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“ CIVIL ENGINEERING ”

# D I P L O M A T H E S I S

## **The Establishment of Integrated Project Delivery Methods in Europe’s Construction Industry**

*The Implementation of Project Alliancing and Lean Construction in Austria*

to earn the academic degree

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for

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## Abstract

During the delivery of complex construction projects the occurrence of problems emerging from the lack of collaboration is increasing throughout the industry. The separation of project participants due to the lack of trust amongst them restrains the accomplishment of overall satisfying solutions for the project.

That leads to the conclusion that the current management and project delivery methods can no longer keep pace with the requirements within the industry. The low-bid approach, which has been in execution for 2000 years already, in combination with the allocation of risk followed by extensive legal measures as well as the fragmented view of the procedure resulting in a restricted flow of information do not allow an efficient processing of the project. In fact, only a few projects spawn winners and if so, they also leave as many losers fall by the wayside. The following three ways of thinking that are generated and intensified by the current system prevent a project delivery that generates satisfied stakeholders only.

*"my gain is your loss"*

*"fix the blame, not the problem"*

*"best for self instead of best for project"*

Because of these reasons it is of significant importance for the construction industry, and therefore also subject of this thesis, to establish new and innovative methods to diminish these patterns of behavior at future projects and achieve outstanding results. Both integrated project delivery methods, Lean Construction as well as Project Alliances, constitute a positive development in these regards. The thesis at hand examines what effects the application of these methods could have on the construction industry. It crystallized that both, essentially very similar methods, could precipitate most of the necessary and desired change. Amongst other beneficial effects, the implementation of integrated methods would cause a raise in quality and efficiency of the structure itself, but also improve of the atmosphere and collaboration during the delivery.

Even though these methods have been in use successfully in Australia and the United States for several years already, the European construction industry makes no decisive move approaching integrated ideas and principles yet. It could be determined that one of the biggest hurdles at establishment is the lack of trust amongst parties but also towards the new approach. To promote and spread the adoption of integrated practices it is therefore necessary to achieve a rethinking and thereby create ethical values, to deliver future projects in an atmosphere of mutual respect and trust. Only an environment

like that will allow to meet the requirements in regards to the efficiency and quality of the building, but further also of the project management procedures itself and accomplish results satisfying all stakeholders in equal measure.

**Keywords:** Collaborative, integrated, efficient und innovative project delivery, Lean Construction, Project Alliancing

## Kurzfassung

Bei der Abwicklung von komplexen Bauprojekten treten vermehrt Probleme auf, welche größtenteils auf mangelnde Kooperation zurückzuführen sind. Die Abschottung der Projektbeteiligten aufgrund von mangelndem Vertrauen behindert das Erreichen von zufriedenstellenden Ergebnissen für das gesamte Projekt.

Dies führt zu der Schlussfolgerung, dass die derzeitigen Management- und Projektabwicklungs-Methoden den Erwartungen und Anforderungen nicht länger gerecht werden. Das Billigstbieter-Prinzip, welches bereits vor 2000 Jahren entwickelt wurde, in Kombination mit der Risikoabwälzung und den daraus folgenden rechtlichen Schritten, die fragmentierte Betrachtung der Prozesse und der dadurch gehemmte Informationsfluss lassen keine effiziente Abwicklung von Bauprojekten zu. Vielmehr bringen Projekte nur in wenigen Fällen Gewinner hervor und diese auch nur auf Kosten ebenso vieler Verlierer. Die drei folgenden Denkweisen, welche durch das System an sich hervorgerufen werden, verhindern somit eine für alle Parteien zufriedenstellende Abwicklung.

*„mein Gewinn ist dein Verlust“,*

*„löse die Schuldfrage, nicht das Problem“*

*„das eigene Wohl steht über dem des Projektes“*

Aus diesen Gründen ist es für die Bauwirtschaft von großer Bedeutung, und darum auch Inhalt dieser Diplomarbeit, neue und innovative Methoden zu etablieren um diese Verhaltensmuster in Zukunft zu verhindern und herausragende Projektergebnisse zu erzielen. Die beiden integrativen Projektabwicklungsmethoden Lean Construction und Project Alliancing stellen in dieser Hinsicht eine positive Entwicklung dar. Diese Arbeit untersucht, welche positiven Effekte die Anwendung dieser Verfahren auf die Bauwirtschaft haben und wie eine Einführung am Markt aussehen könnten. Es hat sich gezeigt, dass die beiden im Grunde sehr ähnlichen Verfahren, den Großteil der benötigten und gewünschten Veränderungen herbeiführen könnten. Zum Einen wird durch die Einführung von integrativen Verfahren um einiges effizienter und qualitativ hochwertiger gebaut, zum Anderen verbessern sich das Klima und die Zusammenarbeit während der Abwicklung signifikant.

Obwohl mit diesen integrativen Verfahren, vor allem in Australien und den USA, nachgewiesener Maßen durchgehend positive Erfahrungen gemacht wurden, tastet sich die europäische Bauwirtschaft nur sehr langsam an Ideen aus Project Alliancing oder Lean Construction heran. Die größten Hürden scheinen das mangelnde Vertrauen unter den Parteien aber auch in die neuen Verfahren selbst zu sein. Um den Einsatz von integrati-

ven Methoden voranzutreiben ist es demnach erforderlich ein Umdenken zu erreichen und moralische Werte zu schaffen, um Projekte zukünftig unter gegenseitigem Vertrauen und Respekt abwickeln zu können. Nur in einem solchen Umfeld ist es möglich den heutigen Anforderungen an Effizienz und Qualität des Bauwerkes, aber auch der Projektabwicklung selbst gerecht zu werden und Projektergebnisse zu erreichen, welche für alle Beteiligten zufriedenstellend sind.

**Schlüsselwörter:** Kooperative, integrative, effiziente und innovative Projektabwicklung, Lean Construction, Project Alliancing



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# 1 Introduction

In today's construction industry it seems there is only one thing that matters: costs. It is neither about making the most out of the available resources, nor about reaching goals or creating satisfying solutions for stakeholders. At least that was what the author of this thesis experienced, heard and thought about this until Otto Greiner and Roland Köck came to report that there is something else. That it doesn't have to be a semi-win/semi-lose-situation at it's best, but that a construction process can spawn winners only. When it was found that such methods deliver outstanding results for several years already, the question that remained was why Austrian companies still fight for every order by calculating at cost price and then have to fight for financial survival.

The choice of the topic has been influenced by the personal interest of the author as well as the timeliness, since current project delivery practice is causing more and more problems throughout the industry. Therefore this thesis shall demonstrate how the management and delivery methods being in practice now have developed and why their approach is no longer generating satisfying results. Given these shortcomings of the way construction projects are being handled, the thesis on hand will present innovative and cooperative approaches to deliver projects for the good of all involved parties. The methods of Lean Construction and Project Alliancing have been chosen to illustrate that, since they are the most prevalent integrated delivery methods being in practice. Even though they are applied successfully in the United States and Australia for several years already, the attitude towards integrated practices is skeptical throughout the European construction industry. Therefore this thesis shall deliver the major positive effects these methods would have and how they could be implemented in the European construction industry to make efficient projects the norm and not a rare coincidence.

In this introductory chapter the significance of the thesis, the scientific problem and the methodology of the thesis will be presented.

## 1.1 Significance of the Thesis

The project delivery practice does not facilitate cooperation or innovation because it creates insuperable barriers between stakeholders due to lack of trust and the shifting of risk. However, research and approaches from other disciplines show, that outstanding results can only be achieved if synergies are identified and used for the benefit of the

whole project. Therefore the mindset needs to change from *“best for self”* to *“best for project”* and cooperation needs to be enforced by the delivery method itself. Since integrated approaches such as Lean Construction and Project Alliancing imply these principles, the significance of this thesis will be to:

- Develop the awareness that innovative awarding and procurement strategies as well as collaborative project management methods will lead to more efficient projects.
- Demonstrate that an atmosphere of mutual respect and trust between all stakeholders will not lead to exploitation, but to an overall rise in efficiency, satisfaction and humanity.
- Present that integrated project delivery methods could be implemented in Austria’s construction industry.

By writing this diploma thesis, the author fulfills the requirement to obtain the academic degree of Dipl.-Ing. and concludes the masters program of civil engineering with the specialization in project management at the Carinthia University of Applied Sciences.

## 1.2 Scientific Problem

The scientific problem includes three research questions as well as a hypothesis, established on the before presented significance of the thesis.

### **Research Questions**

The research questions have been framed as follows in regards to the problem statement presented above:

- Is there a need to change the current project delivery practice in Austria?
- What impact on quality, target costs and schedule, innovation as well as the overall project atmosphere could integrated project delivery methods have?
- What needs to change to make cooperative methods like Lean Construction or Project Alliancing applicable in Europe’s construction industry?

### ***Hypothesis***

Austria's construction industry would certainly benefit from less strict and price dependent award and procurement strategies as well as from integrated project delivery methods. The implementation of Lean Construction and Project Alliancing principles could lead to better overall quality of buildings, reduction of cost and construction time as well as higher potential for innovation and stakeholder satisfaction.

## **1.3 Methodology of the Thesis**

The thesis includes a literature research discussing the procurement law as well as Lean Construction and Project Alliancing. This part of the thesis delivers the essential background for the empirical research captured in the further chapters. To gather the information for the empirical part, an interview guideline was developed to answer the questions that remained unanswered by the literature study. The following table displays the sequence of the study.

Conduct a literature study about cooperative project management methods applied in construction projects in regard to their diffusion, application and advantages as well as disadvantages.
Investigate the present status and future request within the Austrian construction market regarding project delivery.
Develop an interview guideline for construction companies and representatives from the United States.
Examine how cooperative methods are being implemented in the United States and in Australia in regards to legal, engineering and administrative conditions.
Interview representatives from the United States to deduce benefits from cooperative project delivery methods.
Compare the methods of Lean Construction and Project Alliancing and how they could be applied within the current system. Furthermore analyze what would need to change to make it more likely that these methods will be adapted in the European construction market.

*Table 1: Sequence of Study.*

As the table of content shows, this thesis consists of ten chapters, including this introduction, the body and the conclusion. The body inherits the information from the literature and empirical study, while the theory is comprised in chapters two to six and the empiricism in chapters eight to nine.

In chapter two the Austrian procurement law is being presented. After a brief history about the development of the awarding practice, the principles, the scope of application, the threshold values and the awarding procedures are being presented in more detail. In the conclusion the major shortcomings as well as the trend in the awarding practice is being highlighted.

The following chapters number three, four and five deal with integrated project delivery methods that are Lean Construction and Project Alliancing. At first both methods are being presented in regards to their principles and ideas as well as the framework and processes. In chapter five the two methods will be compared to one another. Their approach in regards to awarding, designing and constructing a building as well as the contractual framework will be examined in greater detail. Chapter six is the last one established on the literature findings and displays where the before presented integrated methods interfere with the procurement law and how they could be implemented within the legal framework.

As mentioned chapters seven, eight and nine express the findings from the interviews conducted within the empiric research. The expert interviews have been conducted during the authors stay at the Columbia University in the United States. The interview guideline consists of seven main questions including more precise follow-up questions. The interviews took approximately one hour and have been recorded and transcribed. A short introduction of each interviewee and the interview guideline as well as the transcripts can be found in the appendices. The interview partners are experts from the construction industry who have made experience with integrated project delivery methods in the United States. All of them are distinguished professionals with several years of experience in the construction industry and experts in their field of work. To answer the research questions presented above, the interviews have been combined in three chapters addressing the:

- Desired Change of Practice [Chapter 7]
- Impact of integrated Practices [Chapter 8] and
- Hurdles and Chances at Implementation [Chapter 9]

In chapter seven the downsides of the current practice are being presented in regard to literature findings and more extensively from interview findings. Furthermore the changes that are necessary for more efficient project deliveries are being displayed.

Subsequently chapter eight answers the question if these changes can be achieved with integrated methods like Lean Construction or Project Alliancing. The impact the implementation of these methods could have will be covered comprehensively. Especially regarding collaboration, risk allocation, productivity, quality and contracting. To ensure a holistic consideration possible negative effects will be discussed as well.

In chapter nine the hurdles as well as the chances for establishing integrated practices will be presented. The major factors preventing ideas and principles from Lean Construction or Project Alliancing to getting applied more often will be listed. Furthermore it will be examined what could be motivational factors for parties to consider a change in their way of delivering projects and how a paradigm shift could be caused to spread integrated practices.

The final chapter of this thesis contains a conclusion and further research possibilities regarding the topic of cooperative project delivery. It further implies a summary of the most significant findings especially concerning the before presented research questions.



## 2 The Procurement Law

This chapter should give an outline of the current awarding law as it is being practiced in Austria. To be able to deliver a deeper understanding of the topic, the situation will be looked on from a historic point of view and deliver a future outlook as well. With the information of this chapter the reader should be able to comprehend appraisals and comparisons regarding to the current procurement law in the continuing chapters.

At first the development of the awarding law will be illustrated and how its historic roots still exert influence on today's awarding and project development practice. Afterwards the basics of the recent European, and therefore Austrian, awarding law will be delivered. The conclusion should show how the awarding systems and methods work and what are the key points regarding to cooperative project delivery.

### 2.1 The History of the Awarding Practice in Austria

It was in the 18<sup>th</sup> century B.C. in ancient Babylon, when king Hammurabi established the first law code that still preserves. The Code of Hammurabi includes 282 paragraphs that regulate several fundamental topics, amongst them also some concerning construction. One of the paragraphs for example sets the price a master-builder should demand for creating living space; a fixed price of *two shekel of silver for one musar of space*. Even though the Code of Hammurabi pays more attention at how a master-builder should get penalized if his construction failed, most of that could be summarized with *"An eye for an eye, a tooth for a tooth."*

A real milestone at procurement was developed, as so often in history in general, but in construction in specific, by the Romans. It is not for sure if it was them who came up with the idea or if they just reinvented it, but nevertheless that form of awarding can be seen as the foundation for the procurement systems being in practice today. It was a method developed especially for public awarding authorities ensuring an efficient investment of public assets. Hence it was applied at every temple, coliseum, bath or fountain the emperor wanted to build. The method was called *auctio licitatio* what means auction or bidding at an auction. At the procedure possible tenderers got invited to study plans and models of the building to be constructed and then eventually take part at the *licitatio* itself. At the verbal reverse auction the authority set a maximum price from

which on the tenderers could undercut their bids downwards until a final lowest bid was reached and the work got awarded. cf. [1].

If you break up the Design-Bid-Build (DBB) or the open awarding procedure, which are the most commonly used project delivery methods in the US respectively in Austria and the European Union, and compare its fundamentals to the ancient method of *licitatio* it can be found, that both methods basically follow the same idea. At both methods the design process is detached from awarding and further project development. The only factor that is deceiving at the awarding stage is the price. Certainly today it is no longer a verbal public auction, but a structured process with no insight to other tenderers bids. However if you consider the knowledge of the market and competitors that most companies have, they do have an idea of where the price level will be. This comparison shows in a very simple, yet eye-opening way how far awarding has come in more than 2000 years of development. That signifies how antiquated the current awarding approach is today where Gandhi's quote is more recent than ever before:

*If you have done it that way for two years, look at it carefully.  
If you have done it that way for five years, look at it distrustfully.  
If you have done it that way for ten years, change the way you are doing it.*  
[Mahatma Gandhi]

*If you have done it that way for 2000 years...?*

The procurement practice in Austria can be followed back into the 16<sup>th</sup> century, when Austria was first an archduchy and became a monarchy at the beginning of the 18<sup>th</sup> century. Throughout these years the procurement was regulated by imperial orders and acts from the ministry, but was basically still executed with the method introduced by the Romans mentioned above, the *licitatio*. Invitations to this very kind of auctions can be found in Austrian papers from back then. cf. [2]. When the years of the monarchy passed by, merely the latest of the imperial acts got transferred into the law of the first Austrian Republic in 1918. cf. [3] p. 3. At that point the *licitatio* had been replaced by a written bidding process similar to today's tendering. There were several reasons the verbal auction *licitatio* got abandon. One was that the personal attendance in a growing market the economy was facing at the turn of the 19<sup>th</sup> century caused difficulties. The other more important one was the manufacturing quality was getting worse until it even caused severe failures of structures. The fact that the companies manufactured at such a low quality could be lead back to the ruinous price level caused by the verbal auctions. It was not possible to calculate a reasonable and profound price for complex structures like

bridges or railroads within the heated environment these auctions represented. cf. [5] p. 410 ff. Marie Heller commented on the situation in Germany in 1907 as follows:

*“Without any doubt does the licitatio, by verbal undercutting, deliver the lowest possible bid; however they abandoned it, because the passion of tenderers, the excitement of the moment and briefness of time constrains careful deliberation.”*

[6] p. 19.

It took until 1957 when the Institute for Austrian Standard published the ÖNORM A 2050 as a nonbinding standard for awarding contracts. Even though this standard got declared as mandatory by several ministries, it never delivered a legal base for procurement. cf. [3] p. 270. Therefore it can be said, that the so-called “*Hoflieferantentum*” (purveyor to the court) in interaction with the *licitatio* influenced and formed Austria’s awarding practice for at least 400 years. That means awarding at random, being bound to no law and expecting no consequences, with a method considering only the price of a bidding was how the awarding practice looked like until the current awarding law was introduced in 1994. Since January 1<sup>st</sup>, 1994 the Austrian procurement law (*Bundesvergabegesetz*) regulates how public authorities have to proceed when awarding contracts in a very detailed manner. The main reason for enacting the procurement law in the first place was the accession to the European Union in 1995. cf. [3] p. 3 f.

In comparison to the Austrian procurement law, which was introduced in 1994, there are laws of other countries and their dates of issue listed below:

- Germany 1926: VOB (Vergabe- und Vertragsordnung für Bauleistungen)
- France 1964: Code des marchés publics
- Unites States of America 1949: Federal Property and Administrative Service Act
- Australia 1997: Commonwealth Procurement Guidelines

This short history shows how the Austrian legislation has been neglecting the awarding law until 1994. However since then, the law experienced several customizations and alterations. After coming into effect the law got revised for the first time in 1997 and amended five times until 2002 when a new version of the law replaced the older one. That process repeated in 2006 when the current awarding law got into effect. cf. [5] p. 36 ff. This current version was amended twice and experienced an adaption of the quantitative threshold values so far. The following subchapter should deliver the key contents of the current procurement law relevant to the thesis at hand in a coherent manner.

## 2.2 The Austrian Procurement Law

The current Austrian procurement law, BundesvergabeGesetz (BVerG), came into effect on February 1<sup>st</sup>, 2006 and got developed due to the need to adapt it to the European community law. The following subchapters deliver the knowledge of how the awarding law works to subsequently investigate if and how cooperative methods like lean construction and project alliancing could be established within the judicial framework. At first the structure and the key principles of the law will be summed up. Afterwards the area of application, quantitative threshold values and the main awarding procedures will be explained.

### 2.2.1 Structure and Principles of the Awarding Law

The Austrian awarding law consists of 6 parts divided into main- and subchapters containing 351 paragraphs and includes 19 appendices. The first part specifies the significance of the law and contains a detailed catalogue of terms and definitions. The second part will be subject to the following subchapter since it includes the areas of application but also regulates the awarding processes and awarding methods, which will be covered in 2.2.4. The third part is similar to the second one, but with a special consideration for sectoral contracting entities. Part four of the legal text deals with legal protection and competences of the Federal Procurement Authority (Bundesvergabeamt). The less extensive parts five and six regulate external monitoring and compensational claims for contractors as well as clauses regarding fines, final provisions and interim regulations. cf. [5] p. 40 f.

There are several principles forming the foundation of the law and representing the key concept for fair, transparent and competitive public awarding. The main goal of the law is stated to be awarding contracts at a fair price by considering maxims like non-discrimination and fair trade, to tenderers being authorized, capable and reliable. Therefore the awarding law specifies the following principles, whereat they should be seen and reviewed as directly connected and dependent from one another. cf. [5] p. 44 f.

#### ***The Principle of Competition***

Regarding to this principle, the law defines that there should be as many competing tenderers as possible facing the same conditions and terms to achieve a proposal as low as possible. Further the legal text states that no tenderer shall be privileged or discriminated by any criteria, especially by defining specifications favoring a certain tenderer.

Therefore the awarding should be dependent on impartial criteria only and the competition should be accessible freely to ensure efficient contracting. cf. [5] p. 45.

### **The Principle of Equal Treatment**

The principle of equal treatment, which is also covered by the prohibition of discrimination within the principle of competition, secures that every tenderer is granted an equal position during the awarding process. This contains two major topics: the equal treatment of tenderers from other countries within the European Economic Area and the discrimination of local companies. Relating to the discrimination of foreign tenderers the awarding authority has to secure that they have the same chances to participate in the bidding procedure. To ensure an equal treatment within the local market it is mandatory to allow every tenderer permitted to execute the work, take part at the bidding and ensure that everybody is receiving the same information. cf. [5] p. 47 f.

### **The Principle of Awarding Capable Contractors**

As mentioned in the introduction to this sub-chapter, the procurement law has the goal to ensure that only authorized, capable and reliable tenderers get awarded a contract. Whereat it is easy to verify if a tenderer is authorized, the matter about his capability and reliability is much harder to define and leaves space for interpretation. Therefore it is important to investigate the capacity, organization and former projects of possible contractors to be able to evaluate their technical, economical and financial capability as well as their reliability. cf. [5] p. 48.

### **The Principle of Awarding at a Reasonable Price**

The main purpose of this regulation is of course that contracts are not awarded at a price unusually high, but also not unusually low. This is especially hard to judge on, if all biddings are too high or too low. However the law tries to block prior consultations, speculative biddings and collusions by governing that tenderers have to calculate cost-effective, economically explainable and comprehensibly. cf. [5] p. 49.

### **The Principle of Transparency**

To make the process of procurement comprehensible and transparent, the law defines regulations about documentation and the duty of announcements. Those regulations may differ from one awarding method to the other, but secure that the process is verifiable at a later point in any case. However this principle is especially important for awarding methods like direct contracting where announcements are not required, which will be characterized in subchapter 2.2.4., cf. [5] p. 49 f.

### **2.2.2 Scope of Application**

The Austrian procurement law defines the personal scope of application as well as the scope of application as regards the subject matter. That means it regulates who has to adopt the law at awarding what kind of contracts.

#### **Personal Scope of Application – WHO?**

The law divides the parties bound to the law into three general groups that are public contracting authorities, Public-Private-Partnerships (PPP) and sectoral contracting authorities.

By public contracting authority the law defines the ones directly affiliated to the public body and some that are referred to as public contracting authorities in a broader sense. The directly affiliated organizations are the ones adjunct to the federal government, the states, the communities and their unions. Authorities the law entitles as the ones being public contracting authorities in a broader sense are universities, the national TV and radio broadcaster, museums or medical service organizations to name a few of them. cf. [5] p. 55 ff.

Concerning the PPP model, the project must be financed by public funds with at least 50 % to be bound to the procurement law. If that is the case, the private corporation in cooperation with the public authority has to award all contractors and trades by the regulations of the procurement law. This comes into effect only, if the project costs exceed the threshold value. cf. [5] p. 59 f.

The last organizations bound to the procurement law are sectoral contracting authorities. These can either be public contracting authorities, public corporations or private sectoral contracting authorities. Any kind of corporation or organization of the above acting as a contracting authority in the fields of infrastructure, water or energy supply has to award contracts according to the law. cf. [5] p. 61 f. The main sectoral contracting authorities in respects to construction industry are the Austrian Railroads and the energy producers and distributors. cf. [8].

#### **Scope of Application as Regards the Subject Matter – WHAT?**

This section of the procurement law defines what kind of contracts are subject to its application. Besides the most relevant kinds being the building contract for construction, the service contract for design and the supply contract for material, it also covers concession contracts for construction and service processes. Further a catalog of excluded contracts is listed, which however has no relevance for this thesis.

While the regular building contract always requires a payment, the concession contract for construction is generally linked to the use and earnings of a building. Otherwise they are alike and are adopted for the construction and planning of buildings, which may however contain further service and supply contracts. Whenever the design is awarded separately, it is considered to be a service contract. cf. [5] p. 62 ff.

### **2.2.3 Quantitative Threshold Values**

The contract value is a key in every construction project, but especially if the awarding authority is bound to the procurement law. The thresholds influence the deadlines in the awarding process as well as the choice and procedure of the awarding method itself. Besides the threshold values the procurement law also defines how the contract value needs to be calculated.

#### **Threshold Values for Public and Sectoral Contracting Authorities**

As mentioned at the end of subchapter 2.1, the threshold values were due to an adoption since the current version of the law came into effect. This adoption was made in order to counteract on the current financial crisis and therefore most threshold were lowered. These thresholds will stay effective until the end of 2013 and may be extended or adapted then. The following chart should give an overview of what the thresholds for construction as well as service (e.g. design) and supply contracts are and what awarding methods are applicable.

	<b>Threshold</b> (excl. tax)	<b>Awarding Method</b>
<b>Construction Contracts</b>	from € 5.000.000	Open or restricted awarding with an announcement throughout the European Union
	up to € 5.000.000	Open or restricted awarding with an announcement
	up to € 1.000.000	Restricted awarding without an announcement or Negotiated awarding with an announcement
	up to € 500.000	No bid awarding with an announcement
	up to 100.000	No bid awarding or Negotiated awarding without an announcement
<b>Service Contracts</b>	from € 200.000 federal € 130.000 sectoral € 400.000	Negotiated awarding with an announcement throughout the European Union
	up to € 200.000	Negotiated awarding with an announcement
	up to € 100.000	Negotiated awarding without an announcement
	up to € 130.000 sectoral € 200.000	No bid awarding with an announcement
	up to € 100.000	No bid awarding
<b>Supply Contracts</b>	from € 200.000 federal € 130.000 sectoral € 400.000	Open or restricted awarding with an announcement throughout the European Union
	up to € 200.000	Open or restricted awarding with an announcement
	up to € 130.000 sectoral € 200.000	No bid awarding with an announcement
	up to € 100.000	No bid awarding or Negotiated awarding without an announcement or Restricted awarding without an announcement

Table 2: Threshold Values. Adapted from [8].



### **Determining the Contract Value of Construction Projects**

Since the amount of the value to be contracted is crucial for the legitimacy of the awarding methods it represents a key point in the procurement law. According to the legal text the amount should reflect the value of the contract at the time of the initiation of the awarding process without taxes and must be estimated properly in a competent manner. Splitting a construction project into multiple contracts to fall below the threshold values is not allowed. cf. [9] § 13.

In the paragraphs regarding the scope of application the law defines construction, supply and service contracts. However it states that within a construction contract there may be embed several service and supply contracts as well. A similar statement can be found at how to determine the contract value of construction projects, that declares the value to include all construction work as well as all needed materials and services. Whenever one project is divided into units or sections that are getting awarded separately, the value of each unit has to be accumulated. If the total value is above threshold, all units have to be awarded accordingly. cf. [5] p. 73 f.

#### **2.2.4 Awarding Procedures**

The Austrian procurement law declares the following seven awarding procedures as binding and does not allow any other methods than those:

- Open procedure
- Restricted procedure
- Negotiated procedure
- Competitive dialogue procedure
- Framework agreement
- Dynamic procurement

The following paragraphs should provide an overview of the relevant procedures and their applicability for awarding construction contracts.

#### **The Open Procedure**

Awarding a construction contract using the open procedure is applicable for projects with a value of € 1.000.000 and more, however the owner can decide to use it for any minor project, too. The basic steps every open procedure passes through are:

- The announcement
- The request for bid documents by tenderers
- Opening and evaluating the proposals

- Decision on preferred tenderer
- Awarding the contract

This method restricts the owner and dictates every step very detailed to secure the principles of transparency, equal treatment and competition. Therefore the owner is not allowed to negotiate with any party nor exclude any tenderer from the bidding process. The contract has to be awarded to the economically most convenient bid, what basically means to the lowest one. cf. [5] p. 78.

Thus the awarding authority has to make sure not to contravene against any principle or step mandated by the law, since otherwise the whole awarding procedure could be declared null and void what would mean a major throwback to any project.

The law declares the open procedure to be equivalent to the restricted procedure that will be explained in the following paragraph. Thereby the owner can choose between both of them and according to the legal text award any contract by carrying them out. cf. [9] § 237.

### ***The Restricted Procedure***

The restricted procurement method can either be carried out with or without an announcement, depending on exceeding or undercutting the threshold of € 1.000.000. At the procedure without an announcement, the owner invites at least five capable, eligible and reliable tenderers he is familiar with to submit a bid. Whenever the threshold is overrun an announcement, asking tenderers to submit their request to participate, has to be issued. Afterwards the owner decides by before defined and indicated criteria who will be the preferred tenderers asked to submit a bid. However the number of preferred tenderers must exceed the number of five. The number of tenderers succeeding as well as the criteria the choice is based on must be announced beforehand. cf. [5] p. 79 ff.

Therefore the process of this method looks as follows, whereat the first three steps are being in effect only at the procedure with an announcement:

- The announcement
- The arrival of requests to participate
- The evaluation of the requests
- Choosing the preferred tenderers
- Receiving and evaluating the bids
- Awarding the contract

### **The Negotiated Procedure**

Just as the restricted procedure, the negotiated also may be executed with or without an announcement, whereat the threshold to be allowed to omit the announcement is € 100.000. The negotiated procedure with an announcement is applicable for a project-value up to € 1.000.000 and contains the same steps as the restricted procedure with an announcement does, with one exception: Between the evaluation of the bids and the awarding of the contract, the owner is allowed to negotiate with the tenderers, which can lead to modifications of the bids. cf. [5] p. 81 ff.

Further the law defines several special cases for the applicability of this procedure, especially for construction projects exceeding the threshold. Therefore the negotiated procedure with an announcement would be eligible for projects valued above € 1.000.000 if no acceptable bids were submitted during a before executed open or restricted procedure with an announcement, to name one of the more common of the seven exceptions. cf. [9] § 28.

### **No Bid or Direct Awarding**

This procedure represents the least regulated one, since the owner can award the contract to his preferred contractor without any restrictions. However, since its informal characteristics, this method can only be applied for contracts with a value of € 100.000 or less. cf. [5] p. 90.

### **The Competitive Dialogue Procedure**

The method of awarding a contract by implementing the competitive dialogue procedure is a very diverse one compared to all the other procedures the law defines. The competitive dialogue was implemented within the legal text to apply it at projects that are complex regarding to technical and legal aspects and cannot be awarded by using the open or restricted procedure. The law states, that a project can be seen as complex and therefore eligible for the implementation of the competitive dialogue, if the owner cannot specify the technical, financial or legal terms of the project at the stage of awarding. However this awarding procedure is not applicable for sectoral awarding authorities.

The process is divided into three phases with the goal to not only award the contract to the technical and economic most convenient bid, but to develop the most convenient solutions in the first place. Hence, after narrowing the group of participants in the first phase, the second phase is affected by the dialogue between the owner and each tenderer. At the end of this phase there should be worked out a design, which is being kept

confidential between the owner and each tenderer, on which the bidding is based on in phase three, where the owner decides which is the technical and economic most convenient proposal. cf. [5] p. 88 f.

As mentioned above, the competitive dialogue is only applicable if it is impossible for the owner to award the contract by applying any other procedure. Therefore he must be objectively unable to define the technical specifications, as well as financial or legal conditions, required for any traditional awarding method. cf. [9] § 34. Even though the very low applicability, the awarding procedure of the competitive dialogue can be seen as the legislations first small step towards integrated project delivery and therefore also towards cooperative methods like Lean Construction and Project Alliancing. To be able to demonstrate the likeness of those methods in chapter 3.4.3, the process of the competitive dialogue is shown in the following conclusion where the trend in the awarding practice is being discussed.

## **2.3 Conclusion**

As one can recognize by looking at the history and the current state of Austria's procurement law, there is a tremendous alteration within the last 20 years. From an almost non-regulated procurement, without any legal base, to a highly complex and detailed legal text making Austria leading the way within the European Union. That pioneer task can be lead back to the prompt implementation of European Community law requirements and therefore early rulings from the European Court of Justice supporting further development. cf. [10].

However the Austrian procurement law, being praised by so many legal experts, did turn into a hermetism, not being manageable for most stakeholders in the construction industry without a legal counsel any longer. cf. [10]. That leads to difficulties for smaller businesses in particular and may make it impossible for them to compete against legal steps taken by their competitors as well as the awarding authorities. But also big players in the construction industry keep struggling with the complexity of the law, which can be seen on several failed major award procedures during the last years.

### **2.3.1 Shortcomings of Traditional Project Delivery**

Traditional awarding and project delivery, which in the United States mostly refers to Design-Bid-Build and to the open or restricted awarding procedure in Austria, showed ever more shortcomings during the past decade. Dipl.-Ing. Jörg Werner states in his

paper published by the Institute of Construction Industry, that the base for successful cooperation, that is vastly dependent from the effective flow and exchange of information, is being disturbed by one-sided terms within contracts and deficient management and coordination. Further he declares the choice of the award procedure to be a key factor to develop a solid base for further project delivery and avoid inequalities amongst contractual partners. Even more a bad decision regarding the awarding method can lead to bad quality because the sides concentrate on minimizing their own loss, by maximizing their "opponents" ones. cf. [11]. Two figures that underline the need of a change even more are the stagnating yearly productivity increase and the inefficiencies within construction processes. Even though several major technical improvements the increase in productivity from 1966 to 2003 was only at about 0,78 % per year while the average was at 1,75 %. This low productivity comes with a high percentage of inefficiencies built in every construction process. The percentages range from 15 up to 50 whereat inefficiencies of 30 % can be rated as realistic and average. cf. [12] p. 1 ff.

One key element evoking bad performance is the high potential for disputes and the high fragmentation that gets enforced by traditional awarding and project delivery. The following chart shows findings of a study conducted in 2004 analyzing the most frequent instances causing disputes and litigation.

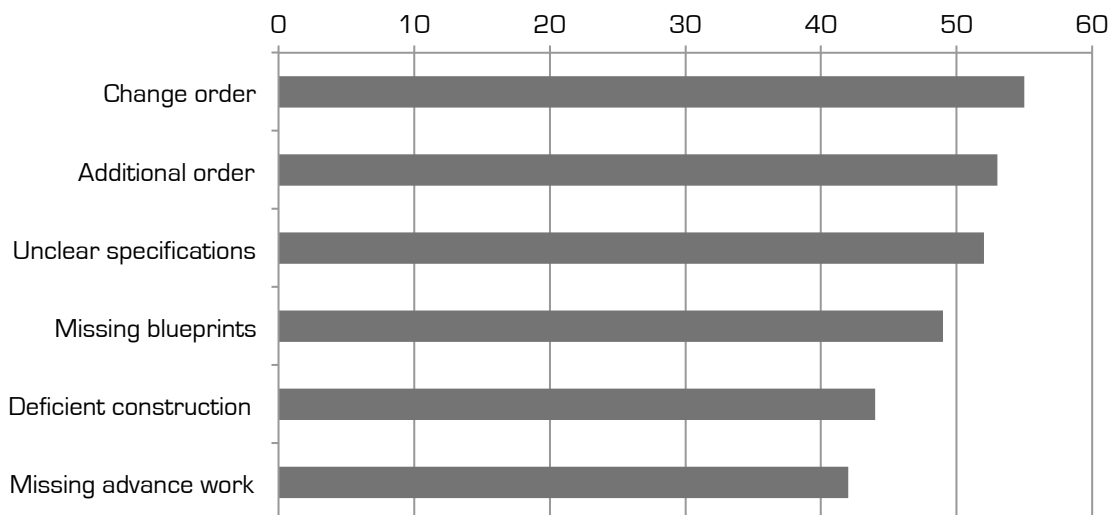


Table 3: Reasons for Disputes and Litigation. Adapted from [13] p. 130 f.

That table shows that the four most frequent reasons for disputes can be ascribed to disagreements between the design and the actual work to be carried out. Consequently it can be said that a reconfiguration of the design process and an investment into more sensible methods could lower the disputes and therefore inefficiencies tremendously. cf. [12] p. 2 f.

Even though Design-Bid-Build, or the low-bid approach in general can have advantages like the comprehensible, fair and clear award procedure or that the impartial design team looks for the owners interests primarily, the negative side effects of the method prevail. It starts with a usually very fragmented design process where the contractor is not involved yet and therefore not able to bring in his expert knowledge and help develop a more efficient design. As mentioned before that causes design failures and inconsistencies in the specifications, which may lead to change orders and delays and therefore extra charges for the owner at a later project stage. At the awarding stage dissonances are emerging due to the one-sided focus on the price of the bids that frequently lead to disputes and litigation between the owner, designer and contractor. There is also a lot of pressure on the contractors due to the low bids that forces them to compensate by manufacturing at the lowest possible and allowed quality and claim for change orders. cf. [12] p. 9 ff.

Out of those shortcomings a sequence that hinders cooperation, flow of information and facilitates disputes, unsatisfied stakeholders and a low level of trust and price can be deduced throughout the construction process. Therefore the following chart can be seen as a vicious circle of traditional project delivery, or low-bid awarding, without claiming to be complete.

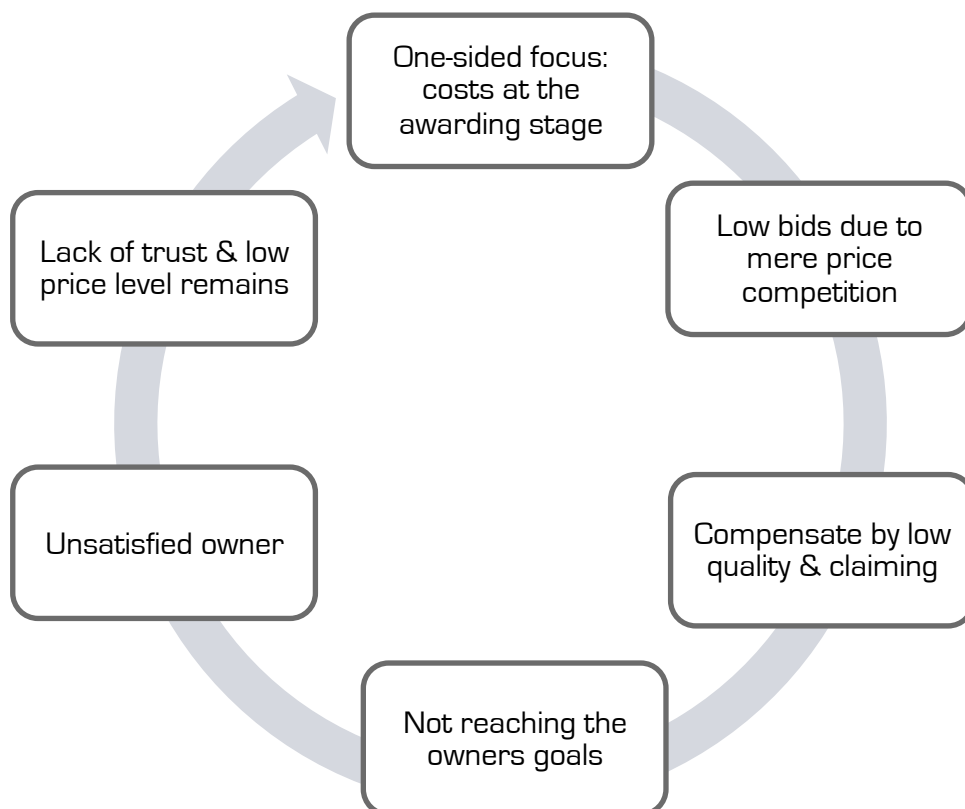


Figure 1: Vicious Circle of Traditional Project Delivery. Based on [12] and [11].

Further Matthews and Howell (2005) introduced four major systemic problems with traditional contracts. One is that the expert knowledge and innovative ideas of the contractors is not being taken advantage of in the design phase, since they are not involved at all. The problem with that is that at traditional awarding there is no way to involve them since no contract has been awarded at the design stage. Another shortcoming of traditional contracts is that they do not encourage contractors to collaborate with one another, but they layout of the contracts may even reward them for optimizing their performance at the expense of other trades and therefore cause more harm than they avoided. cf. [23] p. 47.

### **2.3.2 Trend in the Awarding Practice**

A first approach towards cooperative project delivery methods can be determined throughout the industry. One indicator that a rethinking and hence questioning of the current system is slowly starting to take off can be discovered when looking at conference papers from the past ten years. Articles discussing the topic in the past were asking about how could those methods change the current situation as well as why would the industry need them, since most companies were still doing fairly well. Then, at the turn of the decade, the question was less about if the methods work in practice or if they are necessary but more about where and how could they be implemented next. cf. [14]. That shows that a change in mindset slowly started to happen during the last years and is now really taking shape throughout the industry.

There are recent examples, like the introduction of the competitive dialogue procedure into the procurement law, integrated project delivery methods in the portfolio of major construction companies or a guideline published by the *Austrian Society for Construction Technology* underlining this rethinking and representing one step towards cooperative project delivery methods.

#### **Cooperative Methods Developed by Construction Companies**

Regarding to this topic the project delivery model developed by Ed. Zübling AG shall be highlighted. Ed. Züblin AG is operating worldwide and is the leading company in the field of building construction in Germany and Austria. Züblin is a part of Austria's construction enterprise Strabag SE, which is Europe's 5<sup>th</sup> biggest construction company measured by its total revenue of 2011. cf. [15]. During the past 15 years Züblin developed a cooperative project delivery method they call *Züblin teamconcept*, that is now being implemented throughout the whole Strabag enterprise. Several of the key principles, like early involvement, mutual goals, cost transparency, handling of risks or the dispute reso-

lution model can be linked directly to ideas from lean construction or alliancing. They provide the method of teamconcept for different areas of application like project definition, design, construction and operation as well as a holistic solution. Further they define a similar process as the lean and alliancing approach does and offer different contract types amongst others also GMP-contract, alliance contract or a joint venture model. On the list of references one can find more than 20 major projects delivered successfully by implementing the *teamconcept* approach during the past years. cf. [16]. This method gets ever more demanded by private owners and Züblin tries to push its adoption even further, hence they made positive experience with it.

### **The Competitive Dialogue Procedure**

The competitive dialogue procedure presented in subchapter 2.2.4 does imply some key principles from methods like lean construction or alliancing. It features three phases prior to the awarding of a contract: the prequalification, the dialogue and the bid phase. The Austrian procurement law regulates those phases in paragraphs §§ 160 – 162. Therefore it sets the procedures at each phase that are shown in the following chart.

<b>Prequalification</b>  <b>§ 160</b>	<ul style="list-style-type: none"> <li>▪ Publishing an announcement</li> <li>▪ Choosing partners for further dialogue</li> <li>▪ Sending required information to dialogue partners</li> </ul>
<b>Dialogue</b>  <b>§ 161</b>	<ul style="list-style-type: none"> <li>▪ Dialogues to clear legal and technical requirements</li> <li>▪ Separate discussions about the dialogue partners proposal for solution</li> <li>▪ Reducing the dialogue partners</li> <li>▪ Result: determining the best solution(s)</li> </ul>
<b>Tendering</b>  <b>§ 162</b>	<ul style="list-style-type: none"> <li>▪ Adoption of contract documents according to solution developed during the dialogue</li> <li>▪ Request for a bid based on completed documents</li> <li>▪ Matching of bids (no negotiation)</li> <li>▪ Determination of the best bid and awarding</li> </ul>

*Table 4: The Competitive Dialogue Procedure. Based on [9] and [21].*

By looking at the steps this procurement method goes through, it can be determined, that it shows several synergies with integrated processes such as lean construction or project alliancing that will be explained later and presented in chapter 4.4.3.



**Guideline for Cooperative Project Delivery**

The *Austrian Society for Construction Technology* is an organization with the objective to jointly develop the state of the art in construction technology. Therefore they publish guidelines and arrange seminars and conventions. Each guideline is being developed and composed by a team of experts to the current topic and is based on current standards. cf. [17]. That means that all guidelines are bound to the standards and therefore also to the laws. Hence it cannot contain statements interfering with any of those, but is only a recommendation about how to handle and implement those requirements in a more practical way. Since this is valid for the guideline about “*Cooperative Project Delivery – Recommendations to handle Complex Construction Projects*” as well, you will not find passages disrupt with the procurement law or the standards regulating contracting and project delivery.

However several affiliations towards cooperative methods and ideas comparable to the lean and alliancing models can be located within the guideline. They state that a balanced and clear risk allocation as well as technically, economically and especially socially skilled stakeholders with the authority to make good and fast decisions are key requirements for cooperation. Further the guideline recommends focusing on clarifying goals, duties and form clusters regarding to different expertise as well as detecting interfaces to secure the flow of information. A fair compensation and reward model as well as a no blame conflict resolution model is being encouraged. cf. [17]

# Introduction to Integrated Project Delivery Methods

*Instead of collaboration, it is confrontation projects are being coined by, leading to many unsatisfied stakeholders and litigation. Mutual respect and understanding as well as a balanced concentration on social, technical and economic aspects could lead to cooperation and mutual success of the project.*

*Bettina Bogner [17]*

The upcoming three chapters shall provide an insight to cooperative project delivery methods just like the previous did on the procurement law. Therefore the theoretical fundamentals of the two methods Lean Construction and Project Alliancing will be explained and compared to the legal context of chapter two. This thesis focuses on Lean Construction (LC) and Project Alliancing (PA) because those are the two most developed cooperative models in practice. The following chapters three and four are dealing with those methods and will contain a brief history as well as a more detailed view on the principles, contracts, processes and framework of each method. However, due to the restricted extent of the thesis only the scope relating to cooperation will be covered in detail. Further it will be examined in chapter five what are the synergies and discrepancies of those two methods as well as what are the conflicts in relation to the procurement law in chapter six.

## 3 Lean Construction

*Lean construction is a new project delivery approach that can be applied to any kind of construction project, with the goal of better meeting customer needs while using less of everything.*

*Gregory A. Howell [18]*

In the Introduction of this subchapter the history of Lean Construction (LC) will be presented. Afterwards essential principles, ideas and tools supporting the Lean philosophy will be explained including the five Lean principles and five big ideas. In paragraph 4.1.3 about the framework and process within a LC project, the Lean Project Delivery System (LPDS), the Last Planner System (LPS), the Integrated Project Delivery (IPD) Team, Target Value Design (TVD) and the Integrated Form of Agreement (IFOA) will be addressed.

### 3.1 Introduction

Lean Construction emerged out of the Toyota Production System (TPS) developed by Taiichi Ohno back in the 1950-ies. When Ohno developed the method he did strive for bringing the production process of a car to perfection. His main objectives were to meet the requirements of a specific customer, deliver the car instantly and produce it without maintaining inventories. cf. [18] p. 2.

Even though this early implementation at Toyota, it wasn't until the 1990-ies when western companies started to apply the method. The discussion about lean production and lean management started in the United States due to the recession in the 80-ies and therefore commissioned research projects analyzing the success of Japanese companies published by the Massachusetts Institute of Technology (MIT). cf. [19] p. 7 f. In those studies the term lean got established, standing for using fewer resources like labor, manufacturing space and materials compared to mass production, but still resulting in fewer defects and generating a higher variety of products. Further lean production means to avoid the principles of mass production where unskilled workers produce standardized and a narrow range of goods in large quantities with an acceptable level of defects and rather concentrate on value-adding processes aiming for zero defects and inventories while declining costs. cf. [12] p. 46.

Since the lean idea is nothing like mass production, it should be predestinated for construction processes. However the construction industry, taking the individual production

with very high values, long lifecycle within highly uncertain environments under great time pressure, is also very unlike the manufacturing industry. cf. [18] and [20]. Forbes and Syed compare the difference of lean and traditional methods to craft production in the preindustrial era and mass production afterwards. Craft production was based on highly skilled workers making products specifically fitted for costumers, one at a time, what basically is what the construction industry shall be doing, too. cf. [12] p. 46.

If this main goal of the whole lean idea is being analyzed, collaboration and cooperation are not mentioned apparently. However, if a secured flow of the value stream through a system of interacting processes is aspired, cooperation between each single process is a key factor and therefore also one of the principles of the lean approach explained below.

## **3.2 Principles, Ideas and Tools**

Lean construction is a holistic approach that considers projects as production systems and tries to optimize the whole instead of the piece. cf. [22]. Therefore there are several basic principles and ideas that support and guide the implementation of lean construction. The five fundamental principles of lean management developed by Ohno in the 1950-ies have been adopted to lean construction as well.

### **3.2.1 The 5 Lean Principles**

Womack and Jones have developed the five lean principles that are applicable for any organizational form and industry in 1996. These are the:

- Identification of value
- Specification of value stream
- Flow of value
- Pull of value
- Strive for perfection cf. [12] p. 61.

#### **Identification of Value and Specification of the Value Stream**

The first two principles regarding the identification and specification of value are very critical in two ways. Primarily to specify what value the owner really wants to get delivered. This might not be what the contractor may find easiest or best to provide, but only by that it is possible to truly reach the owners goal to his satisfaction. Second it is crucial to identify and understand which steps of each process are actually adding value and

which are not. cf. [12] p. 61. Therefore there are 3 types of activities: one where the adding of value is clear and two types where it is not. These non-value adding steps are called muda-type I and II. The muda-type I is a activity that is necessary for the actual value adding activity, hence also being referred to as an apparent activity. The muda-type II activities, or blind activities, are the ones not adding any value and not being necessary for the execution of the activity itself at all. These activities are usually called waste in a lean project. cf. [19] p. 10.

On the example of the installation of an electric outlet in a preinstalled outlet box these three types of activities can be explained as follows. The value adding activity is connecting of the two wires by cutting them, stripping the insulation, screwing them together and putting them back in place. A muda-type I activity would be carrying the tools or a ladder to the outlet box and muda-type II activities could be searching for the right wire. The value related activities in this example may take two minutes, whereas the muda-type II activity could take up to 8 minutes what makes the process itself only 20 % effective. cf. [12] p. 61 f. Lean construction focuses on the identification of those non-value-adding activities and tries to minimize them.

### ***The Flow of Value***

The flow of the value can easily be explained by thinking of the assembly lines at a car manufacturing plant, where these ideas emerged. The goal of lean thinking is to secure the flow of the production line without delays or errors, what is a key point at every manufacturing process. Beneath the manufacturing process itself it shall also secure the flow within the supply chain. cf. [12] p. 62. In terms of a construction project, where the processes, because of their singularity, are not planned as detailed, this principle refers mainly to secure the flow of the different trades and maintaining high workflow predictability.

The principle of pulling the value is completely diverse of what mass production is doing. Pull manufacturing means to assemble a product requested by a specific customer, where mass production is pushing products that meet the customers forecasted needs. cf. [19] p. 10.

Striving for perfection is the fifth principle of lean thinking and shall secure a continuous and holistic development to retain the ability to compete on the market. cf. [19] p. 11.

Besides those five principles that can be applied to any industry there are several adaptations at further tools and ideas to cope with the special conditions construction projects

are facing. Therefore lean construction has introduced some ideas and tools not being a part of the original lean methods developed in the manufacturing industry.

### 3.2.2 Five Big Ideas

Lean Project Consulting had developed these ideas in collaboration with Sutter Health, an owner implementing lean methods at the construction of hospitals. Unlike the five principles introduced above, these ideas have been developed for construction processes in particular and can therefore be seen as the more practical ones, too. They are the foundation for the implementation of the Lean Project Deliver System. They manage the organization of every project, the design of the contract as well as the construction process itself and are specified as follows:

- Collaborate, really collaborate
- Increase the relatedness among all project participants
- Projects are networks of commitments
- Optimize the project, not the piece
- Tightly couple action with learning cf. [19] p. 58

For the first time while looking at LC, cooperation gets manifested as a major part of the method. The collaboration between all parties, but in particular between the owner, designer and builder is crucial during the design phase, but also throughout the construction process. Further, cooperation drives innovation and distinguishes negative iterations for an overall better project outcome. cf. [12] p. 68

The second idea is to focus on the relationships between the team members to promote mutual trust, openness and a positive atmosphere. The trust amongst the team members is also being encouraged by the third idea, which is to see a project as a network of commitments. These commitments shall help the participants to plan their processes more accurately, make the workflow more reliable and diminish disruptions at interfaces. Also the idea about optimizing the project and not the piece is aiming at a better workflow. By concentrating on making a single process faster, the predictability of the whole project suffers and may even cause delays. The last idea about learning, is very much related to the last principle, that is striving for perfection, since the quality of the outcome can be raised by introducing contemporary learning loops. cf. [12] p. 68. These five ideas really form the base for the Lean Project Delivery System™ and all the follow-up processes and tools presented in the next subchapter.

### 3.3 Framework and Processes

When trying to implement a lean framework and collaborative processes, the Lean Project Delivery System (LPDS) is the tool comprising it all. It was developed by Glen Ballard in 2000, with the goal to find a better way to build capital facilities, by improving the entire design and construction process. cf. [24]. The LPDS governs the project phases and processes, but also adheres further tools to support the lean ideas and principles such as the Last Planner System (LPS), the Integrated Project Development (IPD), Target Value Design (TVD) and the Integrated Form of Agreement (IFOA). These tools and their approaches will be described below.

#### 3.3.1 Lean Project Delivery System (LPDS)

The LPDS is a holistic model that leads every lean project from its definition throughout the use of the facility. It is organized in 5 interconnecting triangular phases that are:

- Project Definition
- Lean Design
- Lean Supply
- Lean Assembly
- Use

Each of these phases consists of three modules, whereas the first and third of them constitute the connection to the previous respectively the following phase. cf. [25] p. 5. The following figure shows the whole framework descriptively.

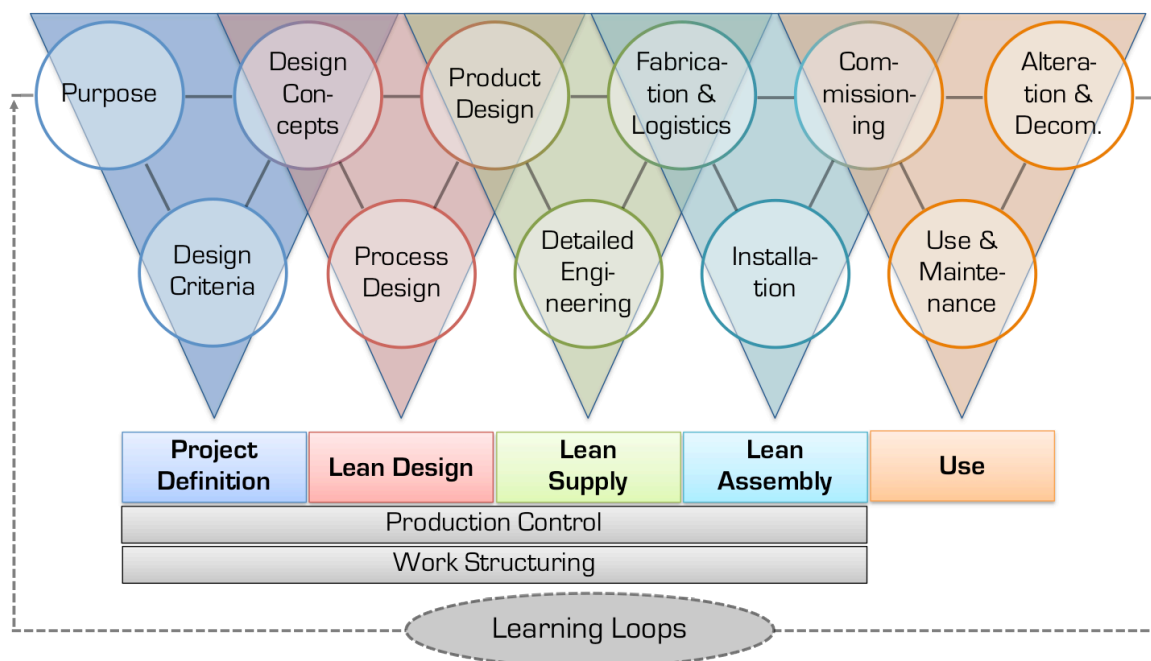


Figure 2: Lean Project Delivery System (LPDS). [25] p. 5.

### **Project Definition**

The purpose of the first phase is to define the project goals, by having the owner state what he wants to accomplish and setting constraints on the means for achieving it. Even though this sounds like common practice, the LPDS goes one step further by incorporating architects, engineers and constructors into this process. In common practice the architect may be involved, but certainly not the engineer or the constructor. However these parties can provide a deeper understanding, which could affect the owners' decisions tremendously. Therefore it is not only the job of the architect, engineers and constructors to deliver the customer needs, but also to help them decide what they want in the first place. cf. [25] p. 4f.

### **Lean Design**

The lean design phase is very unlike every traditional approach because of several reasons. The single most important divergence is that there is a strong interaction between the architect and engineers throughout the design phase. Traditional projects are very linear and do not include the special knowledge of engineers nor constructors into design decisions, but rather has them work around the preliminary drawings provided by the architect. At the LPDS approach there are cross-functional teams of architects, engineers, contractors, subcontractors and the owner working on the product and process design collaboratively. This can be seen as a major shortcoming of design-bid-build projects, where the design is separated from the construction and the deep understanding of engineers and constructors, of how things really get done, is being ignored. Another positive aspect of the focus on process design in the LPDS instead of product design in traditional projects is the safety factor being added in the design phase. Since the constructor has an idea of how the work is actually going to be executed, the safety of the workforce can be improved by the design and make lean projects the safer ones in comparison with traditional ones. cf. [12] p. 76f.

### **Lean Supply**

The lean supply phase consist of detailed engineering, product design and the logistics of purchasing components and materials as well as deliveries and inventories. Since flaws in this phase usually cause serious delays during the construction process, it is crucial to manage the supply chain and keep the workflow up later on the project. For example, if incorrect material is being delivered, that can not only cause delays but accumulated inventories also create an unsafe work environment and tie up capital that could be used elsewhere to actually add value. cf. [12] p. 77. Therefore lean supply concentrates on im-



proving the workflow-reliability, increasing transparency across value streams and linking workflow with material supply. cf. [26]

### ***Lean Assembly***

Lean assembly represents the actual construction process. It begins with the first delivery to the site and ends when the keys are turned over to the owner. Therefore the phase triangle consists of fabrication and logistics, installation as well as commissioning. The main goal during this phase is to minimize non-value adding steps during the construction process. As an example, the choice of prefabrication as a production technique eliminates uncertain conditions that on-site-production is experiencing. The construction process is accompanied by the commissioning process, which should secure that the facility will meet the costumers requirements. cf. [12] p. 77.

### ***Use Phase***

The use phase, which Glenn Ballard added in his revision of the LPDS in 2008, refers to a completed facility that should undergo an operations and maintenance phase. It also includes the alteration and decommissioning in case the building needs to be renovated or demolished. cf. [12] p. 78.

### ***Production Control and Work Structuring***

The two processes of production control and work structuring extend throughout the whole lifecycle of a project. The term “work structuring” was created by the Lean Construction Institute and relates to processes within the particular phases, thriving for higher workflow reliability. According to Ballard (2000) it aims to answer the following questions:

- In what chunks will the work be assigned to specialist production units (PU)?
- How will work chunks be sequenced through various PUs?
- In what chunks will work be released from one PU to the next?
- Where will decoupling buffers be needed and how should they be sized?
- When will the different chunks of work be done?

The term production control strongly refers to the Last Planner System that will be highlighted in the following subchapter. It governs the execution of plans and therefore its main function is to control the workflow by look-ahead planning and the production by weekly work planning. It is the duty of interdisciplinary teams to develop schedules, set milestones and track the execution of the scheduled tasks. cf. [24] p. 3.

### 3.3.2 The Last Planner System (LPS)

As mentioned before, the Last Planner System (LPS) is one of the tools that got introduced particularly for construction projects. Glenn Ballard and Gregory Howell, the founders of the Lean Construction Institute, developed it as one major part of their holistic Lean Project Delivery System. The LPS is essential and unique also in regards to the collaboration amongst involved parties, since the major stakeholders are involved from the very beginning and carry out the planning process together. Just like traditional project management practice, it aims to maximize productivity, however the approach is a completely different. The LPS takes into consideration that optimizing one piece of the work is not leading to an optimization of the whole project. That can only be achieved by looking at the pieces as one continuous production process where one trade affects the following ones. Hence the LPS aim is to make the workflow of these processes more reliable and eventually be able to optimize the whole project. The schedules are being developed collaboratively by the last planners of different trades, who are the people actually executing the work. These people, for example foreman, squad bosses or front line supervisors have to give reliable commitments about when their part of the work is going to be finished to secure the flow of the following work. cf. [27] p. 122.

#### *Principles of the Last Planner System*

To achieve the reliable workflow mentioned above, the LPS declares the following five principles:

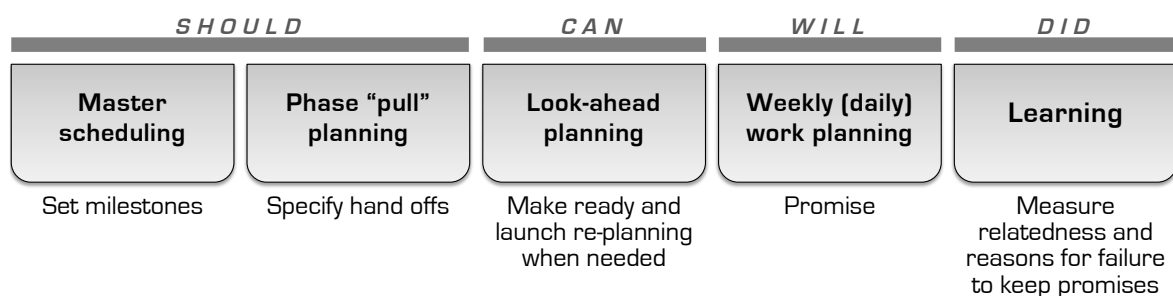
- Planning is more detailed the closer the construction gets.
- Plans are made in collaboration with those who will execute the work.
- Constraints should be identified and removed by a team effort.
- Construction team members must make reliable promises.
- Plan failures should be treated as an opportunity for learning, not for negative actions. cf. [12] p. 86.

The first principle is paying justice to the required level of detail, which is rising as the construction process itself is coming closer. Therefore the involvement of every subcontractor may not be compelling at the stage of a master schedule, though crucial at a later, more detailed work plan. The next two principles target the cooperation and collaboration amongst all participants directly. Reliable commitments, as stated in the fourth principle, are another diverse approach compared to traditional project management. To enforce this principle it is necessary to have team members that are not only capable, but also authorized to make decisions. cf. [19] p. 14 f. Therefore it is crucial

to have the power of decision-making with the people who are in direct contact with the work. By establish a decentralized structure, the people knowing best what to do, become the last planners. The LPS also encourages them to make reliable commitments, even if that means saying no to an assignment that seems infeasible. cf. [18] and [22]. Further it is also screening the relatedness of these commitments to analyze and learn from the reasons for failures to keep the promises. cf. [19] p. 15. This idea of learning from failures instead of searching for someone guilty is also what is implied at the last principle.

### ***Structure of the Last Planner System***

These principles are inherited in a structure leading the project delivery team through the levels of the planning process. It usually starts with a master schedule, where the major milestones are set, continues with the look-ahead schedule followed by even more detailed weekly or even daily work plans. However, at the end of this process it is possible to evaluate and learn from the relatedness of the commitments that where made throughout the project. The following figure shows this process of interconnected conversations in the last planner system.



*Figure 3: Interconnected Conversation in The Last Planner System. From [12] p. 87.*

As already mentioned, the continuous flow of the different processes within the whole project is a main goal of the lean idea. Therefore the focus of the LPS lies on the communication between the different trades. In traditional practice every party looks out for their own portion of the work only. In lean construction however, it was learned that it is more effective to secure the flow of the consecutive operations instead of optimizing only a few of them. That is important because time made up by one process will usually not be given on to the following one, where lost time always will be. To secure the flow and minimize waste in the hand off from one trade to another, reliable commitments and cooperation amongst the stakeholders is a key factor. cf. [12] p. 88.

### **Master Scheduling and Phase Planning**

The master scheduling starts off with a meeting of the core group that consists of the owner, user, designer, engineer and constructor. The goal is to determine the duration of the project and set major milestones for design and construction. The fidelity of the master schedule is limited, since the people who are actually going to execute the work are not yet involved. However the schedule is being adapted continuously. During the phase planning process the contractors who are going to do the work are being involved and collaboratively work out a schedule using pull principles. The characteristic of the pull planning is that it starts at the last element in the delivery chain and the processes needed to get there are being arranged accordingly. cf. [12] p. 94 f.

### **Look Ahead Planning**

After these planning phases, which determine what should be done, the phase of look ahead planning identifies what and how things could be done. It aims to sequence workflow and match it with the capacity, maintain a backlog of ready work as well as develop detailed plans for how work is going to be done. cf. [27] p. 122. It usually covers a timeframe from six to eight weeks and is developed by cluster groups being responsible for different pieces of work. cf. [12] p. 93.

### **Weekly Work Planning**

The weekly work plan, developed by the people who are actually going to do the work is the most detailed schedule, showing who is going to do what activity, while using what resources. The activities that are being integrated into the weekly work plan, are only eligible to be pulled from the look-ahead schedule, if it does not show constraints and resources are available and assigned. cf. [12] p. 98. This rule once more secures the workflow and the reliability of commitments scheduled within the work plan.

### **Learning**

A learning loop takes place whenever one schedule is being completed and is being replaced by the more current one. The parties working on them go through the tasks and try to analyze why some of the commitments may not have been completed. For example, every week the people developing the new weekly work plan review last week's plan and try to analyze failures to avoid them in the future. Shortcomings may be even followed back to the look-ahead schedule and the stage of pull planning, to enable people from this phase to learn about the consequence of their decisions and assignments. cf. [27] p. 127.

### 3.3.3 Integrated Project Delivery (IPD) Team

The integrated project delivery team can be seen as one of the main cornerstones of the whole lean idea, just as the other tools presented in this section. It is crucial for maintaining a collaborative and honest relation between all project participants. Further it supports the open sharing of information and an honest and respectful interaction between all involved parties. Therefore representatives of all companies involved in the project join the IPD team at a certain stage of the delivery process. The core group consists of the owner and his representative as well as the architect's and construction manager's or general contractor's project manager. This group is involved in the project from the very beginning and signs the integrated form of agreement (IFOA). It is their duty to coordinate and supervise the implementation of the lean project delivery system (LPDS), decide about targeted cost and govern the process of target value design (TVD) and other processes supporting the work of the cluster groups. The core group meets at least once a month; however especially during the beginning of a project the iterations may be shorter. cf. [19] p. 60 f.

The cluster groups mentioned above are being assigned to work on specific areas of the whole process. They join the project at the stage the core group thinks their expert knowledge is necessary and consist of representatives of the general contractor and the architect as well as subcontractors, specialist engineers and suppliers. The head of each cluster group, either from the general contractor's or architect's side, decides in collaboration with the team at what point additional people get involved in the group. Stakeholders might be involved in more than one cluster group at once. Cluster groups usually meet at least once a week where they might invite additional people from other groups if their work affects them. cf. [19] p. 60.

Figure 4 shows the formation of an integrated project delivery team arranged of the owner, architect, construction manager or general contractor, subcontractors, engineers and suppliers. The members of the core group sign the integrated form of agreement (IFOA) and all members of the cluster group sign a joining agreement. This shall secure the commitment to the crucial ingredients of IPD such as collaboration, reliable promises and encourage trust among team members. cf. [12] p. 180 ff. While the core group is engaged with the project from the very beginning, cluster groups join the team gradually. That means that at the beginning of the design phase there may be a cluster group responsible for the planning of the structural framework, the exterior of the building and one for the mechanical, electrical and plumbing (MEP) trades. At an advanced project stage clusters for the interior, production or equipment might join. cf. [19] p. 60. Each cluster group can include a representative of the architect (A), general

contractor (GC) and owner (O) as well as specialist engineers (E), suppliers (S) and sub-contractors (SC). The exemplary indication of the members of a cluster group for the exterior and structural team shows, that the same engineer (E) and architect (A) may be involved in two different teams, if their expert knowledge and competence makes them appropriate and the participation in one team won't have a negative effect to the other.

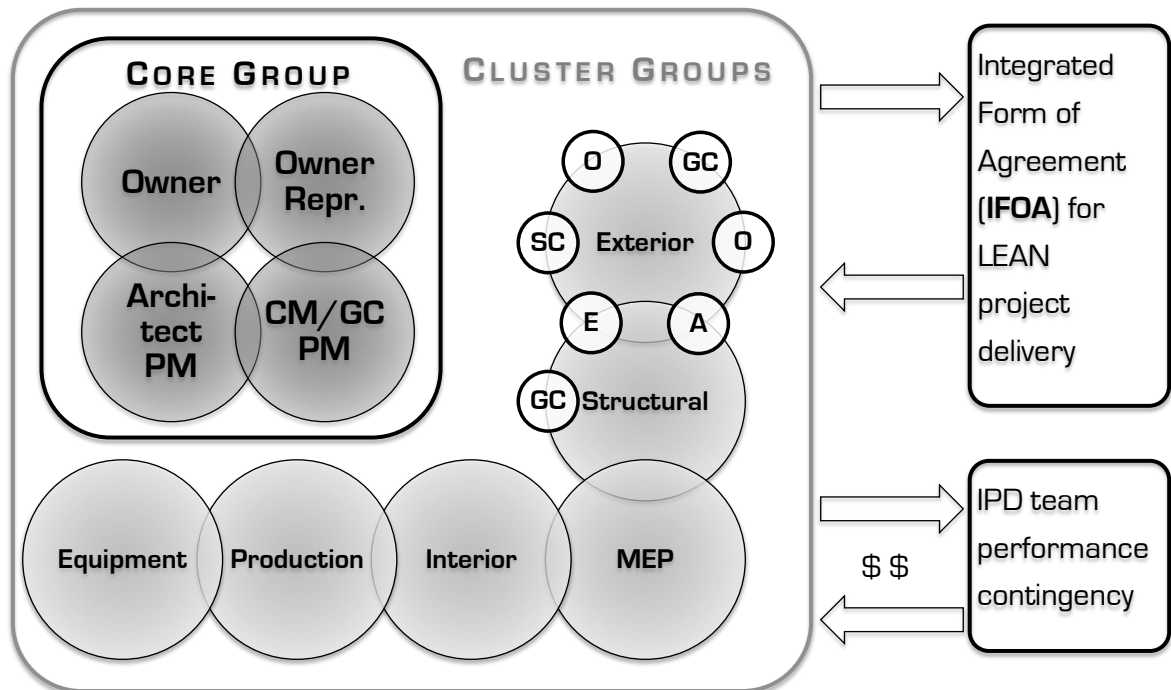


Figure 4: IPD Team formation. Adapted from [12] p. 180.

### 3.3.4 Target Value Design (TVD) and Target Costing

#### Target Value Design (TVD)

The main goal of TVD is to minimize the cost of the project and simultaneously maximize the value for the owner. There are several criteria emphasizing the concepts of the lean ideas throughout the process of TVD. One is, that the available budget and the constructability governs the design of the building and is not the outcome of the planning process. Another maxim is that different proposals for solutions are being examined simultaneously and the decision is made at the last responsible moment. The members of the cross-functional planning teams should be localized close to one another to avoid long paths of information. cf. [19] p. 64 ff. Further foundations of this process are being defined by Macomber, Howell and Barberio. Some of them include the idea of a Big Room where the product development is conducted to make communication more effective and decisions timelier. In more detailed planning phases, eight or fewer people should make up

one team and keep conversations on the results of each design cycle, to capture the gained knowledge. Another principle is to encourage stakeholders to work closely with the client when establishing the target value and always work with the customer needs in mind. For the success of this process it is significant to have engaged team members who are ready to do and see things differently. The owner must be accessible throughout the design phases and be prepared to be a member of the team. The construction manager as well as the subcontractors must be willing to share their expert knowledge honestly and the architects must therefore be receptive to get critical feedback on their design regarding constructability and pricing. cf. [12] p. 83 f. In summarization, teams consisting of architects, constructors and subcontractors design the building according to established design criteria that are value, cost, schedule and constructability. cf. [12] p. 182 f. The following figure shows the standardized process that guides the IPD team through the TVD.

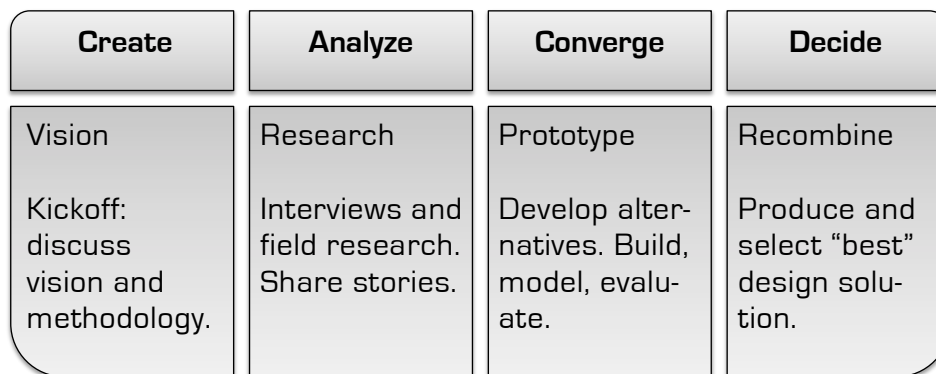


Figure 5: The Target Value Design (TVD) Process. From [12] p. 85.

### **Target Costing**

Target costing is a method that helps improve the process in a holistic view, by reducing variation through experiments and actions on the root causes. Taiichi Ohno, the originator of lean production, underlined this part of the philosophy with the statement:

*"Lower the river to reveal the rocks."*

By that he means to reduce buffers like inventory, capacity, time or money, in our processes to determine where the cause of variation hides. Then the buffers shall be matched to the actual variation in the process, without over exceeding it. cf. [28]

Ballard states that the reduction of buffers has a high potential in the construction industry, since traditional practice fails to align incentives and encourages local optimization instead of localizing the root of the problem and taking it from there. cf. [25] p. 11.

An example from the car manufacturing industry can underline this theory. When chief engineer Suzuki was designing a new Lexus model at Toyota, he strived for a super quiet and lightweight car. Therefore they could no longer reduce the noise by adding mass to absorb the vibration, but had to lower the engine vibration, the source of the noise itself. cf. [29]. However, undertakings like this include a certain amount of risk, as all experiments do, and shall therefore be considered with care, since the revealed rocks can put a hole in the commercial boat. [25] p. 12.

The following flow chart shows the standardized target costing process in a lean construction project.

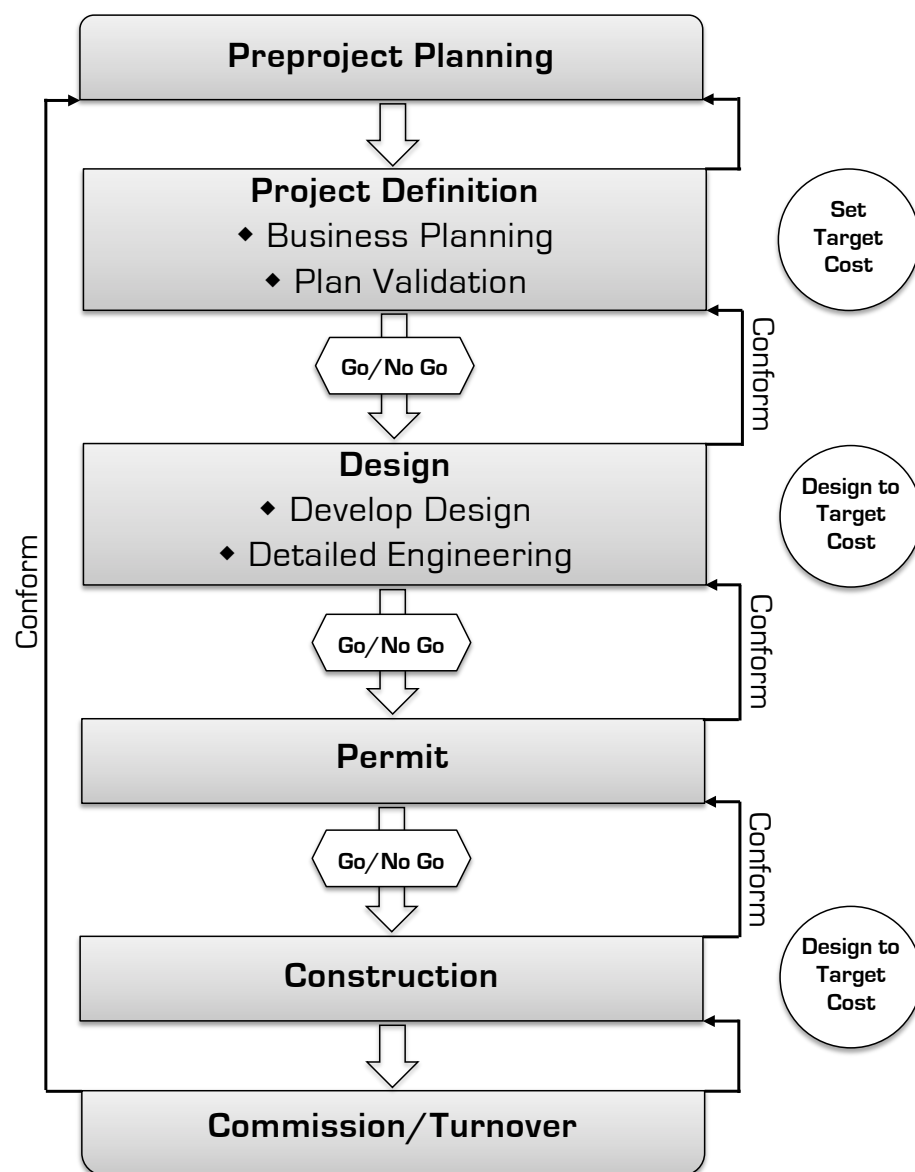


Figure 6: Project Phases and Target Costing. From [25] p. 8.



The main divergences in comparison with traditional projects are:

- The whole team is setting the targets collaboratively in the definition phase.
- The target guides and influences the design.
- After each phase it is made sure the design is still conform to the customer needs.
- The owner can cancel the project if he finds the targets are not within reach any longer.
- If the owner decides to back down, the phase may be repeated or the stakeholders get paid their fees and the project is stopped.

### **3.3.5 Integrated Form Of Agreement (IFOA)**

The IFOA is a multiparty contractual method that was developed and implemented for the first time in 2005 by an owner pushing lean construction in his construction projects: Sutter Health System in California. It is a relational contract that encourages lean principles, manages change and supports collaboration within a project. The owner, architect and general contractor or construction manager sign the IFOA at the start of the project. Besides the commercial conditions it also governs the relation between the contractual partners. It focuses on setting a mutual foundation for a cooperative project delivery where risks and rewards are being shared amongst all parties. cf. [19] p. 48.

The awarding process for the core group in a lean construction project is usually based on experiences and preferences the owner has. The architect as well as the general contractor or construction manager are being chosen after the owner advertises a business case, containing the project requirements, the available budget and a conceptual schedule. The core group is selecting stakeholders, such as engineers, subcontractors or suppliers, who are joining the team at a later project stage and form the cluster groups. cf. [19] p. 73 f. The cluster groups then decide if and when they want to introduce further team members also by following a selection process specified by the core group. Usually this process includes conducting interviews with possible parties and suggesting the preferred one to the core group. Stakeholders joining the project that way sign a joining or trade-partner agreement to commit to the ideas of lean construction and the LPDS. cf. [19] p. 78 f.

The IFOA is as diverse at the awarding procedure as it is with the compensation, reward and risk sharing. Contractors and designers get compensated their actual reimbursable cost, consisting of labor expense, cost for material and machinery. These may not be higher than the customary market cost at the particular conditions are. The before agreed on corporate overheads and the profit is being added onto these expenses. Then a percentage of these overheads is being put at risk, meaning the contractor may only get three quarters of his fees with certainty. The payment of the other quarter depends on the actual outcome of the work. If the contractor manages to undercut the targeted cost or schedule, he gets his overhead from the risk pool plus adds to his profit by sharing some of the savings with the owner. In addition to that the contractor can earn another benefit if the owner decides to reinvest the saved money. If the project comes out over budget, the quarter from the risk pool absorbs the cost overrun. Any costs exceeding the amount from the risk pool are being borne by the owner, referred to as super risk. cf. [19] p. 75 f.

## 4 Project Alliancing

*A new alliance boundary is established when partners commit their resources and abilities towards common goals.*

*Crowley, L.G., & Karim, M.A [35]*

In the last two years the advisors of this thesis, DI Dr. Otto Greiner and Ing. Roland W. Köck, consulted two other theses studying Project Alliancing. Both of them are diploma theses conducted at the Carinthia University of Applied Sciences. They describe and analyze the process of Project Alliancing in great detail and full scope. Due to that some of the relevant material for this chapter will be taken out of the thesis from Dipl.-Ing. Petra Hötzer. [33]

Just as in the subchapter about Lean Construction, the following paragraph should deliver a first insight into the practice of Project Alliancing (PA) and how it developed. Afterwards, the key principles and ideas of PA will be explained in more detail. The subchapter about the framework and processes of PA contains information about the sequence and phases of an alliancing project, the organizational structure and the members of an alliance as well as the Project Alliancing Agreement.

### 4.1 Introduction

Alliancing is a concept that was used in other industries several decades ago, either as long-term strategic alliances or as project alliances for shorter undertakings. They can further be differentiated by the combination of participating parties:

- vertical alliances between suppliers and purchasers
- horizontal alliances between competitors
- diagonal alliances between organizations from different industries

The method has a broad scope of application while the main goal is to emphasize collaboration amongst alliance members. However, it is more than just a new approach towards cooperative project delivery, it is a tangible and proven project management method. cf. [32] p. 1 f.

The first implementation of Alliancing in a construction project came when traditional approaches were no longer able to deliver a satisfying solution. It was in the 1990ies when the “Andrew Drilling Platform” project by BP in the North Sea was about to fail,

because the bids of 450 million £ exceeded the budget. By forming an alliance, disclosing knowledge and cost as well as managing the risk collaboratively and honestly, they were able to cut the cost of the project to 373 million £. Eventually the project came out six months before schedule and under budget with overall costs from about 290 million £. cf. [30] p. 17 f.

From there on PA came to Australia where it was first implemented at offshore oil and gas platforms, too. Eventually in the year 1999 the first infrastructure projects and the first building construction project, the National Museum of Australia, were delivered with the new method. During the following ten years the application of PA rose by 1000 % to a yearly capacity of € 8 billion in the year 2009, what is about 10 % of the total construction work done and one third of all infrastructure projects. cf. [31] p. 147. At the beginning, alliances were introduced to construction projects with a scope of 10 million up to 250 million AUD, now also the biggest amongst Australia's construction projects with a budget of over one billion AUD are delivered with PA. The method is especially well established and successful in the public sector of Australia's construction industry. cf. [19] p. 81 ff.

According to the Department of Treasury and Finance in the State of Victoria, Australia, where the application of the method is being fairly supported, PA is mostly implied and especially applicable for projects: cf. [34] p. 19. and [19] p. 89.

- That are complex and include many interfaces.
- Demanding a high amount of flexibility due to uncertainties.
- With hard to define scope of work, risk or other conditions.
- With tight schedules or funding.

The method of PA cannot prove its strength at projects that are rather certain, simple and only comprise a small scope of work. In these cases traditional project delivery and contracting models are more likely to achieve similar outcomes and the benefits of PA are not as evident as at projects with attributes listed above. cf. [34] p. 19.

## 4.2 Principles and Ideas

PA has been in use and implemented at projects from several disciplines in the construction industry. Emerging from offshore projects in the United Kingdom, now established at infrastructure and building construction projects in Australia and New Zealand, there are many perspectives influencing the ideas of PA. However some key principles that are essential for every implementation of this collaborative project delivery method stick out.

The selection of the team members is primary based on a “best for project” choice focusing on the tenderers competence and attitude towards PA. Risks and rewards are being shared amongst all alliance members collectively by aligning the owners project with the non-owners commercial objectives. Enhancing cooperation, fairness and mutual respect among all alliance members is a key factor. It establishes a peer and open relationship among the owner and non-owner participants (NOPs). This relationship is founded on equal say in decisions, honest sharing of information and the commitment to the “open book” methodology in terms of data, documentation and reporting. Decisions shall be made collectively and based on a “best for project” instead of a “best for self” consideration. Further all stakeholders must commit to the “no blame no disputes” clause excluding litigation, securing an effective dispute resolution and prompt error correction. cf. [32] p. 107.

Hötzer determined the following principles as crucial and summarized them as follows in her diploma thesis: cf. [33] p. 21.

- All parties win or lose together, one-sided “win-lose” scenarios may not occur.
- Every stakeholder has the same say in project decisions.
- Project risks and liabilities are being carried collectively and managed mutually amongst all participants.
- Important decisions regarding the project have to be unanimous.
- Litigation is excluded by the “no blame, no disputes” clause.
- Open and honest communication amongst stakeholders is a must.
- All transactions and estimates are subject to the “open-book” agreement.
- The “3-limb” model governs the compensation of the NOPs.

The research group around Chen from the University in Melbourne and the University of Western Sydney investigated the acknowledgments from the past decade regarding the success factors of PA. They found that trust, adequate resources, open communication, coordination, top management support, creativity and alignment of goals are the most common factors affecting the success of alliancing projects. Further they divided them into formal and informal mechanisms, affecting different parts and principles of PA. However only a combination and interaction of both, formal and informal mechanisms, can secure cooperative relationships among all alliance members. cf. [32] p. 108.

**Formal Mechanisms**

- Team selection process
- Incentive system
- Dispute resolution

**Informal Mechanisms**

- Team dynamics
- Management strategies
- Information systems

## 4.3 Framework and Processes

In the following paragraphs the sequence of the PA process, the organizational structure and the members of an alliance will be presented. Then the contracting model of PA, the Project Alliancing Agreement including the 3-Limb compensation model as well as the risk and reward system, will be explained.

### 4.3.1 PA Process and Phases

The process of Project Alliancing is subdivided into four phases: selection, development, implementation and correction. Figure 7 shows them in a comprised diagram.

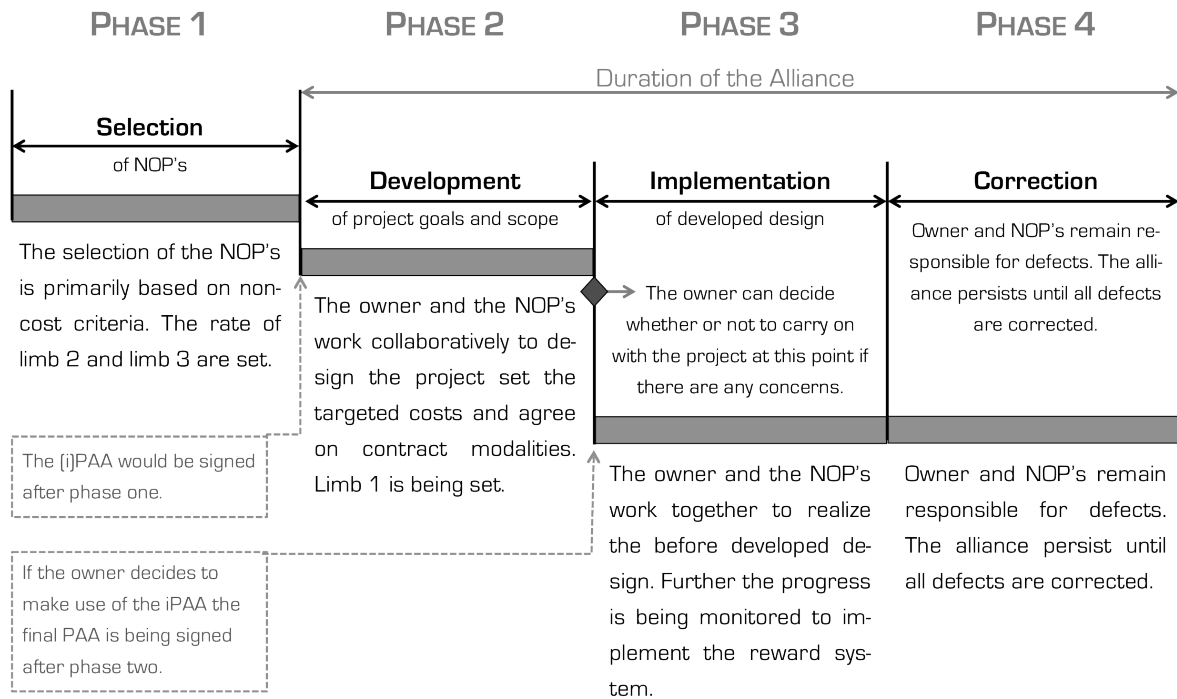


Figure 7: Project Alliancing Diagram. From: [33] p. 34.

It needs to be mentioned that PA features two selection procedures, the single and multiple target outturn cost (TOC) method. The single TOC method is the one presented in the following paragraphs and it diverges from the multiple TOC method in only one significant way. At the multiple TOC method two preferred bidders are chosen and sign the interim project alliancing agreement (iPAA) at the end of phase one. Then both teams simultaneously work on the development phase and come up with a design and target costs. This method shall provide higher competitiveness and therefore improve the price/performance ratio and innovation. After the development phase the owner can make his choice about which team he prefers to sign the PAA and continue to work in the implementation phase with. Since the idea of competitiveness in the multiple TOC method conflicts with the idea of an alliance and the costs for the development phase are doubled for the owner, the single TOC method is by far the more established one and therefore the one this thesis focuses on. cf. [19] p. 112.

### **Phase 1: Selection**

The selection of the non-owner participants (NOP's) is governed in greater detail at PA than it is at Lean Construction. Even though there may be divergences since each alliance is being handled slightly differently, the procedure of the selection can be broken down into three general steps, listed in the following figure.

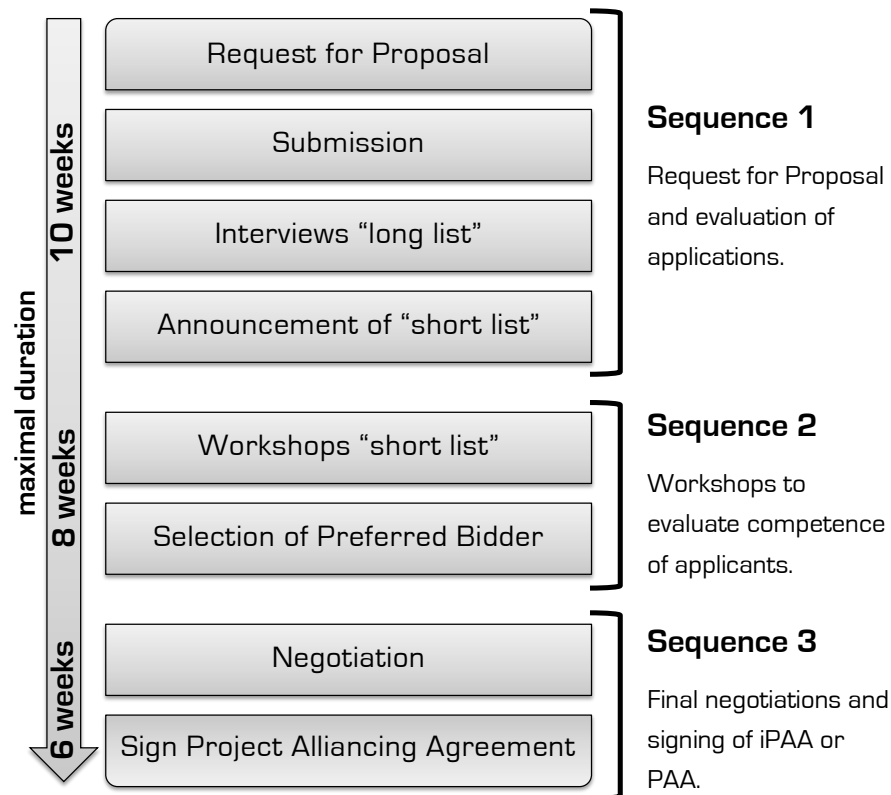


Figure 8: Diagram of Phase 1 - Selection Procedure. From: [33] p. 37.

In Australia where PA is applicable for public owners, a comprehensible procedure is defined in greater detail, while still on the basis of the diagram above. The request for proposal (RFP) for public contracts has to be published and made accessible for interested companies. It has to include the following documents and information: cf. [19] p. 91.

- The project description.
- The description of the scope of construction work.
- The terms and conditions regarding the proposal and awarding.
- The strategy and characteristics of project delivery within an alliance.
- The procedure of how to guarantee the value for money ratio.
- The process and characteristics of the selection process.

The proposals developed by interested companies are based on this information. The selection of the bidders is being based on different criteria, depending on the project, however all of them are non-cost criteria. The criteria and their emphasis on the selection process have to be published in the RFP. They further classify two types of criteria, necessary ones the bidders have to comply with, and criteria to determine a ranking of the proposals. cf. [33] p. 39 ff.



**Necessary Criteria**

- Ability to meet financial obligations
- Prove of technical capacity
- Set overheads
- Completed similar projects
- Information about experience

**Ranking Criteria**

- Team members and their skills
- Experience with PA
- Innovative solutions
- First approach to realization

If the proposal meets the necessary criteria, a commission including principals from the owner and an independent consultant, ranks them. They either develop a “long list” as an interim stage, or skip to the “short list” listing the two or three best proposals. If they decide to do a “long list”, bidders are invited to an interview lasting two to six hours. After conducting the interviews they cut down the list to two remaining candidates and announce the “short list” and the selection process comes to the second sequence, where workshops are being carried out. cf. [33] p. 41 f. The workshop usually takes two days and aims to identify the team with the highest potential to develop an outstanding project outcome. Commercial as well as social attributes are being discussed and the team configuration is being developed. After an evaluation process, the preferred bidder is being announced and sequence three of the selection procedure starts. cf. [19] p. 95. In the negotiation with the preferred bidder, the compensational model and the overheads are being approved. The final contract version is being developed and if a mutual unity is being achieved, the PAA or the iPAA is being signed. If there is no consensus between the parties, sequence two starts again with a new round of workshops now including the before third ranked bidder. cf. [33] p. 47.

***Phase 2: Development***

At phase two the development of the project starts and aims to integrate the know-how of all participants to reach the best possible outcome. Therefore it is necessary to establish a most efficient team and motivate all stakeholders to participate with a “best for project” mindset. To identify the best possible solution the key principle is to investigate different alternatives simultaneously. The goal is not only to develop a detailed design, schedule and construction process of the project, but also to set the target cost estimate (TCE), target outturn cost (TOC), key result areas (KRA) and key performance indicators (KPI). cf. [33] p. 49 f. These indicators are crucial for the further project delivery and must be agreed on by the whole team. The TCE are basically the manufacturing costs of the NOP's, incorporating material and labor cost, and therefore represent the

base for the direct costs or Limb 1 of the compensation model. The TOC are the targeted project costs including corporate overheads and profit margins, referred to as Limb 2, as well as costs for PA consultants. The KPI and KRA are important to define the Limb 3 of the compensation model, which will be presented in the subchapter about the PAA. The KRA's can be seen as major milestones and targets regarding quality, safety, operating costs or other criteria that is of importance to the owner. These criteria make up the Limb 3 and therefore the bonus malus system of the compensational model. However to make the KRAs appraisable it is necessary to specify impartial and comprehensible measurement methods and values. cf. [33] p. 12 ff. After an independent consultant reviewed the targets, validates them and the stakeholders agree on them, the owner can decide to carry on with the implementation or to dismiss the design if it does not cope with his expectations and quit the project. If the project is abandoned, the NOP's get compensated according to their Limb 1 agreement. If the owner decides to start with the construction, the PAA is being adapted according to the targets set and the implementation phase starts. cf. [33] p. 50.

### ***Phase 3: Implementation***

During the implementation of the project the goal is to undercut the targeted costs and achieve outstanding results in all the KRA's. The progress of the project is being documented and compared to the targets throughout the implementation phase. This should help to identify aberrations as soon as possible and therefore minimize the risk for all participants. cf. [19] p. 110. Further, detailed monitoring of the KRA's is necessary to identify the Limb 3 portion. At the end of this phase the acceptance of the building takes place and the fourth and final phase, the correction, begins.

In phase 4 all alliance partners remain responsible collectively for any defects. The alliance persists until all defects have been corrected and the period of warranty passes. cf. [33] p. 51.

### **4.3.2 Organizational Structure and Members of Alliances**

The idea of PA is to establish a sophisticated team, where all major participants are involved from a very early project stage on, to deliver the project collaboratively. These multi-level teams consist of representatives from architects and engineers, contractors and sub-contractors, construction managers and the owner. The assignment of different jobs is based on who is most suitable for it, independently from what alliance member he or she is coming from. Beside this unusual job occupation strategy, there are

three further premises for an efficient project development within the formed team. One is that all participants, irrespectively of which company they work for, collaborate with one another. Another is the adjustment of the office that should inherit all alliance members to enable efficient communication and strengthen the team spirit. A final requirement is that all participants' leadership embraces and exemplifies the principles of PA to their employees. cf. [19] p. 103 f. and [33] p. 58.

The organizational structure in PA usually consists of three teams working on three organizational levels as well as of additional stakeholders involved in the process and the optional catalyst team. Representatives from the owner and the NOP's join the following three teams: cf. [19] p. 106.

- Alliance Leadership Team (ALT)
- Alliance Management Team (AMT)
- Wider Project Team (WPT)
- Catalyst Team

In addition to that the whole process is governed and supported by independent boards. cf. [33] p. 59.

The structure of this common setup of PA teams and supporting boards is shown in the following figure and the functions of each team and board member is presented subsequently.

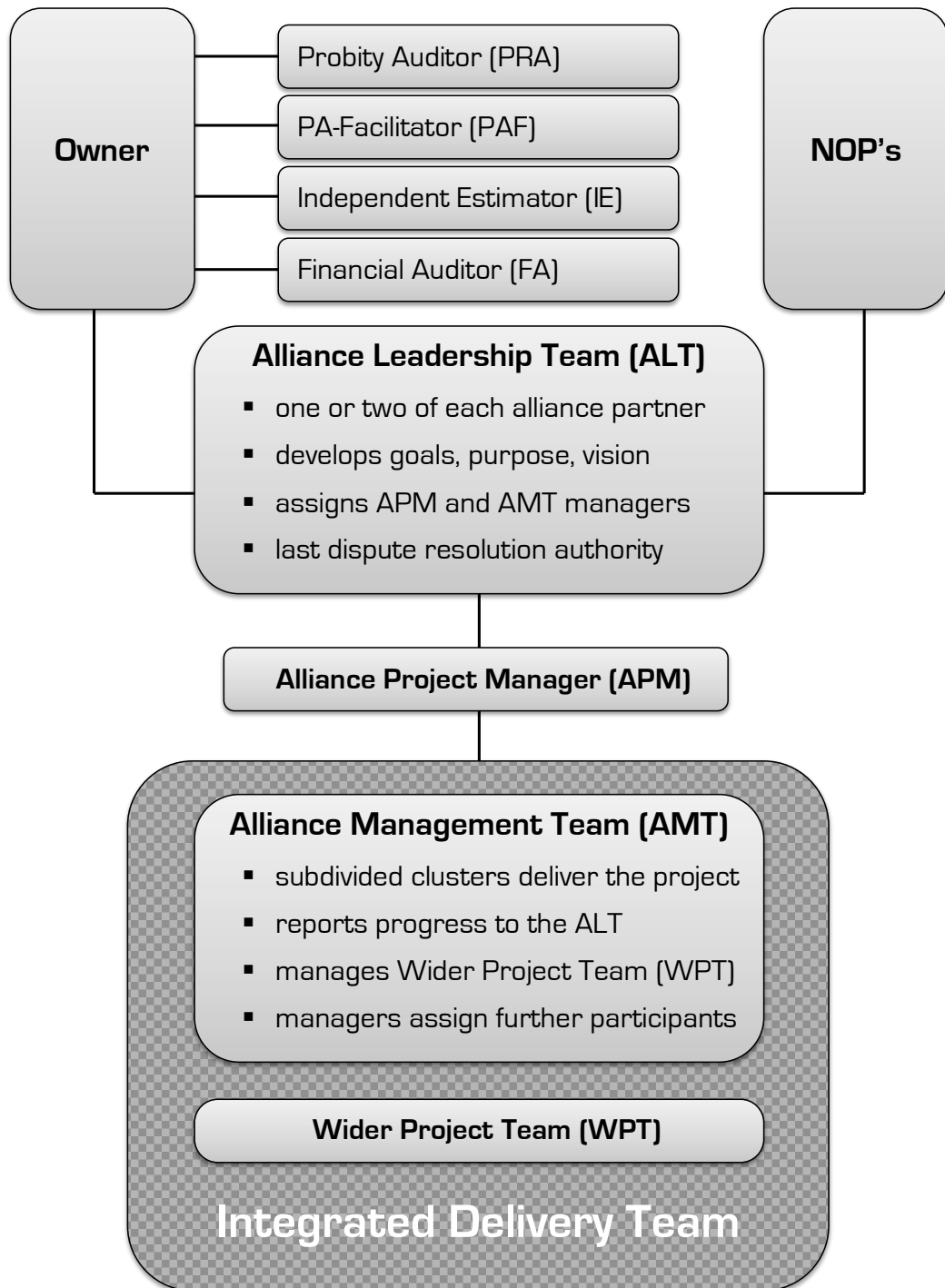


Figure 9: Organizational Structure of PA. Modified from [33] p. 59.

### **Owner**

The role of the owner in an alliancing project significantly differs from traditional practice, where the owner is involved as a control entity only. At PA the owner becomes an equitable member of the team and his representatives might assign roles within the ALT, AMT, WPT and Catalyst Team. They are involved throughout the process and have to possess power of decision-making. cf. [33] p. 59.

### **Alliance Leadership Team**

The Alliance Leadership Team (ALT) can be compared to the management board of a business. It consists of one or two of the top ambassadors of each alliance member, who are usually not concerned with daily tasks during the project delivery, but meet at least once a month. Their functions are to develop the mutual goals, purpose and vision of the alliance. During the ongoing delivery the ALT governs the implementation of these principles and assigns the responsibilities amongst the AMT. Further it is also the authority that governs the dispute resolution process, if the problem could not have been solved on the lower organizational levels. One member of the ALT gets designated to be the Alliance Project Manager (APM) who links the ALT with the AMT and represents the project publicly. cf. [19] p. 105.

### **Alliance Management Team**

The Alliance Management Team (AMT) is subdivided in several clusters apportioned by responsibilities. The AMT divisions usually features a commercial, technical, design, delivery, quality, controlling, communication and safety cluster to name some the most common ones. This is the organizational layer where all the decisions throughout the project delivery are being made. The members of the AMT have to be extraordinary qualified regarding technical matters, but also need to be able to manage and lead the Wider Project Team. cf. [19] p. 105.

### **Wider Project Team**

The Wider Project Team (WPT) consists of people having very well defined areas of responsibilities, but also work in a very collaborative way to deliver the project. They are governed by the AMT and together they represent the Integrated Delivery Team. Even at this level of the organization, the responsibilities are being assigned according to the

above-mentioned principle of the best suitable person, meaning company affiliation has no influence. cf. [19] p. 105.

### **Board Members**

Alongside these teams there are four board members that should be integrated in any alliancing project:

- the PA-Facilitator (PAF)
- the Probity Auditor (PRA)
- the Independent Estimator (IE)
- the Financial Auditor (FA)

The PAF's task is to support the owner from the very beginning of an alliancing project. He or she helps to develop the request for proposal, the framework of the alliance and key process within the project. The PRA is a key participant regarding the fairness of the NOP's selection. While supervising the selection process the PRA verifies if the overheads are within the limits, without communicating them. The IE is responsible for checking if the estimated costs that are developed by the NOP's are reasonable. The FA is an expert monitoring the compensational model and verifies the billing of the NOP's. To outline the responsibilities of the board members it can be said that most of their duties shall provide security for the owner, especially the FA and IE. cf. [33] p. 63 ff.

### **Catalyst Team**

The Catalyst Team usually consists of five specialists whose task it is to support all project stakeholders. They should help to develop innovative solutions without constraining the project participants, but by acting like a coach and pushing them to come up with even better results. Therefore the Catalyst Team is most commonly occupied with people having great experience and knowledge in a special field and who are familiar with the processes and ideas of PA. Unlike the other teams and stakeholders presented above, the catalyst team is not compulsory, especially if sufficient special knowledge can be brought in by the board members and alliance participants. cf. [19] p. 106.

### 4.3.3 Project Alliancing Agreement

Unlike the current contracting model, there is no contract template for the Project Alliancing Agreement (PAA). The foundation usually gets developed by the owner and then adapted during the selection and development phase. Therefore every alliance contract could be completely diverse from another, however during the years of practice the following characteristics stand out to be more prevalent and common. The formation of a fictitious project corporation that appears and behaves like a classical company is something imported at every alliancing project. Even though the formation of an individual organization, the employment remains at the alliance members. Further the PAA represents a multiparty relational contract that defines the same terms for all alliance members.

These terms contain two major areas covering the commercial and behavioral strategies that are governed and defined within the PAA. The behavior that is instructed by the agreement should strengthen the team spirit and secure a collaborative mindset within the formed fictitious project corporation. These relational principles have already been presented in subchapter 4.2.2. The commercial strategy also implies some ideas already mentioned in this chapter, but will be explained in greater detail below. cf [19] p. 96 f.

- The 3-limb compensational model.
- The risk allocation and limitation as well as the sharing of risk.
- The reward system clinched to commercial and qualitative achievements.

During the development and establishment phase NOP's are compensated according to the 3-limb compensational model regulated by the PAA. It features three cost portions called limb 1, limb 2 and limb 3. Limb 1 includes direct project costs and project specific overheads. Limb 2 is referred to as the fee, usually a defined percentage adding corporate overheads and profit to the limb 1. Limb 3 inherits the pain and gain sharing regulation and therefore depends on the outcome of the project. cf. [30] p. 4 f. The following figure shows the composition of the limbs.

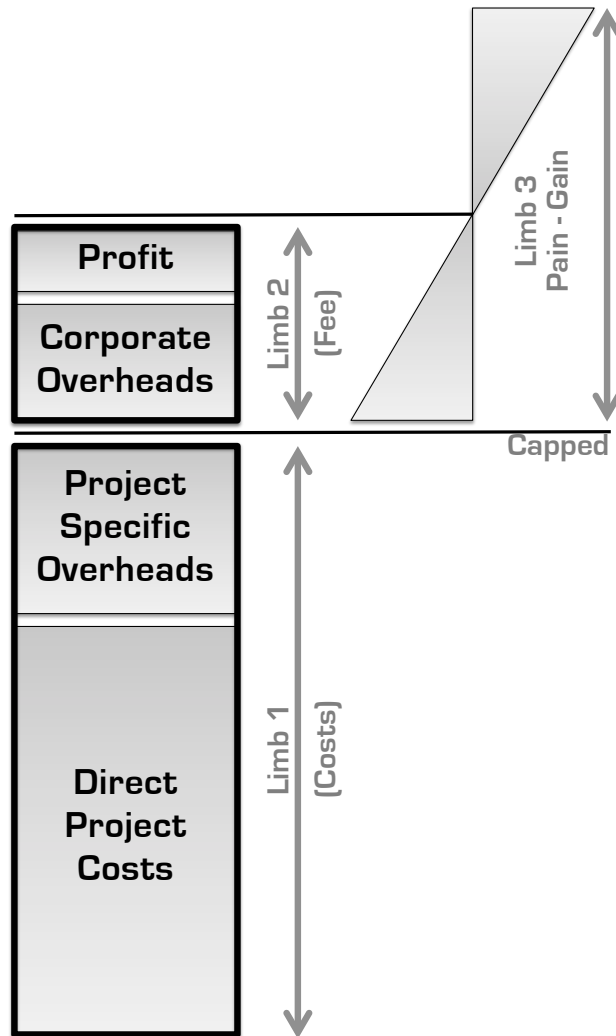


Figure 10: 3-Limb Compensational Model. Adapted from: [30] p. 4.

The implementation of an open book culture between NOP's and the owner must be developed to assess the reimbursable costs under limb 1. In addition to that joint perception, the reimbursement must not include any hidden adjunct and is therefore subject to an audit by the before mentioned independent estimator (IE). Since there are no profit and corporate overhead margins included in limb 1, these fees are being compensated under limb 2. The fee can either be defined as a fixed lump sum or a percentage of the actual costs. Either way, the fee will be paid progressively to the portion of complete work. The parties have to agree on the height as well as on the way of paying the fee before signing the PAA. The limb 2 fee is at risk under limb 3, meaning the NOP's could lose their profit and corporate overheads if the project comes out over budget. However, if they manage to undercut the target outturn cost (TOC), they share the gain with the owner. The extent of the shared savings is defined in the PAA and measured with key performance indicators (KPI's) in key result areas (KRA's). When developing the



pain and gain sharing mechanism, there is one particular principle that must be considered. An alliancing project should never result in a win–lose, but always either in lose–lose or win–win situation, according to the head note:

*“we all win or we all lose together”.*

*cf. [30] p. 5 ff.*

The distribution of risk is also completely diverse from current practice where the owner tries to transfer the risk to the contractor. PAA includes the equal sharing of all risk among the alliance members according to the principle stating:

*“risk is our risk and no risk is my risk alone”*

This risk sharing approach is tightly linked to the reward approach and in a lot of cases these two principles are referred to as the risk and reward system. That is because the possible reward of all alliance members is dependent from the outcome of the whole project. If for example the builder causes a failure during the construction, the architect may lose some of his limb 2 fees that are at risk even if he had nothing to do with it directly. PA defines two reward systems: one is linked to the costs of the project and one to achievements regarding non-cost criteria. The cost dependent one can either produce a pain for all parties, if the TOC are exceeded, or a gain if they are undercut. The pain or gain is being shared among the alliance members equally. Usually the owner and the NOP's split the gain or pain by 50 %, whereat the pain of the NOP's is capped and can not exceed their limb 2 fees. The non-cost KRA's are being measured with the KPI's throughout the project delivery. At the end of the project they show the NOP's performance in a comprehensible way and allow the evaluation of rewards for good performance or penalties for bad performance. cf. [19] p. 100 ff.

## 5 Comparison of LC and PA

In this subchapter the two before presented cooperative project delivery methods Lean Construction and Project Alliancing will be compared. Key synergies and discrepancies will be determined based on the accomplishments from chapters 3 and 4. Therefore this subchapter can also be considered as an abstract of these previous two. The statements will be arranged according to the sequence of a construction project, from the awarding procedure, to the design and construction phase. Therefore the contracts and framework within each project delivery method will be discussed as well.

### 5.1 Awarding

The awarding of the prime contractor and designer follows the same ideas and principles in PA as it does in LC, however it shows two significant differences. In both awarding procedures, the cost of the project is not a critical factor, but the choice of the parties is based on non-cost criteria. That means no design or specifications for tenderers, as usual for traditional procurement methods, are established for the awarding process. The factors influencing the choice of the owner are know-how and experience of the tenderer and the team members who will actually deliver the work.

One key divergence is that PA is much more specific at its awarding process. That can be determined by looking at figures 2 and 7, showing the sequence of each delivery method. While PA has one phase determined exclusively to find the preferred bidder, PA has nothing like it. If the alliance is conducted implementing the multiple TOC approach, where two tenderers enter the development phase, two phases pass until the owner to make has to make his decision about whom to award the contract. That very specific awarding procedure can be ascribed to the fact that PA is applicable for public owners in Australia. Accordingly, since public money is being invested, a transparent and impartial awarding procedure was established. That selection sequence can be seen as a major backing if a similar integrated project delivery method would ever be introduced for public owners elsewhere.

The second difference regards the awarding of subcontractors and, other than the specific selection process, can be seen as a slight downside of PA. The advantage of LC over PA is that subcontractors are being integrated in the alliance. Where at most alliancing projects only the prime contractor and designer, hence the NOP's, enter the alliance with the owner, at LC most subcontractors are involved within the cluster groups. At LC

subcontractors sign the joining agreement and are therefore bound to the same regulations. They are also awarded using the same principles, namely non-cost criteria while subcontractors at alliancing projects may be awarded traditionally. That awarding strategy for subcontractors interferes with many principles of an integrated project delivery and represents the biggest difference as well as shortcoming of PA. Since subcontractors can be awarded traditionally, their expert knowledge is not made use of and all the collaborative principles incorporated in PA are only helping three parties: the owner, prime contractor and designer, instead of improving the situation for all stakeholders. Other scholars examining PA practice have also identified this as a major shortcoming and it is being tried to find a way to integrate subcontractors more closely. The paper about the integration of subcontractors in alliancing contracts by Vilasini (et al.) from the Auckland University of Technology stands out at this field and shall be mentioned here. [36]

## 5.2 Design

The design phases at LC projects, called Project Definition, Lean Design and Supply as well as the Development phase in PA, are following the same ideas, but approaching them differently. Both methods enforce a deep interaction and collaboration of the owner, designer and constructor. That is very unlike any traditional approach where each party works detached from one another. While PA is more specific in defining the selection process of the NOP's, LC has a much richer phase to develop an effective design for a project. At PA the definitions and regulations in the development phase concentrate on setting the before mentioned KRA's, KPI's and develop TOC's and TCE's. Even though PA states that the team shall determine the best possible solutions, there are no supporting tools on how to achieve these solutions effectively. On the other side the first three phase of a LC project, shown in figure two, cover that process in great detail and introduce several supporting tools like the LPS, the IPD team or TVD. All these tools aim for delivering the best possible design within the given constraints. Taking the single procedures within these three interacting triangles, one gets the following sequence, whereat the order is not mandated strictly:

- Define the purpose
- Set the design criteria
- Develop design concepts
- Develop process design
- Develop product design
- Conduct detailed engineering
- Fabrication and logistics

In regard to these steps that develop a lean design, it shall be highlighted that at LC, the design of the process is equivalent to the design of the product itself. Transferred to construction projects this means that while developing the design and plans, the teams also look at how it is going to be built. So while one considers what is going to be built, it is also being considered how it is going to be done. That approach really underlines the fact, that LC is more of a systems design model. Also the phase of Lean Supply, especially the process of fabrication and logistics, adds a whole other dimension to that method, by recognizing the supply chain as a crucial factor for the success of any project. It aims to optimize the supply chain and therefore minimize inventories, support just-in-time deliveries and increase their relatedness.

Another major benefit from the integration of the subcontractors at LC over PA, as described in the subchapter above, is that their expert knowledge can be made use of during the design phase already. Since they are not being awarded traditionally, no design and specifications need to be developed before they become a part of the team. The fact that the design is not set yet, allows subcontractors to have an impact on the design or scheduling of the project regarding their profession and know-how.

### **5.3 Construction**

Both methods, LC and PA, declare one phase within their plan of procedures (shown in figure 2 and 7) for the construction process itself: the Lean Assembly at LC and the Implementation at PA. During both phases the teams shall strive for an outstanding project outcome as well as reach or even outperform their goals set during the design phases. At PA the focus lies on the documentation of the achievements within the before set KRA's. The accurate documentation also allows a prompt action if a deviation is being determined and by that secures the accomplishment of goals. The main goal at LC projects is to minimize the waste within the processes and deliver a building meeting the customer requirements. Therefore it can be noted that both methods basically pursue the same ideas about reaching the customer needs and delivering the building most effectively. However it must be said again, that LC has more detailed and specific guidelines about how to achieve this.

## 5.4 Contracts and Framework

The contractual methods used in LC and PA have been presented in chapters 3.3.5 respectively 4.3.3. Both, the Integrated Form of Agreement (IFOA) at LC and the Project Alliancing Agreement (PAA) are relational contracts that embrace and manage change within projects. The following statement explains the difference of traditional contracts, being in use now, and relational contracts in a simple yet proper manner. A traditional contract is suitable for buying a product, which has a single and easy to define outcome, without being subject to any external influences and therefore changes. A relational contract also works for buying goods and services with many possible outcomes that are subject to unforeseeable changes.

The owner, architect and general constructor (NOP's) sign the PAA at the end of the selection phase. The same stakeholders are signing the IFOA at the beginning of the project definition phase. However at LC the subcontractors are being integrated in the team by signing a joining agreement. Subcontractors at alliancing projects are usually not incorporated in a likewise manner. Another important aspect both contracts inherit in a likewise manner is the dispute resolution process. PA as well as LC exclude litigation and instead define a dispute resolution process, featuring different steps to solve conflicts efficiently. The compensation of the stakeholders is similar at both contractual models, too. The contractors get reimbursed their actual costs and overheads, which the parties agree on in the contract. The overheads are linked to the risk and reward pool and may be lost if the project comes out over budget. Even though both contracts include similar principles, PA is much more specific at defining and governing the compensation within the 3-limb model.

If the two models of the framework, showing the configuration of stakeholders within a LC and PA project (figures 4 and 9), are being compared, some differences can be determined. First of all can be seen that the PA framework has somewhat more of a hierarchical structure than LC does. At LC there are only two groups, the core and cluster groups, and in practice they are not completely detached since members from the core group may also participate in a cluster group. This flat framework secures short paths of information and allows quick responses. The PA framework looks less flat on paper, but is not quite as hierarchical in practice. The Integrated Delivery Team from PA can be compared to the cluster groups at LC and the Alliance Leadership team to the core group. Another divergence can be lead back to the before mentioned integration of subcontractors. The subcontractors at PA are being integrated in the Wider Project Team (WPT) and are managed by the Alliance Management Team (AMT). On the contrary,

subcontractors at LC are being included within the cluster groups and are therefore even more involved in the process.

Another thing that distinguishes an alliancing from a LC framework is the implementation of independent board members at PA. That board includes the Probity Auditor, the PA-Facilitator, the Independent Estimator and the Financial Auditor. These supporting authorities may be a big help for all stakeholders, but especially owners who are not experienced in the implementation of the innovative project delivery that is PA, yet.

## 5.5 Conclusion

It can be determined that both methods have a broad common base with a lot of similar principles and ideas. Both methods enforce collaboration, innovation fairness and trust. Further they strive for an outstanding project outcome and aim to achieve the costumers' requirements. The divergences of PA over LC can mostly be lead back to basically two things. One is the differing fields of implementation and the other the different origins of the two methods. Since PA is applicable for public owners in Australia it has different approaches to several ideas. The introduction of independent boards, the very specific award procedure or the detailed compensational at PA is definitely due to the implementation in the public sector. On the other hand, the very diverse origin of LC, making its way from the Japanese car manufacturing industry to the construction industry in the US, is the other main reason for differences. That is why LC is so very eager to eliminate waste within processes, has a very detailed and rich planning phase with a lot of supporting tools or takes the power of decision making to the lowest possible level, namely the "assembly line".

Subsequently, the most significant synergies and divergences of LC and PA are listed to deliver an outline of how similar the two project delivery methods are, but also how much the approaches differ at certain perspectives. Further figure 11 shows milestones and the key procedures of LC and PA summarized and listed according to the timeline of a project.

**Synergies**

- Both methods make use of relational contracts featuring:
  - similar compensational models
  - sharing of risks and rewards
  - awarding at non-cost criteria
  - the exclusion of litigation
- Strive for cooperation and collaboration among stakeholders.
- Holistic consideration from definition to the use of a project (lifecycle)
- Best for project decisions and mindset and creating value for the customer.

**Divergences**

- Awarding of NOP's at PA is much more specific than at LC.
- Subcontractors at PA
  - are usually not involved during the design phase
  - and may be awarded traditionally.
- PA does not declare nor has it a resort of as many supporting tools as LC has.

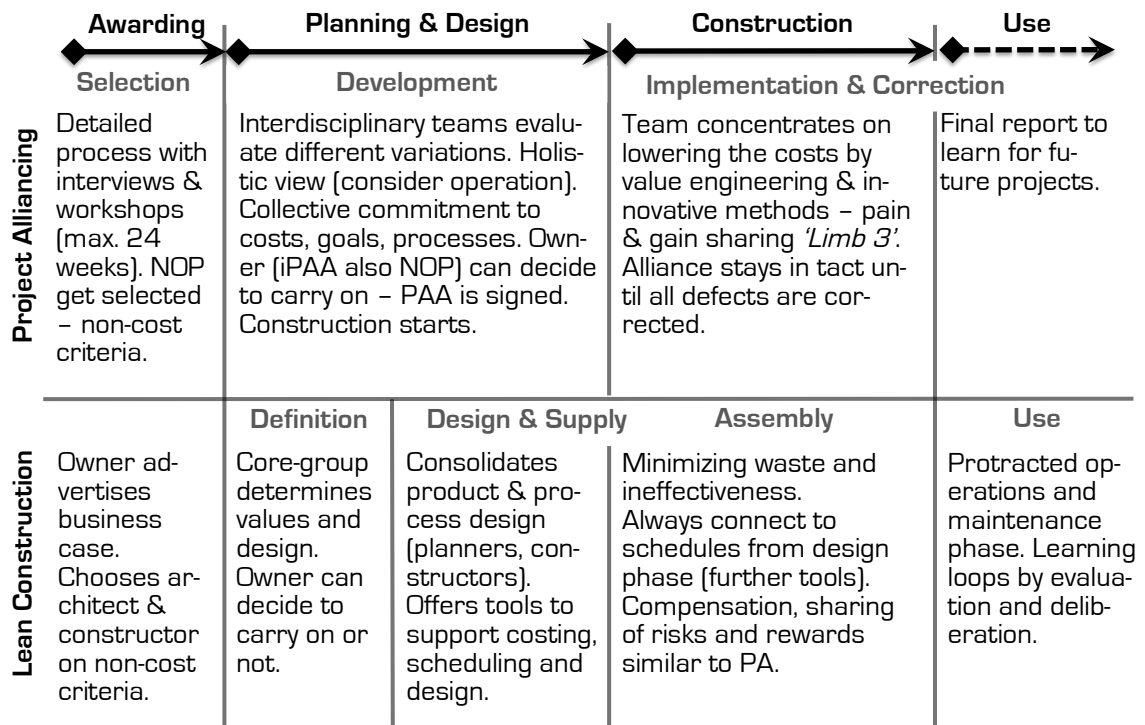


Figure 11: Summarization of Milestones of PA and LC.

In summarization it can be stated that the two methods of Lean Construction and Project Alliancing are so very similar, that they can be seen as one management approach. It shall be recorded that in the ongoing layout of this thesis, it always will be referred to both methods as “integrated practices” if not mentioned explicitly.

## 6 Cooperative Methods and the Law

In this chapter the implementation of the before presented integrated project delivery methods Lean Construction (LC) and Project Alliancing (PA) within the Austrian procurement law (Bundesvergabegesetz 2006) will be examined. This examination could be a short one if one goes for the obvious, that states that no other awarding methods than the ones regulated within the legal text can be applied. However there is more to that than this since, laws are subject to change and they are only as expandable as its users want them to be.

*If you have ten thousand regulations you destroy all respect for the law.  
[Winston Churchill]*

Therefore in the following abstracts the compatibility of integrated project delivery methods with the principles of the law, its scope of application and threshold values as well as the particular awarding procedures will be examined. That compatibility is crucial if a method like LC or PA should ever be introduced to the Austrian or European procurement law and made applicable for public owners. That applicability for awarding authorities bound to the law is very important, because of the broad scope of application of the law.

### 6.1 Principles of the Awarding Law

The five principles of the procurement law have been presented in chapter 2.2.1. It is crucial that none of the procedures from integrated practices interfere with those principles, since they are not as likely to be changed or adapted as the rest of the paragraphs are. The Austrian awarding law includes the following five principles:

- The Principle of Competition
- The Principle of Awarding at a Reasonable Price
- The Principle of Equal Treatment
- The Principle of Transparency
- The Principle of Awarding Capable Contractors

The principles of equal treatment and transparency as well as awarding capable contractors are not being affected negatively by integrated practices at all. By using non-cost criteria for the awarding in the first place, the contractors' capability is being assured. The transparency and equal treatment during the awarding procedure is secured



by a coherent and objective process with before defined and published criteria, especially in the detailed selection process of PA.

The principle of competition states, that as many competitors as possible should have access to the tendering to achieve low proposals. Even though neither LC nor PA feature proposals including the costs of a project, the competition at integrated methods proceeds on another level: know-how. Integrated practices with the way of awarding at non-cost criteria follow the idea, that every activity must have the same price, since the economy dictates material and labor cost. Therefore the only thing making a difference is the way of doing the work. If one company has an innovative idea, cutting their labor time or material usage for a particular operation, they gained a competitive advantage. This diverse look at competition highlights the effect of know-how to the price of a piece of work. And that approach towards competition really eliminates the necessity of a price competition through tendering as the construction industry executes it since the Romans established the procedure of the *auction licitacio*.

The principle of awarding at a reasonable price is definitely a point that will be under consideration. However, if the independent board at alliancing projects is being considered, the board members will secure reasonable pricing by permanently reviewing the costs and estimates. It shall also be mentioned, that the principle never demands to award the contract to the lowest bid, but to the economical most favorable one.

## 6.2 Scope of Application and Threshold Values

As presented in chapter 2.2.2 the law covers the personal scope of application and the scope of application regarding the subject matter. That means it declares who is bound to the law and what kind of contracts are subject to follow its paragraphs. Further the quantitative threshold values are defining what awarding procedure is applicable for contracts up to a certain amount. To recapitulate it can be said, that all public owners, sectoral awarding authorities and PPP's have to follow the law whenever they award a construction, design or supply contract exceeding € 100.000. That said, it can be determined that most of the 40 billion € invested into construction projects in Austria each year are bound to the law, since the government invests approximately the same amount into procurement of goods. cf [37] p. 5 and [38]. Even though private owners are not bound to the law, these numbers show that the majority of the construction projects are funded by public money and therefore subject to the procurement law.

These very strict scopes of applications in combination with the threshold values do not leave any space for other awarding approaches. Depending on the costs of the project, the law defines several awarding procedures the awarding authorities have to conform to. These procedures and how integrated practice could fit into them is the subject of the following subchapter.

## **6.3 Awarding Procedures**

There are basically three procedures applicable for construction, design or supply contracts:

- The Open Procedure
- The Restricted Procedure
- The Negotiated Procedure

All of them declare the tendering process to be based on a before developed design and therefore do not allow the implementation of an integrated project delivery, since it would require to award the contracts before a design has been developed. It would even further demand the awarding decision to be based on non-cost criteria, while the law states that the contract should be awarded to the tender offering the economical most favorable bid, what in the majority of cases comes down to the lowest bid. Therefore integrated project delivery methods like LC and PA are not applicable for public owners since their approach is not compatible with the current conduction of the law. However there is one approach that got introduce to the law during its last revision and shows similarities to cooperative methods: the competitive dialogue procedure.

### **6.3.1 The Competitive Dialogue Procedure**

The competitive dialogue procedure presented in chapter 2.3.2 shows several key affinities with the process of PA or LC. There is a collaborative development of the design as well as technical and legal requirements. Especially the selection process at PA and the one defined within the competitive dialogue show strong synergies. At both methods the contract is being signed after a detailed process of announcements, as well as dialogues and workshops about legal and technical problems. Therefore it is imaginable that an integrated project delivery could be conducted within the legal framework of the competitive dialogue procedure. However this innovative awarding method is only applicable if no other method regulated by the law can secure a positive tendering procedure. For example if the owner is unable to define technical, financial or legal conditions and the pro-

ject can therefore be seen as too complex. The challenge in this case is to define the term complex and make it explicit legally and to find awarding authorities courageous enough to apply this method for the first time.

## 6.4 Conclusion and Introduction to Empiricism

It could be determined that integrated practices like LC or PA are not compliant to the law without any changes or adaptations. However, a way of more collaborative project delivery was found in the competitive dialogue procedure, even though it is not being applied yet. The ignorance of the possibility to try integrated practices, also in the private sector, raises the question if the owners, constructors and designers even want to make use of collaborative approaches as of now.

So the questions remaining to be answered are:

- How could an owner be convinced to apply an integrated project delivery method?
- What are the changes the different parties in construction industry seek for anyway and could integrated practices meet these requirements?
- What are the hurdles to establish methods like LC in an industry so very used to the current contractual approach and what would be the impact of the implementation?

Therefore the following three chapters shall answer the questions the literature review left unanswered. The material for the following chapters was gathered by conducting expert interviews during a stay in the United States. The interview guideline consists of seven main questions including more precise follow-up questions. The interviews took approximately one hour and have been recorded and transcribed. A short introduction of each interviewee and the interview guideline as well as the transcripts can be found in the appendices. The interview partners are experts from the construction industry who have made experience with integrated project delivery methods in the US. All of them are distinguished professionals with several years of experience in the construction industry and experts in their field of work.

It was the goal to interview represents from all parties and thereby get perspectives from an owner, designer, contractor and consultant towards the topic. Six interviews have been conducted in the time between April and June 2013, to fill the gap found during the literature review and therefore answer the following questions:

▪ What are the downsides of traditional practice?	7
▪ Is the current situation satisfying and enduring?	
▪ What impact could the introduction of integrated practices have?	8
▪ What are major positive and possible negative effects of integrated practices?	
▪ What are the main obstacles at introducing integrated practices?	9
▪ What are future steps to spread integrated practices?	

These questions remained partly unanswered during the literature research and therefore shall be discussed in the following three chapters covering the desired and promised change of the current practice, the impact that the implementation of these innovative methods could come by with and the hurdles at the establishment of integrated practices.

## 7 Desired Change of Practice

*When we are no longer able to change a situation -  
we are challenged to change ourselves.*

*[Viktor E. Frankl]*

The quote by Viktor E. Frankl displays the ability of people, to adapt their behavior to fit with the system again, if changing a situation seems no longer possible or too hard. That is what happened with the practice in project delivery. Since it is so unbelievably hard to change a methodology that is being practiced by so many people for such a long time, the way we handle our projects has adapted to the contractual method in practice and causes more and more problems throughout the industry.

This first chapter, covering the findings from the empiricism, shall determine what are the improvements and changes that are being demanded by the construction industry. First of all the downsides of traditional practice will be presented based on the literature review linked with interview findings. Then the desired and necessary changes will be discussed while the focus lies on productivity, contracting, risk allocation, workflow, project management and the current awarding and project delivery practice.

### 7.1 Downsides of Current Practice

In this subchapter the disadvantages and problems with traditional project delivery will be highlighted using some findings from the literature as well as hands-on insights from the interviews conducted for this thesis.

#### 7.1.1 Literature Findings

Several downsides of the current awarding practice have already been addressed in chapter 2.3.1. However, since the approach from Owen Matthews and Gregory A. Howell is summarizing what several books and papers emphasize and constitutes a hands on catalogue, it is presented here. They have developed four major systemic problems with the traditional contractual approach in their paper released in the Lean Construction Journal in 2005. The four problems they labeled and presented in more detail subsequently: [23] p. 47.

***Problem 1: Good Ideas are Held Back***

That problem refers to the input of “*field know-how*” by subcontractors during the design phase. Even though the general contractor may consult contractors for different trades during the design phase of a traditional project, there is no incentive for them to share their ideas with him. Actually the very reverse is the case, since the subcontractors will hold back their best ideas to gain some competitive advantage for the bidding process after the design is finished.

***Problem 2: Contracting Limits Cooperation and Innovation***

This can be seen as a major problem and shortcoming of traditional practice, since cooperation is the foundation for a successful project delivery. However that cooperation and coordination among contractors is being restrained by contracts hoisting insuperable boundaries amongst interdependent trades.

***Problem 3: Inability to Coordinate***

This problem is strongly linked to the previous causing similar shortcomings. Due to the silo-type view of all subcontractors they do not coordinate their work with one another. Therefore it is not possible for them to develop pieces of work that are interconnecting in an efficient way. This random unlinked organization without mutual commitments causes bad performance throughout traditional projects.

***Problem 4: Pressure for Local Optimization***

The previous problems two and three drive each subcontractor to optimize his very own scope of work without considering the interconnecting pieces done by other trades. This optimization often takes place on the expense of other subcontractors and therefore also the client, making the whole project less reliable and restraining good workflow. Furthermore the pressure to achieve a profit under these circumstances, makes subcontractors incorporate the philosophy of “*my gain is your loss*” driving them to become litigious if they see no other way.

All these problems are in one way or another being generated by the traditional contracting model the construction industry is so strongly utilizing. Since the way our contracts are designed has been strongly affected by the lack of trust among the parties, that untrustworthy atmosphere can be seen as the root of the majority of the problems the construction industry is facing today. As long as there are contracts that encourage and build on lack of trust and unequal information, a gap of understanding among the parties, restraining outstanding project achievements, will remain.

### **7.1.2 Interview Findings**

During the interviews several shortcomings could have been determined. By analyzing the transcript one can see that some problems have been addressed by several interviewees while others have been mentioned just once. These shortcomings that have been discussed in the interviews are the subject of this subchapter and are characterized subsequently. First the lack of trust among stakeholders will be displayed, then the drawbacks of high fragmentation, the low bid approach and the unpredictability of the workflow will be presented.

#### ***Lack of Cooperation and Trust***

The construction industry is lacking cooperation, because trades are watching out for themselves only. This shortfall on collaboration can be lead back to the lack of trust among the parties and the “silo-type” view within a project. That lack of trust is being compensated by extensive legal coverage in construction contracts which make the whole process of construction very inefficient and produces a lot of unnecessary work. [Nagaraja] The lack of trust is also the reason for the fact, that the stakeholders involved in a construction process became very litigious-conscious and by that put up even higher boundaries between them. Due to these boundaries the owner as well as the designer distracted themselves from the construction process itself, leaving only the contractor with the knowledge of how things get built, how much things cost and how long it will take to build them. This hypertrophying of the constructor leads to a heavy asymmetry in the relationship between the owner, designer and constructor. Furthermore the constructor has no incentives, as stated in problem one of the literature findings, to share his knowledge honestly. [Spata] All these factors can emphasize the formation of disputes throughout the project phases and therefore restrain an efficient development of the project.

#### ***High Fragmentation***

The fragmentation begins with three very independent relationships between the owner, designer and constructor. These relations are diverse in regards to the time they begin and to the information they involve. The relation and communication between the owner and designer will establish the framework for the work. The owner in collaboration with the constructor is going to develop when the work is going to be started, what quality is going to be installed in the field and so on. Then there is the relationship between constructor and designer that may be more or less closely and collaborative. Because of these different independent relationships there is a lot of room for misunderstandings

and ambiguities. These uncertainties do not only make the ongoing project delivery frail to disputes, delays and rework, but also add to the cost of the project. The costs go up since each stakeholder will protect himself from every risk and unknowns included in the project by adding contingency to his price. That is why a high fragmentation of the stakeholders and different views towards risks and unknowns due to gaps of understandings and dishonest communication between the parties will prohibit an efficient and successful project delivery. [Nikain] The reason for the fragmentation and allocation of risk is the way the current contracting model works. It is really those legal and insurance assignments of responsibilities that are causing the construction industry to be fragmented and therefore inefficient. [Jarvis]

### ***The Low Bid Approach***

In addition to the lack of trust and cooperation, the current tendering and contracting practice cause further problems. One being contractors submitting bids too low, whether on purpose or because of a bad calculation. [Maimis] That problem can be observed at a lot of low-bid approaches in the US as well as in Europe. As a result those contractors will try to compensate for the low bid by arguing for every possible change order. [Spata] This phenomenon has also been addressed in chapter 2.3.1 where the *“vicious circle of traditional project delivery”* was developed based on literature findings and displayed in Figure 1. Further construction companies making dangerously low bets on projects, focusing on the act of setting the price more than they focus on the actual organization of the work. [Howell] This behavior of contractors is being caused by the low bid approach.

Sam Spata states that the low bid approach is the most litigious and least integrative form of project delivery. As an architect he experienced that in ten projects with the same construction manager and different branches of federal government as the owner. Five of those ten projects were done using Design-Bid-Build (DBB) as a low bid approach and the other five as a Construction-Manager-at-Guaranteed-Maximum-Price (CM-GMP). The five done with CM-GMP were done more collaboratively while the five done with DBB went to either the thread of litigation and lawsuit or settlement for that. Sam Spata makes the low bid responsible for that, since the contractor is put under enormous pressure regarding the amount of his bid. Therefore the tenderers won't hand in a bid reflecting the actual price for the work if they are interested in getting awarded, but their best estimate as to what number the owner is willing to accept and they will deliver the lowest bid. [Spata] This course of action shows a strong affinity to the *“licitacio”* approach, developed in the Roman Empire and presented in chapter 2.1, that got applied throughout the history of tendering procedures.



### **Unpredictable Workflow**

Another drawback strongly relating to low bids in combination with the lack of cooperation is the aspect, mentioned in problem three and four above, emerging in the “silo-type” view within construction projects. Since every trade tries to increase their own performance, no matter what influence this may have on other trades, the whole process becomes more and more unreliable. Glenn Ballard who co-founded the Lean Construction Institute with Gregory Howell first investigated this unreliability of assignments in construction projects. He investigated how many of the tasks, people promised to finish until next week actually got finished until then. Ballard discovered that people are able to do what they say they are going to do until next week only half of the time. With that he found that bad and unreliable assignments are generating low productivity. Therefore it was no longer unmotivated workforce being responsible for bad performance, as it was believed in the 90-ies, but a false planning system allowing only individual perspectives of a project, leading to unpredictable workflow, instead of a holistic view. [Howell]

### **7.1.3 Conclusion**

All these problems presented above can be seen as results of the contracting and project delivery modality currently being conducted. The introduction of the parties at different stages of the project causes a gap of understanding through unequal levels of information among the stakeholders. These inequalities often cause disputes in the ongoing project development and make the construction process much less efficient. It can also be derived from these findings, that all the unnecessary steps within the processes have been introduced due to the lack of trust in the first place.

Mysore Nagaraja, who worked at the Metropolitan Transportation Authority (MTA), being responsible for one of the worlds biggest public transportation systems in New York City, said that at the construction of the first subway line in NY, the number one line, the legal part of the contract did not exceed one page. That was at the turn of the 19<sup>th</sup> century, hence something during the past 100 years caused the trust among parties to decrease and the legal parts of contracts to increase massively. Now there are built in all these ineffective, non-value adding steps and procedures in construction projects, making it ever harder to induce a change towards a more integrative form of project delivery. [Nagaraja]

Also according to Andrew Jarvis the low bid approach is most likely to endure, since it satisfies the objectives of the owner to get a fixed price for the cost of the project and gives him some assurance that he has attained the best possible price for the work.

However the major weakness of the procedure is that it does cause disputes on the construction site and problems if the contractor underbid the job. [Jarvis] That is especially present in the buyers market the design and construction services faces right now. Since the recession is still prevailing less money is being spent and owners can therefore afford to pay lower fees, forcing the tenderers to deliver lower bids to get a job in the first place. [Spata]

Fixing these drawbacks by implementing new management techniques and ideas is crucial in the globalized environment the companies are working in today, if one considers the following statement by Greg Howell. In the past owners and contractors were able to maintain successful professional relationships if they worked in a kind of similar market and they were stable and they worked together frequently and they both belonged to the same church or something like that. But that is less and less common. [Howell]

Another aspect related to the statement above that needs to be considered. Due to the high need for construction projects and the globalized construction market, most projects will be delivered by people who have not worked together before, do not know each other and are not A-Team players when it comes to project management. Therefore the challenge will be to get this broad scope of B-Teamers to deliver like A-Teamers. And that can only be achieved through best processes and management techniques offered by Lean Construction or Project Alliancing. [Spata]

## **7.2 Desired and Necessary Change**

This chapter shall provide and express the findings from the interviews about what are the changes the construction industry is in need of. Therefore it will be presented what are the reasons for reduced efficiency and therefore also profits in traditional practice. The focus lies on these two aspects, because they are the necessary factors if you want to bring around change. Therefore the only motivational factors that can supersede the resistance to change are an improvement in productivity, achieving a higher rate of return for the owner or the improvement of the competitive advantage of the contractor. [Nikain]

The following chapters are structured according to the topics addressed by the interviewees implying productivity, contracting and risk allocation as well as quality.

### 7.2.1 Productivity and Efficiency

First of all it has to be said that the productivity in the construction industry has not kept pace with the clients expectation. This gap can be seen as a leadership- and management-problem. [Spata] That gap of expectation and reality is especially present during the financial crisis the industry is suffering from. Currently the funding is very tight, but the need of high quality infrastructure is higher than ever before. This necessity of higher productivity to meet the required criteria while using fewer resources is really approaching integrated practices and can therefore be seen as a chance to push these methods. The raised productivity is the reason why Mr. Nagaraja thinks that integrated project delivery methods will become the way the industry will work within the next ten years. [Nagaraja] Basically it can be said that traditional practice forces duplication of work, due to a lot of unnecessary procedures within the delivery. [Jarvis]

Another reason for inefficient processes is that construction is a very labor driven industry and therefore the productivity is strongly dependent from human effort. [Maimis] However, if the outcome of Glenn Ballard's survey presented in the previous subchapter is taken into consideration, one can tell that the importance of a good planning system exceeds the motivation of the labor force. Therefore it is more important to manage and coordinate processes than to try to maximize the productivity of the workforce.

During the developed of the Lean Construction methodology Ballard and Howell found that tremendous improvements in productivity could be achieved in two different ways. One is to change the design of the system people are working in. The other is to actually change the details of the operations. [Howell] When trying to improve productivity, further factors that improve the overall efficiency of a project, must always be considered. Efficiency can only be raised if rework is being decreased and quality is still being improved. So efficiency shall never be measured by the productive number of minutes per hour that the labor force is working. [Nikain] Interfering with that is the topmost goal for contractors, namely to have their workers fully utilized, even if that approach may restrain other processes. Contractors achieve that high capacity utilization by holding their people back from the project until there is a lot of work for them available. However, by doing that they make the whole process unreliable and take longer, since the time it takes to go through a fully utilized system is higher. To picture that theory one has to think of a highway at rush hour and at 3 am. While the so-called capacity utilization is very low at 3 am, the highway will be fully utilized at rush hour. Therefore it will take you longer to go through the system at rush hour than during a time when the highway is not fully utilized and the same is true for construction projects. [Howell]

### 7.2.2 Contracting and Risk Allocation

The transfer of risk as it is being practiced in traditional project delivery is another aspect that needs to change to make construction more efficient and keep pace with today's expectations. Especially the owner has to realize that transferring the risk to contractors and designers is costing him money. At every of the many interfaces, due to the high fragmentation mentioned above, contingencies are being added as a reaction to the risks being transferred. That means every party puts a little extra on top of the estimated costs without knowing how much extra has already been added by other parties. [Nagaraja]

So the risk keeps circling from one party to another without really being considered or even minimized. [Spata] That means that every interface adds contingencies in terms of money or time and therefore raises the cost or schedule of a project without it is really cognizable for any other party. That process of evaluating the risk and adding a safety factor, depending on how an individual sees the danger from where they are, can be seen as a major part of our planning process. It is a natural reaction to the way our contracts are being designed and no one can be blamed for doing that. However, that local incomprehensible protection makes it impossible to recognize the amount of contingency that is buried in our projects. [Howell]

Another consequence of added contingencies due to risk allocation is that money is taken out of the quality of a building. When a construction management (CM) company guarantees to build a capital facility for 100 million \$ taking all the risk onto their shoulders, they know that they can build it for 90 million \$. Some of these additional 10 million \$ might be needed during the delivery for contingency that does happen, but the majority of it goes straight into the CM's pocket. Regrettably, these additional millions could have been invested into the quality of the project in sense of a greener facility or better equipment for the user. [Jarvis] If one considers that not only the CM is acting in such a manner, but also everybody else involved in the project is adding some contingency, the transfer of risk is affecting the cost of a project tremendously.

### 7.2.3 Quality

The quality of a project can depend from a variety of factors from the energy efficiency to the quality of the interior of a building. However it always has to be considered and realized, that:

*“Quality exists only in the mind of the costumer.”*

*[Sam Spata]*

The importance of the quality scope has been mentioned in the subchapter about productivity above, stating that an improvement in efficiency shall never reduce the quality of the work. The quality of a project is also strongly correlating to the possible return on investment of a facility that is being very important for any investment. That was also the reason why green building design gained importance during the 90ies. When architects came up with the Leadership in Energy and Environmental Design (LEED) idea, owners did only follow when they learned that their investment would lead to a greater return in a long-term view. [Spata]

Another example from the pharmacy industry shows how important quality is to some owners. Around the year 2000 most pharmaceutical companies changed their awarding practice from the traditional DBB approach to Guaranteed-Maximum-Price-Construction-Manager (GMP-CM). Doing that, they knew they potentially paid 15-18% more, but they got reliable numbers regarding cost and schedule. Even though they knew the cost were too high and the schedule too long, they were willing to pay that price to get that reliable declaration. In that case a secured budget and timeframe represents quality for the owner, who is the pharmaceutical industry. [Spata]

### 7.2.4 Conclusion

One of the crucial findings from this subchapter is that the productivity is lagging behind the owners' expectation. These inefficiencies in the way of delivering construction projects could be led back to several reasons like the high fragmentation, the risk allocation or bad management methods. Further it has to be realized, that improving the productivity while reducing the quality of the work and therefore boosting the frequency of failures and rework, is harming the whole project. Also entailing disadvantages for the whole project is the attempt of contractors to keep their workers fully facilitated. It has to be understood that a high capacity facilitation makes the whole process take longer, as the allegory with a highway at rush hour proves.

In summarization it can be said, that an improvement in efficiency can only be achieved if the mindset in the construction industry can change. Especially a better approach to-

wards the allocation of risk and the fragmentation of our projects can bring tremendous improvements in productivity. Basically it is the combination of high fragmentation and the way of managing processes that produce the highest amount of waste within projects.

### **7.3 Conclusion**

In this chapter the downsides as well as desired and necessary changes within the current project delivery methods have been discussed. The most important statements from the interviews regarding these questions have been comprehended and linked together. It was found that a combination of high fragmentation, the lack of trust, the low bid approach and the unpredictable workflow are being recognized as the major downsides of current practice. These four reasons are interdependent from one another and a combination of them multiplies the drawbacks for a project. Regarding the desired and necessary change, it could be determined that raising the productivity and quality as well as bringing about change in the contracting practice are of capital importance to the industry. Also in that regards the improvement of productivity is strongly dependent from a change of the current contracting model. Further it can also be stated that improving the productivity locally causes an unreliable workflow for the whole project resulting in bad performance. The following two chapters will answer the questions if integrated practices can cause these improvements and changes as well as what could be the hurdles at introducing Lean Construction or Project Alliancing to the industry.

## 8 Impact of Integrated Practices

In this chapter it will be discussed, if the changes and adaptations that are demanded by the industry can be achieved by introducing integrated practices like Lean Construction or Project Alliancing. Therefore the downsides and changes introduced in the previous chapter will be compared to the improvements that the implementation of integrated practices can bring about. As mentioned above, the main drawbacks and demanded changes are concerning the fragmentation of projects, the lack of trust and cooperation, the unpredictable workflow and the low bid awarding method. Further an improvement in productivity, risk allocation and quality are being desired by the industry.

Therefore the impact of integrated practices will be presented according to the downsides of current practices and desired changes developed above. In a final chapter, possible negative impacts that could be caused by integrated practices will be presented to consider the effects of Lean Construction and Project Alliancing from all possible perspectives. The topics will be arranged as follows:

- |                                      |   |
|--------------------------------------|---|
| <b>8.1. Increasing Collaboration</b> | <b>8.5. Early Integration and Information</b> |
| <b>8.2. Handling the Risk</b>        | <b>8.6. Diverse Contracting</b>               |
| <b>8.3. Productivity Improvement</b> | <b>8.7. Possible Negative Effects</b>         |
| <b>8.4. Higher Value</b>             | <b>8.8. Conclusion</b>                        |

### 8.1 Increasing Collaboration

*Unity is strength...when there is teamwork and collaboration  
wonderful things can be achieved.  
[Mattie Stepanek]*

Collaboration is affecting and enabling several of the other points listed in this subchapter. It backs up risk allocation, improvement of productivity as well as innovation and enables the holistic view for all project participants. Therefore it can be seen as a crucial ingredient for successful project deliveries and thus it does not come as a big surprise that integrated practices like Lean Construction and Project Alliancing are really all about the parties working together. If there is a trustworthy atmosphere amongst all project participants and they work as a unified team, the risk of the whole project can be minimized and the best way to manufacture the building can be determined. [Nagaraja]

However, the main goal of Lean Construction has never been to establish collaboration amongst the participants, but to raise the productivity of a system. The founder of the Lean Construction Institute Gregory Howell stated, that they “did not wanted to be nice to everybody”. What lead to the establishment of the integrated project delivery was that it was the key to design more effective systems. They found that what was hindering the improvement of the whole process were boundaries between the individual trades and parties. Howell exemplifies that as follows: if the structural contractor would weld the pipe hangers onto the steel when it was in their shop it would be much less expensive than for the mechanical contractor. Since moving that money from one trade to the other is not possible within a traditional practice, they saw the need to introduce another framework, which enables a holistic view and collaboration among all project participants. [Howell]

### **8.1.1 Holistic View**

Unlike the car manufacturing where Lean Construction has its roots, in construction look at a project only in pieces and never consider it in a holistic system. We look at the trades for themselves as well as contractors, the owner and designers are fragmented, even within their own organization. Since there is no trust among all of these stakeholders, every party puts a contingency on top of the estimated costs – due to that each intersection between trades, contractors, designer and owner adds to the price. If you add the time being needed for those inefficiencies, the whole waste adds up to at least 20 to 30 %. [Nagaraja]

Now if one would think of a car assembly line where one step of the whole process does not consider the previous and following step, the whole assembly line would break down within minutes. Only a holistic view of a process makes it possible to improve the efficiency of the interacting steps in a coherent manner. Single processes cannot be improved effectively until all processes are not being synchronized with one another. The acceleration of single steps, as it is being practiced at traditional projects, does only make the whole procedure less reliable and more likely to take longer, as demonstrated with the Parade of Trades game in the following chapter.

### **8.1.2 Fewer Interfaces – Lower Costs**

As mentioned several times, the fragmentation and many interfaces are making the whole process of construction very inefficient. Another side effect of so many stakeholders being involved in a project is that all of them are feeding from the project. The extensive incorporation of insurance companies, legal parties and dispute resolution manag-



ers, to name a few, make the cost of the whole project go up. Since a lot of these parties are not needed in an integrated project delivery, the profit of a project is being shared among fewer parties. However, these unnecessary stakeholders need to be considered as a hurdle at the change towards integrated practices, since they will need to be occupied elsewhere. [Nagaraja] Chapter nine about the hurdles and chances for integrated practices will address this problem.

## 8.2 Handling the Risk

*Owners will take the least amount of risk  
and push that off to the constructor and designer  
...because they can.  
[Sam Spata]*

### 8.2.1 Reducing the Risk by Increasing Exposure and Cooperation

At traditional project delivery approaches such as design-bid-build, the parties are trying to reduce their own risk instead of reducing the risk of the whole project. The risk is being passed from one party to another, without really being considered. The whole process starts with the owner pushing all the risk to the designer and the general contractor or construction manager. He does that because the current contracting practice and market situation allows him to do that. [Spata]

The paradox at integrated practices is that the owner actually reduces the overall risk of the project by exposing himself to the risk. Even though the increased exposure towards pain- and gain sharing the risk is minimized if working in an integrative fashion with people who have an incentive to solve the problem and don't fix the blame. At traditional projects the focus lies on the latter, since the goal is to make sure somebody else is at fault. That approach makes the solution take longer and therefore allows the problem to grow bigger and cause more damage. [Howell]

### 8.2.2 Reducing the Risk by Reducing the Uncertainties

Unknowns and uncertainties are one of the main reasons for disputes, delays and rework in a construction process. Therefore they also represent a major risk for all project participants. To reduce these uncertainties it is crucial to introduce all parties early to the project. Further the evaluation of the unknowns has to be conducted in a collaborative manner with honest communication. That approach will lead to a shared perspective of uncertainties amongst the parties and into a more successful project. [Nikain] At tradi-

tional practice uncertainties and unknowns are not being handled in such a manner. Further it can be stated that the fragmentation will increase the gap in perspectives and even create further unknowns due to dishonesties among parties.

The distribution of risk among the stakeholders has even more positive effects, as will be carried out in the following chapter about the boost of innovation through shared risk. The OOPS-Game on the other hand should show, how important it is to make the right decisions during the design and delivery of a project to reduce and manage the risk of unknowns and uncertainties.

### **8.2.3 Innovations Through Shared Risk**

There are two reasons hindering the application of innovative methods at traditional projects. One is the unknowledgeable owners, who are not aware of innovations regarding construction techniques, because they are no experts. The other is that parties, who would have the expert knowledge and are aware of innovative solutions, will not apply them, because the risk would transfer onto their side. So owners put conservative solutions into their specifications and contractors will just do it that way to avoid any additional risk.

At projects delivered with Lean Construction or Project Alliancing much more innovative solutions can be applied. Since all parties are integrated from the very beginning the construction companies and designers are introducing the knowledge about new technologies, methods and approaches. Then these innovations can be discussed honestly and eventually, with the agreement of all parties, be applied because the risk is being carried collectively. [Nagaraja]

### **8.2.4 OOPS-Game**

Gregory Howell and Mike Vorster have created the OOPS-Game around 1991. It is a simple card game highlighting the risk of decision-making under uncertain conditions. By putting the player into a situation he has no certainty about the aftermath of his decision the game simulates how projects are being managed. To play the game only nine cards numbered from 1 to 9 are needed. The framework of the game, presented in figure 12, includes the yard and two decks for the planned and oops'd cards as well as a field to place the project cards. The project field affiliates a place for each card. Once all the spaces from the project field are occupied with the according card, the game is finished. The arrows between the fields show what moves a card can make and how much it

costs to move a card along the particular arrow. The aim of the game is to place all cards in the project field while gathering as little points as possible.

To play the game, the nine cards need to be shuffled and lying face down on the yard. At the beginning the first card is turned over and placed on the according field of the project, costing one credit. From now on only cards that share an adjacent edge with one already placed in the project field can be put there. For example, card 1 shares an edge with cards 2 and 4; card 5 shares the edges with cards 2, 4, 6 and 7. In addition to that, the player has to decide before turning the next card over, if he would like to try to build it or plan it first. Both moves cost one credit, however if trying to build a card and the turned card does not share an edge with one already place in the project, that card needs to be put onto the oops deck, costing two credits. Cards that are lying on the oops or planning deck can be put into the project at any time, assuming they share the edge with another card on the project.

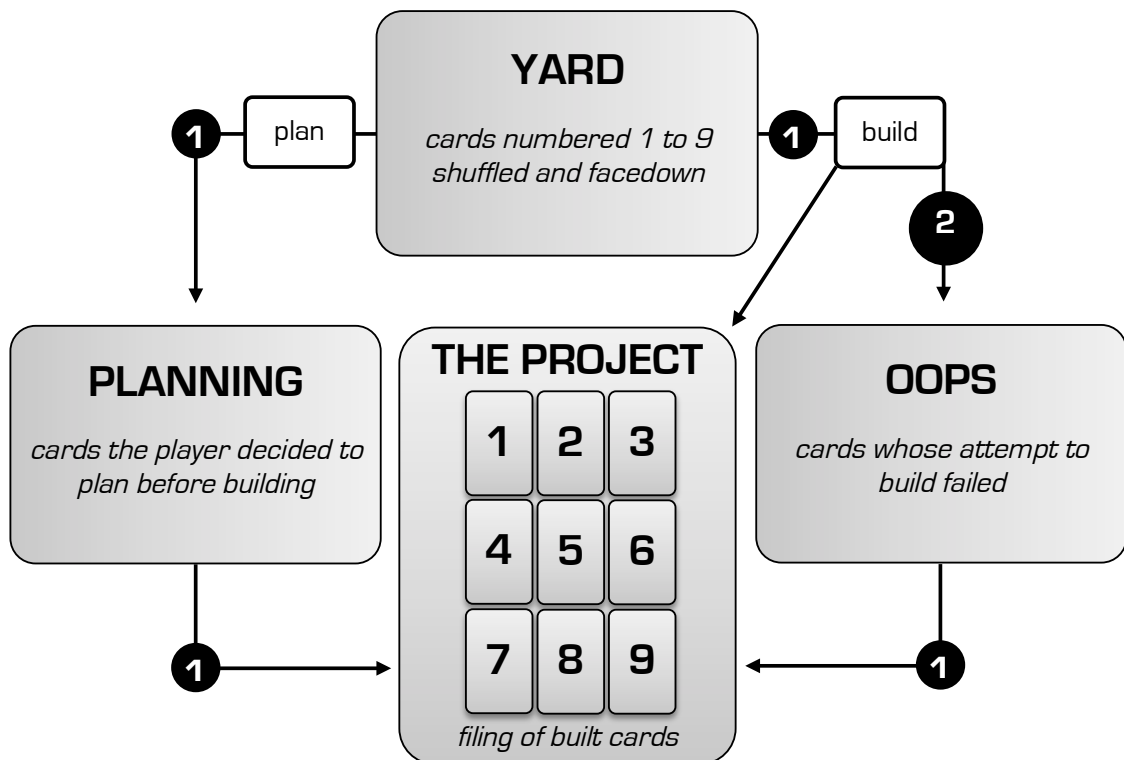


Figure 12: OOPS Game Framework. From [Howell]

It is obvious that the cheapest way to put all cards into their places at the project field is just building them directly from the yard. By that a score of nine would be achievable, however, with that strategy the risk is very high that a card is being oops'd, costing three credits more. On the other hand, if one plans all cards before building them, each card

costs two credits. Therefore the strategy is critical to achieve a good score. If the first six cards are being planned, it is impossible that a card is getting oops'd. However, no scores lower than 15 are achievable by doing that. It is a good strategy to plan the first card and only attempt to build one if the chance to oops it is lower than 50 %. If for example card number 1 and 4 are already on the project field, the attempt to build the next one is the right decision, because the chance to oops it is 3 to 4. The situation gets more complex if the value of cards lying on the planning or oops deck are visible.

With that game it is possible to experience the results of decision making under uncertain circumstances. It also shows that planning in the beginning can be linked to lower scores, because building is more risky in the beginning of the game. Towards the end of a game, planning becomes more and more dispensable. With these similarities to the actual process in planning and delivering a real project, the Oops-Game can be seen as a good tool to raise the awareness about consequences of decisions made under uncertain conditions.

### 8.3 Productivity Improvement

*Productivity is pretty much dependent from human effort.*

*If you think about it, we basically still use the same ideas as they did when building the pyramids or awarding contracts in Greece more than 2000 years ago.*

*[Gus Maimis]*

The Lean approach instantly links the reliability of the workflow to the productivity of a system. As mentioned in the subchapter about the importance of a holistic view, the consideration of all interacting processes is crucial to make the whole project more productive. So it is not until the productivity of all steps is secured that the whole procedure can be reliable and therefore also productive. Sam Spata refers to that challenge with an analogy to the development of the first computer after World War II. John Van Neumann faced the need to develop software that could get reliable results from a computer using unreliable hardware. At construction process the software is the form of agreement as well as how we manage the project to deliver the hardware – a new building. The unreliable components in that case are human beings involved in that process. Integrated practices try to create processes by which those unreliable elements can deliver highly reliable results. [Spata]

The importance of the improvement of reliability in regards to productivity will be exemplified with the Parade of Trades game.

### 8.3.1 The Parade of Trades

Gregory A. Howell, the co-founder of the Lean Construction Institute, developed the game. The Parade of Trades illustrates the impact workflow reliability has on the overall performance of projects. The construction process is being simulated by a number of trades passing pieces of work from one to another. Resources produced by the first trade are necessary for the second to start working. Therefore the second trade cannot start working until the first one passed a piece and so forth. The game shows how variations in the flow of work influence the time it takes for the work pieces to go through the trades. Beforehand it can be stated that variability has a devastating impact on the continuous flow of work. Only when single steps within a procedure are synchronized with one another, the waste accumulating in a production process can be reduced. Therefore the simulation proves that the reliability of the workflow is a crucial factor to make a process more efficient. cf. [39] p. 1 f.

Several versions of the game varying in the number of trades or pieces of work can be found, however they all feature the same principles and processes. These essential parts and rules of the game will be explained subsequently.

#### Procedure

As mentioned, the parade game features different trades passing units of work (UoW) from one to another. The number of pieces that one trade is allowed to pass by is being determined by rolling a dice. The game is split into sequences, while one sequence represents one week of work and allows one roll per trade. So the rolled number shows the capacity of the trade for that week. The passed pieces of work go into the buffers arranged between the trades and can be processed by the following trade during the next sequence.

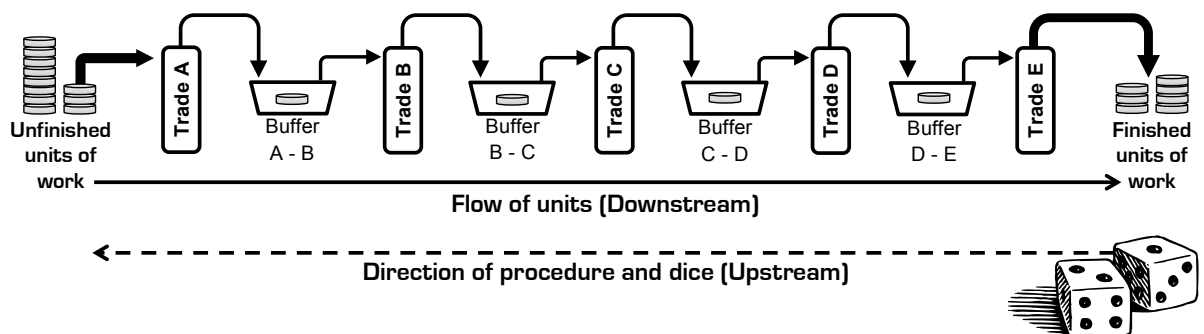


Figure 13: Parade of Trades Procedure. From [39] p. 4.

A sequence starts with the last trade rolling the die if he has resources available from upstream, or passing the die to the next trade if there are no resources in his buffer. So the units of work (UoW) are travelling downstream from the first trade to the last one, while the sequence of rolling the dice goes the opposite direction.

As shown, the units of work are travelling downstream, while the direction of the procedure goes the opposite way. By that it becomes obvious, that units of work need to be in the buffers already to enable a trade to work. So pieces of work that were completed the week before, need to be available from upstream to allow a continuous flow. Therefore the only trade able to work during the first sequence is trade number one. During the second sequence also trade number two should have units of work available in his upstream buffer and so forth and so on.

If one would assume that five trades have a reliable weekly capacity of five units of work and the total number of unfinished units is 100 pieces, the duration of the process can be calculated easily. The first trade will pass five pieces for the first ten weeks. The second trade will do the same, starting with a delay of one week. Consequently the third will start two weeks later, the fourth three weeks later and fifth trade will pass his first five units of work four weeks after trade number one did. Therefore the process will take the number of units of work (UoW) divided by the weekly capacity of each trade plus the number of trades minus one week.

$$\text{Duration [weeks]} = \frac{\text{total number of UoW [UoW]}}{\text{weekly capacity [UoW/week]}} + (\text{number of trades} - 1)$$

For the given example with 100 UoW, a weekly capacity of 5 UoW and 5 trades the duration is 14 weeks. With that simple formula the duration for any combination of capacity, number of trades and number of UoW can be determined. That formula only works for non-varying weekly capacities. However, at the simulation of the parade of trades, different dice are being used representing more or less reliable weekly capacities.

### **Dice and Trades**

As mentioned the Parade of Trades is using different dice representing the weekly capacity to cope with different workflow reliabilities. That is being achieved by using dice which all roll the same number on average, but with different reliabilities. A die rolling a five every time is representing the non-varying weekly capacity from the example above. Dice like that deliver the most efficient and shortest possible duration of the process, since they are a hundred percent reliable. Beneath that dice several other can be ap-

plied to simulate less reliable capacity. For the ongoing demonstration and simulation the average roll of 5 from the example above will be retained. However dice with a higher average roll will be introduced to make the difference of reliable and unreliable capacity even more obvious. For the example presented below, the following dice will be used:

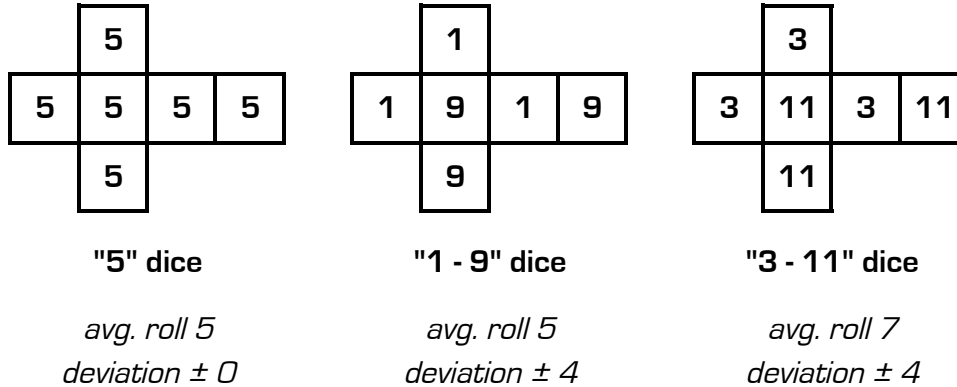


Figure 14: Variety of Dice for the Parade of Trades.

Just as the dice, also the number of trades can vary dependent on the version of the Parade Game. As mentioned in the example given above and shown in figure 12, in this version there are five different trades, labeled A, B, C, D and E.

### **Simulation**

The simulation presented here has been adopted from the paper published by professor Iris D. Tommelein and Greg A. Howell. [39] The criteria for this simulation of the Parade of Trades have been presented in the previous subchapters and can be summarized as follows:

- Number of Trades: five, Trade A, B, C, D and E [see figure 13]
- Units of Work (UoW): 100
- Used dice: "5", "1 - 9", "3 - 11" [see figure 14]

The following charts show the results of a single iteration with each of the different dice. They show how the unfinished UoW decrease (blue curve) and the UoW processed by the trades increase. The orange curve shows the UoW processed by the last trade E and therefore represents the finished UoW. At the first chart, displaying the reliable dice that always rolls a five, one can see that there is a constant curve for all processes. The time it takes until all UoW passed trade E is 24 weeks or sequences, accordingly to the formula developed before. That duration is taken as a reference point to compare the curves to the ones produced by the unreliable dice "1 - 9" and "3 - 11".

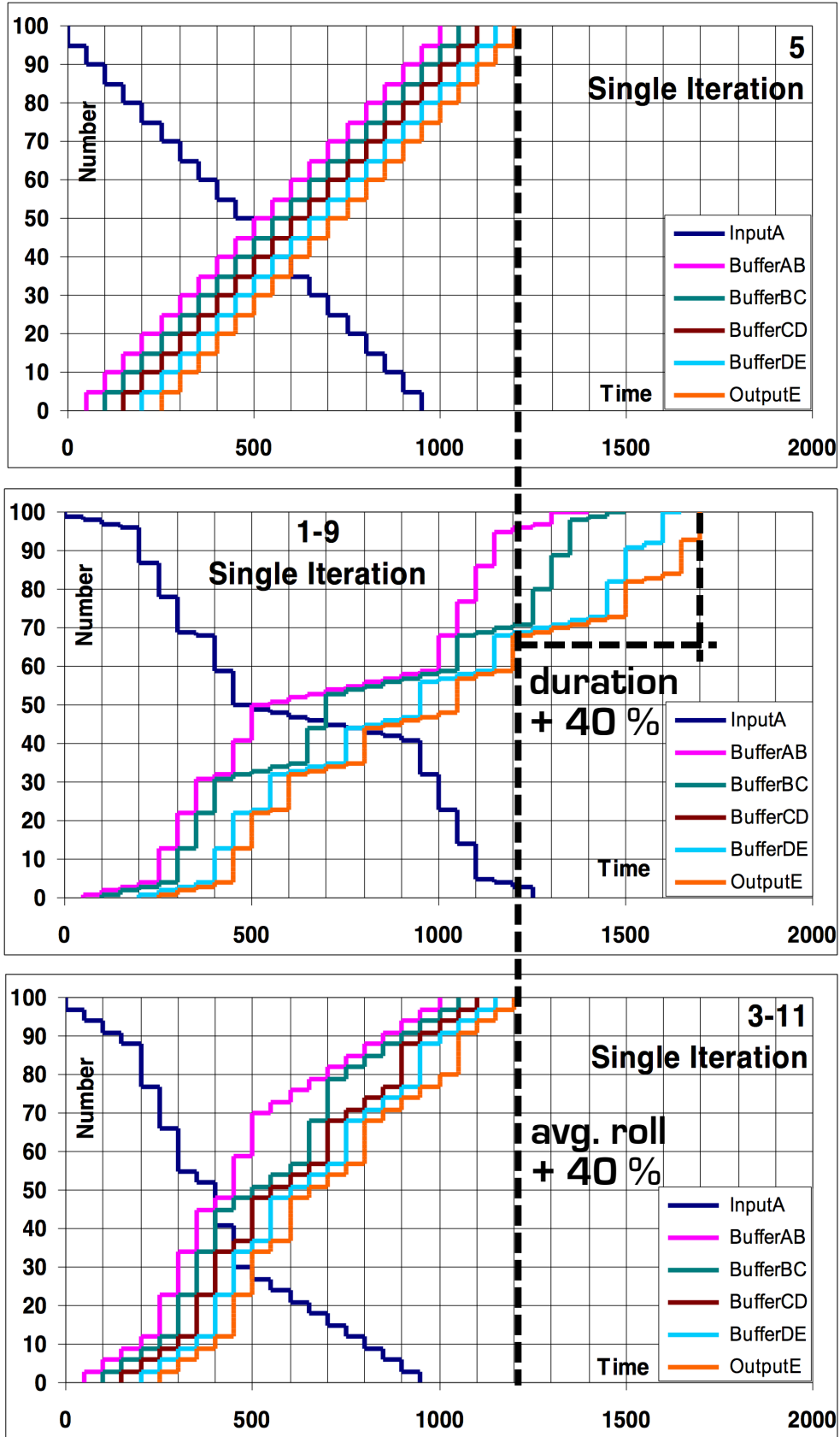


Figure 15: Output from Single-Iteration Simulation. From [39] p. 8.



The two lower charts show the curves produced by the unreliable dice. At the chart from the "1 - 9" dice, which has the same average roll as the "5" dice, the overall duration of the process is more than 40,0 % longer. To achieve the same duration of 24 weeks with an unreliable dice, the average roll of that dice needs to be 40 % higher. Therefore the average roll of the "3 - 11" is seven making it 40 % higher than the initial five. So the duration is the same in chart three and one, as well as the deviation of the dice is the same used in chart two and three. Therefore it can be stated, that an unreliable capacity has to be 40 % higher to achieve the same result as a reliable capacity provides.

If applying these findings onto a construction project it would mean, one either accepts that an unreliable procedure takes longer, or to invest 40 % more into resources to make the unreliable procedure as fast as the reliable one.

The following table displays the information from the single iterations in clearly arranged numbers.

Activity	Number of Rolls	Average Roll	Avg. Roll Realized	$\Delta$ Avg. - Realized	Weighted Average	Weighted Realized	Weighted $\Delta$
<b>reliable "5" dice</b> <i>[avg. throw 5, deviation <math>\pm 0</math>]</i>							
Trade A	20	5,00	5,00	0,00	100,00	100,00	0,00
Trade B	20	5,00	5,00	0,00	100,00	100,00	0,00
Trade C	20	5,00	5,00	0,00	100,00	100,00	0,00
Trade D	20	5,00	5,00	0,00	100,00	100,00	0,00
Trade E	20	5,00	5,00	0,00	100,00	100,00	0,00
<b>Finished in</b>	<b>24 weeks</b>	<b>5,00</b>	<b>5,00</b>	<b>0,00</b>	<b>500,00</b>	<b>500,00</b>	<b>0,00</b>
<b>unreliable "1 - 9" dice</b> <i>[avg. throw 5, deviation <math>\pm 4</math>]</i>							
Trade A	26	4,08	3,85	-0,23	106,08	100,00	-6,08
Trade B	28	3,86	3,57	-0,29	108,08	100,00	-8,08
Trade C	29	5,14	3,45	-1,69	149,06	100,00	-49,06
Trade D	29	6,79	3,45	-3,34	196,91	100,00	-96,91
Trade E	30	6,60	3,33	-3,27	198,00	100,00	-98,00
<b>Finished in</b>	<b>34 weeks</b>	<b>5,29</b>	<b>3,53</b>	<b>-1,76</b>	<b>758,13</b>	<b>500,00</b>	<b>-258,13</b>
<b>unreliable "3 - 11" dice</b> <i>[avg. throw 7, deviation <math>\pm 4</math>]</i>							
Trade A	20	5,40	5,00	-0,40	108,00	100,00	-8,00
Trade B	20	5,80	5,00	-0,80	116,00	100,00	-16,00
Trade C	20	7,80	5,00	-2,80	156,00	100,00	-56,00
Trade D	20	9,40	5,00	-4,40	188,00	100,00	-88,00
Trade E	20	8,60	5,00	-3,60	172,00	100,00	-72,00
<b>Finished in</b>	<b>24 weeks</b>	<b>7,40</b>	<b>5,00</b>	<b>-2,40</b>	<b>740,00</b>	<b>500,00</b>	<b>-240,00</b>

Table 5: Output Values for Single-Iteration Simulation. From [39] p. 9.

A key factor, not being apparent in the charts, is the average roll of each trade as well as the actually realized one. Obviously, the actual average roll and the realized one are alike at the reliable "5" dice, since each trade has a capacity of 5 UoW per sequence. At the unreliable dice however, the discrepancy of the average roll and the realized one is significant. The lower realized roll can be lead back to the fact, that not enough UoW may have been in the upstream buffer so the trade had not enough resources to move his full capacity of UoW into his downstream buffer. In the last column the difference from the average capacity and the realized capacity is given. That amount of unused rolls can also be referred to as wasted capacity. So the capacity wasted with the two unreliable dice ranges somewhere around 250 making the process 50 % less effective than the reliable dice does.

Another aspect that is being displayed in table 5 is that the first trades do not waste as much of their capacity as the others do. While the first trade at the sequence using the unreliable dice only wastes six, respectively eight counts of their capacities, the last two trades waste about ten times as much. That leads to the assumption that the first trades at a construction project, usually the structural trades, are not as affected by bad reliability. However it is them, who set the framework for the project delivery whenever they work as a general contractor.

The following figure shows the inventories that stack up in the buffers between the trades when the capacity is unreliable. To get more accurate results 1000 iterations have been conducted with a computer program.

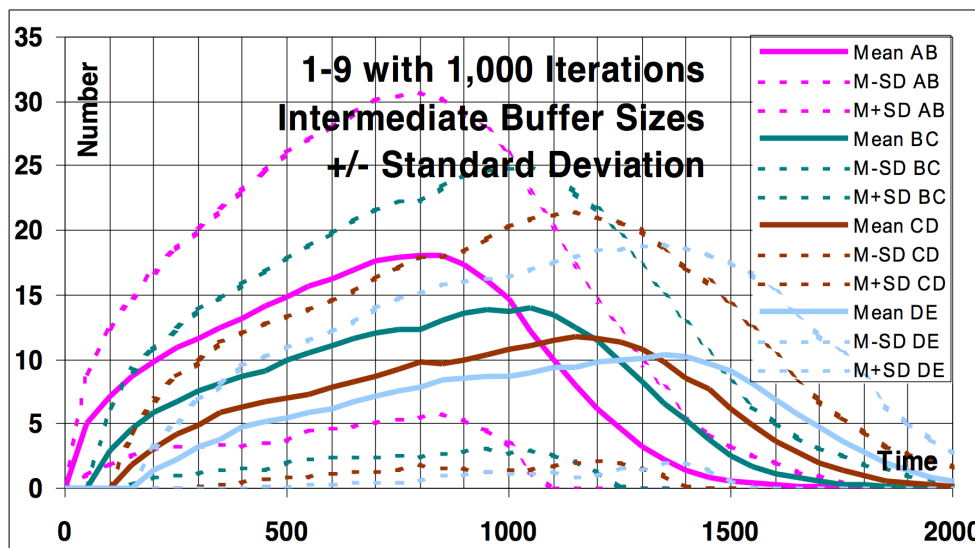


Figure 16: Buffer Size from 1000-iteration Simulation for Die "1 - 9". From [39] p. 11.

It can be determined that the first process, initiated by trade A, produces the highest amount of inventory in Buffer A - B. That is because trade A always has UoW available and is not affected by the variation that adds at every interface between the following trades. That does underline the fact that the first trade, often the structural contractor working as a GC and contractual partner with the owner, is not suffering from unreliable workflow.

### ***Evaluation of the Simulation***

Even though this simulation bares a deep truth regarding the influence of workflow reliability, it has some deficiencies compared to the actual delivery of a construction project. The most significant one is that the simulation assumes that all trades use the same dice. That is a very optimistic assumption if one considers the high fragmentation and lack of trust and collaboration discussed in this thesis before. Another factor that might not apply in reality is that buffers are unlimited. There might be some trades who can produce without considering the capacity of the following processes, however most cannot. For the simulation at hand it would mean that a buffer cannot exceed a certain number of UoW and a fully utilized buffer would restrict the upstream trade to deliver its full capacity. That would reduce the overall workflow even more.

There is another thing beneath the influence of variability the simulation explains. The charts from the computer simulation, displaying the results of 1000 iterations, explain why some traditional, unreliable projects still do well and some do not. The following chart shows the deviation of the curves and therefore gives the best and worst possible development of the process.

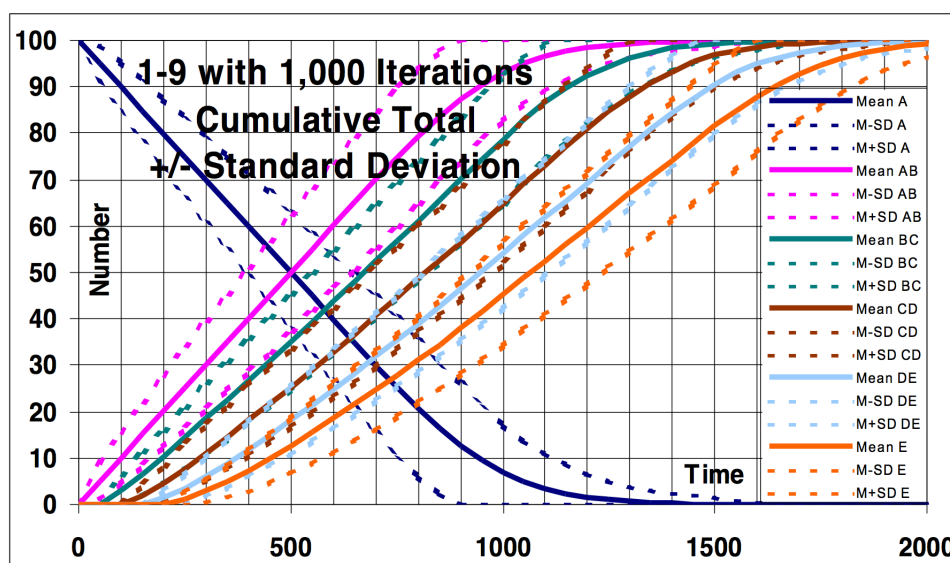


Figure 17: Output from 1000-iteration Simulation for Die "1 - 9". From [39] p. 10.

In general it can be said that the first trades are more efficient, because their slopes are higher, which is directly linked to higher productivity. By looking at the dashed lines one can tell that the first trade can even finish his process faster than with the reliable “5” dice, if he is lucky enough to roll a nine more often than a one. That pattern continues through the following trades, however the rear trades still cannot make up for the bad influence of variability and the duration of the reliable dice remains unreachable. However that chart shows that even with an unreliable dice satisfactory outputs are achievable, depending on the luck rolling the dice in the simulation and on good management techniques at real construction projects.

These drawbacks of variation regarding the capacity is strongly relating to another aspect presented in chapter seven. As mentioned in chapter 7.2.1 contractors try to keep their workforce from the project until there is a lot of work for them available. That can be associated to stacked buffers in this simulation. That approach makes the whole workflow even less reliable and increases the overall risk of the project. [Howell]

## **8.4 Higher Value**

No matter what type of project, there are always three areas being more or less prioritized. The order is dependent of what the owner has decided to be of importance for his building. The well-known triangle is being formed by quality, cost and schedule. These factors can be defined as quality in the owners’ view of a project and are being influenced by any of the decisions made. [Nikain] However award strategies that tend towards integrated design and construction also tend to have better quality and more reliability in cost and schedule. [Spata] According to that statement, Lean Construction and Project Alliancing can secure all three factors of quality to achieve outstanding results.

### **8.4.1 Better Design**

During the design phase at traditional projects the architect is working out the design of the building following the more or less specific requirements defined by the owner. At integrated practices the contractor and engineers are already being a part of the team, just as the owner himself is. At traditional projects the owner is usually not as engaged throughout the project delivery than he is during an integrated project, where he is a part of the team. Since, as Sam Spata put it: *“Lean Construction is not a spectator sport”*.

That close engagement of the client in combination with him making timely decisions he sticks with, is what makes the project delivery at integrated procedures much quicker and more efficient than at most traditional projects. There are two tools at LC that exemplify just that: the Last Planner System (LPS) and Choosing by Advantages. First of all, the LPS starts at a very grass roots level of the project and therefore accomplishes an early integration and a balanced level of information among all parties. That collaborative approach towards scheduling a project further helps building the understanding across stakeholders about what is necessary to design and build the project. Choosing by Advantages is a tool that helps to obey the principle that quality only exists in the mind of the customer. By applying that tool, all decisions concerning the design or facilities of a project are being based on the amount of value they add for the owner. Therefore the invested money is being distributed according to where the investment is adding the highest possible value for the customer. [Spata]

By that early integration of the stakeholders, the close collaboration with the owner and the focus on his objectives, the owner will not only get higher quality, but also a building fitting his needs very accurately.

## 8.5 Early Integration and Information

*If you have a relationship that starts early and is open as the project develops, the unlikelihood of having gaps of understanding is reduced.*

*[Reza Nikain]*

### 8.5.1 Early Integration of Project Participants

As the name integrated project delivery already implies, the parties involved in the construction process are being integrated into the project delivery team. That is happening during the early design phase or even before that, in the project definition phase. By that approach a lot of know how from the people who are actually going to build the job can be imported. The downstream knowledge of different contractors and trades is coming upstream and promotes a better design of the building and the process. To accomplish that early integration, the awarding method needs to allow the selection of contractors at that early stage. Without having the key participants, which is not just the construction manager and the architect, but the people actually executing the work, integrated early, it is hard to design a production system that delivers the job efficiently. [Spata]

The early arrangement of the core team features another major positive effect making it more efficient than design-bid approaches. At traditional low bid projects, the whole design needs to be finished and issued for bid before the construction process itself can start. Integrated approaches like Lean Construction or Project Alliancing however, allow the construction to start while the building is still being designed. Early foundation, steel or structural packages can be executed while the building is still being considered inside. That gives integrated methods a huge advantage over any traditional approach in regards to the schedule. [Howell]

### **8.5.2 Balancing the Level of Information**

This early integration of contractors is especially important for clients who are not so knowledgeable and only do projects every 10 years. These clients are really liable to that a-symmetry in relationship and especially information, since they do not know anything about what should things cost and how long it should take to build them. The fact that the owner buys the service of the whole team, consisting of designers, engineers and constructors, at the very beginning of a project, rectifies this relation by putting every stakeholder to the same level of information. Another tool that can support balancing the level of information is Building Information Modeling (BIM). Through BIM all information concerning the design of a building are being gathered in a 3 or even 4 dimensional computer model serving as a base of information for all project participants, but especially giving the owner information that would have usually been with the contractor exclusively. [Spata]

### **8.5.3 The Flow of Information and Reliable Promises**

Integrated practices are also very diverse in the way people communicate with one another. It is different concerning the direction the information travels and how the relationships between people influence the reliability of that information. For example, the information at Lean Construction projects is rather being pulled than pushed. That means people from downstream are requesting specific information from upstream. The practice at traditional projects usually consists of downstream parties being flooded with a lot of unnecessary information from upstream. The reliable promises are the outcome of the before mentioned personal relationships of people on the project. The maxim in this regard is to never make a promise you cannot keep. Even though this is not legally binding, the cooperation among participants and the fact it is a personal promise is giving the information a much higher quality. So the network of personal commitments is governing the efficient flow of information instead of extensive legal coverage trying to achieve that. [Jarvis]

## 8.6 Diverse Contracting

*Owners has to decide what they are buying.  
Are they buying a product or are they buying a service.  
[Gregory Howell]*

When we see contracts as a set of rules, defining how the game of construction is being played, it becomes obvious that contracts influence the way people behave in a system. Every party has figured out how to behave to avoid being responsible for any failure given the rules our contracts define. It is the way contracts are designed that made the architects become aloof from the construction process, the owner less engaged or made the contractors hit for every change order. These patterns of behavior make the parties more successful under the given circumstances, making the designer become less litigation problems and raising the profit of the contractor.

So the challenge is to change these rules of behavior, and therefore change the way our contracts work and what kinds of behaviors are being rewarded. This restructuring of the game can only be achieved through new forms of award techniques and contracting. Doing that is a leadership decision. Assuming that people will adopt new behaviors automatically is not constructive. So leadership needs to demonstrate to people that they expect them to start working with new behaviors. [Spata]

The architect Andrew Jarvis gave an example of how relational contracts influence the behavior of project participants. He stated that at projects governed by an Integrated Form of Agreement, the parties are looking out for each other and trying to deliver the best possible product. [Jarvis]

Another aspect that diversifies relational contracts from most traditional ones is the approach towards managing complexity. First of all it needs to be said, that construction projects range from simple–certain–slow to complex–uncertain–quick while any combination with different emphasis can be found in practice. However, all projects include a certain portion of complexity and uncertainties, making them more or less hard to handle. Now a traditional contract would try to define the future project as exactly as possible, which of course is impossible given the amount of uncertainties and complexity in the system. So traditional contracts define a product, while every change in the future projects violates with the defined specifications and causes disputes and problems. On the other hand, a relational contract manages that change by allowing the system to adapt. With a relational contract the owner buys the service of a team trying to solve his problem and delivering the project to his satisfaction. [Howell]

The following paragraph showing the impact of transaction cost analysis strongly relates to the previous, however this time the recurrence and complexity of a transaction is being highlighted. Oliver Williamson, a lawyer in economics, states that transactions range from frequent and simple, like buying eggs in the supermarket, to idiosyncratic and occasional, like buying an oil platform. Since the uncertainty is vastly different between those two types of transactions, we cannot implement the same type of contracts to process them. A transactional contract, which foresees a single outcome, is suitable for a well-defined product not facing any uncertainties. A relational contract on the other hand sees many possible outcomes managing and embracing the change a complex system comes by with. [Howell]

## 8.7 Possible Negative Effects

*Systems are not a panacea for human behavior.*

*[Andrew Jarvis]*

During the literature review, but especially from interview findings it could be determined that the establishment of integrated practices could also have negative effects. Therefore the following subchapters present the two major downsides of project delivery methods like Lean Construction and Project Alliancing and a possible solution. However it could be found that the main shortcoming of any system is being a system in the first place. As the quote by Andrew Jarvis indicates, systems can only be a framework for human behavior, since human behavior is too complex to be managed by systems. Any set of rules can be faulted, corrupted and gamed by people as the following concern about integrated approaches shows. [Jarvis]

### 8.7.1 Capitalization of the Reward System

*As soon as the target costs are set  
the contractor or construction manager  
comes up with a bunch of ideas making it cheaper.*

*[Gus Maimis]*

That statement shows how a lot of people in the industry think about delivery methods rewarding cost savings like the construction manager (CM) at risk or CM guaranteed maximum price as well as Lean Construction and Project Alliancing. And also clients are aware of that as the example in chapter 4.2.3 from the pharmaceutical industry shows.



Everybody will put a little extra on top of their numbers to protect themselves for reasons explained before like lack of trust and risk distribution. [Spata]

Andrew Jarvis even stated that reward as well as penalty clauses in contracts are failures since they can encourage disputes. Any system that is creating rewards and penalties can get corrupted. Contractors can set the targets higher or schedules longer to get rewards or take shortcuts to avoid penalties. Because making profits is so important to everybody it can be stated that this behavior is human nature. [Jarvis] Therefore it cannot be prevented by regulations. This insufficiency must be considered as a major problem of our society, exceeding the scope of the construction industry by far.

### ***Solution***

Both integrated methods have a solution for the threat of exploiting the reward system, while the monitoring process at Project Alliancing is more extensive than at Lean Construction. At Project Alliancing there are three independent board members who are governing the process of cost estimation, the extent of the overheads and the development of the reward system. The Independent Estimator (IE) is responsible for verifying if the estimated costs are reasonable and customary in the particular market. The Probity Auditors (PRA) duty is to supervise the selection process of NOP's as well as checking if their submitted overheads are within the defined limits. The Financial Auditor monitors the compensation of the NOP's and verifies their costs.

At Lean Construction there are fewer parties involved in the validation process, which shall secure a fair and true estimate of cost, schedule and quality of the project. The validation process takes place at the beginning of the project where the owner, designer and constructor have to agree on the validated scope of the project. At that point any of the parties can pull out of the project without getting penalized if the risk seems too high. A well-validated project as it is required in integrated forms of delivery should eliminate the potential of padding on the numbers by all parties. [Spata]

### **8.7.2 High Costs Early**

*The early involvement of parties means a more extensive design phase  
and therefore more costs for the owner very early on.*  
[Gus Maimis]

As mentioned before an integrated approach requires having the key participants involved in the delivery team at the grass roots level of a project. By doing that, the costs

during the design phase rise since all these parties need to be paid according to their true expenses already. So that more extensive design phase leads to higher costs for the owner early on where there might not even be any funding available yet. [Maimis]

In most cases owners won't come with a budgeted project, which is an "allocation of money suitable to achieve the program quality and quantity in the time allowed". They may be having a bag of money, but that has not been proven to be the right amount of money for the targeted program and schedule. [Spata]

Due to these two reasons the high costs for the design phase can be seen as critical. Especially for owners being dependent from public funding or corporations reporting to their trustees.

### ***Solution***

The problem of high costs for the design can only be addressed by raising the awareness about how much that early investment can save in the further project development. A statement of the head of the design and construction group of one of the biggest hospital management companies in the United States exemplifies that. He stated that he is paying construction managers and architects higher fees, improving their profits by 50 maybe even 100 %. By giving them these incentives, they work in a lean fashion and reduce the overall cost of the project by 20 % or more. That example shows that paying people to behave in a collaborative fashion exceeds the invested money by far. [Spata] However only a few owners share this mindset and the mission therefore must be to spread this knowledge and positive experience for the good of the construction industry.

## **8.8 Conclusion**

This chapter highlighted the positive as well as negative impacts integrated practices like Lean Construction and Project Alliancing can have. The effects presented in the previous subchapters referring to collaboration, risk, productivity, quality, information and contracting are all interconnected with one another. As long as not all of them are introduced in a project, the positive effects of the others may be hindered. Only with the early establishment of a collaborative team sharing the risk of the project, looking at the owners' needs and values within an appropriate and fair contract, the efficiency, quality and overall project outcome can be improved. The following best practices from a project in California shall exemplify the positive effects a holistic implementation of integrated practice can facilitate.

California has very strict earthquake construction codes because of the prevalence of earthquakes. In the design of this building the intersection of a column and a girder is a moment frame that cannot move during an earthquake. Therefore the connection of the girder and beam cannot be penetrated in any way. Eventually one of the subcontractors drills little holes through the connection making the whole frame to be discarded, removed and refabricated costing 300,000 \$. Now in a traditional scenario the owner would have the construction manager fix it using his insurance. Under an IFOA where all parties have put their money in, they figured out a way to handle it. So to compensate for the 300,000 \$ they came up with the idea changing the design of the mechanical penthouse at the rooftop that saved 1,200,000 \$. They accomplished that by bringing together the steel fabricator, aluminum contractor and curtain wall contractor and find a more efficient way to build the windshield at the rooftop. They build the whole thing out of aluminum and used the already fabricated steel elsewhere. And that was only possible by working and thinking as team. If they had been in a traditional situation the steel fabricator would have said: I have bidden, I build it, it is going in, I get my money.

In addition to that at integrated practices the implementation in a team inspires participants to unknown achievements. It is really fulfilling to work in a collaborative manner with people who are actually building the structure. Architects and engineers working with craftsmen who are ingenious when it comes to how to actually assemble the design, can make the whole construction process much more efficient. [Jarvis]

These examples show what potentials are being disabled by traditional practice. In any traditional project a failure like the one presented above would have led to serious disputes and the search for somebody at fault, making the succeeding work even less efficient. By working in an integrated team, the question whose fault it was did not even occur, since everybody was affected by the consequences likewise and they focused on fixing the problem instead of fixing the blame as it is being practiced at traditional projects.

## 9 Hurdles and Chances at Implementation

Some industries, whether public or private, are embracing new approaches, some industries aren't, because some of the policies are too difficult to change. So it goes back to what is the value and how to measure the value. When a state sees the value in negotiated or integrated contracts, eliminating waste and getting a better quality and schedules, then they may go down the path on changing the approach. But this is probably not going to happen any time soon. [Nikain]

Therefore four things, which will be presented in the following subchapters, need to be considered to make integrated practices like Lean Construction and Project Alliancing get implemented more often:

- Hurdles need to be identified and cleared.
- The motivation to change the practice needs to be evaluated.
- A change in how projects are being considered needs to happen.
- Integrated practices need to be promoted.

### 9.1 Hurdles at Establishment

During the interviews several hurdles standing in the way of integrated practices could be identified. In the following paragraphs structural, moral and intellectual as well as economical and political hurdles will be discussed.

#### 9.1.1 Structural Hurdles

First of all it is obvious that public sector work is limited in the type of agreement and the way of awarding the contract. On the public sector, too much procurement has to go low bid, making it the main structural problem. However, public agencies would probably not even abandon the low bid approach if they could. Even though public projects often have greater autonomy than they admit and the law, just consider the competitive dialogue presented in this thesis, would allow diverse approaches, they stick with low bid procurement. Gregory Howell stated, that nobody who works for a public agency has ever been fired for doing a low bid project. [Howell] Hence, if doing a traditional contract, the majority of the risk is being transferred to the contractor, leaving the agency with nothing but a spectator roll.

However structural problems also occur at private owners and even within the organization of contractors and designers. For example private owners, who are reporting to their boards of trustees, can have troubles introducing innovative ideas. Their objective is to push away the risk and not being engaged within the construction process itself. That is hindering the establishment of a collaborative environment in the first place. Further, the boards do not want to hear about injured workers or the cost going up. They want to believe that they got the best possible price and quality through competitive bidding. That approach will not change until the board of directors of big private companies will not recognize that integrated practices can deliver a better and faster project. So that change really begins at the top chain of any organization. [Jarvis]

### **9.1.2 Moral and Intellectual Hurdles**

The lack of trust has been mentioned by most of the interviewees to be the main shortcoming of current project delivery practice, but also to be the biggest hurdle on the way to introduce integrated methods. Because there is no trust among the parties, they try to protect themselves with extensive legal parts of the contract and each party is looking out for their own share. [Nagaraja] That leads to the high fragmentation, which was already mentioned before and finally, the fragmentation constrains productivity and workflow. So most of the factors being so crucial for a successful project are being destructured by the untrustworthy relationships among parties in the first place.

Beside these hurdles, there are intellectual obstacles emerging from uninformed stakeholders, who may not even be aware of other ways of delivering a project. [Spata] But also people, who might know about it and do not accept or believe the change, cannot be forced into an integrated form of agreement. Their commitment has to be with their willing agreement and they have to identify and develop the belief into the advantages on their own. [Howell] During the interview Gregory Howell cited President Lyndon Johnson who stated, suiting these remarks: *"You can tell them to go to hell, but they just won't go."*

Eventually there is another thing standing in the way of implementing the holistic approach that Lean Construction as well as Project Alliancing stand for. There might be companies or owners, who adapted a few tools or ideas from integrated practices and think, they are already delivering projects in an integrated fashion. That is especially the case, when people are mistaking a particular tool for the broader philosophical approach that these methods represent. So these people, that are doing some things that superficially look like some integrated tools, thinking that they are already doing lean or alliancing, can definitely be seen as another major hurdle. [Spata]

### 9.1.3 Economic and Political Hurdles

As a hurdle in the sense of economics of a project, two things shall be mentioned. One is that an industry that is not communicating anything unsolicited can hardly be convinced to introducing a procedure featuring open books. Furthermore the numbers have to be communicated honestly and also compensated fairly. What comes in the way of this again is the lack of trust between the parties fueling disagreements and disputes. The other thing is, that moving money across financial boundaries can constitute a big problem. As soon as one begins to consider a project as a system in a holistic view, financial boundaries and fragmentation are getting in the way of optimization. In an integrated project, the money needs to be invested in regards to the need of the customer, not the companies involved in the delivery. Since that could mean reducing the turnover from one trade for the good of the project, it contains potentials for disputes. Until the team members do not invest the available money wisely while trying to add value for the customer and without minding their own turnover, an integrated project cannot work effectively. [Howell]

The legal extent of the contract for building the number one subway line in New York City, which was one single page, has already been mentioned in the previous chapters. Nowadays, even comparatively small projects feature extensive legal coverage and a lot of unnecessary, non-value adding parties are involved in them. An industry has been made out of the lack of trust and high fragmentation, introducing insurance companies, lawyers or dispute resolution managers to the project. That makes the process even more fragmented and costs go up, since more parties are feeding from the project now. [Nagaraja] So these parties, actually not adding any value, but only being there due to the lack of trust, are opponents to the introduction of integrated practice, since they fear for their occupation. These parties, especially insurance companies or law firms have a huge influence to the political process and to political decisions, making integrated methods even more difficult to implement.

### 9.1.4 Risk Sharing

*The owner never had risk, other than paying for it, and therefore doesn't want any.*

*That is the number one reason why integrated methods are not popular.*

*[Andrew Jarvis]*

That has mainly to do with the way construction liability is assigned for the cost of the building and the safety of people who work in construction. The responsibility for the costs of the project is usually placed on the construction managers' side. The construc-

tor is responsible for a safe and efficient working environment and the designer for the conformance of the design matching the building codes. It is really those legal and insurance assignments of responsibilities that are causing the construction industry to be fragmented and inefficient. [Jarvis] That traditional approach towards the allocation of risk is another considerable hurdle on the way towards integrated methods.

## 9.2 Motivation for Change

*The only motivational factors that can supersede the resistance to change are to improve productivity, achieve a higher rate of return for the owner or improve the competitive advantage of a contractor.*

*[Reza Nikain]*

As discussed in the previous chapter, the hurdles standing in the way of the introduction of integrated practices need to be eliminated. But in addition to that, also motivational factors supporting the change need to be identified. So in this chapter, a value proposition for integrated practices shall be determined, showing how the resistance to change could be exceeded.

Businesses know that a higher rate of return can be achieved by reducing waste and improving efficiency, leading to a competitive advantage. That competitive advantage is the only motivational factor that will supersede the resistance to change for a contractor. Usually competition takes care of that. Within a competitive construction market, contractors are going to seek for more innovative solutions in how they deliver their projects. This is the reason that they would go down the path of change themselves. If that motivation is not there, the change is not going to come around. Since the vast majority of stakeholders in construction projects are businesses, it is the return on investment that influences the decision-making of owners, contractors and designers. So any change needs to prove how it improves the return on investment for the stakeholder to be considered in the first place. Only if the above-mentioned value proposition is evident to the parties, they will adapt a certain change in practice. [Nikain]

However there are even more reasons to adapt integrated practices. One is that at lean projects fewer workers are being injured or killed. Due to a better design and better processes for the delivery, a lean construction site is not only more effective, but also tends to be saver. [Howell]

There is one more thing all the above-mentioned motivational factors need to be: proven. Before a change can be anticipated, the positive effects of integrated practices need to be demonstrated in practice. The best evidence for owners to implement integrated approaches at future projects is, to have other owners talk to them about their good experiences. However, anything else than an increased return on investment for parties will not be enough to excel the resistance to change, since all the participants are businesses seeking to make profits in the first place.

### 9.3 Paradigm Shift

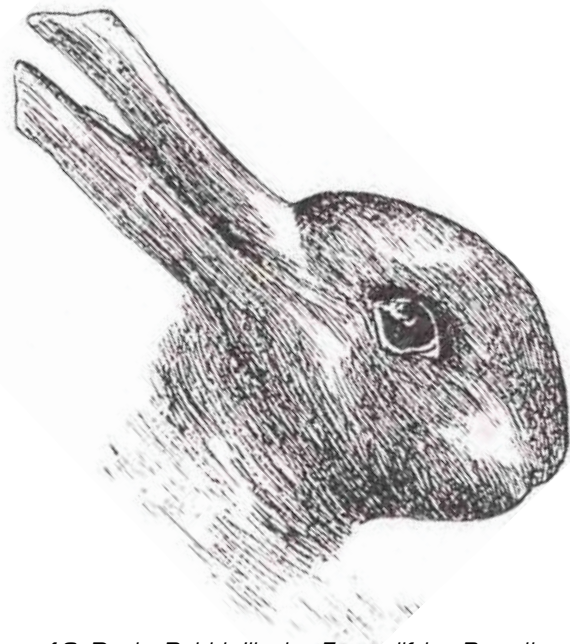
*But it still moves.*

*[Galileo Galilei]*

Big changes never come easy or fast, as the quote by Galileo, referring to his theory indicating that the earth does rotate around the sun, exemplifies. As discussed in this thesis, the current project delivery practice can be lead back to the awarding method used in the Roman Empire more than 2000 years ago. Therefore the traditional practice can be seen as a paradigm that is very much tightened to the way the people in the construction industry see projects. The idiosyncrasy of changing a system that has been in execution for such a long time will be discussed in the following subchapter. First of all the theoretic background about paradigmatic shifts will be discussed. Afterwards these findings will be linked to the current methods being executed in the construction industry.

#### 9.3.1 Theory

Thomas S. Kuhn, an American philosopher of science, shaped the term paradigm shift in his book *The Structure of Scientific Revolutions* published 1962. His theory about paradigm shifts states, that afterwards the problem or information is being seen in a completely different way. To exemplify that he used a drawing showing a duck as well as a rabbit, depending on how the picture is being observed. cf. [39]



*Figure 18: Duck - Rabbit Illusion Exemplifying Paradigm Shifts.*

*From: [39]*



A more current theory about what influence a paradigm shift can have is given by Julio Olalla, a consultant and business coach. He argues that everybody, depending on his social, ethnical or intellectual background, has a certain way of seeing things. So where you are coming from or what you have learned, influences the way you observe the world and the problems within it. Olalla refers to that as the *Unique Observer in the World*. Anybody observing a problem takes actions to get desired results. If the results are not satisfactory, further and different actions may be taken. That process is called incremental learning, illustrating a gradual step of learning. That process is being repeated until a satisfactory result is being achieved. However, if outstanding and completely new results are being aspired, that procedure will not be sufficient. Whenever incremental learning does not work anymore and completely different results need to be produced, we need to adapt at the level of the observer. If our conception of reality shifts, actions that were not even thinkable before, become available and obvious. The following figure shows the two processes of incremental learning and paradigm shifts.

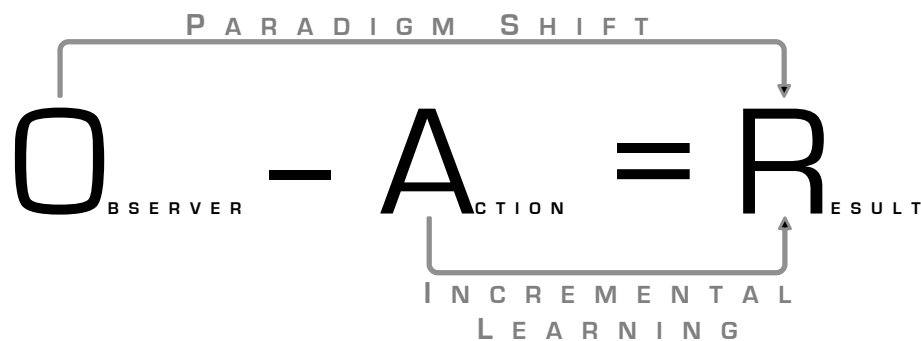


Figure 19: *The Unique Observer in the World*. From Julio Olalla.

Further Olalla addresses the problem of people adding explanations to phenomena of whatever kind. He states that by adding an explanation to problems we are facing, new approaches to solve that problem are prohibited, because we take the explanation as definite and unshiftable. New explanations and approaches are only allowed, if there is space for them. A change of the paradigm can create that required space, making new solutions possible and even obvious.

These theoretical principles of changing and shifting the way we see and handle problems can be transferred to the change that is necessary to establish new project delivery approaches. If we accomplish to make people see projects in a different way, new management methods might be adopted automatically, since their benefits may become obvious. Furthermore, a crisis, like the financial crisis right now, can also support the discharge of obsolete approaches and lead into shifting the way we handle problems.

### 9.3.2 Practice

Also in practice, the shift from traditional approaches constitutes a big challenge. A large portion of the resistance to change can be ascribed to the power of habit. These habits restrict people to see things differently and will not allow new approaches to be even considered. What the change is really all about, is to get people to see the world of project management differently and eventually change their position as observers, like presented above in the theory by Julio Ollala. Another challenge is to get people to really understand the nature of the change from an activity model, which is the traditional approach, to a flow model representing integrated practices. Only a paradigmatic shift, making people see the things differently, can accomplish that change. Lean construction for example, is trying to get people to see things differently in regards to the reliability of the workflow or how to design a project as a production system. The shift from a decomposition model to a holistic model violates with so many things, making the change so hard to achieve. [Howell]

To accomplish that people start to question the current practice in the first place, training in the fundamentals of cooperative approaches is necessary. That is where leadership comes into play, since it is the top management that needs to demonstrate that the favorable behavior is no longer being unfair and exploiting other parties. Leadership needs to drive people to behave in a new way by changing the rules of the game and reward cooperation and trustworthiness. [Spata]

Gregory Howell stated, that the findings by Glenn Ballard, about the low reliability of assignments in projects, were what made people question the current practice. By showing that only half of the promises regarding next week's tasks are being kept, he accomplished to get people see the problem differently. It became obvious that the unreliability of the workflow is restraining productivity and the solution would be to improve the relatedness of these promises. [Howell]

To get leadership to see the advantages of integrated practices, education is a crucial factor. It needs to be identified how the individual parties will benefit from the new methods and prove it to them. In regards to that, the different priorities the owner has in comparison with the contractor or designer needs to be considered. Therefore the interest in the use of the facility versus the design and construction phase itself need to be aligned with one another. The delivery method bringing benefits for all parties has to address how it raises the return on investment for every party, since that is what influences the decision-making of businesses in better part. [Nikain]

A lot of businesses fear for their share if additional services such as insurances and legal advisors may not be necessary anymore. However they have to understand, that the total amount of invested money will remain the same, so the same number of people will find occupation, but delivering diverse services. Furthermore, since the invested money remains the same and integrated methods waste less of that money, more projects will be executed simultaneously, delivering a higher quality. [Nagaraja]

So in conclusion it can be said, that without accomplishing a paradigmatic shift throughout the industry, a change towards integrated practices is very unlikely to happen. Only if people will experience and learn what is restraining the performance of a project, it will become obvious to them that tremendous improvements can only be achieved by approaching it in a completely different way. Doing more of the same can bring minor improvements at its best, but rather worsen the situation even further. Therefore a change in how projects are being considered is essential for a successful implementation of Lean Construction or Project Alliancing in the construction market. As soon as the position as an observer changes, the solution and adoption of integrated practices will become obvious.

## 9.4 How to Spread Integrated Practices

*Some People are not aware that there are alternative ways of delivering projects... until they are pushed and forces, because the traditional way no longer works.*

*[Sam Spata]*

This chapter addresses how methods such as Lean Construction and Project Alliancing could be implemented and pushed into the construction industry. It is separated into subchapters, each representing a way of supporting the application of integrated practices in a unique way. First of all it will be highlighted, of what relevance the current global crisis can be in regards to the introduction of these methods. The statement above by Sam Spata strongly refers to that situation. Further it will be discussed, how political procedures could be pushed towards new approaches, by presenting an example gained during an interview. Subsequently it will be illustrated what other chances and approaches there might be to convince the industry in general and prove that integrated approaches entail positive effects for all stakeholders.

### **9.4.1 Relevance of the Crisis**

Even though the roots of Project Alliancing and Lean Construction are not very alike, the implementation to construction projects happened due to the same reason at both methods: a severe local crisis. At PA it was at an oil platform in the North Sea where the owner, British Petroleum, saw no way to deliver the project in a traditional manner within the targeted costs. The bids of contractors just exceeded the budget by far, making the awarding in a traditional manner no longer possible. At LC it was the construction of healthcare facilities in California, where the owner Sutter Health searched for a method to handle projects, facing a weekly construction cost escalation of about 1%. So it were these local crises making integrated methods take off. Therefore, the global crisis the industry is facing today can be seen as a chance to establish these methods further. The fact that the Chinese characters for crisis are a combination of risk and opportunity might be a romantic or even foolish way of looking at it, but it definitely contains some truth. [Spata]

Also Mysore Nagaraja signifies the crisis to be a chance for establishing new methods in the construction industry. He stated that, even though the funding is very tight at the moment, for private but especially for public owners, the need for investment remains very high. The need for high quality infrastructure as well as efficient commercial and residential buildings is gaining higher priorities constantly. That lack of money in combination with the high need for new structures as well as refurbishing aged ones, will make a change in project delivery necessary. So the crisis the industry finds itself in will eventually support the establishment of integrated practices, when more efficient methods will become a necessity. [Nagaraja]

### **9.4.2 Push the Political Process**

As a response to Hurricane Sandy causing devastating damage on the East coast in 2012, the US government is funding approximately 60 billion \$ for construction projects in affected areas. These 60.000.000.000 \$ are being distributed by an industry task force trying to determine where the money should be invested. Further this task force, manned with distinguished professionals from diverse fields, looks at how to decrease the steps within construction processes and investigates different awarding methodologies. As a result the task force will make recommendations, on how and where to spend the money, to the government. Eventually, there are people consulting the task force about implementing Lean Construction, to achieve higher efficiency in the projects. If the amount of money and the possible savings of about 20% are being considered, implementing integrated practices could fund considerably more projects. By doing that, the

task force tries to push this new approach into the industry and convince the government of the positive effects of these methods. [Nagaraja] If they manage to achieve that parts of the 60 billion \$ are invested into projects delivered in a Lean fashion, this may bring a huge improvement and support the rethinking throughout the United States, but especially within the government.

### **9.4.3 Further Chances to Convince and Prove**

#### ***Proving Evidence***

As it was mentioned in chapter 8.7.2, where the solution for high costs early at an integrated project was presented, paying people to behave in a collaborative manner pays off for the owner during the ongoing delivery. However, that fact must be proven even further and not being relied on. Any project executed in an integrated manner should be promoted and communicated by appropriate representatives, preferably by all stakeholders. So designers, having made good experience with the application of a certain method, should speak to other designers and so forth. By that more and more companies, but also individuals, will have heard about positive experiences and eventually apply the ideas themselves. However the most important party that needs to be convinced is the leadership of owners. They need to say: "We want to do that!" Projects that have been successful are the best evidence for future owners to consider these delivery methods. [Jarvis]

Therefore it can be stated that the establishment of integrated practices stands and falls with the development of trust and demonstration that the savings exceed the investment. To really support that declaration it will further be crucial to carry out more projects and prove the advantages of collaborative methods. [Maimis] The best way to accomplish that is to have a sophisticated owner, for example Sutter Health, who is convinced of these methods, talk to other owners and tell them about their experiences and achievements. [Jarvis]

#### ***One Step at a Time***

The heading refers to the fact, that good experience with some single tools that are emerging from integrated practices may influence parties to adapt more principles and eventually apply the holistic methodology. Even though it has been mentioned to be a hurdle in chapter 9.1.2, if people think they already practice Lean Construction or Project Alliancing, but are actually only applying single tools to their processes. On the other hand, that first step towards integrated practices could also be seen as a chance, if the

party realizes that there is even more potential if the holistic approach is being executed. As an example, the fairly popular tool of Building Information Modeling (BIM) has to be mentioned. Through BIM it is possible to minimize the unknowns regarding the design of a structure and identify possible shortcomings, making the design more constructible. Hence, parties applying BIM reduce the risks of uncertainties and therefore make the output more predictable and the whole process more efficient. [Nikain] So the conviction of a single tool, in combination with the user knowing about the holistic approach standing behind it, may boost the adoption of integrated delivery methods.

Frankly, it can be stated that demonstrating the success of the methods and getting the willingness of more and more people to take risk is what needs to happen. [Spata] Furthermore, now is the perfect time to try to convince people of integrated practices, since when the intensity of the crisis will diminish, innovative approaches will be emphasized. [Nagaraja] Hence the practice after the crisis will most likely not be the same as it has been before.

## 9.5 Conclusion

The findings from this chapter illustrated what are the major hurdles on the way to integrated delivery approaches and how a change towards them could be supported. One essential statement is, that since all the involved parties are businesses in the first place, the return on investment of the new methods needs to be proven and pointed out to the industry. A company will not change unless they see a higher profit or competitive advantage in a new idea. So the positive economic aspect of applying Lean Construction or Project Alliancing needs to be approved to overcome the resistance to change. Furthermore, consciousness-raising needs to happen to call the industry's attention to integrated practices in the first place. The best way to achieve that is to present successful projects, where the application of collaborative ideas paid off.

By analyzing the hurdles, one can tell that all of them share the solution statement of proving, educating and informing about the new approach in the first place. Only getting people to see projects from a different perspective will clear the way for understanding the necessity of changing the current practice. That is the only way to generate a paradigmatic shift, which is required to bring around change in a big way like that. Only if there is enough people convinced of integrated practices, it will be possible to promote and spread them throughout the industry.

Therefore the required course of action to eventually implement and spread Lean Construction and Project Alliancing methods can be summarized as follows:

- Identify local and global hurdles and how to overleap them.
- Educate people about the positive effects of integrated practices, especially in regard to the before determined hurdles.
- Exceed the resistance to change and generate a paradigmatic shift to make people question the current practice critically.
- Implement integrated methods and communicate the results throughout the industry.

If we achieve to get people to see projects as holistic production systems and familiarize them with social and moral principles inherited in collaborative methods, the change towards integrated practices will become obvious to them and a shift in project delivery practice merely a matter of time. However, getting to that point is a challenge of greater complexity than any construction project and a concern rooting in the difficulty of changing peoples behavior and mindset.

# 10 Conclusion And Further Research Possibilities

In the following subchapters the most significant findings from the main body of this thesis will be summarized according to the content and structure of the previous chapters. Further also interconnections between them will be highlighted to determine the influence of one particular attribute on other processes. Finally it will be presented if and how the initial scientific problem could have been solved and what could be future areas of research.

## 10.1 Summarization of Key Findings

### *Chapter 2: The Procurement Law*

Regarding the procurement law, there are several important factors that are of great significance for this thesis, since the law dictates the framework for public as well as sectorial awarding authorities. First of all it is notable, that the low bid approach was basically developed more than 2000 years ago in the Roman Empire. So the basic characteristics of how construction contracts are being awarded did not change significantly ever since. Even more specifically, this ancient awarding method, called “*auctio licitacio*” has been applied in the Austrian Monarchy, too. It wasn't until 1996 that the procurement law got established in Austria to govern the awarding procedures that are still in effect today. The procedures defined by the law only allow low bid approaches based on before developed design and specifications. Given the wide scope of application, ranging from typical public entities to sectorial awarding authorities and PPP projects, the law restricts the larger part of the construction industry in how projects are being approached.

Further, the before mentioned traditional design - bid - build process, causes serious problems, as presented in chapter 2.3.1 in greater detail. Due to several reasons the traditional approach causes severe and multifaceted problems and disputes throughout the industry. The most apparent shortcomings are the constrained cooperation among parties, the enhanced fragmentation as well as the litigious contracts, which are not designed to manage complex projects. Even though there is a slow trend starting to lead towards collaborative approaches, the major shortcomings caused by traditional practice, will probably endure in the foreseeable future. Therefore it must be stated that the awarding law can be seen as the major hurdle standing in the way of innovative man-



agement approaches such as Lean Construction and Project Alliancing. On the other hand they also constitute one of the biggest chances to boost their implementation, if governments decide to adapt it accordingly.

### ***Chapters 3, 4 and 5: Integrated Practices***

The following chapters three, four and five have been devoted to integrated project delivery methods that are Lean Construction and Project Alliancing. It could be determined that both approaches feature similar ideas and principles regarding the cooperation among participants, the contractual method as well as the value and efficiency of a construction project. However, the two approaches set their focus on different parts of the process, what can be ascribable to their diverse origin and area of application. Project Alliancing is very specific regarding the selection of the participants, their compensation and the quantification of reached targets as well as the appointment of independent board members supporting the process. On the other hand, Lean Construction is very much devoted to establish a highly efficient delivery system as well as to incorporate subcontractors during the design phase and gather as much downstream knowledge as possible early on the project.

Further, both methods feature relational contracts that, in contrast to traditional contracts, enhance and manage complex and ever-changing systems most construction projects are. A relational contract is irreplaceable for any integrated project delivery procedure, since it creates a framework that allows an early integration of key stakeholders on non-cost criteria and supports a collaborative and trustful atmosphere. Given the similarities and discrepancies in the emphasis of certain aspects, a delivery method combining the best out of both approaches would be desirable for the European construction industry. That combination would guarantee a comprehensible awarding procedure and reward system as well as a most efficient systems design approach regarding the delivery of the project.

### ***Chapter 6: Integrated Methods and the Law***

Due to the well-documented awarding procedure as well as the verified costs and reimbursements, a combined method would be applicable for public owners, too. Further the emphasis on delivering the work producing the least possible amount of waste as well as considering the value and quality for the owner primarily, a most efficient investment of public funding could be guaranteed. These demonstrations prove, that the so important applicability for public owners, addressed in the paragraph above, would be realizable and justifiable. However, the principles of integrated methods interfere with several are-

as of the procurement law, as illustrated in chapter six. Even though the principles of the awarding law are not being restrained, the processes of integrated practices do not fit within the allowed awarding procedures. That is mainly due to the required low bid tendering approach implied at the open, restricted as well as negotiated procedure. However, integrated practices comply with the principles of the law, guaranteeing a fair competition, equal treatment, awarding of capable contractors, transparency as well as awarding at a reasonable price. Further, the method of the competitive dialogue inherits several ideas of integrated practices, especially regarding the selection of contractors. Given that approach, it could be possible to apply a well-defined integrated method within the law, if it would be interpreted more flexibly. However, it must be said, that the first approach towards methods like Lean Construction and Project Alliancing will most likely be up to innovative and progressive private owners, like it was in the United States. Therefore it is necessary to raise the awareness among owners and project managers. A crucial factor in these regards will be to educate people in consideration of the process itself, to establish the mindset enabling integrated project delivery. By that, stakeholders will learn that the implementation of these methods will deliver more satisfying results for everybody involved.

### ***Chapter 7: Change of Current Practice***

This is the first of three chapters based on findings from expert interviews conducted in the United States. It contains the changes that are being demanded by stakeholders from the industry and the most important downsides of traditional project delivery practice. It could be found that the drawbacks of the methods being in use now are connected to the desired and necessary changes. From the literature study it could be determined, that most handicaps are emerging due to the current contracting and awarding modalities being in practice. It is basically these regulations that are causing the fragmented process with a lack of cooperation and low efficiency. However, what's even worse is that people adapted and absorbed these codes of behaviors and became distrustful towards other stakeholders. That shows that the regulations itself need to change, but also people have to learn new patterns of behavior to establish an atmosphere of mutual respect and trust as a fundament for further steps towards collaboration and integrated practices.

Only if that can be achieved, any continuing steps can bear fruit and change can be brought around, based on these ethics. That is the philosophical introduction to integrated practices that makes a lot of people think, it is not a tangible management methods. Once people accept these principles, the tools causing a tremendous raise in effi-

ciency and quality, what turned out to be the most urgently required changes, could be applied successfully.

### ***Chapter 8: Impact of Integrated Practices***

This chapter illustrated the most significant effects of integrated practices in seven sub-chapters according to the desired change. By that it was able to investigate if methods like Lean Construction and Project Alliancing could cover the demand of desired changes. Their impact has been highlighted in terms of collaboration, risk allocation, productivity, value, integration and contracting as well as possible negative effects. In regards to collaboration it could be found that the holistic view and the decreased number of interfaces are the most significant benefits of integrated practices. By enabling project participants to see the process as a whole and fewer the boundaries amongst them, the efficiency can be raised tremendously. By having the parties involved in the process early, the level of information can be evened out and a common base for the further delivery can be created. In close regard to collaboration as well as likewise and honest information of participants, the handling of risk is being improved drastically. Eventually, by really communicating the risks honestly, the overall project risk will be reduced since it is being considered and shared by all parties instead of pushed from one party to another. While at traditional practice the uncertainties are increased by fragmentation and dishonesty, integrated approaches try to decrease them successfully. With a review on the presented OOPS-Game, which demonstrates decision making under uncertain circumstances, the following statement can be made. Integrated practices make the cards on the yard lying face up by generating an open and honest project atmosphere. By that the project managers gain an outlook of coming tasks making the planning way easier.

All these presented effects of integrated practices increase the performance of the project in one way or another. However there is another principle inherited in these methods that focuses on the improvement of efficiency even more. That principle states that the productivity of a process is strongly dependent from the reliability of single steps within that process. The Parade of Trades Game shows that very vividly, by comparing the productivity generated with a reliable workflow versus an unreliable one. To make all these positive effects possible it is necessary to establish a framework deviating from current practice. The diverse contracting and awarding methodology implied at integrated practices enables and creates that atmosphere of trust and mutual respect. Further it could be discovered that possible negative effects are disarmed by solutions that are already included within the methods.

### **Chapter 9: Hurdles and Chances at Establishment**

Several hurdles standing in the way of integrated practices could have been recognized based on literature and the empirical study. However, there are also chances that could facilitate the implementation of these methods. Therefore it was analyzed what would be the motivation for the industry to consider a change and how this rethinking could be achieved to spread these approaches. The main hurdles, being the procurement law for public owners and the lack of trust and current mindset in general, would need to be excelled by the single most important motivational factor that is the return on investment. Only if we can prove that through the implementation of integrated practices companies will gain a higher rate of return, these methods will be considered earnestly. In addition to that, a shift in people's mindset needs to happen to make collaborative practices applicable. Such a paradigmatic shift will make the industry rethink the current practice and clear the way for integrated ideas. Then the attempt to spread these methods can be approached and eventually earn the acceptance of the whole industry and make integrated practices become the standard in project delivery, not the exception.

## **10.2 Answers to Research Questions**

In this subchapter the scientific problem shall be answered. Therefore it will be examined if the research question can be answered with the gained findings and if the proposed hypothesis can be approved. The research questions and the hypothesis have been presented in the first chapter and read as follows:

- *Is there a need to change the current project delivery practice in Austria?*
- *What impact on quality, innovation, target costs and schedule as well as the overall project atmosphere can integrated project delivery methods have?*
- *What needs to change to make cooperative methods like Lean Construction or Project Alliancing applicable in Europe's construction industry?*

*Austria's construction industry would certainly benefit from less strict and price dependent award and procurement strategies as well as from integrated project delivery methods. The implementation of Lean Construction and Project Alliancing principles could lead to better overall quality of buildings, reduction of cost and construction time as well as higher potential for innovation and stakeholder satisfaction.*

Beforehand it can be said that the questions have been answered as well as the hypothesis could be approved. The need to change the current practice is obvious if the financial situation of construction companies is being considered. Further the dissatisfaction of stakeholders regarding quality as well as the complicated awarding law being responsible for so many shortcomings could be highlighted. The impact and principles of integrated practices have been presented in chapters 3, 4 and 5 from literature findings. Chapter 8 addressed the impact of these methods from interview findings even more specifically. The third questions can be answered by the content of chapter 7 and 9 showing what needs to change and how that change could be induced. Regarding the proposed hypothesis, it can be stated that introducing integrated practices to the European construction market would certainly generate an overall better situation. However, the general conditions need to be arranged first, especially regarding the trust among parties, to prevent the method from being rejected right away. A change needs to happen without question, but it has to come about gradually without overstraining any party and it needs to be carried collectively.

### **10.3 Correlation of Findings**

Considering the whole spectrum of findings, several aspects stick out in comparison with others. One of the most significant is that the law and regulations not only govern how contracts are being awarded, but furthermore also influence the way of delivery and consideration of the processes itself. By setting the rules for the tendering process the law causes the high fragmentation, lack of trust and unequal levels of information and understanding. So it is basically the design – bid – build method, constituting the fundament for every awarding procedure within the Austrian procurement law, which is entailing so many bad effects.

However it must also be stated, that the extensive legal coverage of the procurement law was not in effect forever. There would have been the chance to deliver projects in another, more collaborative way before 1996, but that opportunity was not taken advantage of either. And further, the practice as it is today, does not comprise the passing of risk or detailed legal clauses. These ideas have been adapted to our way of delivering projects due to the lack of trust and exploitation in the first place. Also the fragmentation and dishonesty among participants, being responsible for bad communication can be lead back to the absence of trust and respect. Given these correlations, the dilemma of litigious contracts and the lack of trust show affinities to the questions about which

came first, the chicken or the egg? In that case it was probably both factors aggravating one another.

If that aggravation is taken into consideration, great importance needs to be placed on a change in mindset throughout the industry. Since, doing more of the same may only worsen the situation further. If, for examples, further policies are being introduced, restraining contractors even further or trying to specify the project even more accurately before construction even starts, they will not have any positive effects at all. What the industry really needs is resetting the mind and approaching projects in a completely diverse way. If incremental learning is no longer sufficient, so doing more of the same no longer delivers satisfying results, a paradigmatic shift needs to happen, changing the way we see projects and enabling new solutions. We need to stop accepting low productivity and consider the current situation as immovable. As the approach of the OOPS game presented in the summarization of chapter 8 shows, we need to try to change the rules of the system. Wouldn't it be much easier if the cards are lying face-up instead of facedown?

Speaking of the system our industry is working with, we need to consider the following. Any system that is created by people, can also be corrupted by them. Meaning, that no matter what kind of rules a system contains and how strictly they are controlled, people will always figure out a way to utilize the framework to raise their gain. Therefore, beneath the new set of rules it will also be crucial to achieve a fundamental rethinking in regards to ethical and moral patterns. Only if mutual respect and trust among all parties can be created, truly fair and collaborative approaches can be implemented. That challenge needs to be considered as the most difficult one and exceeds the field of construction alone by far, hence it is of relevance for our entire society.

## **10.4 Future Research Possibilities**

This diploma thesis illustrates the need to change the current project delivery practice. It puts a highlight on the possible solution by introducing collaborative methods such as Lean Construction and Project Alliancing. It also addresses shortcomings of the traditional approach and signifies the positive effects of integrated practices. As a result of the findings it even determines what would be the most significant concerns for the establishment of new methods. Further, the desired changes by the industry have been identified and it was presented how parties could be motivated to approach integrated methods. However, given the major challenge of changing a system that has been in use

for such a long period of time, a study regarding bringing about that change in particular would be of relevance for a future research. That is a topic regarding the field of change management and psychology as well as implying political aspects. Given that combination, such a research could deliver interesting findings about how to approach a modification of our way of handling projects from a diverse perspective.

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## Terminology and Abbreviations

A	Architect
AG	Aktiengesellschaft - Inc. Incorporation
ALT	Alliance Leadership Team
AMT	Alliance Management Team
APM	Alliance Project Manager
AUD	Australian Dollar
BP	formerly British Petroleum
Bundesvergabeamt	Federal Procurement Authority
BVergG	Bundesvergabegesetz, Austrian Procurement Law
CM	Construction Manager
DBB	Design-Bid-Build delivery approach
E	Engineer
EC Law	European Community Law
EEA	European Economic Area
FA	Financial Auditor
GC	General Contractor
GMP	Guaranteed Maximum Price
IE	Independent Estimator
IFOA	Integrated Form of Agreement
iPAA	interim Project Alliancing Agreement
KPI	Key Performance Indicator
KRA	Key Result Area
LC	Lean Construction
LPDS	Lean Project Delivery System
LPS	Last Planner System
MEP trades	Mechanical, electrical, plumbing trades
MIT	Massachusetts Institute of Technology
NOP	Non owner participant in an Alliancing project
O	Owner
ÖNORM	Austrian Standards
PA	Project Alliancing

PAA	Project Alliancing Agreement
PAF	Project Alliancing Facilitator
PPP	Public Private Partnership
PRA	Probity Auditor
PU	Production Unit
RFP	Request for proposal
S	Supplier
SC	Subcontractor
Sectoral client	Client bound to the procurement law
TCE	Target Cost Estimate
TOC	Target outturn cost
TPS	Toyota Production System
TVD	Target Value Design
UoW	Units of Work
WPT	Wider Project Team

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## Appendix: Expert Interviews

### MASTER THESIS

#### *The Establishment of Cooperative Project Development Methods in Europe's Construction Industry*

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**Student:** David Müller

**Supervisor:** DI Dr. Otto Greiner

**Co-Supervisor:** Ing. Roland W. Köck

**Host-Supervisor:** Ibrahim S. Odeh, PhD., MBA

**Home-University:** Carinthia University of Applied Sciences

**Host-University:** Columbia University New York

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As a major part of the research for this thesis, six expert-interviews with representatives from the construction industry have been conducted. The interviews took place in the period from April to July 2013 during the authors' stay as a visiting scholar at the Columbia University in the city of New York. This appendix includes the interview guideline, a short introduction of the interviewees and the interview transcripts. The guideline constituted a loose framework for the interviews and consists of seven main questions including follow-up questions that have been adapted slightly depending on the interviewees' special knowledge. Each question is accompanied by a brief introduction. The interviews approximately took one hour and have been audio-recorded and transcribed afterwards. The transcript of each interview can also be found in this appendix.

As mentioned the questions may have been adapted slightly according to the special knowledge of each interview partner and the course of the interview. Therefore the questions not being consistent with the guideline presented below are recorded in the individual interview transcripts.

## Interview Guideline

*The yearly productivity increase in the construction industry since 1966 was at about 0,78 %, while the average was at 1,75 %. Even though there were major improvements in technical concerns e.g. machinery. This leads to the assumption, that it can only be improvements regarding to management methods we are lacking in comparison with other businesses. From your point of view and based on your experience:*

[cf. Forbes L./Ahmed S. 2011. Modern Construction – Lean Project Delivery and Integrated Practice]

### **1. Would you commit to that statement, or have you experienced it elsewhere?**

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*Since the beginning of 2013 I read about at least 4 major companies filed for bankruptcy, including Austria's 2<sup>nd</sup> biggest construction company, while the 3<sup>rd</sup> biggest reportedly should be close to it. And that's only the ones big enough to make it into the news. I learned that the US construction business is facing a similar, even though not quite as bad, situation.*

### **2. Do you think there are other reasons, besides the financial crisis, for the hard time companies go through at this time?**

---

*Findings showed that employees at the construction industry are more dissatisfied than the average and experience more stress than any other occupation group. This can be led back to several reasons like safety and bad working conditions (e.g. dust, dirt), but also to lack of cooperation, pressure of time and disputes.*

[cf. Chamber of Labor Salzburg. 2010. Austria: Survey in construction industry 2009]

### **3. How have you experienced the relation between owner and contractor at traditionally awarded and delivered projects?**

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*As discussed before, the construction industries resistance to change is higher than any other business'. In fact, the phrase 'That's not how we do business.' describes the willingness to change pretty accurately, since we basically award contracts the same way the Romans did 2000 years ago.*

[cf. Martini, M. 2008 Der Markt als Instrument hoheitlicher Verteilungslenkung]

### **4. What are the three biggest hurdles at establishing Lean Construction?**

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*The low rate of productivity in the construction industry mentioned at the first question can be led back to inefficiency, design mistakes, delays and poor communication. These losses, Lean Management would name them 'waste', make up to 30 % of the total costs of buildings. The industries excuse for low productivity has always been the singularity and complexity of the product (the building), but Lean Construction took the challenge of eliminating waste.*

[cf. Forbes L./Ahmed S. 2011. Modern Construction – Lean Project Delivery and Integrated Practice]

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## **5. According to you what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

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*There is no doubt that construction is a highly complex, dynamic and therefore unpredictable business. But still traditional awarding treats it like a totally predictable thing where change is an anomaly and tries to define that complex project within a contract (e.g. plans and specifications) at a very early stage.*

[cf. Sakal, M. 2005. Project Alliancing: A Relational Contracting Mechanism for Dynamic Projects. Lean Construction Journal: Vol. 2 #1 April 2005]

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## **6. What influence can the choice of awarding strategy have on factors like cooperation, quality, schedule and costs have?**

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*Relational contracts are designed to be able to manage the change and complexity of projects discussed at the previous question. They feature an open-book compensation model, an agreement on trust and reliable commitments and they define project phases including applicable tools and processes (e.g. TVD, Last Planner ® System, dispute resolution, rewards...)*

[cf. Heidemann, A. 2010. Dissertation advised by Gehbauer, F. about Lean Construction and Project Alliancing]

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## **7. Have you experienced managing 'soft-skills' within a contract to be a challenge?**

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## Interview Partners

### **MYSORE NAGARAJA**

Mysore Nagaraja is a proven leader and innovator who has successfully planned and delivered the largest urban transportation construction projects in North America, winning international acclaim and accolades. He is also a recognized leader in sustainability and green design and is very well respected in the construction industry for his resolution of contract disputes. In his most recent position at the Metropolitan Transportation Authority, Nagaraja was responsible for advancing the MTA's multi-billion-dollar capital system expansion projects, including East Side access, the Second Avenue subway and the 7 train extension to the West Side of Manhattan.

[[ce.columbia.edu/construction-administration/faculty-advisors/mysore-nagaraja](http://ce.columbia.edu/construction-administration/faculty-advisors/mysore-nagaraja). Date of access: Aug. 3<sup>rd</sup> 2013]

### **GUS MAIMIS**

Maimis has more than 25 years of experience in the New York market, specifically with healthcare, research and development, commercial and transportation projects, as well as mixed-use facilities. As project executive for the National September 11 Memorial and Museum, Maimis is responsible for the oversight and management of all construction activities for this prestigious project including the preconstruction phase, bid and procurement process, scheduling and project finance.

[[www.stvinc.com/pdf/Gus%20Maimis%20Promoted%20to%20Vice%20President%20at%20STV%20NR.pdf](http://www.stvinc.com/pdf/Gus%20Maimis%20Promoted%20to%20Vice%20President%20at%20STV%20NR.pdf). Date of access: Aug. 3<sup>rd</sup> 2013]

### **SAM SPATA**

Mr. Spata brings more than 25 years of experience as an executive architect and designer across a wide range of industries and has managed significant divisions for leading, globally recognized firms in New York and London over his distinguished career. Over the course of his career, Spata has been recognized as a thought leader in practice and project delivery. He is co-chair of LeanNYC - the New York chapter of the Lean Construction Institute.

[[finance.yahoo.com/news/sam-spata-chosen-lead-callison-191000669.html](http://finance.yahoo.com/news/sam-spata-chosen-lead-callison-191000669.html). Date of access: Aug. 3<sup>rd</sup> 2013]

**REZA NIKAIN**

Mr. Nikain is the President and a Principal of The Nielsen-Wurster Group. He has extensive experience in managing and analyzing claims on a broad spectrum of projects globally. His consulting practice also involves assisting clients in preventing claims and to more proactively identifying and managing risks. He often lectures on various Construction Disputes and Risk Management topics.

(<http://civil.columbia.edu/reza-nikain>. Date of access: Aug. 3rd 2013)

**GREGORY HOWELL**

Gregory A. Howell is both a co-founder and President of the Lean Construction Institute (LCI), a non-profit organization devoted to research in design and management of production systems in project settings. He earned his B.S.C.E & M.S.C.E from Stanford University and served as an officer in the Civil Engineer Corps of the United States Navy in Viet Nam, Thailand and San Diego. Along the way, he worked for the architect Paolo Soleri and construction companies as an Engineer, Superintendent and Project Manager. As a principal and co-founder of Lean Project Consulting, Mr. Howell has helped countless clients improve their projects, processes, and organizations through lean thinking. He is an industry leader and revolutionary whose work will impact the future of construction for generations to come.

([www.leanproject.com/who-we-are/people/gregory-a-howell-p-e-m-s-c-e/](http://www.leanproject.com/who-we-are/people/gregory-a-howell-p-e-m-s-c-e/). Date of access: Aug. 3rd 2013)

**ANDREW JARVIS**

Mr. Jarvis is an architect working for Ewing Cole leading their New York office as a principal. He has dedicated his 30 year career to inventive healthcare facility design, with a specialization in cancer care. His designs depart from traditional solutions and instead seek to enrich the patient experience, improve caregiver effectiveness and maximize energy efficiency. He is well respected among clients for his pragmatic ingenuity, and his collaborative way of leading healthcare providers to innovative yet realistic design decisions.

(<http://www.ewingcole.com/healthcare/>. Date of access: Aug. 3rd 2013)

**Interviewee:** Mysore Nagaraja, Chairman & Co-Founder of Spartan Solutions, former MTA President, Infrastructure & Dispute Resolution Specialist

**Date, Place:** Tuesday April 9<sup>th</sup>, 2:45, Columbia University, New York.

---

**1. Would you commit to the statement that the construction industry is behind establishing management methods that already have been in use elsewhere, or have you experienced it otherwise?**

I totally agree with that because the construction industry is still way behind the manufacturing and also the IT industry. (Note: Refers to LCI report from 2013) The construction industry is the most inefficient amongst all industries. Our industry is more “silotype” than any other – each unit and trade watches out for itself only, there is no real collaboration between owners, contractors, engineers & designers– it’s like three different parties. They unfortunately are litigious, so they protect themselves. With that the whole industry has become very inefficient because there is no trust between the parties.

Most projects in the US are delivered by the DBB method, only lately the Design-Build, which is a little better than DBB but is not there yet a 100%, and now they are also introducing design-build-operate-maintain and finance, in that sense it is what they call PPP – with that there is a lot more collaboration because the designer, the owner and the contractor all work towards only one goal which is the success of the project. So that is slowly taking off, but is not there a hundred percent. Most of the work is still done with DBB, mainly because of the trust factor.

↳ **What is blocking a change in awarding and project delivery in the construction industry? Would you impute that to the legislation or do you see other reasons?**

I would say the lack of trust is one of the main shortcomings. The owner is not going to trust the contractor and vice versa. And then both won’t trust the engineer or architect. So they are looking for how to reduce their own risk instead of looking to reduce the risk of the whole project. So this collaborative method (refers to Lean Construction) is really all about the parties working together to minimize the risk of the project – however that view is not there.

↳ **So the mindset is 'best-for-self' instead of 'best-for-project'?**

Exactly, it's all about how do I make the most out of it for my own company. With that all parties are loosing in a way because we could do a lot more work if we would be more efficient, instead we try to hang on to the mindset: my profit is your loss. However there is a slow change in mindset starting to take off.

One of the main reasons why this is happening is because the funding is becoming tighter and tighter. The government is not funding as much as they should be – even the corporations are not funding as much as they should, even for the upkeep of their own manufacturing facilities. So with that, the capital investment is getting tighter and tighter. The ASCE released a 2013 report on the state of the infrastructure in the US that graded the condition of the facilities with a D+, which is not a passing grade. They also state that, if the economy shall not suffer, during the next 20 years almost 3 trillion \$ need to be invested into infrastructure projects. So now the government is also waking up, however the money is tight. So with DBB we are not taking the advantage of the technology to produce more efficient designs and construction methods. But integrated practices it's not being applied because each party is just looking as far as their own survival. But because of the tight funding and the high need of investing money, the whole industry and also the government is looking at if there are other ways of doing it. That's also why NY state introduced the Design-Build delivery method a year ago, which can be seen as a step towards integrated project delivery and Lean Construction – so the whole rethinking is slowly taking off and forms movements to eliminate waste in construction.

Unlike the manufacturing industry, for example the car manufacturing, in construction we look at a project only in pieces and never consider it in a holistic system. We look at the trades for themselves and than again, the contractor (even within different contractors), owner and designer are fragmented too. Since there is no trust among all of those stakeholders, every party puts a contingency on top of the estimated costs – due to that each intersection between trades, contractors, designer and owner adds to the price. If you add the time being needed for those inefficiencies, the whole waste adds up to at least 20 - 30 %.

I believe that within the next ten years the Integrated Project Delivery, which is all parties working as one team, will become the way the industry will work. And that is really approaching lean construction.

## **2. Do you think there are other reasons, besides the financial crisis, for the hard times companies go through right now?**

Unfortunately we as an industry have built the inefficiency in our own processes - because of the lack of trust, the legal part is the biggest part of any contract. When the first Subway was built in the US in NYC, the number one line, the legal part of the contract was one page. They just shook hands and built it, and they built it most efficiently and in a good quality. The legal part of the contract was that short because there was trust amongst the so-called "master builders". Whereat today's contracts have extensive legal coverage.

We made an industry out of it for ourselves. Instead of just the owner, engineer, and contractor being a part of the team, now we have insurance companies, legal parties, supervisors and dispute resolution people to name some of them. Since all of them are feeding of the project, naturally the cost has to go up. It's not just the owner, designer and contractor that are sharing in the profit but all those other stakeholders.

And we built that in our own way of handling projects, because we won't trust each other. That is why the integrated project delivery will slowly eliminate many of these unnecessary steps. Of course there is also a lot of resistance to such a change, because now your telling people: "You're going to be out of business, because you are not needed on the projects any longer." That will become a political issue as well - that's why the change has to be done gradually.

However the crisis leads to rethinking, because there is no money, but still a lot of things need to be done, and that makes people start to rethink if there isn't a better way it can be done. That's why the crisis we created for ourselves will support the establishment of lean construction and integrated project delivery.

---

## **3. How have you experienced the relation between owner and contractor at traditionally awarded and delivered projects?**

Again, at DBB projects it is exactly the same thing, because all those inefficiencies are built into it. If you look at contracts for example, you get the feeling that the whole thing is about creating disputes rather than avoiding them. As I mentioned, the whole legal part of the contract was one page when the first subway line in NYC was built, now it is hundreds of pages. So before the contractor signs the contract, he will make sure he will

put enough money on top of his price as a risk overhead, to cover the conditions in the contract.

So in DBB all these inefficiencies are built into it and you can't blame any party for piling up their bids or taking care of themselves because they have to abide to the contract and processes in our system. Basically the risk transfer is the main thing that is costing the industry. The owner pays the price for transferring the risk to the parties. But if you work as a unified team you can talk to each other on a trustworthy level and minimize the risk of the whole project.

↳ **How much better would you judge the situation at projects delivered with LPDS?**

Trust, risk and inefficiencies are basically the main things IPD improves. If all the parties work together they can really look at the whole project and determine, what is the best way to build it. One main improvement is, that the builder is already a part of the team from the very beginning. Where at DBB it is often, that when the contractor joins the projects and looks at the design for the first time "that is not a efficient way to do it, I could do it much cheaper". However, due to the risk transfer and the change-process, he will just do it the inefficient way.

So according to this, it is not just the legal part, but also the engineering process which is much better at IPD projects, because you have the input from all the parties. What's even more is by not having all the risk on the contractor, much more innovative solutions can be found. Because at DBB, the contractor goes with conservative method and the designer uses conservative design. But if you work as a team where the liability is being shared amongst the parties and there is trust, you don't need to build in this additional unnecessary factor of safety.

↳ **What are the three main things LPDS improves regarding the stakeholders relation and how is that improvement achieved?**

Again, I think it's the handling of risk that leads to a lot of the inefficiencies. If you think about it: the owner builds in things to minimize his risk, the designer will add to that to make sure and the builder will build on top of it. That can be reduced by LPDS. These inefficiencies are hard to quantified but I will give you a example:

The number 7 line extension we built was procured in DBB but within a negotiated DBB method. So we spend almost 4 months negotiating with the contractor. The first proposal from the contractor was at about 1,45 billion \$. The budget was only at about 1,1 billion \$. In the negotiations we opened up and asked how could we reduce the costs.

One of the key points was that the designer defined the strength of the rock to be tunneled through ranging from 15.000 psi – 45.000 psi and the contractor assumed the worst case for the whole stretch. The contractor asked us to define the strength more accurately and it came out that most of it was at 15.000 psi and only a short distance with 35.000 psi. Only by doing that the price came down by almost 15 million \$.

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**4. What are the biggest hurdles at establishing Lean Construction? Is it rather a particular party (e.g. contractor, owner, architect) or a particular change in general (e.g. rethinking, mistrust, technical issues) that is hindering LC to become applied more often?**

One of the main opponents of introducing Lean Construction is the whole political process itself. Because the stakeholders like insurance and legal companies support the political process.

But even within our own industry it is not possible to implement it over night, because all these built-in inefficiencies. Since companies are growing bigger and bigger to handle all the unnecessary steps within the construction process, all of these people need to be occupied, too.

But the industry will learn that if LC and IPD are being implemented, they will still be able to occupy their staff. They will have more projects to work on, since the invested money remains the same, but it will fund more projects. So this rethinking has to happen, but still nobody is believing that this is going to happen. So at this point the whole LC and IPD is still on a very early stage and most people from the industry do not necessarily believe that it is going to work.

**↳ What would you consider to be future key-point to propagate the delivery method of Lean Construction and innovative and cooperative methods in general?**

So, as mentioned, the whole method is not a proven thing yet and it is on us to prove that we are going to do better as an industry by introducing LC and IPD. The industry has to be convinced that this is a good thing for us and by implementing it we can do more projects rather than less because we won't waste money on them.



**↳ So how could the industry be convinced?**

I think the way to convince is to do more and more projects this way. But also the leadership of the owners have to say: "I want to do this!"

But right now is a good time to start it, because the need is very high and the available money is very short due to the financial crisis. To fulfill this need, we need to produce more efficiently to somehow reach a proficient level of needed construction, but this has to happen step by step.

**↳ Which owners, private or public, are the ones who need to take the first step?**

I would say in this case the public owners have to come forward first because they are the most untrusted amongst the contractors and designers and vice versa. This attitude has to change, and I think it has to start with the public owners. And then the private owners will somehow keep up and get there to eventually transform the whole industry.

**↳ But to make it applicable for public owners the law has to change first, right?**

Yes that's why they have to start showing that this is the way they want to do it. I am currently working in the industry task force for distributing 60 billion \$ coming from the federal government for Sandy recovery projects to harden the infrastructure regarding to future disasters. So for that we are looking at three key things: decrease the steps within the processes of a project, different delivery methods and the prioritization of the projects. Those are the points we are looking at to make recommendations to the government to eventually lead the industry closer to Lean Construction. If you consider the amount of money you could make 20 % more projects by using Lean Construction over DBB, where we are wasting 20-30% in inefficiency. So this is a opportunity to introduce a new concept and push that into the system. That's how we can start to bring in some new things and introducing them and eventually it will spread over the industry..."if it worked there it may be working over here, too!"

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**5. According to what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

That's a very different thing to say, because project costs depend on so many things. Besides the delivery method other key factors influencing costs are how the parties manage each other, how well the project was designed. There are some owners able to

manage their projects actually pretty well by only wasting let's say 15% whereas other owners may waste much more.

↳ **LC supporters state that savings from up to 30 % stand against some single percentages more for planning and design... Shouldn't that be reason enough for an owner to make use of this delivery method?**

Literature from the Lean Construction Institute states that there is even up to 50% of wastage. I would say inefficiencies of 20-30 % is a realistic thing. By adapting these new methods – take the 60 bill \$ for Sandy recovery – if we can save 15 % of it that means 9 bill \$ more to invest into further projects. So that itself is a great benefit, and if we manage to show that we can save 9 bill from those 60 bill \$ we can prove that we can do better by implementing those methods. Once this becomes a reality the whole industry will wakeup and say that's the way we should be doing business. But even with that the transformation wouldn't be 100% but slowly people would start thinking to make changes, and that is what needs to happen.

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**6. What influence can the choice of awarding strategy and therefore the type of contract, have on factors like cooperation, quality, schedule and costs? Can a traditionally awarded and delivered project still secure the same cooperation amongst the project participants or is the inequality emerging at the awarding stage a hurdle too big?**

Yes, if you consider the example of the number 7-extension project I gave you. If all parties can sit together and negotiate in good faith. The need came because there was no money, otherwise the contract would probably have gotten awarded in the first place. That's why the crisis right now really offers a chance for IPD and LC to be spread around the industry.

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**7. Have you experienced managing 'soft-skills' within a contract to be a challenge?**

It is one thing to say let's work as a team, but how sure can you be? I still want to make sure that I make money, and you want to make sure for your profit. But then when the situation arises where I have to give up a part of my project

**Interviewee:** Gus Maimis, Construction Manager at STV Construction, Construction executive at 9/11 Memorial Project

**Date, Place:** Thursday April 11<sup>th</sup>, 4:00, 115 Broadway, New York.

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**1. Would you commit to the statement that the construction industry is behind establishing management methods that already have been in use elsewhere, or have you experienced it elsewhere?**

I think the main reason for this is, that the construction industry is a very labor driven industry and therefore the productivity is pretty much dependent from human effort. If you think about it, we basically still use the same ideas, even if the techniques changed, as they did when building the pyramids or awarding contracts in Greece more than 2000 years ago.

Of course you can raise the efficiency by good management and planning the processes to secure a good flow and higher productivity, but the key factor is the labor.

↳ **What is blocking a change in awarding and project delivery in the construction industry? Would you impute that to the legislation or do you see other reasons?**

Actually Design-Build just got introduced lately, so I would not agree to that there is no change. If I look back my career I get the feeling that it is a changing circle. It kind of started with DB and then there were GC, CM, CM at risk and so forth and now DB gets introduced again.

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**2. Do you think there are other reasons, besides the financial crisis, for the hard time companies go through at this time? Do you think that some of the credit could be given to the traditional awarding procedures being in practice?**

It definitely causes problems if contractors buy a contract too cheap, whether it is because of a bad calculation or no purpose. This leads to disputes since the contractors try to compensate for the cheap bid by trying to force change orders.

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**3. How have you experienced the relation between owner and contractor at traditionally awarded and delivered projects?**

As much as the productivity depends on human effort, the relation between the parties does on the people involved. It's dependent of how they manage themselves and their processes, the quality of the design, if a contractor may be unproductive or gave a bad/cheap bid.

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**4. What are the three biggest hurdles at establishing Lean Construction? Is it rather a particular party (e.g. contractor, owner, architect) than a particular change in general (e.g. rethinking, mistrust, technical issues) that is hindering LC to become applied more often?**

IPD works fine as long as there are no financial problems, within the project itself as well as in the companies in general. That may be a problem, since you may not be able to influence financial problems emerging from other projects within all the companies.

Other reasons could be the lack of trust; both, the trust amongst the different parties, but also the trust towards the new method. Or the need to have all the parties involved at such an early stage and get them to stick to the agreement throughout the process. This involvement means a more extensive design phase and therefore more costs for the owner very early on where there may not even be any funding available yet.

↳ **What would you consider to be future key-points to propagate the delivery method of Lean Construction and innovative and cooperative methods in general?**

To develop trust and demonstrate that the savings exceed the investment it will be important to carry out more projects to prove the advantages of using LC.

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**5. According to what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

Not much, since the whole process is so very restricted by all these factors. First of all we are handling highly complex projects with all the governance and responsibilities which makes it very hard to extinguish "losses" upfront.

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↪ **LC supporters state that savings from up to 30 % stand against some single percentages more for planning and design... Shouldn't that be reason enough for an owner to make use of this delivery method?**

In my opinion DBB delivers the best project outcome with the least inefficiencies, since you get a solid design and buy the cheapest trades according to that design. However it is crucial for the design to be solid and without major mistakes. [His colleague, a experienced construction manager, adds that it surprises him that the numbers weren't turned around: 70% inefficiencies].

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**6. What influence can the choice of awarding strategy and therefore the type of contract, have on factors like cooperation, quality, schedule and costs? Do you think that traditional project delivery can cause and amplify problems during the construction process?**

See 2nd answer.

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**7. Have you experienced managing 'soft-skills' within a contract to be a challenge? Do you think that the contractor could try to generate a reward by increasing the estimated costs?**

Definitely, it is basically the same as at the CM at risk. As soon as the target costs are set, the contractor or CM comes up with a bunch of ideas making it cheaper...

**Interviewee:** **Sam Spata**, Architect and Principal at CALLISON,  
Co-Chair of Lean NYC

**Date, Place:** May 8<sup>th</sup>, 4:00, 148 Lafayette St, New York.

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**1. Would you commit to that statement, or have you experienced it elsewhere? So is the construction industry really behind at establishing methods and ideas that already had been in use elsewhere?**

I am familiar with the curves of the Department for Labor Statistics showing productivity in other non-farm industries, that are increasing since 1964 and construction either flat or tailing off. I think the statistics are both misleading and yet they do reveal a deeper truth.

They are misleading to the extent that a lot of work that got done as field operation in 1964 has been transferred to manufacturing industry. So on a construction site then more was done as handmade onsite work. Now there is more assembly of components that are being fabricated in a factory. So what you can actually see is that some of the productivity in the non-construction includes stuff that used to get done on a jobsite. So that's the misleading part.

That said, I do think that there is accuracy and that construction has not kept pace with client expectations for productivity. That is certainly a management problem but I would also say maybe it's a leadership-problem. Let's say you have 3 major players in a project: owner, designer and constructor. The designer over the last 40 years became very litigation conscious and therefore got isolated from the process. On the other side, the fulltime staff owners used to have for construction projects is all gone, since owners concentrate on their core competencies. So the owner has also distracted himself somewhat from the process, which means that there has been hypertrophying of the constructor. That's what built up the asymmetry in relationship between constructor, owner and designer (Barry LePatner: "Broken Buildings Busted Budgets"). Because there has been, for all the reasons I stated, architects and owners coming out of the process has left only one player understanding the true knowledge of what will things cost and how long it will take to build that: the constructor. However, given the nature of forms of agreement there really hasn't been an incentive for the constructor to share this information honestly.

So in that respective I certainly agree that this is a management problem and one that can be addressed with management techniques such as LEAN project delivery and integrated forms of agreement.

↳ **And the constructor isn't involved at all during initial project phases, so his expert knowledge get's basically ignored during the design process.**

The litigation problems had made us all put up bigger walls, so that during the early design phases where you most need to have the input of the trades that are actually going to build the job, so you have the downstream knowledge coming upstream, is not there because of the way our contracts are set up. Mostly to provide insurability and to pass the risk off as much as possible from one party to another. The risk keeps circling from party to party. That is a management problem: dealing with risk.

↳ **Looking at the awarding and project delivery methods in particular, what is blocking a change there? Is it just the legislation or are there other reasons?**

Certainly for public sector work there are limits to the types of agreements. Integrated forms of project delivery, which are the better management techniques, feature a best value form of selection. On the public sector too much procurement must go low price. So that's a structural problem.

On the private sector side I think there is the fear of the new. I think clients have been persuaded that the way they are doing things is the best way because they get the low price and I continue to point out to them that they got to look at the price after all the change orders, since that is really the number you need to be looking at if you want to compare it to alternative forms of delivery. Yet curiously enough, towards the end of the last boom of construction around 2006, construction cost escalation in health care in California was approaching 1% per week. And that made it impossible for people like Sutter Health to commit to do projects, because they couldn't possibly go to their trustees and say "here's the budget, we built in 60% annual cost escalation"...they would've been thrown out of the room. So, since necessity is the mother of inventions, this led Sutter to experiment with new forms of project delivery and that's how the first Integrated Form of Agreement came about and the idea of integrated project delivery, the lean production and project delivery system, which goes back maybe 10 years before that crisis for Sutter, but that was when it really started to take off. And eventually people started to see that maybe a better management approach focusing on value takes the waste out of the processes and that money can go into quality scope.

So the obstacles are in some cases structural; some parties just can't make a best value selection, they must go low bid. And in some cases it is intellectual in a sense that some people are not aware that there are alternative ways on delivering projects until they were pushed and they had no alternatives, because the traditional way no longer worked.

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**2. Do you think there are other reasons, besides the financial crisis, for the hard time companies go through at this time? Do you think that some of the credit could be given to the traditional awarding procedures being in practice?**

The reality is, the way we get rich in this world is to be there when there is a high demand for the service or product you've got in a growth economy. There are a lot of people who look like geniuses who are really fortunate to be in the right place at the right time. But there is no substitute for macro-economic growth. When the economy as a whole is growing that's what makes it possible to all of us to attain some margin. What happens with the financial crisis is, there is certain amount of luck involved, because there are a lot of good firms being hurt right now. It's not just firms being poor in their management practice that are hurting. However what does happen is a combination of luck and ability that there is a shakeout and that happens generationally. That is what we are going through right now. There are good firms and good people that are underemployed for really no fault of their own.

I think the financial crisis magnifies inherent problems. If firms fundamentals were not good in terms of how they manage their processes, weather it is on the construction or design side. A financial crisis like this magnifies those errors and it puts a very harsh spotlight and reveals them. But after a crisis continues on for the length that this one has, it also affects players that were good and some it's going to come down to luck.

That said, one of the things about a crisis like this is that their become watershed moments and that the nature of practice after the crisis is markedly different that it was before. So there are some folks who are saying let's not waste this crisis, let's think about where is our market space heading, how do we get ahead of it; weather it's the use of technology such as BIM or the use of processes and management tools such as LEAN project delivery. I think smart firms are looking to say: "OK, we going to do what we can to fight to survive now, but we are not surviving to be in the same business that we are in today, we are fighting to survive for the changing business and where the world is heading!"



The financial crisis again, it magnifies effects, this has been a lengthy crisis and I think it's causing smart firms who are fortunate enough to be survivors to think about: "OK, our business is going to be different, how do we get to that new state before the competition."

↳ **So the financial crisis is definitely a chance to implement and establish new methods in project delivery?**

The old chestnut is when you look at the Chinese characters for crises it's a combination of the characters of risk and opportunity. However, that is a very romantic point of view, because a crisis like this has caused unmentionable pain for too many people for too long. That's on of the macro-economic side it does require different types of government intervention and we are seeing it to play out. Here in the States we were not as affected as the folks in Europe, we might be in better shape here right now. But that's really a macro-economic problem that can only be addressed by governments.

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**3. How have you experienced the relation between owner and contractor at traditionally awarded (DBB) and delivered projects?**

The low bid approach, that I assume you refer to, is the least integrative form of project delivery. It is the form that is the most litigious. I have experienced that in 10 projects with the same construction manager and different branches of federal government, 5 were done Design-Bid-Build and 5 were done as a Construction-Manager-at-Guaranteed-Maximum-Price. The five done as GMP were done more collaboratively, there were simple closeout, some cost savings were achieved, the project came in within schedule and target number and client, design and constructor all left happy. The five done DBB all went to either the thread of litigation and lawsuit or settlement for that.

So I have definitely experienced that when your putting a contractor in a low bid situation they are not giving you the price to do the work. They are giving you their best estimate as to what number you will be willing as an owner to accept. That then puts them in the position to argue for every possible change order. So I find when its traditionally awarded its important for me as an architect that I've done high quality documents...regardless of the fee I will get from the client. If I know this is the form oft delivery I have to do the highest quality of documents, I have to keep the most meticulous documentation files for decisions of the owner and timeliness how we are responding to request for information. Because what we realized is that the contractor here has an incentive to build a case

that they entitle for change orders or that the RFIs demonstrate poor quality which causes delays and then we get the damages for delay claims.

So what I found is that it is often times poisonous to the relationship particularly if the owner is unsophisticated. Now if you are working with a sophisticated owner that is a serial builder doing a lot of projects its much more difficult for the contractor to take full advantage because a.) they are knowledgeable and b.) they want to get the next job. It's the client who is not so knowledgeable who maybe does a project every 10 or 15 years who is really liable to that a-symmetry in the relationship were they don't know anything about what the things should cost and how long it should take and the contractor does.

Now one of the things that helped rectify this relation is information. So BIM can make a difference in this regard. We have experienced two projects, both with precast concrete, where we were able to show the owner that the quantities of precast concrete were too high because the bidders had misunderstood the and it aided 30% more then really was necessary. Because in that case, having modeled the building corrected the a-symmetry, since we got information through the model that would have usually been only with the contractor.

↳ **What are the three main things LPDS improves regarding the stakeholders relation and how is that improvement achieved?**

It is still very much a time driven business...everyone in our business, whether the constructor or the designer will tell you, that projects that move quickly can make money. Owners that make timely decisions to move projects along quickly are the ones we want to work with. A LEAN tool such as "Last Planner" which is a collaborative approach towards scheduling a project that helps build and enforce an understanding across parties in terms of what's necessary to design and build a project. So that's a LEAN tool that starts at a very grass roots level to build relationships between designers, constructors and owners that are positive, that drive how we manage time. And it is the management of time that is the most critical thing. So I think the Last Planner is an important LEAN tool.

I think that how we make decisions is kind of the summit in mind. If you are familiar with Abraham Maslow what human beings need to be happy...I think what projects needs to be happy at the pinnacle of that pyramid is decision-making. Clients making decisions that they than stick with, so I am talking about sticky decisions that aren't changed later on. So there is a LEAN tool "Choosing by Advantages" that I think has great promise for our industry. I've used it on a project where an independent peer review questioned the

approach that we took towards heating and cooling a private school where we used a two pipe fan cooler system. With a two-pipe-fan-cooler-system you've got one supply one return...so you can either have hot water or cold water. So that means you are either heating or cooling the building. And the engineers who did the peer sad you should have used a four-pipe system, because that way you can heat and cool simultaneously. The problem is, when you say something like that to an engineer, he would automatically say "yeah you're right four pipe is better". They say that because they don't have the LEAN understanding of quality that says: "Quality exists only in the mind of the costumer." At that example I said hold on, there is no absolute opinion that four pipe is better than two and I started asking questions. It turned out that you face the need of heating and cooling at the same time only on 5 days per year while costing 1 million \$ more (at a 40 million \$ project). In that case the choosing by advantages approach demonstrated to the client that their initial decision was the right one, because for the usage of 5 days it simply wasn't worth it to spend a million \$, because that capital could add more value if invested elsewhere. So I think "Choosing by Advantages" is another tool that is helpful for LEAN. "Target Value Design" as it is practiced right now in LEAN is another key factor that can improve the way we do our work.

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#### **4. What are the three biggest hurdles at establishing Lean Construction?**

The biggest Hurdle is of course human nature. That is why most attempts to implement LEAN don't begin with tools with tools like Last Planner, choosing by advantages and TVD...they will begin with a some more philosophical approach of understanding LPD and understanding buildings as production systems, understanding a project as a network of commitments. That's really the key to change people's mindset. The problem I've seen is because that's most people's first introduction to LEAN on the somewhat theoretical level, that some people have labeled it a philosophy, but it isn't! It is a project management methodology. It begins with a philosophical approach of understanding systems and the causes of variation.

The biggest hurdle is people. The next biggest hurdle is going to be in some cases the structural ability of some owners to do contracts that enable the best value selection and enable an early selection of key participants. To do LEAN right you want your key participants, which is not your construction manager, but the people who actually build the building to be sitting down with you...your HVAC, carpentry... If you are unable to se-

lect players before you have a final design it is hard to do LEAN. And without having them early it is hard to design a production system to deliver the project.

So that's definitely a second hurdle the first being peoples awareness and their mental attitude. I would then say that the third hurdle at establishing LEAN is that when people hear of TVD they say we are doing that now, it's like stipulated sum agreements... And so they than make the leap that what they are doing must be LEAN already, because some of the things you are talking about are some of the things we've done. And I think that that's the case when people are mistaking a particular tool for the broader philosophical approach that is LEAN. So this is the third hurdle: people that are doing some things that superficially look like some LEAN tools thinking that they are already doing LEAN, so why do I need to change, why do I need to know more.

↳ **What would you consider to be future key-points to propagate the delivery method of Lean Construction and cooperative methods in general?**

So certainly there needs to be a consciousness rising. Here in NYC I chair LEAN NYC, we are the NY chapter of Lean Construction Institute and our goal here in NY is really consciousness raising for LEAN, because there isn't really enough LEAN practice going on here the way it is for example in Sacramento CA. And best way we've found to do that is for people to hear from owners because they are the ones that determine which innovations become accepted. 15-20 years ago it was architects who drove green building design, it was architects who came up with the LEED idea. And that has proven to be greatly successful. But what really made it take off was when owners decided, "maybe we can't get any more money for a green project, but if we don't build green, our buildings are more likely to become obsolete sooner and not to be as attractive at the tenant market". So although architects were the first ones to put out green, what really made it take off was when owners said "we need to invest in this for a lot of reasons, even if there is not an immediate return on the investment, long-term that is what will give our properties quality".

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**5. According to you what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

Bill Seed who runs the design and construction group at Universal Health Systems, they are building hospitals, was telling people: "I'm paying my construction managers and my architects higher fees, improving their profits by 50 maybe 100%, but when I give them

these incentives and they work in a LEAN fashion, they are reducing my overall cost by 20+ %” So it pays for him to pay people to behave in a LEAN fashion, because he is getting a great return on that investment.

So there are statistics out there demonstrating to owners and others that LEAN is eliminating waste and lowering their cost, as well as delivering higher quality and safety. Safety is a factor we missed out earlier, because LEAN projects tend to be safer as well. You can put a price to when something happens, but for people in most cases it is a priceless event.

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## **6. What influence can the choice of awarding strategy have on factors like cooperation, quality, schedule and costs have?**

I remember attending a conference by the ISPE (International Society of Pharmaceutical Engineers). Pharmacy companies where the last refuge of corporations that had strong design and construction departments, because their building types where very expensive and if you didn't do it the right way, a business could be at stake. So they kept strong independent design and construction staff for a long time. And yet, I remember hearing at one of their conferences at around the year 2000 a statement that most of the pharmacy industry has moved from traditional DBB to Guaranteed-Max-Construction-Manager. They also said, we know that we are paying 15-18% more than we did in our low bid days, however we are getting a reliable price. And for those guys, what really mattered was, once they got an approval from the board of directors setting their capital budget, they couldn't get back and ask for more money.

So they found that the reliability, which is a key function of LEAN, of the Gmax process, was worth potentially overpaying. Now LEAN can aim at giving you reliability without overpaying. It aims giving you reliability at a lower cost. So the awarding strategy is huge with regard to cooperation and quality etc.

The example I gave earlier with the design firm doing 10 projects, 5 Gmax with no problems and 5 DBB where every one of them went to settlement or litigation, that's prove right there that how the owner transfers risk is critical. So that it is all about award strategy. Award strategies that tend towards integrated design and construction tend to have better cooperation, better quality and more reliability in schedule and cost.

So Gmax would give the client a reliable number of cost that's too high and a schedule too long, without the client knowing it. With LEAN you make these issues more transparent so you can get the reliability at lower cost and quicker time to completion.

↳ **Can a traditionally awarded and delivered project still secure the same cooperation amongst the project participants and deliver the same quality in the same time?**

Dana Cuff wrote the book "Architecture the Story of Practice" for MIT press somewhat 20 years ago, in which she stated that the best projects had really engaged clients. LEAN is not a spectator sport. If you do LPD as a client you are going to be very much engaged in the process. That said you can still have an excellent engaged client at a traditional DBB if there is a knowledgeable client who is willing to pay the design team the fee that is necessary to do a competent set of documents that is thoroughly coordinated and comprehensive, not missing anything, that's code compliant and constructible; all those things are possible with the proper fee and schedule on the design side, because you get one shot and it has to all be there in the contract document e.g. plans and specs. Then you have bedded teams that you go to a shortlist of contractors who you already have previously determined to be competent you can do traditional DBB and get good results.

And you will find that for people who are serial builders like developers who really understand how things get done. But if you're not that type of owner and you don't bring that amount of knowledge you might think about a more integrated form of delivery such as LEAN to get those good results. With the right team of people that are motivated and that are willing to work together you can accomplish anything regardless of the form of agreement, I do believe that traditional DBB projects can deliver good results!

Here is a little story...I read this book "Turing's Cathedral" recently which is about John Von Neumann a physicist after World War II and the need to build a computer. They were faced with the problem that switching on and off bits and bytes, the zeros and ones the binary was handled electronically by vacuum tubes back in 1947. And the typical vacuum tube was maybe 80% reliable, so they were faced with the situation how to get really reliable results, because this was about thermonuclear warfare, so they needed to get this right before the Russians do, that was the situation they were in. So they needed high reliability of results using components that individually were highly unreliable. That was what gave birth to the types of software and programming codes that were written at that time, because they had to have software that can get reliable results using unreliable hardware. The analogy to my mind for construction was that the software is the

form of agreement, the processes and how we organize ourselves and the project to deliver the hardware - a new building. I do think that LEAN as a way of taking what are individually unreliable human beings and to create processes by which those unreliable elements can deliver highly reliable results...I think that that's something that you cannot consistently duplicate simply with best efforts on more traditional forms of delivery. Of course, if you put the best people together, they trust each other and worked together before you get good results, but that is a one-off situation. How do you do all the projects that need to get done right now to deal with the sustainability challenges, dealing with population growth and aging infrastructure... So there is a lot of projects that need to get done and not all of those will be build up by people who worked together in the past, are good friends and who are the A-Team. The real trick is, most of us are B-Team in the Bell-curve of life. So how do we get that big bulge of the B-team players to be able to deliver like A-teamers. Well it's not through best efforts, it's through best processes and procedures and that's what LEAN offers.

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## **7. Have you experienced managing 'soft-skills' within a contract to be a challenge?**

First of all you can't just say: "You guys are collaborating!" because I've seen instances where people would've fault to their normal behavior. Folks have figured out how to play the game, and I mean game in the John Nash equilibrium sense of game theory. When a collective group is working together, you figure out certain norms of how to behave. Designers have figured out, if they stay aloof from the process I'm going to be less engaged and I'm going to get less litigation. Contractors have figured out I hit for every change order. Owners have figured out: I'm going to be unreasonable and pound the table and be brutal to people, I'm just going to treat anyone who comes to me as if they're a liar. That's why you need a little bit of resetting the mind with some training in the fundamentals of LEAN - that's the philosophical part. And that is where leadership comes into play! You cannot simply direct people, now you going to work collaboratively.

I will give you an example from a personal experience at a major project here in NYC. We had a colocation of the team: the user and his agency, the designers and the constructors all sitting in a single space. And you still had examples when there were difficult questions, sending an e-mail to the client sitting 30 feet away, instead of getting up and say let's have a meeting, let's discuss this issue and figure it out collaboratively. So leadership needs to demonstrate to people that it's OK to stop working the way you did in the past, we expect you to work with new behaviors. LEAN ultimately is a sweet of be-

aviors that deliver better results. But those behaviors are only going to happen if leadership demonstrates that those are the behaviors that will be rewarded in the team.

I participated as co-facilitator at a LEAN course by the AGC (Association of General Contractors). One of the things we did was to encourage people to talk about how they solved problems in the past. Whether it was a constructor or designer, the way things got delivered up to know was that things started going wrong and than one person will just kind of step up and do what it takes to get it straight. So there is this hero-mythology in design and construction that somebody steps in and sorts it all out when things are going wrong. I maintain that the same mindset that creates these heroes is the mindset that creates the prevalence of people that behave like jerks in our industry, or not collaborative. Because that's what they learned to be the successful behavior given the way the game is currently structured.

So restructuring the game through new forms of award techniques and contracting is a leadership decision that can drive people to different behaviors. What's important is not to assume that people will adopt those behaviors automatically. To go back to the beginning of the conversation with the famous curve that shows productivity tailing off and construction going higher in the rest of the world: We can't say to everybody start behaving like in 1964, before this great divergence. Because people who are still here from that era are old and most of us weren't there which means there is a need for folks who can facilitate the conversation. I do believe that there is a room for LEAN practitioners and LEAN consultants who can help people both with tools like the Last Planner and even more importantly the new behaviors required. Those consultants need to be able to speak directly to executive leadership on projects, which is why a good LEAN project will have an executive team as well as a project implementation team that's hands-on with the delivery. Because the executive team are the ones that have to demonstrate to the folks working at the coalface "These are the behaviors we will reward, these are the behaviors we will expect!" You simply can't expect people to pickup to where their ancestors left off 50 years ago.

↳ **Do you think that the contractor could try to generate a higher reward by increasing the estimated costs?**

That's how "Construction Management Guaranteed Maximum" has worked for a long time... Clients call GMP Guaranteed Maximum Profit. Clients are aware that the numbers a padded and they are aware that there is hedging atop of hedging. The trades will put in number and then they will put in a little extra on and then the next line up will put their extra on and the construction manager will put a little extra on and even the owner



and designers. That artificially inflates the number drastically. So yes its being done all along and has always been there.

That's why in LEAN the validation process, which is the beginning of the LEAN project delivery, where owner, designer and constructor all have to agree on the validated scope of the project, the quality, in other words the program, the schedule and cost. In this way any one of those can say I don't buy into that number and can pull out of the project at that point with no penalty. Now the owner in most of these contract kinds says I'm going to overwrite your opinions, I want you to go ahead and then people can decide if they want to take the risk and continue with the job. That validation is key, because owners will not come with a budgeted project, because to me a project per definition is an "allocation of money suitable to achieve the program quality and quantity in the time allowed". Owners will often come with a bag full of money, which is simply an allocation, it hasn't really been proven that it will be the right amount of money for the program and the schedule. It might be close, but that's what the validation process is all about, because a well-validated project as it is required in integrated forms of delivery should eliminate the potential of padding on the numbers...by all parties.

↳ **Why is there still a certain dislike for relational contracts? Could it be the sharing of risks which owners are not willing to agree on, because they aren't used to it yet?**

Yes because right now we are in a buyers market for design and construction services. In 2007 it was a sellers market. I did a presentation around 2006 including a chart showing the consumer price index raising at 3%, the input index which was the cost of material going up at 6% and then I had the Turner index which is an output index showing the cost of bids which were raising at 12%.

So index going up by 3%, materials by 6% and the bid prices by 12%. So what that told me was that this was a sellers market...highly inflationary. In a market like that owners were desperate for a good team and had to pay what they had to pay. Now in the great recession it's a buyers market and owners are doing three things they have done in every downturn: trying to get more value for their money. That means right of the bat, for the given scope of work they want a lower fee. They also want to hold on to their cash as long as possible because they are in the same macro-economy so they extend out a couch receivable and finally they will do the maximum amount of risk transfer. They will take the least amount of risk and push that off to the constructor and designer...because they can. The motivation for them to do that is they're doing things in a traditional fashion in a declining economy, because it is what they have to do. But I want to

be able to say to owners, there is another approach that is, even in a declining or stable economy, finding a different ways of doing project delivery. The paradox is, as you increase your exposure you are actually reducing your risk. The reinsurance companies seem to say now we think that Integrated Forms of Delivery are less risky. I am hearing attorney say that the best risk management tool that I am telling clients to use is LEAN construction and integrated forms of delivers.

Even though owners may look like they have more exposure to pain- and gain share, the paradox is, by working in a more integrated fashion they have got more people who have an incentive to first solve the problem. The expression "Fix the problem, don't fix the blame" is not how we work at traditional projects where the goal is to make sure somebody else is at fault and not you. As we help owners understand that fixing the problem first means that the problem becomes a much less expensive problem to deal with and that the team now has an incentive to find cost savings elsewhere.

A real live example from a project in California where despite warnings trades penetrated moment connections in a seismically braced frame, and that's a "no-no". It was going to cost 300.000 \$ to fix it and these moneys the team hadn't planned to spend, so potentially that money would go out of the bonus pool for the designer and constructor – which effected everybody. As it turned out, one of the trades was the aluminum curtain wall trade and they decided to extend it and therefore cut the screen for the mechanical equipment on the roof, which would have cost 1,5 million \$. Even though the steel was already ordered, the team as a whole found ways to reuse that steel elsewhere on the project and still made up 1.5 million savings elsewhere and ended up 1.2 million to the good.

So certainly everybody had more risk exposure, but because the system has incentives to solve problems you have less actual risk. It's a paradox, but that's what I've seen play out.

**Interviewee:** Reza Nikain, Leader of Global Dispute Resolution Management at MARSH

**Date, Place:** May 14<sup>th</sup>, 4:00, via telephone call.

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**1. Would you commit to that statement, or have you experienced it elsewhere? Is the construction industry behind at establishing methods and ideas that already had been in use elsewhere?**

I think the way those comparisons are made doesn't really take all of the factors into consideration. It's not as simple of a comparison as you would expect. Certainly construction work is a lot more productive today than it was years ago and that productivity is, in spite of all of the other conditions that added to the construction work like: regulations, safety, impeditive pattern to deal with values, sight issues, the way labor operates...

So just to compare construction on one to one bases to other industries and say construction is not as good is a very narrow way of looking at it. However, I do agree that productivity is lagging relative to other industries, but just to say core manufacturing is a lot more productive today because improvements in a shop-environment vs. in the field where most construction work takes place is not the right way of comparing it. Every project is unique and the environment it is constructed in is different and there are a lot of different variables: environmental, condition of the site, design... play a huge role in what is realized in the field by a construction crew that is not comparable to a controlled environment you would realize in a factory.

So it is like comparing apples and oranges when you compare fieldwork to a shop environment.

↳ **What is blocking a change in awarding and project delivery in the construction industry? Would you impute that to the legislation or do you see other reasons?**

That goes to the heart of bringing around change. Changing things an industry is so very used to do in a certain way is always hard. I think the only way you can bring around change is to eliminate the resistance to barriers that prevent the change from happening and then being able to identify how value is added. If you can't accomplish both, no-

body is going to change. As long as you don't have a good value proposition that excels the resistance against change, nothing changes.

So economics of projects trying to reduce waste and improve efficiency, achieve a higher rate of return or improving the competitive advantage of a contractor - those are the only motivational factors that will supersede the resistance to change. I think competition takes care of that, so if you have a competitive construction market you are going to see contractors see more innovative in how they deliver the projects. Whether they take agitated risks, whether they value their risks better or identify and protect themselves from the unknown. Those are the reasons that they would go down the path of change themselves.

Those areas or those geographies in the world that are more accommodating for labor to improve their ways of how they work or contractors the way they deliver their projects and take the risks. Those are the only geographies that accommodated different project delivery methods. If motivation is not there, the change isn't going to come around.

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### **3. How have you experienced the relation between owner and contractor at traditionally awarded and delivered projects?**

Traditional delivery methods require a clear understanding of what the objectives are. So the bilateral (two-way) communication between the owner and the designer will establish the framework for the work: delivery schedule, quality requirements... Another relationship between owner and the contractor that establishes when the work is going to be started, what quality is going to be installed in the field. Because of those two different independent relationships there is a lot of room for misunderstandings, lack of communication, unclear specification and scope definition. What means one party having a different point of view and a different understanding of what the other party is expecting. That lack of clarity and understanding will lead into potentials for disputes, delays and rework.

So how do you make sure there is a clear communication between the parties, how do you control that you have a clear understanding of what the requirements are and then how do you handle the unknown risks that a project has with a reasonable and informed value. All of that will lead into whether or not you will have an environment that could lead into disputes or a successful project. Those are the elements that often kind lead into unresolvable differences between party who then require a third party to resolve.

↳ **How much better would you judge the situation at projects delivered with LPDS?**

Certainly bringing in all the parties together is helpful. So the ultimate objective is to reduce the amount of unknowns. However you achieve that, there are many different ways to size and value the unknowns and then try to communicate the information to all parties so everybody knows what and when is needed.

So if you have a relationship that starts early and is open as the project develops the unlikelihood of having gaps of understanding and differences in perspectives is reduced. However you reduce that, because there are many different approaches to reduce it, but if you can reduce that it will lead to a more successful project. If there are different points of view that go unresolved then those very things can lead into projects that cannot be resolved later on.

↳ **What are the three main things LPDS improves regarding the stakeholders relation and how is that improvement achieved?**

Problems within the contract.

Problems with peoples understanding - how they view their role and their responsibility.

Differences in how the involved parties value the unknown, how they handle the risk.

So any one of these three very broad categories can lead into disputes. If the risk is mis-allocated or wrongly allocated it can it can lead into disputes particularly.

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**4. What were the three biggest hurdles at establishing Lean Construction? Is it rather a particular party (e.g. contractor, owner, architect) than a particular change in general (e.g. rethinking, mistrust, technical issues) that is hindering LC to become applied more often?**

Well I think education is one aspect of - understanding what it is that is being talked about. Just talking about a better form of a better form of delivery methods is not adequate. Or labeling something as LEAN construction is better is also not adequate. Being able to identify how the industry or how the parties will benefit from it, is the issue.

One of the biggest hurdles in construction is the different priorities the owners have versus the contractors. Owners build a project to use it for their life or their business, so

the interest for owners focuses on the use of the building. Contractors and engineers view the phase of construction only. So how can you align the two interests and identify how both parties that have two entirely different interests at the end, how do you identify a delivery method that can benefit for both sides. These are business, so ultimately it is the return on investment that influences the decision-making of contractors and owners. So any delivery method needs to ultimately be able to address: how does it improve your rate of return on your business.

↳ **What would you consider to be future key-points to propagate the delivery method of Lean Construction and innovative and cooperative methods in general?**

I think the industry is moving towards reducing the gaps in understanding and the roles of responsibilities. So what they are trying to do is to integrate the responsibilities so there are no unmet needs of a project during the development. Meaning the designer is preparing a set of plans the industry is towards that set of plans being fully constructible and free of errors and issues in the field so the plans can be constructed rather than having changes during construction. So if you look at the new innovative ways of integrating all the documentation looking at 3D and 4D modeling to identify shortcomings in design and making the design more constructible.

Those methods all share their reason to have fewer unknowns and therefore reduce risk. That is the single most important aspect of the technology that is being added and all the changes in management – to make the output more predictable, which that comes higher efficiency.

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**5. According to you what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

I think first of all inefficiency is relative. It depends on what labor force you have. What will be considered productive in NYC is different in Kansas or for that matter in Canada or even Asia. So everything is relative with respect to the standard of practice in the region the project is located in.

Having said that, there is room for improvement. The logistics of getting the labor to work continuously is driving the behavior of what is taking place. For example: If you are building a large power plant boiler and all of the laborers are taking a 15 minute break and they climb down to go to a lunch room and then go back up – they lose 30 minutes

to get their and back. Of course there are ways to improve on absolute waste-time. Another example is the time wasted on waiting for tools and equipment or a lift, which is also a logistical issue. So there are workflow improvements: to reduce the moving around the waiting and all of that; which is the big part of the minutes per hour wasted dependent on the particulars of the project, the laborer, the trade that they are working on. All of that can be improved, but the real challenge is how to improve that in a save way. In a way to eliminate rework but still improve quality. Because those are other factors leading to the overall efficiency of projects, not just the productive number of minutes per hour that the labor force is working.

So there is plenty of room for improvement there: material handling, just-in-time delivery, having better packaging so you have no wait time for anything. How that improvement is achieved is a very comment topic it differentiates good, efficient and competitive contractors from contractors that will eventually go out of business.

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## **6. What influence can the choice of awarding strategy have on factors like cooperation, quality, schedule and costs have?**

I think the awarding strategy will depend on the sector of the industry that is in question. There are parts of the industry that are more production oriented; lets say doing a high-rise has to be very productive, also because of the reputation is there, and it is not a complex construction undertaking.

So if you want to know how does it influence one versus the other you need to almost look at what are the risks through quality, schedule or cost based on he complexity of the project. Which one has a higher priority, which one is driving the success of the project and how do you prioritize the decision-making.

If the quality of a project is prioritized the decisions that need to be made have to be prioritized in the context of quality accordingly. If its going to cost some more or take some longer that is the prize to pay to achieve the quality. So awarding strategy needs to accommodate that, it needs to accommodate what are the projects priorities and then the emphasis needs to be placed on achieving those goals. Not all projects are as time sensitive as others. If you are building a chip manufacturing facility schedule is very important because you may be loosing a million dollars a day if the facility is not on line. So the owner will gladly pay extra in order to achieve the schedule.

**7. Have you experienced managing 'soft-skills' within a contract to be a challenge?**

Well open book contracting for example is being used in the industry now, and has been used for many years. However a key factor is, that not every form of contract works in every sector in the industry. So you have different owners and contractors within different sectors in the construction industry. The reason for that is, that there are different standards, quality needs, complexities as well as different risks and rewards in those different sectors.

For example in the power industry open-book-estimates is very much used because you have sophisticated private entities dealing with one another. The better and more suitable the risk-allocation-model is, the more likely the parties will be successful on the project. Whereas you have public money, building highways for example, they have to obey by certain government and state regulations in terms of what the procurement practice is. So you won't see open-book estimates in public procurement practice, for example. Maybe someday in the future they will go down to negotiated strategies, but right now they don't. The vast majority of public infrastructure projects are competitive bid-build, where the lowest bid wins the project. But I think it is unlikely to change for that in the near future.

Some industries, whether it's public or private and whether it's risk & reward strategy or traditional, are embracing new approaches, some industries aren't, because some of the policies are too difficult to change. So it goes back to: what is the value and how do you measure the value. When a state sees the value in negotiated or integrated contracts, that they can eliminate waste and get a better quality and schedules, then they may go down the path on changing the approach on all of their future projects. But how I see it, this is probably not going to happen any time soon.



**Interviewee:**       **Greg Howell**, Co-Founder and chair of Lean Construction Institute

**Date, Place:**       June 6<sup>th</sup>, 11:00 am, via video call.

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**1. Would you commit to that statement, or have you experienced it elsewhere? So is the construction industry really behind at establishing methods and ideas that already had been in use elsewhere?**

The question on productivity is: typically when they are measuring productivity they are measuring how much does it cost to put one brick onto another. They are measuring the output versus the costs of the work. And that's where I started in my career working on that kind of thing and in that model you assume that all of the cost of the work arise at the place where the work is done. That is what accountants think. So these numbers about productivity improvement may be, especially when those numbers are that small, I don't think we actually know what's going on. It may be that in some way some contribution is technology; somebody made bricks that are lighter and easier to put up there; or maybe it's that the economy has been such that now less effective workers had been laid off and now we have more effective workers. I mean there is all kinds of stuff and when you have that tiny amount of change I don't think you can go and saying that's the result of this or that. We have a very weak ability to judge cause and effect. So I wouldn't say what it is about that. I suspect that the productivity is about the same and it's remained flat and everybody has an opinion about that and they can point to the bases of their opinion but that still doesn't make it a fact. You know there is a difference between facts and opinions and I wouldn't say you can judge these very small numbers in an accurate manner.

What I have seen though is that we can see tremendous improvements in productivity in two different ways. One is when we change the design of the system people are working in; that's like in lean construction. The other one is when we actually change the details of the operations. I will send you a presentation about Improving Construction Labor Productivity by Dr. Glenn Ballard. *(file Realized Productivity Session 3 Glenn Ballard 3 5 13)*

If the question is “productivity remained about the same” I would say yes it has because the fundamental management of the work hasn’t changed and expecting it to change without something like that is crazy.

↳ **Looking at the awarding and project delivery methods in particular, what is blocking a change there? Is it a particular party or a change in mindset that isn’t allowed innovative methods to get implemented?**

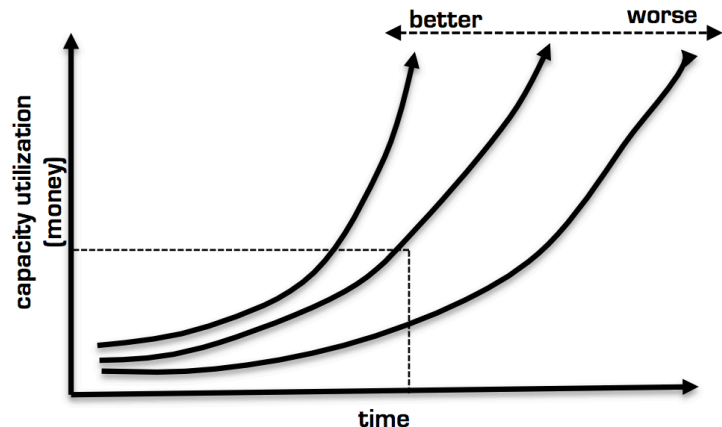
I think it’s the power of habit – we have this way of looking at the world and nobody is immune to that. But I think we have these habits of mind, these ways of seeing things. Maybe this goes back to motivation, but lets say I am trying to get you to work in this new frame of teamwork, I can try to motivate you to do that. I can tell you how wonderful it is going to be. When you see this video I will send you by Julio Olalla, there is something different to do here. He sais we are all observers in this world. We see the world as we see it from different views depending on our history and our background. If you want people to change in a big way I think you have to bring them to see something different. Otherwise they are where they are, but big changes only happen when you can change how people are as observers, to change the position they stand.

Everybody who had worked in construction had experienced unpredictable flow of work, everybody. It probably goes back to the pharaohs in Egypt. Everybody has experienced that somebody upstream has not performed in the time or in the way that they expected them to perform. That is a wide experience. Glenn Ballard came up with this idea of measuring the planning systems performance and he discovered that workflow is unreliable. He could say only half of the time people are able to do what they say they are going to do next week. Everybody in the industry if you would ask them probably would have said that is about right but they never really stood in a place where they saw that from it’s industry consequences. Before Glenn nobody in the industry, this may be too hard, believed that you could change that. But he said: look people can’t make good assignments - we can change that. So what he did was he brought people to see something different in the world, he changed the way he was seeing the world. Instead of seeing it as a failure in your motivation he now saw it as a failure of the planning system. So there was a shift from a kind of individual perspective to a systems perspective and then he found an obvious way to improve that performance. Now Glenn and I had been friends for years before that, we both were suspicious bout project management, we had lots of reasons to be suspicious, but we couldn’t put our finger on it. We were trying to improve productivity, but we couldn’t figure it out until this happened and it became obvious.

If you expecting big change you have to bring people to bring something different and I think that's a role for leaders that we don't yet understand very well and I don't know how to do that yet. I can do it in some small domains like we are right here, but it's not that I am trying to do that in politics, that's for sure. But if you go look at politics people are trying to do that.

↳ **Have you ever experienced, that consequences in an advanced project stage could be led back to the awarding method? Due to competitive price bidding**

Well yes of course. There is this kind of craziness. One of the things we know, we talk about it in construction as the time - cost - tradeoff and if you look at queuing-theory, which I will draw you a chart right now.



There is a rule you can find in traffic engineering, it is called the capacity - delay - curve. As the capacity of the highway increases the time it takes you to get through the system goes up. So as the capacity utilization of the system increases the time it takes something to go through the system goes up. Think about rush-hour on a highway. At 3 am in the morning the capacity utilization is very low and the time it takes you to get through is very short. When the highway is fully utilized at 6pm then the capacity utilization is really high and the time it takes you to get though is very long. At 3 am if you are involved in a wreck the ambulance can get to you very quickly, but at 6pm it might take the ambulance some time to get to you. This is the time - cost - tradeoff.

So when a contractor puts a budget on a project, they think that they are going to have some capacity utilization and it is going to take them a certain time to do the work. As a contractor I want to have my people fully utilized at the project so what I do is I keep my people off of the project until there is a lot of work available for them so their capacity utilization will be higher. That causes the duration of the project to go up. The owner says he wants the project to be done more quickly and wants the contractor to bring more people out to the project so the capacity utilization will be lower but the project duration will be shorter. The key here is that the shape of the curve is defined by the predictability of the workflow. So if you can increase the predictability of the workflow you get a better

curve that allows the project to have higher utilization and is shorter. A lot of people have a difficult time believing that, but if you want to improve both cost and time you have to make workflow more predictable. People don't believe that until you say: Well if you have ever been at a job that was really screwed up that is the project became less reliable and therefore costs more and takes longer.

What we stumbled into here is, from a physics point of view since this is the physics of production – the way at which production systems are design; it's something completely missing in the activity centered view of traditional project management. We play a game on the traditional project management as if it was gods curve, as if there is nothing we can do about it. But we know we can do something about it by making the workflow more predictable. That's kind of the underlining conceptual foundation we have of our work that distinguishes us from the rest of the world.

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**2. Do you think there are other reasons, besides the financial crisis, for the hard time companies go through at this time? Do you think that some of the credit could be given to the traditional awarding procedures being in practice?**

That is kind of a tradition in the construction industry in the United States. Particularly when the economy shrinks then what happens is people make more dangerous bets. One part of the problem is that construction companies think they make money by betting on projects and then delivering them and they focus on the act of setting the price more than they focus on the actual organization of the work. And so I say, well this project used to cost me 1,000,000 \$ but I am going to say 900,000 \$ and will try to get a lower price from my mechanical engineer or other trades.

Traditional practice is, I'd call it "motivationist", that says that the contract motivates people to do work and if we have a low price they will work more fully. But I think that there are practical limits to that. Motivation doesn't change the way that work is being done. So where we live is in a world of system design. So we are talking about the design of the system we are working in and one of the principals we have is that we want to optimize the project and not the piece. In systems theory you know that if you optimize one piece of the system it causes degeneration in the performance of the whole system. And that is the fundamental conceptual failure in traditional practice. So traditional practice is fundamentally a contractual form and that is where we are different. Companies go out of business because they are probably wasteful and they make bad decisions and the world punished them.

### **3. How have you experienced the relation between owner and contractor at traditionally awarded (DBB) and delivered projects?**

Sometimes those relationships are good sometimes they are bad. The issue about the people in the industry being dissatisfied is very interesting. I can give you kind of a small story.

We've been involved in many implementation of lean construction in companies. So the company would say we want to make a change and we go to that company and we will have a meeting with usually 10 or 15 people. And there will be a young man or woman sitting in the corner off to the side signaling disinterest and unhappiness. In most cases it turns out it's true, so they are unhappy with their job, because they thought when they went through college they would get into something that would use their intelligence or in general they would go to a place that is more interesting. And they had been really dissatisfied, they think they had made a bad mistake in their career and they don't know what to do about it. And they hear about what we are doing and they turn on like a light bulb. I've learned that when you see that person in a company that that person may be the best person to put into this initiative, because they're the one who is really looking to do something bigger. The fact that they had been not a great employee and they had been unhappy and dissatisfied probably is for a pretty good reason. I have actually two stories of that from the same company we worked with but from different divisions around the world where that happened.

So lots of people are dissatisfied, the industry eats people up. We have a terrible safety record and there are dissatisfied employees. There are some owners and contractors that are able to maintain professional relationships if they work in a kind of similar market and they are stable and they work together frequently and they both belong to the same church or go to the same social club or something like that. But that is less and less common.

#### **↳ How much better would you judge the situation at projects delivered with LPDS?**

It depends on how well the parties understand the differences and so I think that people actually want to cooperate and you have to explain them what the structure is going to work to make that more effective. The development for us was that we started off by making workflow more predictable and then we realized we should design the projects as production systems. We began to take a system view and realized we were trying to optimize the project not the piece and then we began to realize that the ability to move

money across boundaries was getting in the way of our optimizing the project. In other words if the structural contractor would weld the pipe hangers onto the steel when it was in their shop it would be much less expansive for the mechanical contractor. So we needed to move that money across a boundary so that we could maximize the performance of the whole project. Setting aside those financial boundaries and allowing the team how to invest their money wisely in the project is a really big opportunity that most people haven't yet figured out. That was actually what let us to the integrated project agreement. It wasn't that we wanted to be nice to everybody it was a key to our ability to design more effective systems that we are working with. It was a production system design issue.

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#### **4. What are the three biggest hurdles at establishing Lean Construction?**

I think the first hurdle is to reconceive the nature of the change. We have an industry that is built around a contracting model and this change is a system design model. So getting people to really understand the nature of the change is a big problem. And that change from an activity model to a flow model is really where that starts. I think this is a paradigmatic shift and getting people to change is never an easy thing to accomplish. You know people don't go: oh the world is round it's not flat. I like that story about Galileo because. Today I had a discussion about IPD and why an owner would do this and I gave an argument for it and thought about using Galileo's statement after he was excommunicated by the church and at the end of that he said: "But it still moves". That it was clear that we were rotating about the sun. So it is very difficult to change minds in a big way like that. We [the LCI] didn't set out to do that, we had no intention to upset people, we just followed the line of thinking. I don't know if you've seen the video about this. *(Julio Olalla - ICF Keynote Speech: Our Unique Observer in the World - Newfield Network)*

I think that the problem with the adoption of lean construction is beginning to get people to see the world differently. And I think a big part of that is that we are trying to optimize the project and not the piece. It's from a decomposition model to a holistic model of the project and that just violates so many things. I am wondering we are not part of a larger shift in society, you know you have more dispraise of the social media, that kind of horizontal authority now. And that we are kind of in that and I am wondering if that set of changes in societies underlined thinking isn't making it easier for us.

↳ **What would you consider to be future key-points to propagate the delivery method of Lean Construction and innovative and cooperative methods in general?**

There are two reasons that stand out to me. One is because we kill fewer people! The second reason is because we are trying to learn to manage very large and dynamic systems effectively and we find it's very difficult to do that. It's very difficult to manage a large dynamic system. The problem the world faces in terms of global warming is the management of a very very large dynamic system. I think that what we may be learn about how to do that by learning how to develop a common understanding, a common sense of purpose...all those kinds of things in very complicated circumstances; that may be useful for that.

So I think if you think in big terms one is quit killing as many people the second learn how to manage really big systems and third is reduce the actual waste in projects so our project themselves are less polluting and more efficient in their use of resources.

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**5. According to what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

I reinterpret the question as: "How much planning is enough?"

I have a small simulation called the "OOPS-Game" that is built around this question; I will send it to you, too. Because the world is such that you have to decide before you know what's going to happen how much planning you are going to do. And we have this ability to make decisions. A classic example has to do with how risky you think the world is and how resilient the world is. So for example I like to have more gasoline in my car because you never know how things are going to turn out and if it's an emergency the last things you want to do is stop to get gas or run out of gas. So I am willing to spend more money on planning in the sense of adding contingency to our plans. So I would say adding contingency is a part of planning and so the question then is: "How to you decide on how much contingency to carry with you in an uncertain world?" You may have great experience but things go wrong all the time and I think we are remarkably good at coping, we find ways to work around it. So we are ingenious, we carry contingency, but we still suffer this dilemma of how much planning is enough?

One way to understand lean construction is that we are putting a different focus on planning and we can learn from our experience about that. One of the research areas that I want to go on to is the following: right now everybody involved in a project is adding some contingency in terms of time, money or something to protect themselves as they see the danger where they are. Nobody knows how they do that; there is no advice in any kind of scientific bases for doing that and anybody is trying to protect themselves locally but we don't know the amount of contingency that is buried out in our projects.

Now our projects manage on lean bases better because we are more productive or projects on lean bases are better because we are not using up the contingency that everybody has out in to protect themselves from unexpected events. We have no idea and so one of my urges in research is – I call it the “contingency project” – and I have a believe that ... have you ever seen the parade of trades simulation (workflow variability) ? OK, so the parade of trades simulation is a simulation where we move 35 pieces of work through seven trades and the trades come on to the project one week in advance. And we move the work by rolling a dice. So in the first week I roll a 5 and move 5 forward. Since the average roll of a die is 3.5 you might say the first trade should complete their work in ten weeks... rolling an average of 3.5 for 35 pieces should in 10 weeks per trade on average. However since every week a new trade comes on, every roll higher than the previous slows down the following trade. So trades loose some of their capability because you can't move forward. Other times large inventories build up between the stations when I roll higher numbers and you can't keep up.

That gives you a sense of what happens on projects. And what I do in that when playing the simulation is recording how much each station rolled, how much capacity they brought that we record how long they did the work. So it's typical that one station might have spent 45 units of capacity to move 35 pieces of work because other work wasn't available from upstream. And we record the inventory that builds up at the project and we record how long the project takes. And we play that out in a seminar, but what we don't say is that we are using different dice. We say all are the same, but actually they are not. They do have the same average roll of 3.5, but one die goes 1-2-2-5-5-6 so it is less reliable. The other die goes 2-3-3-4-4-5 so it rolls closer to the average and is more reliable. And the difference of the performance of these teams is dramatically different simply by the different dice. So we record that and people are shocked by that and at the end I will say will you rather have a die that can be faster, or one that is more reliable. Everybody will say, well of course more reliable and I ask them back what they choose in their projects everyday. So now we are to that moment where our current, normal thinking is failing us because we push everybody to go as fast as possible every week, we



don't push for predictable workflows. And that's what the Last Planner is designed to produce.

So we don't know the answer to how much planning is necessary, there is some research going on, because I believe, if you take a chain of trades, you don't know how much planning do they do to protect themselves. It might be smarter for the project to have more reliable flow if they did more planning, but they won't do that planning unless they are being compensated for it so I think there is a real question about how that dynamic is at a project. I think our research here should be very much connected to observation of what's actually happening. We need to go out and stand in some place and try to understand how people do that now. What I want to do now and talk to superintendents and foreman to get to know how they protect themselves so that they assure that they get that done. How much contingency do they have, how much extra tools do you have, how much extra stuff do you carry with you to absorb the uncertainty that you can't yet see. And you'd be crazy when you for example take off into the mountains with a pack on your bag you have to think through how much water you going to carry and how much extra food you going to carry and if you don't carry an extra candy bar and a book of matches you are not being very smart. So it's that kind of thing that I think is a big question here about how we remove losses and where they are. We don't understand the nature of them very well right now.

↳ **Do you think DBB project could deliver the same quality in the same time?**

I think it depends on the projects. Particularly the complex – uncertain – and quick projects I am confident we beat the traditional methods. If it gets down to simple – slow – certain I think there is less and less advantage of the new system.

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**6. What influence can the choice of awarding strategy have on factors like cooperation, quality, schedule and costs have? Can a traditionally awarded and delivered project still secure the same cooperation amongst the project participants and deliver the same quality in the same time?**

*“An owner has to decide what they are buying.”*

Are they buying a service, are they buying a product... Are they buying this hard drive or this one. It is completely defined, we know how it works and it has specifications. It may be defective, but we are buying this product that is well defined and described – so many gigabytes, certain speeds and all that.

So in construction buying a product would mean buying a project or are we buying a service of a team that is trying to solve our problem that nobody completely understands and it keeps changing. I think construction projects range from simple-slow-certain to complex-uncertain-quick. And the strategy for purchasing that projects, the awarding strategy, depends on where you are on that spectrum. If it's simple-slow-certain, for example painting my fence, I can buy that as a product. If it is designing and building that fence where there is uncertain geology below that – we don't know where we can drill postholes or not – then I may want to consider not shifting the burden on to the contractor, because he will have to raise his price because of the uncertainty to protect him.

Now think about building a hospital.... The cycle time of medical equipment is shorter than the time it takes to design and build a hospital. So if you set out today to design and build a hospital for the equipment we have today, it takes you several years until completion, the medical equipment you designed it and the whole healthcare system you designed this around has changed. How do we design a hospital, because it's complex, uncertain and quick. How do we design and build it to maximize its performance? What decisions do we want to hold open? We have worked on a hospital once where they knew their demand of MRIs was growing, but they have as much money as they wanted. We made the space but didn't actually put all the wiring and supporting systems for the MRIs in them and by the time we finished the hospital there was another generation of equipment that was available, we had the space for them and then we did the other things to fit them in at much less cost than if we would have tried to predict the kind of equipment that would be available. It's a classic example of delaying decisions until you need to take care of them.

I think the awarding strategy has to do with the complexity, the uncertainty and the speed in which we are trying to do things.

↳ **How could the integrated agreement you mentioned earlier be implemented, especially for public owners?**

Well it is pretty interesting. First of all, nobody that works for a public agency has ever been fired for doing bidding. Because then they can say well I've bidden out and he took it and then the project got all screwed up...but it is his fault not mine. I think that is a big obstacle doing it.

The fact that most people in public projects have greater autonomy than they admit. If you actually go and read the law that they are working under it often says for them to use the best approach to buy their work but they don't put that forward in the world. One

of the interesting things is that most public agencies can do anything they want in an emergency...so how can we make that project an emergency??

We know agencies where they have worked together as if they have had integrated forms of agreements in place because it is to the benefit of all the parties.

In the Paper of Oliver Williamson who is a lawyer in economics that I will send you, he wrote this paper on transaction cost analysis: What is the cost of doing the transaction. For example at the supermarkets now they have many places where you check yourself out. That is reducing the cost of the transaction for the store, not the cost of the good itself. Williamson said there is a range of transactions from frequent and standard, like buying something in the supermarket to idiosyncratic and occasional, like buying an oil refinery. The uncertainty is vastly different between those two transactions. In the simple transaction the rule is we are sharp in an agreement and sharp out by performance. If I want to buy a dozen eggs the machine says 1\$, I give one dollar and I have a dozen eggs, they have the dollar. Absolutely clean transaction. I get home and find one of the eggs is rotten! If I get back to that store the dealer could say: well that is your problem, you bought it and had the chance to inspect them before, your bad. He could do that...but he won't. Because he knows there is a relational component even in that transaction and he will say here is another dozen eggs I'm sorry for that happening because he wants you to come back. There is a footnote in this article to relational contracts and a man named Ian McNeal. When we had a meeting with people from all over the world using relational contracts we discussed this topic. And Ian McNeals biographer who also wrote the book in the footnote, said: a transactional contract foresees a single outcome. A dollar = a dozen eggs. That's it. In a relational contract it sees many possible outcomes The marriage contract is one that is in that way right: rich or poor, sickness or health right now and forever. It's a relational contract. If you think about project on this spectrum from simple-slow-certain to complex-uncertain-quick now think about the kind of transaction you need for the first and second one. We began to try and figure out how to make that a coherent relationship.

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## **7. Have you experienced managing 'soft-skills' within a contract to be a challenge?**

This is often written about motivation, you know how do we motivate people to behave in our organizations. How do I convince you that you need to do this for me? There is some remarkable research, some of the best-established research in sociology that shows that people have a sense of equity and fairness, which is more powerful in individuals

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than economic motivation. That is a very radical thought and in other words means, that we have an urge to cooperate and be fair with one another. We don't like it when we are treated unfairly and we might take action on that.

A man who is writing the best about that is Samuel Bowles, who says that what's necessary for teams to have, is the ability to identify what he calls "free-riders". Those are people who are on the team who are not carrying their weight. People who are not doing their jobs. And that economic motivation is not going to be as effective as me saying: "Mr. Müller, you are not carrying you weight!" And the ability to identify free-riders and to first speak to them directly and give them a warning "you need to change what you are doing here" the second time we do that publicly and if you don't change your behavior we need to get rid of you. I think we have responsibilities to ourselves and to other people to tolerate people who are not carrying their weight

If you've ever played sports you know you've been on a team sometime when there is somebody who hasn't been carrying their load on that team. Personally I played a lot of sport and there were many times when I was a free-rider on the team. So I don't think it's necessarily a moral failure, but I think the ability of coaches to identify those people and coach them and work with those people who are not carrying their weight at the moment.

So I would recommend reading Bowels on the topic of soft-skills. He reframes them in a very different way and I will send you a paper that ties some of these ideas together.

↳ **Why is there still a certain dislike for relational contracts? Could it be the sharing of risks which owners are not willing to agree on, because they aren't used to it yet?**

President Lyndon Johnson had a great line, it was the end of a long story: "You can tell them to go to hell but they just won't go." So I don't think you can bring any force to bear on that it's like a force to marriage, to stick with the topic. I think a relational contract has to be with the willing agreement of both parties and you can't force it.

**Interviewee:** Andrew Jarvis, Principal at EwingCole, Healthcare design  
**Date, Place:** June 25<sup>th</sup>, 4:00, 14 Penn Plaza, New York.

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**1. Would you commit to that statement, or have you experienced it elsewhere? So is the construction industry really behind at establishing methods and ideas that already had been in use elsewhere?**

The construction industry is far behind. Other industries make complex technological devices, whether manufacturing automobiles, manufacturing appliances or ships. The construction industry is fundamentally a 19<sup>th</sup> century industry in the way it currently designs, fabricates and constructs buildings. One distinction between the building construction industry and industries that make products of a mass production nature like a ship, automobile or a cell phone, is the idea of replication. These products may have some moderate customizations but in reality they are replications of each other. But we are really going through a part in history where we are kind of up against the ceiling of what the construction industry should be doing. Historically the idea that there is bidding in construction which is ruled in the law of every nation really goes back to the 19<sup>th</sup> century idea that separates architects away from contractors and allows competitive bidding by having an architect to put drawings out to bid. What this results in is a tremendous duplication of effort and thought between architects, builders, fabricators and subcontractors. To make a long story short I subscribe to the idea that we are certainly an inefficient instrument for construction.

↳ **What is blocking a change in awarding and project delivery in the construction industry? Is it a specific party or a general mindset amongst all participants?**

It's not a mindset; it mainly has to do with the way construction liability is assigned for the cost of construction and for the safety of people who work in construction. The contracts essentially place responsibility for construction safety on the construction company. They replace responsibility for construction cost, and most owners to put responsibility for cost, on the construction manager. Most contractors do not want to take responsibility for conformance to the building code which architects and engineers are typically responsible for. So this idea of pushing risk away onto other parties and having contracts which establish the limits of responsibilities and even laws is forcing the frag-

mentation of the construction process and even the construction contracts themselves the standard American Institute of Architects Contracts assign responsibilities of different parties for different types of work. It is really those legal and insurance assignments of responsibilities that are causing the construction industry to be fragmented and inefficient.

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**2. Do you think there are other reasons, besides the financial crisis, for the hard time companies go through at this time? Does the low bid approach contribute to the failure of construction companies?**

Here in the US there have been some construction companies who have failed and I know of two recent examples in NYC. In the case of a medium size construction company that recently failed it overextended itself by bidding on too many projects. It could not its cash flow and pay its subcontractors and went to bankruptcy. I don't know if I can say that that's because of competitive bidding process. In my opinion this was due to poor fiscal and business management. The other construction company that effectively failed (they are still around) was due to two incidents that occurred within a few years. One was the death of two or three construction workers in an accident – I think it was a fire – down at the WTC. That was very bad news for this company and then a couple of years later this company was discovered to be falsifying its accounting. As to how it was paying its subcontractors and this was a scandal the undermined its reputation. So in neither of these cases I am familiar with in New York, has a construction company failed because of competitive bidding. So I am not sure I can subscribe to that.

↳ **Would you characterize the mere price competition arising from the current awarding situation (design-bid-build) as a satisfying even enduring practice?**

I think it does satisfy several objectives that a building owner would have. One is to establish a fixed price for the cost of the project so the owner knows how much money he has to finance. Number two: it gives the owner some assurance that he has attained the best possible price for the work and presumably if the bidding takes place among equally qualified builders than he is assured of a good quality for a low price. So those factors do make the DBB process satisfactory and likely to endure. I don't think it is going to go away.

↳ **Have you ever experienced, that consequences in an advanced project stage could be led back to the awarding method? Due to competitive price bidding, unfair and one-sided contracts, risk allocation, imperfect specifications...**

Yes that can be a problem, it is a well understood problem everyone who is experienced in the design and construction industry knows that is a possible consequence. A whole lot of effort is spent to make sure when the low bid is opened that the low bid contains the full scope of work represented by the construction documents and what everybody wants to avoid, including the builder, is situations the builder has underbid the job and needs to fight with the owner, fight with the architect to get compensated or loose dollars. So yes, that is one of the drawbacks: it does cause fighting on the construction site and it can cause problems and it that sense that is one of the weaknesses of the system.

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### **3. How have you experienced the relation between owner, designer and contractor at traditionally awarded and delivered projects?**

Many of the projects that I have worked on have not been low bid, but most of them were design-build at risk. In that instance in my personal experience of really the last 20 years I have found the design-build methodology of construction delivery to be very satisfactory. It combines elements of competition because the subcontractors competitively bid their portion of the work but the construction manager is typically hired at the same time the architect. And these three parties – architect, owner, contractor – work as a team to define the project scope to estimate the project, to competitively bid the trades and I have found there is a very high level of cooperation among the parties. Not without conflicts but by a large satisfactory, productive and harmonious. And in the end that is what all of us in the construction industry strive for. We have a good sense of what mutual objectives are of the owner and work to anticipate each other's needs regardless of the method of construction contract. So I would say in my experience work delivery has been productive and professionally and personally fulfilling.

↳ **What are the three main things LPDS improves regarding the stakeholders relation and how is that improvement achieved?**

Yes, integrated project delivery is a method of building buildings that is not very common on the east coast – much more common on the west coast in California. We are building a major project in California using integrated project delivery, which is different than DBB and different than CMR. In IPD the owner, architect and construction manager

have signed a three-way-agreement called an IFOA. It stills assigns traditional responsibilities to each of the parties: the architect responsible for codes and design, the builder for safety, costs, schedule, the owner to pay and define his needs. So those traditional roles are maintained but in IPD all parties are taking a portion of their fee and putting it in risk. So the owner is taking the risk that comes with being part of the team. We have modeled our working relationship on the way Toyota builds automobiles. All of the participants went to Toyota Lean building school. We learned Toyota terminology and about project delivery. We established a very complicated set of requirements for scheduling for managing cost, for delivering design documents for avoiding repetition. This project is probably almost complete after being in construction for about 3 years. It has been very successful relationship but has had problems. I think the test of every construction methodology is when things go wrong. In this project some things have gone wrong which have kind of proven some of the weaknesses of this system but also some of its strengths.

↳ **Could you tell me what were considered to be weaknesses and strength ?**

I will give you an example of something that went wrong. California has very strict earthquake construction codes because of the prevalence of earthquakes. In the design of this building where you have the intersection of a column and a girder it is a moment frame that can't move during an earthquake. Therefore the connection of the girder and beam cannot be penetrated in any way. Eventually one of the subcontractors, I think it was the electrician, drills little holes through the connection. After this happens the whole connection has to be discarded, removed and refabricated costing 300000 \$ just because of these little holes. Now in a traditional DB, DBB or CMR scenario the owner would say to the CM: "Fix it. It's on you, use your insurance, pay for it." Under an IFOA where all parties have put their money in this they figured out a way to handle it. So to compensate for the 300000 \$ they came up with a idea that saved 1200000 \$. By changing the design of the mechanical penthouse at the rooftop. They accomplished that by bringing the Steel fabricator, aluminum contractor and curtain wall contractor and finding a more efficient way to build the windshield of the rooftop. They build the whole thing out of aluminum and used the already fabricated steel elsewhere. And that was only possible by working and thinking as team. If we had been in a traditional situation the steel guy would have said: I have bidden, I build it, it's going in. I get my money.

I admire the ship-building company Kvaerner who built a big ship yard and we were the engineering firm. It is amazing to see how they make a ship: everything is prefabricated, everything is pre-engineered and figured out three-dimensionally. Even whole sections of the ship are taken into a shop to be painted in a special building. It is unbelievable and I



am thinking ships are like buildings why can't we make building like ships. So this example I gave you is like building a ship not a 19-century building.

So it has benefits and I think in reality everybody involved in the construction industry whether it is an electrician or a sheet metal worker or an architect or a mason. All of them have smarts of how to build things and it's much more accelerating and I would think personally fulfilling for trades people to be working with architects and engineers and figure things out, because the guys who build these things really know how to build these things. You know we architects and construction people we go to universities, they might not have a university education, maybe they do, but they are smart as hell when it comes to the craft of building. I think it is exciting for me as an architect to work with smart people who are really good at figuring out how to make things, and it must be exciting for them. I find it much more fulfilling to work collaboratively than to work in an assembly line.

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#### **4. What were the three biggest hurdles at establishing Lean Construction?**

Well I think there are no laws about bidding unless the owner is the federal government of the US or the state of New York or the US army. So public owners have these regulations where private owners don't. I was just talking to a hospitals and I was telling them about all the different ways they could contract for construction. The biggest hurdle I think is in the idea that a private owner, lets say a hospital or university, who have boards of trustees who are worried about liability. Their objective is to push that liability onto the shoulders of somebody else. I think that's the number one barrier to a collaborative construction environment. The boards of trustees want a fixed price they don't want to hear about a injured worker or the cost going up, but that they have got the best value for their money through competitive bidding. Until larger private clients think differently then they are going to get the traditional process. For example Sutter Health, a very large health system client, who was the client at the example I gave earlier. Their board and their management did believe that they could get a better, faster and less expensive product through integrated project delivery. Even though they had spent 300000 \$ for that accident, they had to pay for it, but they also got the benefit from 1.2 million \$ savings. They were more enlightened and more attuned to the process. I think it really begins at the top of the chain.

I think the construction industry can try to talk about it, the architecture and engineering industry can try to talk about it with owners, but unless boards of directors believe it then what they are going to continue to get is more the same. And I believe that what

they are getting is that they are paying more for their buildings than they should be. That is because for complex projects like a hospital, they are desired for somebody to take on the risk. Means that a construction management company will basically say: "Sure, I will guarantee I will build you the building for 100 million \$ and I will give it to you in 3 years and I will take on the risk and I promise no change orders." So what happens with that is the construction company guaranteeing 100 million \$ basically knows that they can build it for 90 million and that 10 million \$ spread, they might have to take 2 million of that, because of contingency that does happen, but the other 8 million go right in their pocket. And those construction companies that can operate that way are taking the risk away but out of that 100 million project 8 million of that is the client paying unnecessary money.

What I don't like about this is that those 8 million \$ is taken out of the quality of the building. The 8 million \$ is money that the owner could be spending, instead of putting it into the CM pocket, on more medical equipment, better interior, greener facilities.

↳ **What would you consider to be future key-points to propagate the delivery method of Lean Construction and innovative and cooperative methods in general?**

Projects that have been successful are the best evidence for future owners to consider this delivery method. Sutter Health will have a successful project to tell a story about, the lessons learned can be used for future projects. There is also the advantage of BIM which does facilitate and effect the manufacturing of a custom made building, just as digital technology has enabled customization, of everything from a pair of shoes to a car, for the consumer. Very few cars come off the assembly line are identical cars, they have been customized for the consumer. The ship, which I like to talk about, is very much customized for the consumer and yet it's mass-produced in a way. And I think that is what's transforming the way we deliver building from the 19<sup>th</sup> century to the 20<sup>th</sup> century. And by the way, it's interesting to hear that the romans were the first to introduce design bid, but throughout the middle ages in Europe it was the guild that actually build the building; the stone masons guild, the metal workers guild. When I was a student I was very interested in how the great cathedral in Florence was constructed. The architect was Filippo Brunoleschi and he was actually not a member of any of the construction guilds, but of the jewelry guild, he was a goldsmith. He had great battles with the guilds, who were the trade unions of the middle ages. It wasn't until the 15 hundreds they began to have architects who were outside and independent of the guilds, but even going into America to the early 18<sup>th</sup> century where Thomas Jefferson was an architect as well as the president. He would develop designs for buildings but It would still be contractors or trades

people who build them. So it wasn't until the 19<sup>th</sup> century in America that you begin to have the idea of contractors who were competing against each other. That's why I say 19<sup>th</sup> century industry.

To get back to the question I think frankly it's demonstrating success and the willingness of more and more people to take risk.

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## **5. According to you what you have experienced: To what degree can those losses be eliminated and how much more planning is necessary to achieve it?**

I think in a number of ways the traditional process of design and then bid really forces duplication of work. The engineer for example will lay out the sheet metal for a ducted air system on the drawings that go out to bid. The selected sheet metal subcontractor will redraw those drawings and the engineer will review these drawings and then go out to the field to make sure the sheet metal is being installed accordingly. So you have a lot of wasted work in that process. In an integrated form of delivery the engineer would not even draw the drawings but say I need to deliver 600 f<sup>2</sup> of air at 70 degrees to this location. The sheet metal fabricator would basically work to design the duct that does that and would fabricate it inside the building model that we are creating. I think that's a very obvious example of how you eliminate waste and it's really evident throughout any complicated project that that's the way to do it.

### **↳ Do you think DBB project could deliver the same quality in the same time?**

No they can't. Because in lean construction the construction can start while the building is still being designed, you can get early foundation packages, early steel packages under construction while the building is still being considered inside. While in design-bid you have to finish the drawings, issue them for bid, wait for bid and then construct. In a major project you are using 3 to 12 months of lost time just from that process.

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## **6. What influence can the choice of awarding strategy have on factors like cooperation, quality, schedule and costs have?**

There is a huge distinction. Under IPD cooperation is everything, I used to mention that the Toyota lean construction delivery method includes an own vocabulary regarding cooperation. It's like learning a new language of pulling information rather than pushing it. It's almost a cult like process of bonding with the engineers the construction people the owner – we are a team, this is our project, we all own it. There are even such terms as

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an inexcusable delay and an excusable delay. There is such thing as terms in a contract, which specify what you mean when you give a reliable promise. You should never make a promise of something you can't do – if I say I am going to have that drawing of the sheet metal by next Tuesday, you have to have it. It's an expectation and your cooperation isn't legally binding, but it's a personal promise. So the network of personal obligations is extremely important in that essence. What I find very interesting about IPD is that the idea of personal relationships and personal promises is not new in the construction work; probably the romans had it, too. Which is that even in a big city like NYC relationships are paramount in delivering projects, because I as an architect know that I am going to be working with Turner and Bar construction again, so this project is only one project that we are going to do as a team. So I want to be a good team player, I want my partners on the owner and the builders side to respect me and what the Toyota lean delivery process tries to do is to bring the best out of that personal network of relationships to bear in a creation of something unique and exciting and advanced. That is what I like about it, it recognizes that that is really the successful ingredient in any project. Now the other methodologies, DBB, DB, CMR they work, because there is that respect for relationships. If you ever work with a subcontractor who breaks promises, you don't want to work with them again. I think that these are complicated buildings, complicated technologies, but they all revert to complicated relationships among people.

Troubles with laws regulations etc. is what they tend to do is that they get in the way of those relationships. And the contractors you mention in Austria who say forget about the regulations, I can't even think about them, I am just going to do what I know how to do; that's a natural reaction. It is probably the only way you can react.

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## **7. Have you experienced managing 'soft-skills' within a contract to be a challenge?**

It works really well in the IFOA. Our California project is a highly cooperative. In fact, my partner who is in California, told me: "When I am in the room with the owner and builder I forget I am the architect sometimes. I find myself worrying about things I am not supposed to be worried about. I am worried about the schedule, the cost, safety, the quality of the construction..." He says it really does work that you are looking out for each other. In any good project that will happen and we all like to do that because all we in the construction industry really want is really good buildings. So we all want that and we want partners who want that and we want partners who care more about the buildings sometimes than they care about themselves. And all good projects I think, throughout history, have that mentality. So IFOA does work but I have to tell you, so do the others.

Maybe not as efficiently but we have built great buildings in every construction methodology, and that's one of the unspoken secrets is that regardless of the structure, the contract or the incentives or the penalties – in the end great buildings occur because great teams have a personal commitment to each other, even within any structure.

↳ **So it depends very much in the people involved, but do you think a not so engaged team in traditional practice could do better by using lean construction?**

It may be possible. The B and C team players may be more successful in that setting, but I believe there is a tendency for anyone who creates rules for anything as complex as construction; whether it's the Austrian agencies who create rules for competitive bidding or Sutter Health who created the IFOA. Any set of rules can be faulted, corrupted or gamed. Even though the IFOA there is no recipe that guarantees cooperation, trust, etc. Any system will work any system will fail – systems are not ... for human behavior. Systems are a framework for human behavior, because human behavior is too complex to be managed by systems.

So I am a believer in IPD but I am not so naive to think it is a panacea or cure for human behavior.

↳ **Do you think that the contractor could try to generate a higher reward by increasing the estimated costs?**

I mean I think that happens now – take the example of the 100 million project that actually costs 92 million. You set the target higher to get the reward, it absolutely happens. I think it is gamed – making money is important for everybody and I think any systems that creates rewards and penalties gets corrupted. Reverse is when you have a penalty clause that says you have to finish the job by June 1<sup>st</sup> or you pay 100000 \$ a month. Conversely if you can complete construction earlier – it can be completely gamed by the contractor. If there is a penalty, everything that happens in the project there are going to email saying the architect didn't answer my questions soon enough, the shop drawings didn't come back – if there are penalties you can be sure that there will be shortcuts taken. It's human nature.

I think they are failures. I had an argument with a client about putting a penalty clause in a hospital project and I said I would not do that. I would neither put a reward clause. Because these clause will encourage disputes.

↳ **Could it be the sharing of risks which owners are not willing to agree on, because they aren't used to it yet?**

The owner never had risk, other than paying for it, and therefore doesn't want any. That is the number one reason why integrated methods are not popular.

↳ **How could we change that?**

I think it would be an owner, like Sutter Health, that is very advanced in this way. Or a private developer, I would say a housing developer or a company like Google or a private cooperation that is highly entrepreneurial, that is more willing to take risk and be engaged in the project. Those are the kinds of projects, but there are a lot of big corporations that are inventive that are also very punishing and not a particularly innovative owner. So it doesn't always follow that the entrepreneurial company has an entrepreneurial mindset towards construction.