-and-spoke network as earlier described.

Also, the system capacity is tied to the capacity of the design lead in today's setup. One could say that in the model representation of Figure E—2 on page 34, there is a bottle neck in the role of the design lead. The information processing, distribution and delegation capacity of the design lead— this is the capacity of the whole design team. It is also a clearly non-scalable system. No matter the size of the information flows (ultimately the size of the design work to be carried out) that need to pass the design lead role, the setup is largely the same. Particularly, this is easy to recognize when the e-mail inbox overflows.

Design leads do realize that coordination will have to be done without their involvement when the system grows beyond a certain point, but this is hard to actually bring about as it is still the design lead's responsibility to facilitate this coordination.

Because of the perceived capping of design team capacity to the coordination and delegation capacity of the design lead, the recommended structural setup in the succeeding chapter will provide basis for short circuiting the bottle neck through informal and spontaneous information flows.

G.e.b. Operational design process, the use of 'Visual planning' versus the Last Planner System

On the operational level a reactive working methodology is pursued (see E.e.a Problem orientation, p. 45). If a process does exist – and certainly, at some level of generality it does – the processes are mapped in the minds of each team member, after years of experience and exposure to different project settings. The processes in the back of each team member's minds are different, however, and this is clear when visual planning is to be carried out and discussions arise of sequencing, sizing, and interdependency between work packages.

Because of these differences in how the best process shall be mapped, and partly due to the fact that variability is something positive in design (see F.b.a Design in the Lean Project Delivery System starting on page 51), there needs to be flexibility in the process mapping on an operational level.

For the purpose of making flexible processes reliable, the Last Planner system has been worked out. Today, the visual planning sessions are not utilizing the strengths of the Last Planner system for reliability in scheduling, which was the system's original purpose. As can be seen in E.d.b. Visual planning on page 40, look-ahead windows are not used. Particularly, only in the one project where the scheduling had not been observed, the planning was done in a right-to-left manner to reassure that the project milestones are kept.

None of the observed sessions utilized the system's feedback loop to correct the cause of planning errors. Feed-forwarding was used briefly when the notes were sequenced, but commonly overseen and never systematically done.

The one strong similarity to the Last Planner System as described in F.b.b. on page 54, is the collaborative aspect. The observed sessions of visual planning did show features of mutual understanding of specialists' needs and the willingness to collaborate.

Because of this gap, between the 'visual planning' sessions as observed in practice and the Last Planner System, as described in F.b Lean Construction, a new operational process has been proposed and will be further elaborated on in H.c New operational design process through correct utilization of the Last Planner System on page 75.

H. RECOMMENDATIONS

Based on the analysis made in the previous chapter, changes to the design team constellation and how the work within the studio is to be carried out will be proposed. The new structural setup is presented first. Thereafter the new design process on a strategic level is presented. Finally, a new operational design process is proposed. Recommendations are also further discussed in regards to external effects they might incur on the system. Externalities discussed are less grounded in the empirics found and theory from the theoretical framework.

H.a. New organization structural setup of the NCC Project Studio design team

On the basis of the analysis in the previous chapter, a new design team structural setup to work in the NCC Project Studio is hereby proposed. To compare with Figure E—2 on page 34, the new setup is schematically drawn in Figure H—1.

The units within the dark gray box will be granted continuous access to, and will be encouraged to do their everyday work within the project studio. Basically, within the box all key players already part of the team are found.

The proposed setup has one, major, distinction in comparison the one found in the current state of the NCC PS systematic setup. *That is the*

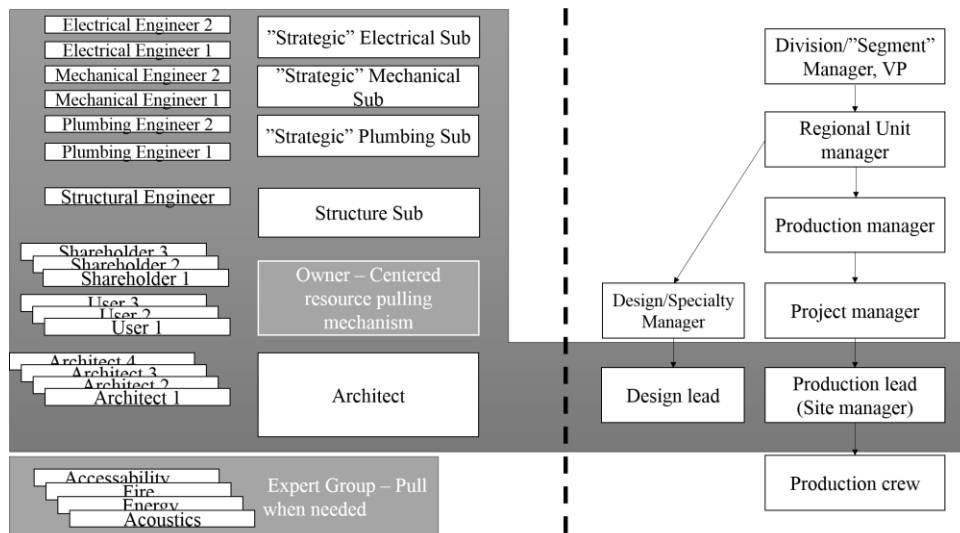


Figure H—1 Schematic of proposed new organization structural setup. Another tier of suppliers (the detailers and customer shareholders) are continuously allowed space to work in the NCC Project Studio.

continuous involvement, and Project Studio presence, of all design team members on a regular basis.

Each one of the detailers at the home offices will be invited into the everyday work in the PS. It will ease their understanding of the value creation that they contribute to, and it will also avoid non-value adding time delays in hand offs and information sharing via administrators. Within an integrated system, as proposed, the team is gathered in the project studio on a continuous basis and formal and informal communicational links in between detailers will be established.

H.a.a. Discussion of externality; the customer as a centered player

That the owner is the centered pulling mechanism in the proposed setup in Figure H—1 does *not* mean that they will take the current role of the design lead. It simply means that all initiatives taken will be in the interest of the project owner – sometimes against his understanding.

It also means that the design team members are present because they individually, or through interaction with other team members, have knowledge that the owner is willing to pay for. Therefore, as a centered pulling mechanism, the owner is *not* expected to tell team members what to do or what is best – they are there to judge, based on the experts' work what is best for them or not.

If it would be that the customer centric system would be driven by the owner (much like the way it is now driven by the design lead) it would still be in contradiction to lean principles. Certainly, the system does not depend on the title and company of the one leading the work, it depends on the way coordination takes place and who takes responsibility for it.

H.a.b. Discussion of externality; the depreciation of expert knowledge

NCC will have to seize the opportunity to recognize the specialist career as an alternative to the upper moving, managerial, career path. The new structural setting does not praise personality traits traditionally recognized. In order to successfully implement a lean transformation, the buy in from each individual is crucial, and the expert personality could possibly find the new setting intimidating.

Information technology makes specialist knowledge from all parts of the world readily available just one mouse click away and it is an intimidating development for specialists that have spent decades to develop this expertise. Therefore, the company needs to find a way for the individuals that are not global optimizers and systems thinkers to find their value. Without these people, the variability that gives superior design results is less likely to be

found – even though these people might not be the most likely to lead the work to get there.

In the time of change the value of senior team members' apprehended and recognized within the company in novel ways. This can be done e.g. through specialist career paths and seniority titling. The specialist career path differs from the path of upper hierarchical movement with increasing people managerial responsibility. The person that would rather sit and crunch numbers or work on the details of the form of an interior wall is needed within the Project Studio, despite that this person might not be the most suitable to lead the work of others. That this person would only be disturbed by sitting with the other team members would only be true if the number crunching in this case would be non-value-adding design work. The transparency of the new system would make it obvious in which cases this is true.

H.b. Proposed new strategic process of design

What are we trying to fulfill? What is design success? What is considered to be design delivery above and beyond expectations? What is design failure?

These questions need to be answered unambiguously by the owner, communicated with-, and validated by the design team, before design work begins. Unfortunately, a change will be possible only if NCC as the main contractor, and the partnering sub-contractors, has the courage and ability to make their customers, the project owners buy into the new process.

Naturally and understandably, it seems contradictory for the project owner to reveal his or her financial budget before the design can begin. What if the building can be designed cheaper and the contractors would be paid more than what would be needed? Maybe, it would be better for me as an owner to give the builders an architectural shell and then let a few builders compete in between themselves making guesses of the costs they would incur if I gave them a few parameters to work with. The winner will get the opportunity to work for us, as traditionally.

Now, this view is fundamentally flawed. It means that information that exists, such as the owner's actual preferences and budget constraints are not necessarily worked into the proposed designs, it will only be a set of designs for which the owner has to choose the one closest to what he wants. It also means that expertise and knowledge that the builder and his estimators would be able to get in order to validate some of the assumptions made in the design proposal will only be financially sound for a small number of the assumptions made, because of the risk that the project will not be awarded. Only after the project has been awarded, assumptions can be validated, or worse still, invalidated.

H.b.a. Discussion of externality; new contract standards

Ultimately, in order to change to a globally optimizing value-driven process a new contractual standard will have to be used. Details around the contract formation is left outside the thesis scope. However, the reason why new contract seem necessary is that the ones building upon the Swedish 'Allmänna Bygglagen' (AB)'s standard formulations seem better suited for more predictable settings where a reductionist break-down of work is better easier done.

In contrast to the settings earlier described as 'small construction' in B.a Motivation of study purpose, contributions to target reader groups on page 7, large construction projects inhibit many forms of risks and variability. The AB contractual setups of today build on a reductionist mindset and is therefore better suited for small projects where the risks are low and promises can be made clearly and unambiguous before the work starts. With the project size, the number of interdependencies between experts grow quickly, and so does the number of ways the project work can be carried out, why an integrated collaborative contract type is needed.

The new contract type proposed is the Integrated Form of Agreement where the fact that 'how' the customer's wants will be fulfilled cannot yet be known, but merely forms an integrated team with the one and only purpose to fulfill the customer goals after the customer's business plan seems reliable. This way trust between all parties in the contract is established before work can begin and the interdependencies between one and other are transparent.

Many times construction projects are known to be delayed or run over budget. But there are reasons why construction projects regularly seem to underperform to project owner and ultimately end customer or stakeholder requirements.

Firstly, at the point in time when the decisions that are most important and that has the ability to best influence project success, the contractor is not given access to the project owner's list of preferences and constraints. At the point in time that these are given, many decisions have already been made that could have been worked out differently, more client-appropriately.

The allowable costs are revealed in the startup of the design work. The allowable cost will, on a high level, be broken down into cross-functional sub-systems with company cross-border teams controlling their own budgets from day one. Yet-goals will be translated to quantifiable measures that each of the sub-systems can easily relate to in order to see their part of the full design project scope. Competition in between sub-systems inducing the risk of local optimization will *not* be allowed however, any one of the sub-systems will share resources with the others if it will increase the probability of total project success.

Secondly, the contractor that bids the lowest is generally the winner. That assumption is part of the bid made at this point is a given. Most likely, the ones that make the most optimistic, client-friendly, assumptions at the point of contract award will be the ones that get to do the work. The promises made are not always easy to fulfill, why unreliability is common.

Instead of this, the owner will have to believe in the fact that the most capable design team, given all the information and end-user interaction he or she can provide as a customer, and given the resources within the constraints provided, will have the best chance of delivering what he or she wants. A competition of hypothesizing the owner's wishes will not be the best way of finding this team.

Naturally, this may seem to drive the risk of diversity within NCC, known for large, highly decentralized companies. In the worst of cases, each design team could externally be seen as their own company. This risk will have to be minimized through the organization around standardized processes shared within NCC building upon the belief that the right process will give the right results.

The company's coordination around processes has started and is currently being shared on the corporate intranet. The standard process schemes are not used on a daily basis, however, because they are still on a very high level describing the project phases instead of everyday work processes. Also, little opportunity seem to be given for each employee to feed back his opinion on the standardized process schemes.

H.c. New operational design process through correct utilization of the Last Planner System

In order to facilitate high reliability within complex systems, the Last Planner System is a scalable planning tool worked out for this purpose. The visual planning tool, sometimes under the name of phase planning or pull planning is in many aspects supposed to be critically different from the traditional way of planning work. Today, this is not the case in NCC PS.

As of today, the major difference between the traditional planning methodology and the one used in NCC PS is that design team administrators are allowed to participate in the planning, and that coordination, driven by consensus, between team members is thereby naturally initiated.

The last planner system, which the visual planning sessions are really intended to follow is not operationalized correctly. Particularly, feedback and feed forward loops that are built into the last planner system as originally developed, are not utilized as they should.

Firstly, feed forward is about updating the system with known information about system inputs. In this case it is about updating the schedule,

which in a systems perspective is nothing but a thought of how work should best be carried out, with information on how activities can or cannot be performed as planned. A scheduling system that oversees information that an event will not play out according to plan, and keeps it in the schedule, is a system overseeing the possibility of feed forwarding and making the best out of the situation in each new setting. When NCC PS planning is done, feed forwarding is used only as a reaction when a prerequisite has not been done according to plan.

Secondly, feedback from the system is also underutilized. There is no learning from mistakes systematically used. When something goes wrong, the team more or less shrugs and moves on to the next activity. Feedback in the system is fundamental for continuous improvements (and in the long term development of partnerships).

I. CONCLUSION

In this chapter, the research question that has driven the thesis work will be answered. The thesis author also finds some of his findings in need of further validation as well as some suggestions for theory development.

Describe and analyze the current use of NCC PS, and propose recommendations for improvements to the design team constellations. Of particular importance are the issues of who to involve in the NCC Project Studio, how, and to what extent, during the design phase.

After having analyzed NCC Project Studio, using a holistic systems perspective, three recommendations have been proposed for NCC Project Studio to improve the design team constellations, and in what way the design teams will work.

First, a new organization structural setup, as described in the preceding chapter, is thought to align the goals of different team members' with the goal of the project owner. The company is recommended to involve and empower one more supply chain tier of design team participants. These are known as 'detailers' on the supplier side of the main contractor and customer stakeholders on the customer side. These will be involved through the invitation into the everyday work in the NCC Project Studio. NCC Project Studio is, under the current state conditions, not found to fully enjoy the positive effects that the co-location of design team participants that the implementation attempt originally set out to address. The new setup is also thought to align the project teams' goals within NCC with the corporate goals. This will facilitate a flatter corporate structure through decentralization of financial resources

Secondly, a new design process, building on transparent end customer criteria from day one is also found to be a crucial part to make the system work in line with the Lean concepts originally taken from the Toyota Production System. The design team will have to validate the customer's business case before design work can begin and through this validation, the customer will have the possibility to notice when team members are working for their own good instead of the goal of the project. Key for getting to the proposed setup is buy in from NCC's customers, the project owners. As found by the thesis author, the proposed setup will have to be used already at day one of a construction project. If the settings are not right from day one and the team participants are not continuously encouraged to work in accordance

to the new setup, the system runs the risk of falling back to the traditional ways of working.

Third, in order to make the team member interdependencies clear and to make planning of the everyday design work more reliable, the team is to correctly use the feed forwarding and feedback loops built into the Last Planner System to complement the collaborative exercise that is currently perceived from the ‘visual planning’ sessions held.

I.a. Proposed future areas of study

A large scale deductive study driving the hypothesis that detailers/remote team members would rather work side by side in the NCC PS than at their own office.

A quantitative study on how much time is spent in meetings in a PS.

A case study on how Choosing by Advantages can be applied as a decision making tool throughout the design phase, based on customer business case targets.

A case study on how a “Balanced Scorecard” can be utilized as a tool to help the design team make sound decisions in line with end customer preferences.

Additional process mappings, on other specialist areas, such as the one Liljenfeldt and Norling (2012) made on Geo-tech.

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K. QUESTIONNAIRE

Note: The questions were posed in Swedish [as translated below].

K.a. About the respondent

1. What experiences has led you to your current position in the company and working with the methodology Project Studio (PS)?
Vilka erfarenheter har gjort att du idag har din position i företaget och arbetar med arbetsmetoden Projektstudio (PS)?

K.b. About Project Studio

2. What happens during a day in a PS?
Vad händer en dag i en PS?
3. How does the design work in a PS differ from when a PS is not used?
Hur skiljer det sig att projektera i en PS i jämförelse med när en PS inte används?

K.c. Functions within PS

4. Can you visualize what would be a suitable level of work effort over time in the graph below? (appended A4 page) Please also visualize how you find the curve to be currently, in the PS where you participate.
Kan du visualisera vad du tycker skulle vara en lämplig arbetsbörda över tiden i grafen nedan? (bilagd A4 enl. utseende)
Visualisera gärna även hur du tycker att det är just nu i PS där du deltar.



5. In what way does the demand differ for different specialists' expertise over time in the design phase?

På vilket sätt skiljer sig behovet av olika specialisters expertis över tiden i projekteringen?

6. Who (or whom) is (are) most suitable to take responsibility to lead the work during a day in a PS?
Vem (eller vilka) är bäst lämpad(e) att ansvara för att leda arbetet under en dag i en PS?
7. What design should not be performed in a PS?
Vilket projekteringsarbete skall inte utföras i en PS?
8. How is a steering committee used if such exists?
Hur används en ”styrgrupp” om sådan finns?

K.d. Contracts

9. Do traditional, standardized contract types such as the ABT, ABK work well for PS-method?
Är traditionella, standardiserade kontraktstyper såsom ABT eller ABK anpassade till samarbetsformer som man använder i PS?
10. How is the target cost agreed upon if such is used?
Hur kommer man överens om riktkostnaden om sådan finns?
11. How do you make sure that team members in this PS share project risks and share project rewards for success?
Hur säkerställer ni att lagmedlemmarna i denna PS delar ansvaret för projektets risker och delar projektets belöningar vid framgång?
12. How do you use the experience from earlier projects for choosing team members to a new PS?
Hur används erfarenheter av tidigare projekt då man väljer teammedlemmar till en ny PS?

K.e. Intention with PS

13. What is the intention with a day in the PS?
Vad önskar man åstadkomma med en dag i en PS?
14. What aspects are considered when a person is asked to part-take a day in the PS?
Vilka anledningar övervägs då en person kallas till en dag i en PS?
15. How do you make sure that a person has the authority to make decisions on behalf of its company when in the PS?
Hur säkerställs det att en person har rättigheten att ta beslut å sitt företags vägnar då denna befinner sig i en PS?
16. What physical and human resources would be added to the PS if costs were neglected?
Vilka fysiska och mänskliga resurser skulle läggas till i en PS om man bortsåg från kostnader?

K.f. Formalized process mapping

17. How are unexperienced employees helped to know how far in the design process the team has processed and what steps are to follow? (Knowledge that senior colleagues knows by heart)
Hur underlättar man för juniora lagmedlemmar att veta hur långt gången projekteringsprocessen är samt vilka steg som följer?
(Något som kan sitta i ryggmärgen hos erfarna kollegor)
18. How do you facilitate for senior team members to learn and develop?
Hur säkerställs att seniora lagmedlemmar fortsätter lära sig nytt och utvecklas?

K.g. BIM

19. How do you work with Building Information Modelling (BIM) in this PS?
Hur arbetar ni med Building Information Modelling (BIM) i denna PS?

L. ORIGINAL INTERVIEW TRANSCRIPT EXTRACTS IN SWEDISH

^a vi sätter ju inte hit hela projekteringsgänget utan de flesta har ju ganska stora organisationer som sitter på hemmaplan och ritar. Sedan är det ju någon från varje disciplin som är här, en som är ansvarig så att säga

^b de är nog bara störda av att sitta med hundra andra - vi har ju löst allt åt dem. Sen hade dem ju egna arbetsmöten konsulter emellan ändå för att de var tvungna.

^c “[På ett annat projekt] var det ju lite mindre. Då kunde man ju sätta sig in i alla detaljer. Nu måste jag ju kunna lita på att de kan samordna sig. Jag sitter ju på projekteringsmötet och delar ut uppgifter hur dem skall samordna sig under dagen. Förut hann jag sitta med i alla de här och dra i allting men nu måste jag ju kunna lita på de andra.”

^d det krävs ju väldigt mycket utav den som skall leda det -som jag nu då, att den tror på det. Och att den förbereder det och jobbar väldigt mycket med det och vet vad den vill få ut utav det. Skulle jag inte vara lika drivande i det som jag är så skulle det ju inte alls ge lika bra resultat.

^e ”det är ju sällan vi kan fånga in hela uppdraget från början /.../ i samband med denna typ av genomgångar har ju xxx en diskussion kring resurser. Man träffas och diskuterar, hur klarar man att leverera enligt leveransplan och behöver vi ha mer resurser eller behöver vi rent av dra ned på resurserna? Har vi inte fått in? Till exempel om vi har trott att vi skall få in såhär många hyresgäster vid det här läget, och det börjar det visa sig att det kommer vi inte få, då måste vi ju liksom strypa takten.”

^f ”Asså vi hade det då vi hade det typ när vi hade kört en sex månader tror jag. Inte ens det jag tror en fyra eller fem månader. Och vi frågade såhär vad, vad funkar och vad funkar inte vi hade ett tvåtimmarsmöte med det. Nej mer tror jag vi hade. Och då kom det ju fram en massa grejer som konsulterna tyckte och då ändrade vi ju om det och sade att nej okej, det funkade ju inte. Då ändrade vi ju, jag tror det var lite med tiderna”

^g ”Ja, det är ju bara en punkt i projekteringsmötesprotokollet, den kan jag skriva ut men jag har inget protokoll från det mötet utan jag valde bara att ta de bästa och de sämsta delarna.”

^h Och jag, uppmuntrar inte att köra det här, för att jag tror inte att alla har den personligheten att klara det. Alltså jag, vi har ju kämpat hårt liksom med att driva igenom det här och kämpat hårt med liksom att hålla det sociala -det sociala uppe hela tiden. Att liksom högt i tak, prestigelöst...

ⁱ så gör man ju i inkösportalen blir de ju, där måste man ju göra en bedömning. Där blir det ju en grön gubbe en gul gubbe eller en röd gubbe, beroende på vad man har fått för betyg. Så har ju inte vi direkt med konsulterna men vi har ju listan liggande hos vår chef där man vet vem som har jobbat med vilka och så ringer man upp och frågar. Det är ju samma sak, egentligen kan man ju inte gå på det där i inkösportalen heller utan man måste ju gå till någon som man litar på

^j Man får inte vara för... ehh.. för mycket nybörjare för att sitta i en projektstudio. Man måste bemästra sin disciplin som man är där för att representera.

^k man får inte vika sig för mycket i diskussioner med andra vilket... eh... min erfarenhet är att om man får in folk som är lite för gröna eller lite för nya, ehm, så vill man kanske inte riktigt gå i konflikt eller vad man skall kalla det

^l dem seniora är mycket mer att dem bara kör från höften och bara skall köra på liksom! O dem bara aja, men det där löser vi, det är inga problem, och det där det är som det alltid brukar vara. Jaha? Är det? Och sedan nästa gång det är möte så bara: ja men juste! Det skulle jag ju göra. Ja, men hade du haft det på ett Gantt-diagram som du hade stämt av varje vecka då hade du haft koll på det här /.../ Jag tycker att dem juniora är mycket duktigare på att se det.

^m Men när han sitter på arbetsmöten då plockar han fram sin miniräknare från 1974 och där sitter han och plinkar på den liksom såhär och så säger han liksom ja, men det funkar, så kan vi göra. /.../ Han vill inte ha programvaror och modeller

ⁿ Nej, man kanske skulle kunna tänka sig en bättre lokal än den vi har. Med mer utrymmen med rum runt om. Eh, och sen kan man ju fundera på det här med, vi har ju funderingar på det här kontoret på hur vi skall bygga upp en projektstudio och jag kan ju tycka att det hade varit bättre att bygga upp en projektstudio runt ett sånt här, ett landskap, och att det i det här landskapet, att det finns plats även för externer att sitta här och jobba då. Men där är vi inte, nu

^o innan jag kom in i projektet när man körde programhandlingen så satt man nere i en gammal avdankad källarlokal liksom och det var ganska sunkigt, det var mörkt, det är i utbildningslokalerna på NCC, det var borta på en lastkaj och det var liksom verkligen -det var ett litet rum. Så projektörerna och konsulterna var ju inte motiverade, dem satt ju aldrig där, dem var på möten./.../ingen ville sitta där, man gick på möten men man hade ingen energi-, så kanske man stannade kvar och pratade en kvart efteråt och utbytte liksom frågor, men man ville liksom inte sitta där. Så därför kämpade jag liksom jättemycket för att få den här lokalen [NCC PS Vallgatan]

^p Ja, nej, vi hade ju en, vi hade ju till och med köpt in en sådan här smartboard som vi använde. I: Mm, var det bra eller att ha? – Jaa, det tycker jag, vi hade ju en och jag tyckte att vi använde den för lite bara ibland. Asså, jag kan känna att vi var I: Då satt man med modellen och så hade man någon penna som man ritade på eller? - Nej, inte modellsamordningen, ja precis, precis, vi kunde sitta på arbetsmöten eller något sånt där I: Sen loggförde man någon vy sådär? Ja, så, och sedan ritade man på det och sen sparade man den bilden och skickade med i protokollet eller något. I början hade vi lite den. Men det är lite sådär -det är ny teknik och alla är inte bekväma med den och det tar lite tid när man skall starta och såhär du vet. Men du vet ibland

^q Men det är väl det! Så, precis! Det är väl det då i så fall kanske att man skulle göra då att man kanske skulle lägga mer tid på att utbilda dem inblandade i dem system som vi skall använda som till exempel för varje gång dem skall starta ett nytt projekt med en ny byggare så får dem ju alltid en ny typ av dokumenthanteringssystem vi har pds-en och du pratar om byggnet och det finns ju hundra olika varianter och varje gång är det olika liksom. Att man skulle ha mer utbildningar och sånt där, nu hade vi ju utbildningar i pds-en. Men mer sånt! Att det skall finnas tid för mer sånt.

^r Ja, men vi kallar ju det för, det är ju så mycket liksom med projektstudio och Big Room och visuella rummet och begrepp som man inte riktigt tydligt -asså vad är projektstudio? Vad är big room? Vad är visuella rummet och så? Vi kallade det ju, asså det här stora rummet är ju liksom Big Room. Och vi kallar det ju för det visuella rummet, där visualiserar vi ju liksom

allting så mycket som möjligt, vi försökte visualisera så mycket som möjligt av allting. Att liksom vi sade såhär att, går du in i Big Room, så finns allt där, vi har en projektstudio där vi har öppna kontorslösningar där alla skall sitta, vi har ett ritningsrum där det finns ritningar, vi har ett Big Room -alla får gå in där när det inte är möte. Och där har vi då satt upp alla protokoll, du behöver inte gå in på PDS-en vi har skrivit ut alla protokollen, alla frågor, allting, du ser hela planeringen där liksom. Då har vi ju visualiserat det där liksom, det förstår ju även en senior liksom.

^s Det vi hade gjort var att vi hade gått runt och intervjuat andra projektstudior liksom och kolla hur dem hade arbetat och så. Eh och den största grejen var väl det att dem som var projekteringsledare på andra stora projekt bara satt i möten och bara och satt och renskrev protokoll och bara satt och svarade på mail liksom. Så det var liksom prio ett liksom, vi skall bara ha ett protokoll att skriva och det är projekteringsmötesprotokollet och vi skall inte hålla på och maila varandra. Och det tyckte jag att vi lyckades ganska bra med.

^t det som jag har funderat på är ju svårigheten med protokoll. Att det blir mycket protokoll /.../ Man lägger ner ganska mycket tid och jobb på dem där och sen är det ingen som tittar på dem ens. Eh, så jag vet inte. Det är en stor nöt att knäcka.

^u Så att det slutade väl med att det var xxx som hade en modell som dem höll vid liv så att dem reviderade den efter ändrade underlag som yyy gjorde

^v Vad är det jag vill få ut av onsdag, torsdag? Vad är det exakt jag vill ta upp för frågor, jag menar för att mötena har ju en sådan rutin. Man tittar på dem här lösa frågorna, vad är det för lösa frågor som jag vill att vi skall få ordning på?

^w Det är ju inte, det känns ju inte som att vi har något vad skall man säga, något riktigt sådär tydligt mål. /.../, men det finns inga, jag kan sakna lite vad skall man säga tydliga direktiv vad vi skall satsa på. Nu är det väldigt upp till projekten att välja och vi har liksom inte den kunskapen, vi har inte det fokuset så att det haltar lite kanske. Jag tror att vi skulle kunna få ut mer om vi skulle ha tydligare mål och.../Men jag kan känna att det finns liksom ingen tydlig vision liksom från företaget att det är det här vi skall göra! Och här skall vi vara om fem år! Eller... och det är lite svårt för liksom varje projekt att sätta upp den typen av mål och...

^x Jag tror vi hade något vite på leverans -om dem inte levererar så är det något vite har jag för mig att vi har satt in. Att om, det är ju svårt att säga såhär att ni levererar inte -vad har vi att förhålla oss till liksom?/.../Så att belöningar har vi ju liksom inte på det sättet mer än att man får en klapp på axeln -bra jobbat! Och det tycker jag hela tiden att vi har gjort. Vi har hela tiden berömt. Jag menar det är ju -att bara få ord av berömmelse det gör ju att folk och människor växer och tycker att det är kul att gå till jobbet

^y Inte med i vånan, asså just, jo asså dem är med och använder våra lokaler och så men det är inte att dem är med i projektstudioformen att dem är delaktiga i mötena på det sättet. Då är det ju separata mötesforum som ofta har varit på måndagen eller tisdagen