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Planning and Management of Megaprojects / Planlegging og ledelse av megaprojekter

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Abstract

In a world where more than 60% of megaprojects exceed budget limitations, finding out what makes or breaks a megaproject will be of utmost relevance. This study compares two successful megaprojects, the Gudrun oil platform by Statoil in the North Sea and the ATLAS detector at CERN, and identifies differences and similarities in these two projects. With the use of semi-structured interviews of key personnel at CERN and Statoil, information about how things were actually done, rather than how procedures dictate how things should be done, is identified. This study makes three significant contributions to knowledge. The first is that megaprojects can benefit from having a high level of staffing, as management costs are relatively small compared with construction costs. The second is that when part of the end design is left to contractors, contractors are given an opening to act in an opportunistic manner, and this can cause contract growth. The third contribution is that when a high level of integration is done in-house, companies can take an extremely cost-driven approach to contracting.

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Abbreviation list

- APC = Area Project Change
CoPS = Complex product or system
CPC = Central Project Change
DCP = Design Change Proposal
DDP = Design Development Proposal
DIIR = Disciplinary Interface Information Request
DVO = Disputed Variation Order
EPC = Engineering, Procurement and Construction
FEED = Front-End Engineering Design
LHC = Large Hadron Collider
NCR = Non-Conformity Request
SPF = SmartPlant Foundation
TC = Technical Coordinator
VOR = Variation Order Request

1. Introduction

1.1. Subject

In a shrinking world, bigger and bigger projects are being started up. Geography is not really an issue anymore, and as companies specialize more and more on their key strengths, they are enabled to shop around for solutions or products that would be more costly to develop in-house (Prahalad & Hamel 1990). These days, there is no need to build everything at the same location, and the cheapest supplier can be selected regardless of location.

Let's say that an oil platform is being built. The oil platform can be divided into different key supplier contracts. When building the platform, the deck can be built in Thailand, the living quarters in Norway, and the jacket in Singapore. The only worry is which contractor to choose. Twenty years ago, that same platform would most likely have been built in one location. The solution that fits best, in terms of both performance and cost, can be selected. Even the integration of the various aspects of building the platform is not a problem anymore, as contractors also do this.

By using the "old" approach of building all in one place, companies had an advantage when it came to putting everything together, simply because they had all the knowledge in-house. This is not the case anymore. As a result of companies focusing on their core capabilities, integrating suddenly becomes a big challenge. And before anything can start being built, the different parties have to agree on who is responsible for the integration. Several contractors may share the responsibility, but it is important to have this in place before startup of the contract. Contractors will need information from each other. Managing the interfaces between contractors is one of the special challenges that megaprojects face (Morrow 2011), and a successful interface management system could prove to be pivotal for successful project management in the implementation stage.

Another aspect to consider is how specification changes will affect the contract set-up and execution. When building that oil platform, or any complex construction, there is a high probability that something will change at some point in the project life cycle. It could be that the specifications were not clear at project startup, or that something is not working like it is supposed to. When dealing with these changes, it is important to realize that a small change

in the deck could have an impact on the living quarters function, or in a worst-case scenario, making the integration of the two impossible or very costly. While it is not possible to know the exact nature of these changes, there should be contingencies in place for when they do arise. Changes should be addressed as early in the project life cycle as possible to avoid large additional costs at the later stages of the project. Who will take responsibility for making sure that all the different pieces of the puzzle will fit together? This is something both buyers and suppliers should know beforehand, but it can be a hard question to answer, especially when there is a gap between perceived reality and actual reality. When companies sit down to finalize the contracts with their contractors, they will always try to cover all possible scenarios. If they then think they are covered for everything, they could be terribly mistaken. The perceived reality at the time when the contract was written can be far from accurate. It is like looking at a picture. If you think that you see the whole picture, when in reality you only see 50%, you are bound to make assumptions or draw conclusions that you would not have done had you seen the whole picture. For buyers, this can be a costly mistake to make, and often, it is the buyers themselves who end up paying for the additional cost. Suppliers may use these changes in an opportunistic manner in order to increase contract growth.

1.2. Framework and general research questions

The findings of this study will be based on two cases. The first case is the Gudrun project by Statoil. The Gudrun project is an oil platform under construction, with startup targeted for the first quarter of 2014. The other case is the ATLAS detector at CERN. Startup for the ATLAS detector was targeted initially for 2004, but as part of the Large Hadron Collider project, it experienced several schedule delays and was completed in 2008.

This master thesis is based on the specialization project I did in the last quarter of 2010. That study was purely theoretical (Villmo 2010). As I had to submit a general problem description before I started with the study, this is the problem description I chose:

What are the differences and similarities in the planning, construction and commissioning phases between the ATLAS project at CERN and the Gudrun project by Statoil? What conclusions and experiences can be drawn from those differences and similarities?

There are probably several thousand differences and similarities between the ATLAS project and the Gudrun project. To address them all would simply not be possible. The scope of this study needs to be restricted in order to come up with something meaningful. While a large number of articles have been previously written about supply management, few of these have used complex megaprojects as cases. The same can be said for theory about project management theory. A lot has been written, but few address project management for complex megaprojects (Merrow 2011). In general, very little literature about megaproject implementation exists, and the literature that exists mostly deals with the conceptualization and estimation of costs (Brockmann 2009). In 2010, the amount spent on industrial megaprojects outside of Chicha was around \$US100 billion, and the amount is expected to rise to \$US200 billion (excluding the electric power generation sector) (Merrow 2011). Merrow explains that megaprojects that are considered to be successes are in general excellent projects, and megaprojects that fail are often miserable projects. That means that learning from a successful megaproject can be very valuable for future megaprojects.

Megaprojects are unpredictable by nature, and nine in 10 transport infrastructure megaprojects face budget overruns (Flyvbjerg 2007). This figure is a little lower for industrial megaprojects, where 35% of megaprojects are considered to be successful with an average cost underrun of 2%. Flyvbjerg focuses on the estimation and forecasting methods behind the budget figures, which tend to be very optimistic. However, when the implementation phase of a megaproject is started, little can be done about the assumptions and estimations that were done in the earlier phases of the project. As literature on the implementation phase of megaprojects is sparse, this study aims to contribute to this field. In order to do so, this study will look into reasons for cost overruns that can be dealt with by the management in the implementation phase. Jergeas has identified several such reasons, and one of these reasons is improper change management (Jergeas 2008). Because megaprojects are often fast-tracked, the scope might not be 100% completed and the result of this is scope changes (Ibid). This is also in line with the thinking of Merrow (Merrow 2011). With this in mind, it would be wise to look into the change management of both the Gudrun project and the ATLAS project. Due to the complexity of megaprojects, a lot of different interfaces will have to deal with each other (Ibid). Merrow identifies interface management as one of the special

challenges for megaproject teams, one that can be a source of many conflicts and misunderstandings (Ibid).

Both projects in this study are considered to be successful. ATLAS delivered approximately 10% over a budget that didn't take inflation and currency fluctuations into account. The Gudrun project is estimated to deliver approximately 15% under budget. A closer look into how these projects have handled project changes could prove interesting.

The narrowing of the problem description is also a result of the available material at both Statoil and CERN. The Gudrun project had a lot of focus on change management, and several of the people I talked to believed that it was one of the most important aspects of the Gudrun project. Change management was quickly linked with opportunistic behavior and contract growth. As a result, I will look into the following question in order to answer my problem description:

How does change and interface management affect contract growth and opportunistic behavior from contractors?

By defining this sub-problem, I will be able to answer the main problem description while making the most of the material available to me at Statoil and ATLAS.

1.3. Structure

This study consists of six sections. The first section is the introduction to the study, followed by the research questions and limitations of the study. Section two explains the methodology for this paper. I also present the assumptions I have made, and why this methodology was chosen. In the third section, I do a literature review on subjects covered in this study. I also use existing theory in order to make definitions about the terminology used in this study. Section four presents the two cases I have reviewed. Four concepts for each of the cases are presented. In section five, the two cases are analyzed against each other and against existing theory. The last section presents the conclusions of the analysis and I propose future directions that research based on this study may take.

1.4. Limitations of study

There are several limitations of this study.

One limitation is that much of the findings of this study are limited to the people who are interviewed. That means that it is very important to interview the right people. Interviewing the wrong people would be a waste of time, and could even lead me to focus on areas that later turn out to be of no interest for this study. Not interviewing people with valuable information is perhaps a bigger risk, as I risk missing important points and observations.

The second limitation of this study is that I got the viewpoints only of Statoil and ATLAS as I did not have access to their contractors. As a result, I had no choice but to believe the information I was given during the interviews. This information might not be the full story, and had I been able to interview the contractors of both ATLAS and Statoil, I could have gotten a more complete picture. This was not possible due to both time and access constraints, and this was considered when I presented the cases.

Another important limitation is that the Gudrun project is not yet completed. In ATLAS, it is known what worked and what did not. For Gudrun, there are things you can say about the project in its current state, but it is not necessarily possible to tell if these things will ultimately be success factors. It is impossible to tell if the project has been a success until the platform is operational, and what looks like a success today can be a failure tomorrow. A result of this is that I will not be looking into the commissioning phase for either project.

The fact that I looked at only two different cases is also a limitation. It meant that the result would be very dependent on the cases I looked into. Had I looked at more cases, this would not have been a problem as the cases would have spanned the whole spectrum.

2. Research method

The timeline for this study is from 1 March to 10 January 2012. The plan was originally to complete it in November, but because of a personal accident, this was not possible. This study is a continuation of the project paper I wrote in the last quarter of 2010, in which I addressed planning of megaprojects. That paper was purely theoretical (Villmo 2010). The plan was to use this master thesis to see how megaprojects are handled in practice. With the first study, I got a theoretical background, and this study would be a chance to see how the theory matched practice. Through previous study, I had gained some contacts at both ATLAS at CERN and Statoil in Norway. Both these organizations agreed to let me use them as case studies, and gave me access to governing documents and let me talk to key personnel. The main advantages of using multiple cases is that it increases generalizability and it deepens understanding (Miles & Huberman 1994).

I spent most of my time at ATLAS, and I scheduled three periods of two weeks each at Statoil. These periods would span the whole timeline of this study. I first spent a month at ATLAS to familiarize myself with the project. After this month at ATLAS, it was time for the first two-week period at Statoil. This phase was used to pinpoint what fields of project management I would look further into. In the first week, I spent my time sitting in on meetings and reading governing documents. The second week was spent talking with key personnel in order to find an interesting subject. I had several topics to choose from, but in the end, the one that interested me the most was what Statoil called “interface & change management”. I thought that this was a very interesting subject, and I decided to look further into it. Another advantage was that there was a lot of information available from Statoil’s side on this topic. After initial investigation, it quickly became apparent that if I was looking into interface & change management, I should not do so without also looking into opportunistic behavior by contractors.

After the two weeks, I returned to ATLAS to process the information and find out whether ATLAS had something similar to Statoil. I followed a similar process to what I had done at Statoil. I read governing documents and talked to key personnel. I also started looking for theory on interface and change management. I went through the past 10 years of the *International Journal of Project Management* and I searched for articles at

scholar.google.com, www.sciencedirect.com and www.jstor.org. I used such search words as “change management”, “buyer-supplier” and “megaprojects”. I also looked for articles in the source lists of relevant articles, which is a good way of finding additional sources (Polonsky & Waller 2006). This yielded results, and I found several relevant articles.

The identified theory was used to construct the questions for my second period at Statoil. I chose to go for semi-structured interviews. The benefit of a semi-structured interview is that it *“combines the flexibility of the unstructured, open-ended interview with the directionality and agenda of the survey instrument to produce focused, qualitative, textual data at the factor level”* (S.L. Schensul et al. 1999). By using semi-structured interviews, the interviewee will lead the way of the conversation, letting the interviewer probe what the interviewee feels (Ibid). Semi-structured interviews require the interviewer to carefully pose questions that will result in meaningful results (Patton 2002). In order to create meaningful questions, I made sure that the interviewee understood the terminology I used. If I used a word or expression that I believed was unknown to the respondent, I explained it. I also tried to keep the questions as short as possible. When I had follow-up questions, I tried to make these as short and precise as possible. I also tried to avoid biased questions that might lead the respondent in the direction I wanted. This includes using either positive or negative association when asking questions. I also stayed away from negatively worded questions. The measures mentioned above correspond with the guidelines on how to make good semi-structured research questions (S.L. Schensul et al. 1999). For a more detailed explanation of how the interviews were conducted, see Appendix 1.

I also performed the interviews anonymously as this could decrease the chance of people withholding information for fear of repercussions. One possible pitfall of having anonymous interviews is that people can use them to talk other people down or themselves up. This was something I was aware of when I conducted the interviews.

For the second period, I had lined up six interviews with different key personnel. I also sat in on relevant meetings for this period. The second period at Statoil was followed by a similar phase at CERN. Key personnel were interviewed. As I began to see the full picture, it became clear where I had gaps in the case studies at ATLAS and at Statoil. One of the fields I felt compelled to look further into was the procurement policies of ATLAS and of Gudrun as this

policy would determine how the contracts were set up. Since it is the contract that both buyers and suppliers will go back to when contractual problem arise, this felt like a natural step. In the third period at Statoil, I filled these gaps, and also tried to go deeper into the material I had already collected. The third period at Gudrun was my last chance of obtaining data, so I tried to make the most out of my interviews and out of the topics I looked into. At ATLAS, it was less of a problem, as I had access to ATLAS personnel and documents every day. Consequently, my process of determining what to look further into, gave me the following four topics: procurement policy, interface management, change management, and opportunism.

At one point in the study, I wondered if differences between ATLAS and Gudrun were a result of the fact that Statoil was a private company and ATLAS a public research project. In order to find this out, I scheduled a test interview at Sintef, which is a public research organization in Norway. The test interview showed no such correlation, and I decided to not follow up further on the matter. The test interview will not be discussed anymore in this study.

I have chosen to list all currency in Swiss Francs (CHF). I chose this because it is a better known currency than the Norwegian Kroner (NOK). Any currency conversions between NOK and CHF is given at are rate of 1 CHF = 6,4 NOK, the currency conversion rate on 5 October 2011. This date was chosen simply because this was when I started with currency conversions.

When it comes to any companies other than Statoil and CERN, I have listed them as Contractor A, Contractor B, etc. This was done because I could obtain only the perspectives of Gudrun and ATLAS, and was thus not getting the full picture: this meant I risked presenting the contractors described in this study in a light I would not have done had I been able to hear their side of the story. There is also a confidentiality aspect as no contractors have given me any form of authorization to reveal information about them.

Because the Gudrun project is in the construction phase, I have chosen to also look at just the planning and construction at ATLAS. There would simply be no point in looking at the commissioning phase seeing that I would have nothing to compare ATLAS with from the

Gudrun case. Similarly, when looking at contracts, I have chosen to look at the contracts that ATLAS placed through CERN, which accounts for about half of the total construction budget of ATLAS. This was done because these types of contracts are comparable with the Gudrun contracts. These are the contracts that go out to the industry and must follow CERN's procurement policy. Comparing contracts that were placed through the institutes at ATLAS would have offered little value to the comparison as they would be more dependent on the specific institute's policies and procedures, rather than the ones at CERN. I have also focused on the key contracts that are important to project progress.

As ATLAS was built several years ago, a lot of the documentation is now outdated or lost. Obtaining data from obscure or complex projects is often difficult and problematic (Fellows & Liu 2008). I have therefore based a lot of the findings at ATLAS on the interviews of key personnel. The persons I interviewed were project leaders for different sub-projects at ATLAS during the construction phase. Statoil uses governing documents for all its processes, and has thus documented everything very well. There is almost too much information for the purposes of the current study. When it came to obtaining information about the Gudrun project, I was given access to all internal Statoil governing documents, and I used these to familiarize myself with Statoil's procedures and processes. At Statoil, it is the responsibility of each project manager to decide how the procedures and guidelines from the governing documents are implemented for each project. As a consequence, I decided that by focusing more on the interviews rather than the governing documents, I would get a more accurate description on how things are done in Gudrun, rather than how things should be done in Statoil. The procedures from the governing documents were fairly generic, and would not offer much insight into how things really were done. As a result, the information in the case section has come from the interviews, unless stated otherwise.

I also visited the ATLAS detector cavern and an oil platform (See Appendix 2 for pictures). I could obviously not visit the Gudrun platform as it is not yet completed. I visited the Sleipner platform, which has several tie-in projects to Gudrun. By visiting both the ATLAS cavern and an oil platform, I felt that I got a better handle on how big and complex these projects really are, and also about how important it is that everything works as one single organism. For the ATLAS project, everything had to be planned down to the smallest millimeter; any errors in

production or planning could prove to be disastrous. The oil platform is assembled in the middle of the ocean, with contractors from different parts of the world contributing.

3. Literature review

For the literature review, I will start by defining some key concepts used in this study. I will then proceed to address relevant project management fields for this study. Because there is little written literature regarding megaproject implementation (Brockmann 2009), I will use whatever megaproject management literature I can find, and supplement it with relevant project management literature from other types of projects.

3.1. Definitions

The first logical step is to define *megaprojects*. Megaprojects have been defined as projects with budgets exceeding US\$1 billion. However, the definition of “megaproject” is not necessarily dependent on a cost (Fiori & Kovaka 2005). Fiori and Kovaka define “megaproject” using five parameters: magnified cost, extreme complexity, increased risk, lofty ideals, and high visibility (Ibid). In this definition, there is no cost threshold. This will be the definition used in this study.

The next term that should be defined is *project complexity*. Brockmann defines it as “*a set of problems that consists of many parts with a multitude of possible interrelations and most of them being of high consequence in the decision making process that brings about the final result*” (Brockmann 2009). Brockmann also identifies several types of complexity, such as task complexity, social complexity and cultural complexity. Task complexity is the “traditional” form of complexity, but social and cultural complexity has been added as a way to describe problems that can arise within the virtual enterprise (Ibid).

When it comes to *supply chain management*, there are several definitions that can be followed. Croom et al. have compiled an extensive list of definitions (Croom et al. 2000), and I mention some here. Berry et al. defines it as the following: “*Supply chain management aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to a particular OEM (original equipment manufacturer) so as to release management resources for developing meaningful, long term relationship*” (Berry et al. 1994). Ellram simply defines it as: “*A network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery*” (L.M.

Ellram 1991). Tan et al., on the other hand, defines it like this: *“Supply chain management encompasses materials/supply management from the supply of basic raw materials to final product (and possible recycling and re-use). Supply chain management focuses on how firms utilize their suppliers’ processes, technology and capability to enhance competitive advantage. It is a management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimization and efficiency”* (Tan et al. 1998). Tan later concludes that “supply chain management” can be used as a *“synonym to describe the purchasing and supply activities of manufacturers”* (Tan 2001). It can also describe logistics and transportation functions, and be used to describe all value adding activities (Ibid). There is no universal definition of “supply chain management”, and this is because it was developed from different points of view in the literature (Croom et al. 2000). Croom et al. mentions several such views, and the most important for this study is purchasing and supply literature and organizational behavior, industrial organization, transaction cost economics and contract view literature (Ibid). It is far easier to find a common definition for “supply chain” (Mentzer et al. 2001), which is defined as a group of firms passing materials forward (La Londe & Masters 1994). These firms will often be independent and they all contribute with something towards the end user (Ibid).

3.2. Megaproject literature

When it comes to megaprojects, there are three different project stages: conception phase, negotiation phase, and implementation phase (Brockmann 2009). The conception phase may include very different tasks, and will be dependent on the routines of the organization and country in which the project is completed (Ibid). The time of this phase can vary from a little as a year to more than 20 years. A conceptual design will be enough, and the overall complexity is at a medium level in this stage. The second stage is the contract negotiation phase, where there is an agreement on price. Few people will be involved, and even though they may have different cultural backgrounds, overall complexity will be at a medium level (Ibid). The implementation stage is very complex overall, with a high level of task complexity, cultural complexity and social complexity. This is the phase in which the end design is finalized and constructed (Ibid). Brockman points out that strategic decisions will be taken in

the implementation stage, and that the strategic choices will have consequences for the operation of the project. He goes on to argue that for megaprojects especially, strategy and operation will be “*two worlds apart*” (Ibid).

As mentioned previously, about 90% of megaprojects experience cost overruns (Flyvbjerg 2007). Some of these overruns can be attributed to optimistic forecasts and estimations (Flyvbjerg 2007). There are also other reasons, and Jergeas identifies one reason as “Incomplete scope definition or inadequate front-end loading and poorly completed front-end deliverables including milestone schedule slippage in front end” (Jergeas 2008). This is a direct result of a megaproject being fast-tracked, and changing customer requirements will result in scope changes (Ibid). Another reason is late or incomplete vendor data. This may affect the engineering progress negatively (Ibid). Another important thing to be aware of is the level of new technology (Merrow 2011). Merrow identifies five levels of new technology types: off-the-shelf, first-time integrations of conventional technology, minor modifications of existing technology, major modifications of existing technology, and substantially new core technology (Ibid). The level of new technology will affect the amount of startup time required, as well as the risk of operational failure (Ibid). Not surprisingly, both the required startup time and risk of failure increase as the level of new technology increases.

Procurement in complex megaprojects cannot necessarily be handled in traditional ways, and there needs to be some level of value co-creation (Caldwell et al. 2009).

There are four basic types of contracting approaches for megaprojects: EPC(Engineering, Procurement and Construction) lump-sum (fixed-price) contracting, reimbursable EPC and EPCm, alliance contracts, and mixed contracts (Merrow 2011). EPC lump sum is the most common, where a contractor will have the responsibility of engineering, procuring and constructing some part of the project (Ibid) for a fixed price. Reimbursable EPC contracts are similar to EPC fixed-price contracts, but instead of a fixed price, the contractor will get reimbursed for the services and materials used for the duration of the project (Ibid). In alliance contracts, a group of contractors will work together on the project with only one compensation scheme, and there are usually some incentives in the form of bonuses or gainshare in the event of a cost underrun. In the event of a cost overrun, the participating contractors may have to share the cost up to some set number. In the last type, mixed

contracts, one firm is responsible for the engineering and procurement, and another for construction. Of these four types, EPC lump-sum is by far the most frequent, being used in more than 50% of contracts (Ibid).

Merrows' study shows that mixed contracts are the most successful, and alliance contracts experience the most failures. Cost overruns in EPC fixed-price contracts averaged 13%, EPC reimbursable contracts averaged just less than a 30% cost overrun, and alliance contracts averaged a more than 50% cost overrun. Only mixed contracts had cost underruns. When selecting what type of contract should be used for a specific project, it is important to consider the capabilities of sponsors, the nature of the project, and the state of the EPC services (Ibid). When it comes to accepting a low bid, buyers should be wary as the low level of the bid can be an indication that the supplier has not fully understood the specifications or the complexity in the project (Ibid). They will then try to make up this cost by cutting corners, stretching schedules (Ibid).

The most successful to use of the four types is the mixed contract (Ibid). The reason for this is that mixed contracts distinguish between engineering and fabrication, installation, and hookup and commissioning: this gives the engineering contractors less reason to manipulate the engineering in order to make more money on non-engineering activities later in the project (Ibid). Another benefit of mixed contracts is that the scope will be much more mature, which results in less changes later in the project (Ibid).

When it comes to change management in megaprojects, a good way of keeping changes to a minimum is having a mature and completed scope (Ibid). Companies that fast-track megaprojects will risk starting construction on a project that is not ready to be constructed. These projects risk scope changes coming at a later time, when they are much more costly (Ibid).

3.3. Supply chain management literature

Suppliers may need to act in accordance with each other and with the end user, and there is a vast amount of literature about buyer-supplier relationships. To give an illustration, a Google scholar search shows 121,000 articles when searching with the keyword, “buyer-supplier”. However, what most of them have in common is that they do not discuss buyer-supplier relationships in megaprojects. If “megaproject” is added as a criterion, the field is significantly narrowed. There are still some 2,000 hits, but a lot of these do not contain all the search words and are not really relevant.

Purchasing strategies must deal with the following: make or buy decisions, supplier technology, desired buyer-supplier relationship, external market forces, and how competitive strategy can be supported by purchasing (L.M. Ellram & A. Carr 1994).

Purchasing strategy should also be a part of the corporate strategy, and with global sourcing and rapid technology changes, the purchasing strategy will need to take more responsibility when it comes to planning and implementation in order to support corporate strategy (Ibid). Firms that consider purchasing to be a strategic function will probably build long-term relationships with key suppliers (A.S. Carr & Pearson 1999).

Whatever buyer-supplier relationships exist will be faced with both planned and unplanned adaptation (Brennan & Turnbull 1999). Planned adaptation will typically take place in such areas as decision-making processes and complexity of data gathering, while unplanned adaptation will often be a result of several “unimportant” decisions that in themselves bear no consequence (Ibid). Over time, these can form a noticeable adaptation. Brennan & Turnbull identify three typical categories of partnership developments: transactional, transitional and partnering. In transactional development, there is no policy in order to develop long-term relationships, and inter-firm development is developed on a transactional basis (Ibid). Transitional partnership development is more of a transition state, where firms that have previously had a transactional approach have now committed themselves to building long-term relationships (Ibid). The last relationship, partnering relationship, happens when practices and processes are firmly established in the organization (Ibid). With no conscious approach to supplier adaptation, companies may risk being victims of an unplanned adaptation that could make them part of a disadvantageous relationship (Ibid).

One of the contributions of the study from Brennan & Turnbull is that long-term relationships that have settled can be revitalized by the right management action (Ibid).

When it comes to buyer-supplier literature, a field that has been overlooked is supplier-supplier relationships and its impact on buyer-supplier relationships (Choi et al. 2002). Choi et al. identify three types of supplier-supplier relationships: competitive, cooperative and co-opetitive (Ibid). The type of relationship will affect the buyer's bargaining power and purchasing effectiveness (Ibid).

In the competitive supplier-supplier relationship, the knowledge of other suppliers is gained through either the media or the buyer (Ibid). They will know that they supply parts or services to the same buyer. Communications between the suppliers in this type of relationships will often be discrete and limited. The buyer will control the information between the suppliers, and can use this advantage to create benefits. In this type of relationship, the buyer should try to maintain the competitive relationship, as it will result in lower prices (Ibid).

In the cooperative supplier-supplier relationship, the tables have turned. There is a high level of information flowing between the suppliers, and they help each other with technological know-how and production capacity in order to reach shared objectives (Ibid). In these relationships, there will be little or no competition between the suppliers, and they can present a unified front towards the buyer that can sometimes border on the side of collusion (Ibid).

The co-opetitive relationship is a mix of the other two relationships, where competition is necessary and cooperation is needed both for learning and market expansion (Sofka & Grimpe 2008). For co-opetitive suppliers, direct communication and exchange of goods is necessary in order for both parties to remain effective and competitive (Choi et al. 2002).

In monopolistic industries, the most likely relationships are cooperative or co-opetitive relationships, and there are typically two or three suppliers that have most of the market share (Ibid). Switching suppliers in this scenario would often be very costly, as products will often differ greatly and not be easily replaced (Ibid). The costs associated with changing suppliers will be high, and most of the bargaining power lies with the suppliers. The biggest

risk when dealing in these types of markets is potential collusion and opportunistic behavior from suppliers (Ibid). Opportunism revolves around cheating in order to improve a position in negotiations, and it is important to take opportunism into account when choosing between contractual alternatives (Nordberg & Verbeke 1999).

When talking about buyer-supplier relationships, transaction cost theory should also be addressed as it plays a role (Williamson 1975). Much of the written literature about transaction cost theory is based on the work of Williamson (Williamson 1975; Williamson 1979; Williamson 1984; Williamson 1985), who identified internal and external boundaries of firms. Some articles written about Williamson's impact on management theory even state that before his transaction cost economics, little or no frameworks existed that addressed these issues (Teece 2010). Transaction costs are the costs associated with maintaining and handling the contract between a buyer and a supplier (Williamson 1985). This includes such costs as negotiating, implementing, monitoring, adjusting, terminating and enforcing agreements (Frazier et al. 1988). Transaction costs are not necessarily quantifiable, and the goal of transaction cost analysis is to minimize transaction costs rather than calculate them (Williamson 1985).

Turner & Simister define five different project contract payment terms: cost plus, remeasurements based on a schedule of rates, remeasurements based on a bill of quantities, remeasurements based on a bill of materials, and fixed price (Turner & Simister 2001). They argue that claims for quantities will be inflated for the first types and claims about variations will arise in the latter types. In their study, they identify two parameters that are essential when selecting the contract payment type. These are: *complexity of the situation*; and *the ability of the client to contribute to the resolution of problems*. They also argue that these parameters are the same as *uncertainty of the product* and *uncertainty of the process*. This is in line with the thinking of Nordberg & Verbeke, who identify *buyer-related asset specificity* and *supplier-related specificity* (Nordberg & Verbeke 1999).

Nordberg & Verbeke discuss how to use asset specificity as a way to determine the risk of transaction costs. A supplier with little or no familiarity with the end product is a supplier with a higher risk of contractual problems because of a potentially high level of supplier-related asset specificity. Asset specificity can also generate supplier benefits. Nordberg &

Verbeke stress that high transaction costs by themselves do not necessarily mean increased supplier benefits, but that high asset specificity can be an indicator of supplier benefits in cases where learning or strategic supplier motivation are part of the transaction.

Turner & Simister also address alliance contracts (Turner & Simister 2001), and present four key criteria. They call the first *owner business philosophy*. For this criterion, it is important to get the whole organization behind the idea of an alliance. The second criterion is *project size*. Projects with financing of less than \$US150 million should not adopt alliance contracts. The third criterion is *project risk and uncertainty*. There has to be risk involved for the alliance partners to share, or else it is simply not worthwhile. The last criterion is *alliance partner availability and capability*. Competence and financial backing are the key parameters here. Without this, there is no way to share the risk. Both parties have to be able to contribute to solving the problem, or else they will only inhibit each other. In megaprojects, however, alliance contracting should not be used as they increase instability in execution (Morrow 2011).

Tan argues that because of the high costs associated with change of suppliers, a company can become a “captive of its suppliers” (Tan 2001). He also states that hostility towards a supplier may prove more profitable in the long run than trusting the supplier. This is not in line with Cheung et al., who conclude that “*trust is the most efficient tool to improve efficiency in construction contracting*” (Cheung et al. 2011). A possible way to mitigate some procurement hazard is to “spread the business around” (Shuen 1995), meaning that several contractors are each given a part of the order. This way, there will be backups in place should problems arise with one of the contractors. Another possible solution is to identify contractors capable of delivering within the technical specifications, or help contractors so that they become capable of doing so (Fine & Whitney 1999).

Brady and Maylor discuss the importance of being informed about bad news. If companies have the policy that “no news is good news”, then contractors and even people in the organization will not come forward with potential problems (Brady & Maylor 2010).

3.4. Complex projects literature

Complex megaprojects differ from smaller projects, and Hobday defines complex products and systems (CoPS) as *any high cost, engineering-intensive product, sub-system, system or construct supplied by a unit of production* (Hobday 1998). CoPS are usually one-off or smaller batch products (Ibid). Hobday also offers several examples of typical CoPSs, such as offshore oil production platforms, supercomputers, mainframe computers, electronic commerce systems, and synchrotron particle accelerators. Both the ATLAS detector and the Gudrun platform fit well into this description. A typical attribute of CoPS firms is that they create markets (Ibid). As a result of this, they need to manage the feedback they get in the different stages of the project (Morris 1994). For complex projects, possible coordination problems could occur for suppliers when having to agree on the specific technology after a contractual agreement has been made (ex-ante) (Miller et al. 1995). One of the problems with CoPS firms is that knowledge sharing between projects can be challenging (Hobday 1998).

Hobday also argues that for CoPS firms, some traditional management tools may be irrelevant, or at the very least require severe modifications in order to be useful. If not done correctly, using such tools can even be harmful. Regarding coordination, CoPS firms have to manage differences when it comes to various contractors' objectives, culture styles and management structures (Ibid). The contractors of CoPS firms will need to work together and sort out these differences, and as a result of this, preferable partnerships will emerge based on who the contractors feel that they can work with (Ibid). Hobday concludes that *the nature of a product (especially its complexity and cost) will play an important part in shaping innovation processes, organizational form and coordination* (Ibid). This is supported by Spekman, who states: *"Competition from offshore producers, technological innovations, and shortened product life cycles have changed buyer-seller relationships. Traditional relationships no longer suffice; closer, more collaborative approaches are needed"* (R. Spekman 1988). CoPS organizations cannot develop just one set of capabilities if they want to achieve success in global CoPS markets (A. Davies & Brady 2000). There will be a need for systemic changes throughout the entire organization (Ibid).

Iyer et al. state that with increased complexities in the project, there is a higher likelihood of more complex contracts (Iyer et al. 2008), and complex contracts will be incomplete

(Williamson 2002). With contracts incomplete, buyers and suppliers will need to adapt to disturbances, such as gaps, errors and omissions, in the contract (Ibid). For a project with a high level of uncertainty, the contract must be monitored and followed up closely (Pinto et al. 2009). There is also a need for change management in projects with high uncertainty and complex scope (Shenhar & Bonen 1997). This may lead to higher transaction costs (Pinto et al. 2009). Because contract language can be difficult to understand, this can cause contractual disputes (Iyer et al. 2008). They also list the six most common triggers for disputes in construction contracts. These are: final and binding power; time, delay and extension; termination of contract; pricing of deviation and extra items by owner representatives; deviation from limit/scope of work; and price escalation. The article focuses on time delays. Iyer et al. argue that all delays eventually lead to time loss, which can cause additional costs. They conclude that a foolproof contract will reduce contractual problems dramatically, but that a foolproof contract is nearly impossible to achieve in practice.

3.5. Conclusions and summary

The literature review tried to identify existing megaproject management and to locate project management literature for smaller projects that could be used for megaprojects. Based on the reviewed literature, there is little available literature about the implementation phase. More literature exists about the conception and negotiation phases, and it mostly focuses on cost estimation and forecasting. The literature showed that the contract type with the most success for megaprojects is the mixed contract. This will give the supplier less reason and opportunity to make additional money after construction has started. For tenders that receive few offers, the worst contract type is the EPC fixed price. The most important things to take into account when selecting contract type are the capabilities of sponsors, the nature of project, and the state of EPC services.

The literature also showed that the complex nature of megaprojects can lead to higher transaction costs. Another potential source of transaction costs is choosing a supplier with no familiarity with the end product, and this is something to be particularly aware of when selecting a very low offer. A very low offer will often be an indication that the contractor has not fully understood the scope of complexity of the project. It is also important to monitor

the supplier-supplier relationship in the industry. Being aware of this can help companies position themselves and gain additional bargaining power.

When it comes to change management, the prevalent strategy is to make sure that the scope is mature and complete. Managers should try to avoid changes that occur during the implementation phase. Parties in complex megaprojects should agree on relevant technology before contracts are finalized.

4. Case study

For this study, there are two cases: ATLAS and Gudrun. The information about these projects has been gathered from interviews and internal governing documents. As mentioned in the methodology section, I will not go into the commissioning phases of ATLAS.

In this chapter, I will start by presenting the procurement policy for the Gudrun project and for ATLAS. The Gudrun project follows the same basic Statoil rules and procedure as any other Statoil project. Therefore this is a description of the general Statoil procurement policy. For ATLAS, the focus is on the contracts that ATLAS places through CERN. These contracts will be in line with the purchasing policy of CERN. This policy is followed on all the projects at CERN.

The second topic is what Statoil calls interface management. This entails technical information exchange between contractors. The third topic in the chapter is change management. This relates to how changes are being handled. The changes are not limited to changes initiated by Gudrun or ATLAS.

The last topic I present from the cases is how ATLAS and Gudrun have been affected by opportunism, and how they deal with it.

4.1. The Gudrun project

The Gudrun project is a field development project in the North Sea, including a new platform, gas and oil pipelines between Gudrun and Sleipner, and large modifications at Sleipner and the Kårstø facility (gas and oil terminal). It is scheduled to be ready to start production in 2014. It is located on the Norwegian side



Figure 4.1 1 Gudrun location

of the border between the United Kingdom and Norway, and it is a high pressure/high temperature reservoir,

which consists of both oil and gas. The reservoir is located between 4,200 and 4,700 meters below mean sea level with pressures up to 820 bar. Statoil is the operator and owns 75% of

the Gudrun license. GdF Suez owns the remaining 25%. Both the oil and gas will be sent from Gudrun to Sleipner A, using two pipelines that are approximately 55 kilometers long. From Sleipner A, oil will be sent by undersea pipe connection to Kårstø, which is a

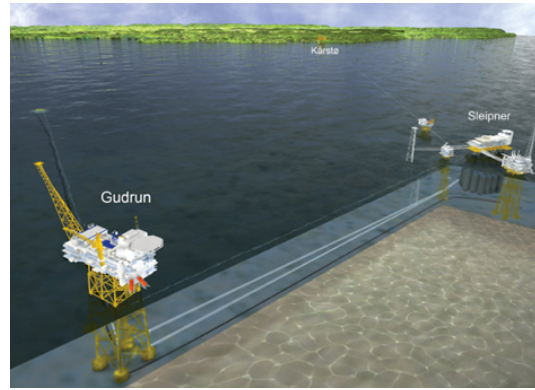


Figure 4.1 2 Gudrun, Sleipner and Kårstø

facility capable of processing the oil. The gas is sent to Europe. Because of the nature of the oil, some modifications at both Sleipner A and the Kårstø facility are required. The total budget for the platform, pipelines, the Sleipner and Kårstø modifications, and drilling and well operations is estimated at 3 billion CHF. There is also a reserve of 0,5 billion CHF set aside for any unforeseen circumstances. The manpower from Statoil's side for this project peaks at between 300 and 350 people.

The Gudrun project consists of four major contracts. The deck is built by Contractor A and will be built at three different locations. The construction will take place in Singapore and Thailand, and the assembly will be done in Norway. Contractor B in Verdal, Norway, builds the jacket. Contractor C in the UK does the transport and installation. Contractor D in Norway will do the living quarters.

The contractors need information from each other in order to make the different parts of the project fit together. Statoil has routines and governing documents that describe how to deal with information and requests between the different contractors. The document describing this procedure is found in two of Statoil's governing documents (BOK12.001 and BOK12.000). These two governing documents first present the tool, SmartPlant Foundation (SPF), that is used for project change and interface management, and then present what constitutes a change and how this should be handled. Each project in Statoil is responsible for how these governing documents will apply to the project and how the different systems will be implemented. In the Gudrun project, Statoil has decided to handle all this information through one department. The department, called Project Change and Interface Management, handles all information between contractors. There are five functional interface areas for the Gudrun project. These are: the Gudrun project (GDR), Gudrun Drilling

& Wells (D&W), Gudrun PETEK(Petroleum Technology), Gudrun Kårstø, and Gudrun Operations. In this section, the main focus will be on the GDR interface.

4.1.1. Procurement policy

For the Gudrun project, there are 30 different contracts. From the Project Execution & Overall Procurement Strategy, a unique strategy for each contract is developed. When the contract strategy is developed, Statoil starts with the prequalification of contractors. As a rule, Statoil will need three different offers for each contract. If the prequalification survey shows that only one or two companies fulfill the prequalification requirement, Statoil will try to help a company reach the prequalification requirements. It does this either by training or by helping the company understand the requirements better. If no suitable company can be found, it is also possible to apply to the Statoil leadership for an exemption from this rule. This is not something that Statoil wants to do as experience has shown that tenders that receive only one or two offers have experienced more contractual problems in the past. As a general rule, Statoil does not wish to engage in contracts with a high level of technological uncertainty. If there is a case of technological uncertainty, there must always be a backup plan, or else policy dictates that no offers will be accepted.

When three or more contractors are prequalified, the specific procurement process for the contract in question is started. After offers have been received, the different contractors will be evaluated based on two main criteria: commercial mindset and technical capabilities. How the criteria are evaluated will differ from contract to contract. The exact way that offers are evaluated is decided before any offers are accepted, and cannot be changed. The specific evaluation conditions cannot be changed after offers are received. The specifics of the strategy will be dependent on the level of technological uncertainty. For projects with a high degree of technological uncertainty, the technological capabilities will be highly prioritized. For contracts that are fairly standard, the commercial mindset of a contractor will be in focus. Regardless of how the evaluation criteria are weighted, the goal is to get the best price for the best quality that is technically acceptable. Note that this does not mean the same as selecting the contractor with the lowest price.

The Statoil procurement policy is flexible and will differ from contract to contract. One contract may weigh technological capabilities to 70%, and commercial mindset to 30%. Another might be evaluated to the completely opposite level, with a 70% focus on commercial mindset and 30% on technological capabilities. It can also choose to score the contractors on various attributes, such as price, technological capabilities, previous experience and commercial mindset. In these cases, the contractor would be evaluated on the parameters selected for the specific contract and the contract with the highest score would be awarded the contract.

It is important to note that when Statoil goes out to the market, the design for its product is typically 80% completed. The remaining 20% of the development is completed by the contractors, and is part of the offer.

Another option that Statoil sometimes uses is to select a supplier that it wishes to build up for future contracts. This can, for example, be done in areas where there are few prequalified contractors. So by paying a bit more on the first contract, all future contracts in this area will see more competition.

Contracts with Statoil are usually repetitive. The contractors that submitted offers for the Gudrun project will likely also submit offers for another Statoil project later.

4.1.2. Interface management

The Gudrun project is divided into four sub-interfaces: Gudrun Platform (PLT), Sleipner Modification (MOD), Gudrun Subsea (SS) and Gudrun Pipelines (PL). Where necessary, these interfaces are split up into

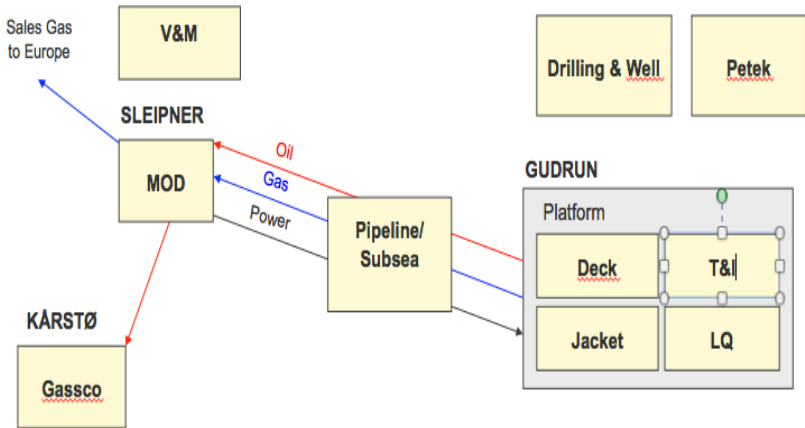


Figure 4.1.2 1: Gudrun project interface

logical interfaces. The Gudrun platform, for example, is divided again into Gudrun Topside (DECK), Gudrun Jacket (JAC), Gudrun Living Quarter (LQ) and Gudrun Transport & Installation (T&I). The different interfaces are divided into the Responsible Interface Party and the Interfacing Party. The responsible party undertakes arranging of interface meetings with the interfacing party on a regular basis. The responsible party also creates and maintains interface agreements and the interface matrix. The most important tasks for successful interface management are interface meetings, interface agreements, interface forum, and system and tools for interface information management. The interface meetings are held mainly to exchange and discuss technical information. Meetings are held when needed. If the need for change is required as a result of these meetings, it will follow the change procedure, which will be explained in the next section.

The interface agreements are mainly there to split responsibilities between interfacing parties. The different areas of responsibility are added to SPF as an interface point. SPF is the main tool used to maintain and monitor information exchange between interfaces.

Whenever technical information between contractors is needed, a Disciplinary Interface Information Request (DIIR) is created. All DIIRs are registered in SPF. For each DIIR, there is a responsible party and an interfacing party. The responsible party provides the information required by the interfacing party. When a DIIR is created, the interfacing party should include the following: what information is needed and when is it needed? The responsible party has to go into SPF and give an expected delivery date for the information in question. SPF logs all communication between contractors. That means that if there is a dispute, it will always be possible to go back and check when information was asked for and delivered. Statoil distinguishes between normal and critical DIIRs. A critical DIIR can cause delays or extra work if it is not delivered before the set time. The two interfacing parties have to agree on an expected delivery date. If the parties cannot agree, Statoil has to be included in the process. It is important to note that an overdue DIIR is not necessarily a critical DIIR.

In order to monitor progress and the status of all the different DIIRs, Statoil has implemented the interface forum. This is a biweekly meeting that the contact person for each of the major interfaces attends. The main objectives of the interface forum is to verify status of interfaces between functional areas, identify overdue interface actions and find

mitigation actions required to have the interface items resolved, identify interface actions that should be treated according to the project change control procedure, and identify interface actions for the value chain that not have been identified by any of the sub-projects. The interface forum is not a place for detailed technical discussion. In these meetings, the persons responsible for the different interfaces present the status of all DIIRs. Any critical or overdue DIIRs are discussed and actions towards these are decided. DIIRs that become overdue before the next interface forum meeting are also discussed.

4.1.3. Project change

Statoil has to approve all project changes. There can be several reasons for change. The most obvious one is saving money. Statoil has been trying really hard in the Gudrun project to identify cost-saving changes, and it spent much time in the earlier phases of construction on identifying these. As the construction phase advances, these changes are harder and harder to come by, and at the state the Gudrun project is in now, almost all changes will carry some kind of extra cost. These costs will vary in size, and the size determines who in the Statoil hierarchy can approve it. The platform project manager can approve changes up to a certain amount. Amounts over the platform project manager's authority will have to be approved by the Gudrun project manager. The project manager for Gudrun can approve changes up to 3 million CHF; if the cost exceeds this amount, it will have to be taken further up the Statoil hierarchy.

Statoil deals with two types of changes. The first one is Area Project Change (APC). This affects only one of Statoil's organization areas or contracts and the cost has to be within the limits of the authority matrix. The other change is Central Project Change (CPC). These changes will typically affect more than one organization area, or the cost of the change is above the limit of the authority matrix. The authority matrix purpose is to identify the person who can approve the change.

There are also two different categories of change. These are called Design Change Proposal (DCP) and Design Development Proposal (DDP). The DCP deals with changes to facility design or design basis. It also treats changes to the key milestones of the project, or any new government requirements. A DDP comes from design development within approved design.

It will typically affect cost, schedule or quality. A DDP can also improve project execution. Any revised company specifications will be considered a DDP. The reason for a DDP is to select optimal solutions and involve affected stakeholders. DDP changes are approved according to the authority matrix.

Project Change Proposal (PCP) is a Statoil definition that covers all types of changes. A PCP is initiated either by Statoil or its contractors. In the proposal, the initiating part has to include main reason for change, pre-evaluation of health, safety and environment consequences, proposed solution, reference to project basis and affected documents, consequences of not implementing the change, and impact on weight, cost and schedule.

The living quarters contract with Contractor D is an engineering, procurement and construction contract. This means that it is Contractor D's responsibility to develop the remaining part of the Front-End Engineering Design (FEED). When an offer is accepted, the FEED is not ready to be constructed. Typically, Statoil has developed 80% of the FEED, and it is the contractor's responsibility to develop the remaining 20%. The cost for this development is part of the offer. Changes in the development phase are considered as DDP changes. These changes are already priced into the contract and should in theory not lead to increased costs for Statoil. Contractor D has claimed that some DDP changes were in fact DCPs. Statoil, on the other hand, will always argue that a DCP is a DDP as this will lead to no increased costs.

Proposed changes from proposed by the contractors are called Variation Order Requests (VORs). When a VOR is submitted, the contractor must provide information, such as reason for change, effect of change and cost of change. All PCPs are handled in SPF, where affected parties can enter relevant information. When affected interfaces have entered relevant information, the changes are evaluated in change boards. In a change board, a representative from each of the different affected interfaces is present and has a say in relation to how the proposed change will affect the specific interface. Based on the information at hand, the change board decides whether to approve the change or not. If the cost of change exceeds that of the specific change board's authority, the next person in the authority matrix will have to approve it. There are two types of change boards: Area Change Board (ACB) and Central Change Board (CCB). The ACB is limited to one interface. That

means that changes approved in the ACB will not affect other interfaces. If the change affects other interfaces, it has to be discussed by a CCB.

When a VOR is accepted, a Variation Order (VO) is issued, and the cost of the VO is negotiated between Statoil and the contractor. If the VOR is rejected, Statoil will contact the company and inform it that it will send a Disputed Variation Order (DVO) if the VOR is not withdrawn. If the VOR is not withdrawn, a DVO is created and given to the contractor. If the contractor then wishes to pursue the matter further, it has the option of taking the issue to a third party expert. The third party expert is appointed based on a list of eligible experts identified at project startup by Statoil and its contractor. From the list, both parties exclude one of the experts and they each create a top five list. The expert with the highest combined rating is approached first. If he is unable to take on the task, the expert with the second highest rating is approached, and so on. If the contractor does not accept the expert's decision, the final step is legal action. There is also an option of accepting parts of the VOR. This is usually what happens, as some parts of the VOR are frequently necessary changes and will more likely than not have to be implemented at some point anyway. For these VORs, the contractor will try to add other VORs as part of the necessary VORs in order to jack up the contract price. In these cases, the parties will typically reach an agreement where part of the VOR is accepted and some percentage of the original VOR asking price will be given.

A VOR must not be confused with a Non-Conformity Request (NCR). An NCR is a request for dispensation and can be sent by the contractor if a requirement cannot be fulfilled. The NCR can be either permanent or temporary by nature. A permanent NCR is divided into three categories (deviation, waiver, exemption). A temporary dispensation is always a waiver, and when applying for a temporary dispensation, compensating measures must be taken until the requirement is met. An NCR must always include description, affected areas, reasons for request, and consequence.

In the Gudrun project, the top management has challenged its employees to find requirements that can be either disregarded or simplified. This has been done to cut costs, and has resulted in several cost-saving changes in the earlier phases.

4.1.4. Opportunism

In Gudrun, compared with other Statoil projects, there have been less Variation Order Requests (VORs) received than normal. It is believed that this is an effect of the rigid change management adopted in Gudrun. Almost at the startup of the project, one of the contractors sent five VORs similar to what it had been given in previous projects. In the Gudrun project, these VORs were almost immediately sent back as Disputed Variation Orders (DVOs). Upon receiving the VORs, Contractor D withdrew two of them, but took the last three to a third party expert. This expert ruled in favor of Statoil on one of them and in favor of Contractor D in another. The last one was so small that he recommended Statoil just accept it as the cost of processing the information was larger than the cost of the change. It is believed in Statoil that because it took up this fight at an early stage, Contractor D sent fewer VORs than it normally would. Historically, Contractor D had been able to increase the contract by approximately 50%.

This does not look to be the case in Gudrun. After almost 50% of the construction was completed, the contract growth was around 4%. This has frustrated Contractor D, and has forced Contractor D to spend more time on managing the contract. As a result, Contractor D has been using the interface management system actively in order to increase the contract value. Because some interface milestone dates are in the contract, Contractor D claims that these dates were not upheld and that this has had an impact of both cost and schedule. Contractor D handed in a big VOR that increased the contract value by approximately 10%. This is something it had done in previous projects with Statoil and was used to getting. Statoil is disputing this, but it has not been resolved yet.

The way that Contractor D has been acting has not affected other parts of the project. The other contractors have not been acting in a similar fashion towards Statoil, but have adopted a tougher line when dealing with Contractor D.

The intention of the interface systems is to supply the different contractors with the necessary technical information. In an ideal world, contractors would be realistic with dates, and together reach an agreement on when the particular information will be given. It is not supposed to be used by contractors in relation to contract growth. Yet this has been the case in the Gudrun project. Contractor D has been using the milestone interface dates from the

contract rigorously, and refused to move the need dates. This has been done in order to later come and submit a big VOR that would have increased the contract by 10% had Statoil accepted it. In this VOR, Contractor D claims that some of the technical information needed from other contractors was not delivered on time, and this had an impact on both cost and schedule. This is typically the type of VOR that Contractor D had sent and been awarded during the middle phase of construction in previous contracts with Statoil.

4.2. The ATLAS project

The ATLAS project is a project at CERN in Geneva. It is one of the particle detectors along the Large Hadron Collider (LHC). The ATLAS detector tries to explore the buildings blocks and forces of the universe. The ATLAS

detector’s main objective is searching for the Higgs boson particle. The ATLAS project is a collaboration between universities and institutes all around the world. The ATLAS collaboration started in 1992. The estimated startup for ATLAS

was 2004, but it was not operational until September 2008. The ATLAS collaboration

consists of 173 institutes from 38 countries. It had an original budget of 475 million CHF, but in the end, the total cost was 520 million CHF. It is important to note that this number does not include labor from employees at ATLAS and institutes around the world. This is because the salary of employees is paid by the institutes themselves and not by CERN. Had labor been included, the budget would likely have been two times higher. ATLAS is extremely complex, and is a one-of-a-kind project. In the early stages of the planning and design phase, there was a need for technology that had not yet been invented.

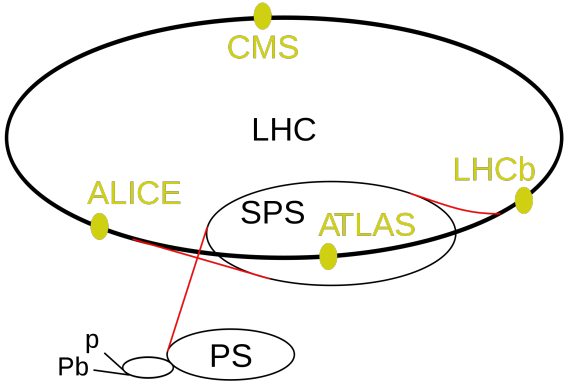


Figure 4.2 1 ATLAS on the LHC

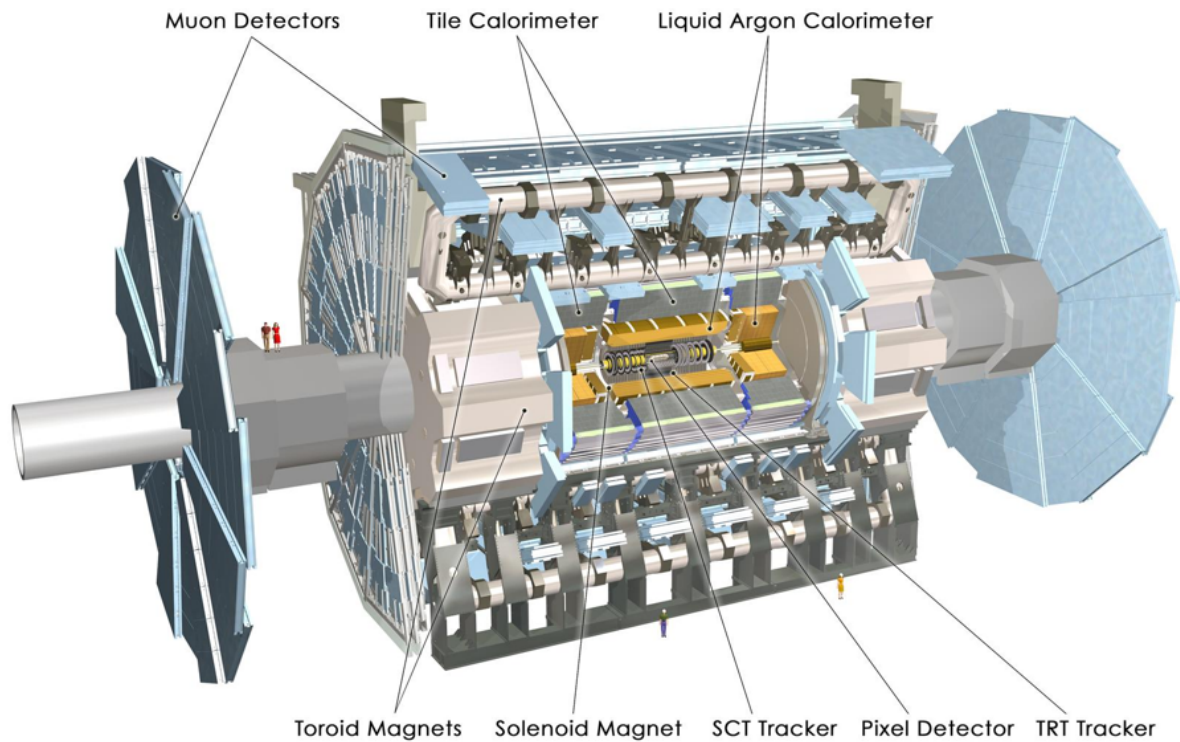


Figure 4.2 2 The ATLAS detector

The ATLAS detector was split into several sub-projects. For tracking, there was the inner detector and the Muon Spectrometer. For Calorimeters, there are Liquid Argon, tile calorimeter and Zero Degree Calorimeter. There were also other groups, like Magnet, Shielding, Trigger DAQ, computing and the test beam.

ATLAS did all of the integration work. There were simply no companies able to handle the level of complexity that followed ATLAS for an affordable cost, and so it had to be broken down into much smaller pieces. This put a lot more responsibility on ATLAS when it came to integration, but with more or less free labor, that was not a big issue. The different institutes around the world all contributed with either money or some in-kind contribution. They would take responsibility for some part of ATLAS, be it a part of the inner detector or something completely different. A price between ATLAS and the institute in question would be agreed on. If the total cost of this contribution exceeded the original estimate, this would be on the heads of the institutes or related Funding Agencies. If the total cost were less, then the excess money would stay with the institutes. In reality, the cost was never less. It was almost always more, and unless the final cost exceeded the estimate by more than 15%, the institutes did not complain too heavily. The institutes could either do it themselves or go to

the market and get proposals from the industry. Institutes or universities delivered 56% of common ATLAS parts, and the remaining 44% involved parts that were simply too complicated or demanding for any one institute to handle alone. In order to acquire these parts, ATLAS went to CERN, which sent out tenders to the industry. As the project management for each of the parts that were delivered by institutes is handled differently, depending on the policies and procedures of the institutes, I have chosen to focus on the contracts that were acquired through CERN. This accounts for roughly half of the 520 million CHF cost of ATLAS. This was done in order to have a meaningful comparison with the Gudrun project. ATLAS managed these contracts, but CERN facilitated them. These contracts followed the CERN procurement policy.

4.2.1. Procurement policy

For the ATLAS project, approximately 2,500 contracts were placed through CERN. This number also includes smaller contracts (<200,000 CHF). For all contracts over 200,000 CHF, a market survey has to be done. If the survey shows that only one or two companies are qualified, then ATLAS tries to split up the contract into smaller products or components to attract more potential bidders. This is done because experience has shown that opportunistic behavior tends to arise in cases with only one offer. Another option that ATLAS has utilized is to first train a couple of selected companies by using small contracts. In these cases, representatives from the companies will work with people from CERN in order to develop the necessary know-how and technological capabilities on a similar type of project. This is done if the market survey or other investigations shows that the price for the contract will be too high for CERN. These different strategies are put in place to ensure that enough offers will be received for all major tenders. For contracts between 200,000 CHF and 750,000 CHF, the target is about 10 offers. For contracts exceeding 750,000 CHF, the goal is 15 received offers.

When all offers have been received, the main selection criterion is price. The bidder with the lowest total price that fulfills the technical specification and delivery time will be awarded the contract. The only exception is if the rule of alignment is used. The rule of alignment states that contracts should be awarded to poorly balanced member states. CERN tries to

match the percentage of contracts awarded in a country with that country's contribution percentage to CERN. So if a country has contributed, say, 2% to the CERN budget, then approximately 2% of the value of all contracts should go to industry from that country. If only 1% of the value of contracts has been awarded to this country, then it is considered a poorly balanced member state. The rule of alignment can only be used if a contractor from a poorly balanced member state is within 20% of the lowest offer. The contractor with the second lowest offer will have the option of aligning its offer with the lowest offer. If this is refused, the contract will be awarded to the contractor with the lowest offer that fulfills the technical specification and delivery time. The offers received will typically look like the chart below (Nordberg & Verbeke 1999):

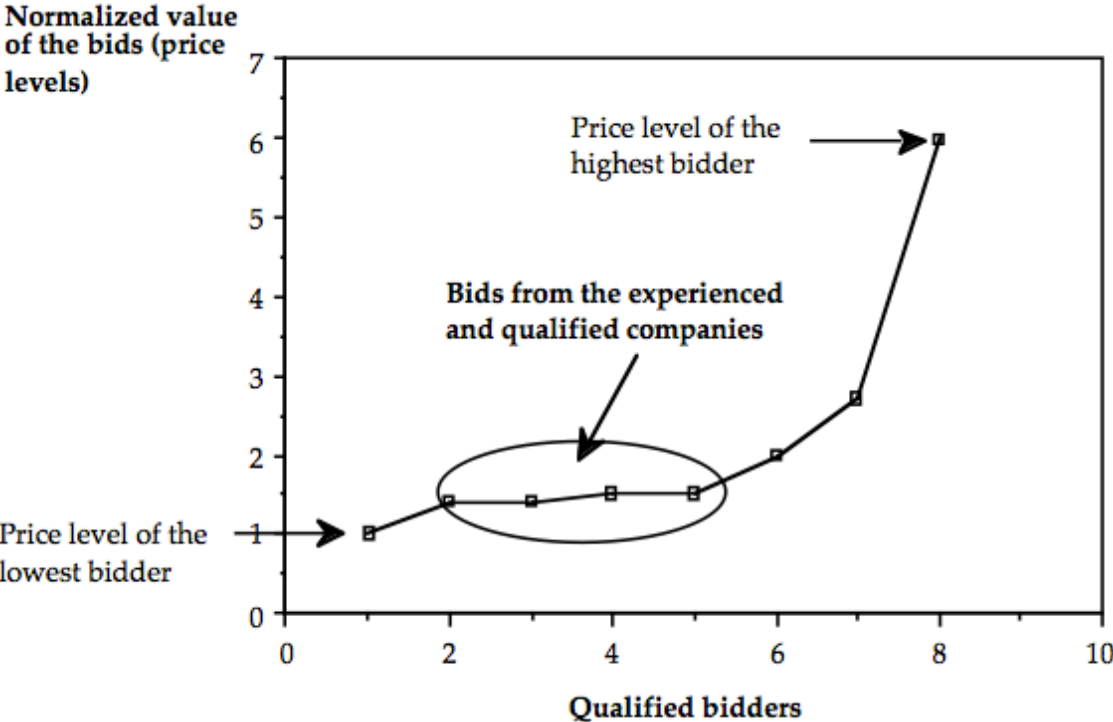


Figure 4.2.1 1: Bidding distribution at CERN

As we can see from this chart, the qualified bidders with previous experience with CERN will not necessarily get a second contract. CERN cannot choose these companies if everything checks out with the lowest bidder. A result of this is that a contract with ATLAS will usually be a one-off. Companies will get the know-how, but as they gain this know-how, they will also get a more accurate estimate of what the real cost of making the product in question will be. As a result, they will often not end up with a second contract, as new suppliers will

not know all the costs and perhaps give a price that is more favorable for CERN than for themselves. There can be other reasons for underbidding, as well. Working with CERN will often benefit companies in ways other than money (Autio et al. 2003).

For the contracts that go through CERN, the technical specifications have to be as complete as possible. Experience has shown that if the specifications were of good quality, then there were fewer problems with the contract. If, on the other hand, the specifications were vague, problems would occur.

All the studied contracts at ATLAS are price- or cost-driven. For this reason, contractors tend to do only the absolute minimum that fulfills the technical specifications. Anything beyond the bare minimum will have to be paid for by ATLAS. This increases the level of follow up from the ATLAS side. As a result, ATLAS has a very tight follow up to all contracts, with continuous milestones and checks. For a complex contract, the contractor has to prove that it is able to deliver the end product. Contractors prove this by first producing a small batch, which will be thoroughly tested by ATLAS. If the batch fulfills the requirement, then a larger order is placed. Even though the contractor has shown that it has the capabilities, ATLAS will keep up with continuous checks and be strict about milestones. There is an example of a contractor who failed to reach the first milestone, and in that particular case, ATLAS cancelled the contract and gave it to someone else.

For critical contracts, ATLAS tries to spread the risk by selecting several contractors. If problems arise with one of the contractors, then it will not delay the whole project, and the slack can be picked up by one of the other contractors. Problems can arise if a critical contract is awarded to only one company. In these cases, it does not necessarily matter how the contract is written, or if ATLAS knows it will win if they decide to take the company to arbitration. The win may come after several years, which means that the whole project will be delayed.

4.2.2. Interface management

When it comes to interface management, ATLAS prefers to operate with a single point of interface. One person is responsible for providing all the technical information that a

supplier requires. However, the contracts are set up in a way that contractors don't really need information from other contracts or contractors. In the rare cases that they do require this information, they will just talk to ATLAS, and ATLAS will simply provide the information. Since ATLAS does all the integration itself and has close follow up and frequent reviews during the construction phase, it knows that the product delivered is the product ordered.

ATLAS has had some trouble with companies either going out of business, changing leadership or ownership, or shifting business priorities. In order to combat this, it has also placed orders with one or two other bidders. In cases where more than one company has been awarded a contract for the same product, it has also encouraged the companies to work together and inspect each other's production facilities. By doing this, ATLAS gets the companies to take responsibility and also has a backup if one of the companies should fail. This is, of course, not possible for all contracts, but it can also give the contractor with the second lowest offer the option to be on "standby" should something happen to the main contractor. However, in these cases, the contractors will work on the same thing and not really need information from each other in order to be able to produce the required product.

ATLAS's interface management, or lack thereof if using the Statoil definition, is highly influenced by the fact that there is no need for contractors to interact with each other. Contractors simply have one point of interface: ATLAS. If problems with one contractor affect another part of ATLAS, it simply handles everything internally.

4.2.3. Change management

When it comes to change management, the ATLAS detector is divided into sub-project-specific envelopes. The envelopes of ATLAS are similar to the interfaces of Gudrun. Within its granted envelope, the sub-project manager is free to make changes as he sees fit, unless it affects other sub-projects. If the changes affect more than one sub-project, then the review office is contacted. The review office is part of the technical coordination, and reports directly to the Technical Coordinator (TC). The task of the review office is to find qualified people for a review committee that will handle that specific change request. The people on

the review committee will vary from case to case, but there will always be someone present from the review office. When everyone has given his or her opinions and consequences, the review office reaches its decision. When a decision has been reached, the TC has to approve the decision. It is also the Technical Coordinator's job to make sure that a change does not affect a part of ATLAS that the review office had not thought of. Changes that would result in increasing the total contract by more than 10% have to be approved by both ATLAS and the CERN management. This generally puts ATLAS in a bad light in the eyes of its funding agencies, and for this reason, ATLAS will try to avoid it if possible. There is no predefined mechanism for a contractor if it wants to claim more money from CERN due to either breach of contract or poor technical specifications. If there are problems, the contractor has to start a dialogue.

As mentioned earlier, Statoil has a very clear-cut process to address contractor claims and other problems with contracts. The use of VORs and PCPs has no counterparts in the ATLAS project. The contract is set up in such a way that contractors have to let ATLAS know about potential problems as soon as they know of the problems. This does not happen in practice, as it is easier for contractors to get more out of the contract at a later stage. For most contracts, the scope of work is close to 100% complete, meaning that there are no development requirements for the contractor. ATLAS has more or less all the know-how, so it designs everything. In the few cases in which a contractor has better knowledge, ATLAS can leave some parts of the design to the contractor. In these cases, ATLAS still has to sign off on all design changes.

ATLAS is very strict about the parts being produced in a special manner. If contractors feel that, for example, some test or requirement of production of a specific part is not necessary, they can start a dialogue with ATLAS and suggest an alternative method of testing. ATLAS will then look into it, and if the proposed alternative is viable, they will let the contractor produce a test batch to see if it matches the specifications. If it does, the contractor will be given the green light to produce the parts using the alternative method.

4.2.4. Opportunism

ATLAS has not been affected by opportunism to a large extent. ATLAS is extremely quality- and cost-driven, and would rather face a schedule delay than an increase in costs. This is because ATLAS has a fixed overall budget, and has extremely little flexibility with funding. In order to keep costs down, there could not be many changes after construction had started. To achieve this, a long design phase was undertaken. There were, of course, still changes in the construction phase as well, but as a whole they were not very costly. An important thing to note is that if companies started getting difficult with ATLAS, it usually had the technical competence and resources to find some other way around it, possibly including the option of going to another company for completion. For example, there was a company dealing with the inner detector that was supposed to complete a certain percentage of delivery by a set date. When the date arrived, it had completed only about half of what was expected. ATLAS then cancelled the contract and gave it to another company. Another option for ATLAS is to just do the job itself. ATLAS has a huge resource base across its 38 countries and because its labor is basically free, it can choose to do the work in-house. As a consequence, companies that get too greedy may end up getting nothing. On average, companies might be able to increase the contract value by 10%, but anything more than that is not common at all. And those 10% may come from necessary changes, and not as a result of opportunistic behavior.

Another important factor is that a lot of companies that dealt with ATLAS genuinely wanted to help. They wanted to be part of something bigger, even if that resulted in not making a profit on the specific project. The latest report about the benefits of working with CERN was published in 2003, and of the 629 companies that were part of the report, 38% developed new products, 14% started new business units, 42% increased international exposure, 44% had significant technological learning, 60% acquired new customers, and all companies experienced great value from having CERN as a marketing reference (Autio et al. 2003).

It is also worth mentioning that any differences between ATLAS and its contractors cannot be settled in courts. CERN cannot be taken to court, and nor can CERN take other companies to court. If any contractual problems cannot be solved, then an arbitration process is started. This is similar to the third party expert of Statoil, but the difference in this case is that the decision is final. This is a costly and time-consuming process, and that will cause delays.

5. Analysis

In this chapter I compare procurement policy, interface management, change management and opportunism for the Gudrun project and ATLAS. Towards the end of the chapter, I analyze potential learning from the two cases.

5.1. Procurement policy

Of the two, Statoil has the more flexible contractual system. This is perhaps a surprise, seeing that there are 30 contracts in Gudrun versus approximately 2,500 contracts in ATLAS. At Gudrun, it can decide which criteria to focus on for each individual contract. If the specific product is complex, then companies with a high score on technology will be favored. For “standard” products, it will focus more on price. It also weighs previous experience with contractors, meaning that if a contractor historically has been able to increase the contract value by 30%, this will be taken into account. This is not really surprising, as Gudrun’s contracts are complex. Because they are complex, there will be a need for adaptation from both Gudrun and its suppliers, and this will cause transaction costs to rise (Williamson 2002).

Perhaps Gudrun’s biggest challenge is to select the right criteria for each contract. With so many possibilities, choosing the wrong selection criteria could be costly. This can typically happen when the perceived reality does not correspond with the actual reality. The obvious example is in cases where the product is not thought to be complex, but after the contract is awarded and the final design is developed, it becomes clear that this is in fact a highly complex project. For this specific project, the lowest price would most likely have been the main driver, while technological capabilities could have been overlooked. This could lead to a higher level of contract growth, and will at the very least require extra resources to be spent on control and follow up.

ATLAS does not have the problem of choosing the selection criteria. By always selecting the contractor with the lowest price that fulfills the technical specifications and schedule, ATLAS ensures that the detector is constructed in the cheapest way possible. This choice of always selecting the cheapest offer does come with consequences, especially if the offer is substantially lower than the rest. This might be an indication that the supplier has not

completely understood the complexity of the project (Merrow 2011). Contracts should be adapted to the product (Turner & Simister 2001). Failure to do so might lead to increased costs, especially when the risks associated with the project grow larger. Adapting the contract can be a way of mitigating some of the risks. As a result of this, ATLAS had to follow up closely. Contractors are in the business of making money. And while a contract with ATLAS might be fruitful in other ways, such as public relations, new technological capabilities and new product lines (Autio et al. 2003), contractors also want to make money. Since contracts are awarded based on the cheapest price principle, it means that there is not a big profit margin. Companies might therefore try to cut corners, which again means that ATLAS needs to monitor and follow the contract very closely. ATLAS can easily do this because it has a large organization and does not pay for its employees, as the collaborating institutes pay their salaries. To exaggerate a bit, it does not matter if the transaction costs for a contract exceed the actual contract value as ATLAS does not pay this cost. On the bottom line, the project will be completed at the given contract cost or close to it. For Statoil, this is not possible, as it has to pay all its employees, and this cost is figured into the budget.

The Gudrun project has been a well-staffed project from the start. This has enabled management to take the necessary contractual fights, and it has been able to identify several cost-saving changes. As a result, the Gudrun project has saved approximately 0,4 billion CHF. Because the cost of management is relatively small compared with the total budget, one can argue that future projects in Statoil could benefit from having more well-staffed projects. In the interviews at ATLAS, people commented that even if the people working on the contracts from ATLAS's side had been calculated in the budget, it would have been worth the extra costs, as errors could be extremely costly. By being very involved in the production, they ensure that they get the end product to be exactly as they want. Changes in design and other problems can be handled early and effectively.

Nordberg & Verbeke found that companies with previous experience with CERN would often not get chosen again for another contract as a result of CERN's procurement policy (Nordberg & Verbeke 1999). As a result of always going with the lowest offer, ATLAS could end up having to help contractors to a larger degree. Had there been some system similar to Statoil, where it could rate companies differently, ATLAS could perhaps be able in some

cases to sit back and let the contractor take more responsibility. Statoil will sometimes choose a contractor with which it has no previous experience in spite of the fact that this can lead to a more costly contract. The reason for this is that it will create more competition for future contracts. In a sense, ATLAS could be doing the same for most of its contracts. As a consequence of the CERN procurement policy, it may end up selecting a contractor with no previous experience with CERN. The result of this could be inflated transaction costs and ATLAS might end up having to train the contractor (even though there are more than three offers for a contract). It would be interesting to look further into whether ATLAS, by selecting the contractor with the lowest cost offer, in reality ends up with the cheapest option. In ATLAS's case, it probably will do so because employment costs are not considered and it does not matter if the transaction costs are higher. To look into this would not be an easy task, but if it had been possible, it could have yielded some interesting findings.

Another important point to note is that ATLAS pushes the boundaries of technology to the extreme. When the ATLAS detector was designed, it required technology that was not yet available. This is not the case for the Gudrun platform, even though the platform itself is fairly complex. Both ATLAS and Gudrun have recognized that tenders that receive one or two offers will be problematic, and they have both taken measures to prevent this. They both train contractors, but only ATLAS divides the contract up into smaller contracts. This could possibly be something Statoil could try for future contracts, in addition to training contractors.

The fact that the scope of work is only 80% complete for Statoil's contractors should also be addressed. Experience in ATLAS has shown that there are more contractual problems in the cases in which technical specifications are not complete. Even though the development of the remaining 20% is part of the offer and should not cause contract growth, the fact is that it does. As mentioned earlier, many contractors will try to claim that the proposed change is not within the development work; Statoil, on the contrary, will claim that it is. In these cases, some will be won and some will be lost, and this will lead to increased costs. Had the scope of work been 100% complete, there would have been no discussion. This has been the case for several ATLAS contracts. For these contracts, every change cost money. If Statoil were to adopt a similar approach, there will be a lot of pressure on the technical specifications,

especially since it is difficult to identify possible scenarios and the complete scope in megaprojects (Flyvbjerg et al. 2003). With good technical specifications, there will be little or no contract growth. On the other hand, with poor technical specifications, costs will increase rapidly. A possible solution for Statoil is to start using mixed contracts to a larger degree. Most of the contracts in Gudrun are fixed-price EPC contracts, which on average have a higher level of cost overruns than mixed contracts (Merrow 2011).

5.2. Interface management

When it comes to interface management, Gudrun has a more flexible system than ATLAS. The contracts in Gudrun are bigger and fewer (30 versus 2,500), whereas in ATLAS, there are more contracts but they are smaller, and each contract covers one tiny aspect of the detector. Almost all ATLAS contractors deal only with ATLAS, and in the few cases in which information is needed from other companies, ATLAS will get it. The result of this is that ATLAS does not need an elaborate interface system, whereas Gudrun does. Because the contracts in Statoil are much more turnkey solutions, Statoil's contractors will need to talk to each other to exchange technical information in order to make sure that the key fits the lock. For this reason, Statoil has to have a system that deals with the communication. The key words here are "integration" and "know-how". By doing all the integration itself, ATLAS will have a lot more control. Contractors will generally not need information from each other. If there are any problems during the production, they can always ask personnel at ATLAS who are more than willing to help. This is not to say that the people in Statoil are not willing to help, but because they have outsourced production of the entire oil platform, there is no need to keep personnel with the know-how to build oil platforms on the Gudrun project payroll. The personnel are released to other projects in order to create other oil platforms. This is a common problem in megaprojects (Merrow 2011). The people at ATLAS mainly work in ATLAS only. The people who designed the different aspects of the detector stuck around and could be asked questions and be of help if needed.

An important observation about the interface system in Statoil is that it can be used opportunistically. The intention of the interface system is that it should be used only for

information, but contractors can use it and maneuver and position themselves in order to increase contract growth.

5.3. Change management

When it comes to change management, ATLAS and Gudrun have a similar system for changes that they initiated themselves. The interfaces in Gudrun can be compared with the envelopes of ATLAS. For changes within one interface or envelope, it is the responsible person within that interface or envelope who makes the decision. When changes start to affect other parts of the project, a more meticulous process is started. Gudrun has change boards at various levels. The Central Change Board is comparable to the review office. The main difference here is that on the change boards, the persons involved do not change. There is a representative from each of the different interfaces, and that person is always responsible for that interface. For ATLAS, the review boards will be dependent on the specific change. Some changes will require, say, magnet experts, while other changes will require radiation experts, for example. Each review board is different from the previous one. ATLAS is arguably more complex than Gudrun, so one can argue that more specialized expertise is needed. In Gudrun, the change boards sign off on changes, thus taking responsibility for the change. In ATLAS, the Technical Coordinator approves all changes. This puts a lot of responsibility on the TC. In one way, the TC acts as a fail-safe for the review board. If the review board overlooks something, the TC can save the day.

As with interface management, change management is affected by the fact that ATLAS does all the integration and Statoil does not. Since Statoil has more of a turnkey approach to its projects, it is more vulnerable to changes. With a handful of big contracts that are both complex and on a tight schedule, any changes in these will carry costs. A delay in the early phase of the project will have repercussions for all parts of the project. It is interesting to note that the Gudrun management has encouraged its employees to come up with changes that decrease cost, or are necessary changes. By actively trying to identify necessary changes at an earlier stage in construction, it also minimizes the cost of these changes. This approach will minimize the cost of change across the board as the changes would have been more expensive at a later time in the project. At the time of the interviews at Gudrun, the project

was about 30% complete. At that time, the message from management was clear: we are past the point of no return; minimize changes and do not go through with changes unless they are absolutely necessary. Ideally, no more changes would come.

For the changes initiated by the contractors, Gudrun and ATLAS have different systems. Gudrun has an established process for a contractor to submit changes and deviations from the contract. This enables the contractor to claim for more money from Statoil. In ATLAS, no such process exists, and the only way it can be done is for contractors to contact ATLAS and start a dialogue. In Statoil, the contractors can send a VOR, which will start the process. This process will have a cost regardless of the outcome as it has to be looked at and considered. If Statoil does not acknowledge the need for change, the contractors have the option of taking it to a third party expert. This has happened in several cases, and in one case, the cost of this expert exceeded the cost of the change. This is perhaps an interesting point, seeing that in ATLAS, there is usually no dialogue started for the smaller changes. This could possibly be of interest to Statoil, and a similar approach at Statoil could perhaps weed out at least the smaller changes that are opportunistically motivated. This is not the same as saying Statoil should have no process for contractor changes.

There should be a process that deals with changes for complex megaprojects (Jergeas 2008). ATLAS has no option of such a system because changes from contractors are much less likely to occur. Because the technical specifications are almost always 100% complete, there is usually no need for the contractor to suggest changes. When it comes to how the detector is assembled, almost all the knowledge is at ATLAS. The contractor might know the best way of producing the particular part it is producing, but how this part will interact with the rest of the detector is ATLAS's responsibility. In Gudrun, on the other hand, it is the other way around: it is the contractors who have the know-how. For this reason, as well as the fact that approximately 20% of the design is done by the contractor, it makes sense for Statoil to have a system that allows contractors to submit their changes. It does, however, seem like this system comes with a price. That price is a system that contractors can use to achieve contract growth. And because of that price, it could perhaps be beneficial for Statoil to revise its current system. If, for example, the scope of work had been 100% complete, the need for such a system would perhaps diminish. Determining the exact way that this can be

implemented is not within the scope of this study, but is something that should be looked into. One possible solution could be to use more mixed contracts, as this will give the constructing contractor less opportunity to claim additional money from the buyer (Merrow 2011).

For the Gudrun project, Statoil has tried something new in terms of Statoil history. It has had a much tougher approach to change management. Normally, contractors dealing with Statoil have been used to seeing a cost increase of up to 80%; the norm has been 50-60%. For the Gudrun project, this has not been the case at all. Statoil has fought every change and really tested its contractors. Changes have not been implemented unless they have been absolutely necessary. This rigid change management has born fruits. Compared with the initial budget, the Gudrun project is now set to deliver the project at 0,4 billion CHF below the estimated cost. That is a decrease of approximately 15%.

5.4. Opportunism

Regarding opportunism, there are some key differences when it comes to ATLAS and Gudrun. In ATLAS, the only way for the supplier to increase the contract value is to start a dialogue. And if contractors get too out of hand, ATLAS can always decide to complete the product itself. In most cases, there are certainly enough people with the necessary know-how. Statoil cannot do this. It has to work out kinks and problems with contractors or it will simply not get the product. This is something that can shift the power from buyer to supplier, and make Statoil a captive of its suppliers (Tan 2001). In some cases, Statoil might be “forced” to accept some contractual growth

The interesting part when it comes to opportunism is not necessarily limited to differences between ATLAS and Gudrun. Gudrun, compared with previous Statoil projects, also offers some valuable insight. The interviews with Statoil personnel showed that contract growth of 50-80% is not uncommon for Statoil projects. Statoil knows and expect it. It even includes it in its budgets. The exact figure added to a project will vary from project to project, and is based on previous projects and experiences. Since the scope is not 100% complete, there will be extra costs that reveal themselves during the project life cycle. So the fact that

Gudrun is likely to experience a contract growth of 10-20% is not a bad thing as it is much less than expected. The Gudrun project has been one of the first projects in Statoil with rigid change management. Every change has been fought for, and every stone has been turned in order to shave as much as possible from the scope, but still fulfill the technical and operational specifications. This has yielded results, and approximately 0,4 billion CHF of the initial budgets has been saved as a result of this. To put that into perspective, that is almost the cost of the ATLAS project. However, one should not just look at the numbers. Some of these savings could perhaps have been cut out in the earlier phases of the project. If, for example, the scope had been more mature and closer to 100%, this saving of 0,4 billion CHF could perhaps have been even bigger. If this had been the case, the budget might have been smaller and there would be less room for decreasing costs, but the overall cost of the project could have been smaller than what it is today. This is something that Statoil should really take into consideration when it comes to future projects. The cost of changes in the early phase is microscopically small compared with the cost in the last stages of the project.

ATLAS, like Gudrun, has been very well staffed, and this has enabled people working on the two projects to follow up closely, and in Gudrun's case, enforce strict change management. ATLAS has been able to limit contract growth to around 10%, and now Gudrun is experiencing similar results on a well-staffed project. The Gudrun project has had a peak of just over 350 persons working on it. Staffing is one of the big challenges of megaprojects (Merrow 2011). In the interviews, it was stated that the success of Gudrun to a great extent is the result of the high level of manpower that have followed the project throughout its life cycle. This is perhaps an indication that future Statoil projects, and other megaprojects, could benefit from being staffed in a similar fashion. An interesting observation about the high level of manpower is that it allows both ATLAS and Gudrun to have a lot of technical competence in-house. With this technical competence, it makes the job of identifying the difference between opportunistic behavior by contractors and necessary changes or claims. If this technical competence had not existed in-house, they would simply have no other choice but to trust the suppliers, with the result that more changes would be approved. This could have given the suppliers an opportunity to make a lot more from the contract. From this observation, one could argue that large projects that outsource almost everything

should keep someone with technical competence on board. This allows them to keep a tougher line with contractors, which is better than having to trust them (Tan 2001).

Another explanation for ATLAS's low cost overrun is that companies are genuinely interested in working with CERN. For products that are not off-the-shelf and have some technical complexity to it, contractors might have other interests than just money in mind. There are other advantages, apart from money, of working with CERN, such as new products, exposure, technical learning and marketing value (Autio et al. 2003). Companies try to do their best even though the result might be a small loss, despite the contract being a one-off. For Statoil's contractors, it is arguably the other way around, as contractors hope to get additional contracts with Statoil for future projects. Other than that, the advantages of working with Statoil are not as apparent as they are in ATLAS's case.

It is also worth mentioning that ATLAS splits up critical components into several contracts in order to decrease the leverage that contractors might hold over it. This has not been done in Gudrun. The simple explanation for this is that Gudrun has bigger contracts. It wants one living quarters, one deck and one jacket. Splitting these into several contracts may not be a viable option. ATLAS can do this because one contract can, for example, be about producing 1,500 aluminum tubes or 4,000 superconducting cables. In order to split up these contracts, one can simply give one contractor an order of 750 aluminum tubes and another contractor the remaining 750. This is a good strategy in order to decrease risk for critical project components (Shuen 1995).

Both ATLAS and Gudrun are cost-driven, with the latter being the more extreme. In ATLAS, delays have been accepted as long as there were no budget consequences. The same is not the case for Gudrun. In the early phases of Gudrun, a lot of effort went into making sure that there were very few changes, and that all the changes either saved Statoil money or were absolutely necessary. Gudrun welcomed, and even encouraged, people to find changes, as long as they were necessary changes. This is a good thing, as it sent the signal that people should not be afraid of coming forward with changes or troublesome areas (Brady & Maylor 2010). In the current phase of Gudrun, the focus is on delivering on time. If spending a little bit of money can make that happen, then so be it. It is important to look at these differences. Projects that focus on keeping costs down will more often than not manage to

do so. The result might be schedule delays. On the other hand, projects that focus on delivering on time may end up having to pay a bit more to do so. In an ideal world, it would be able to focus on both, but in the real world, this is not the case. Not much can be done in this regard, but it is nonetheless important to be aware of what the primary focus of the project is.

5.5. Learning from the Gudrun project and the ATLAS project

There are several things that one should mention when looking at the ATLAS project and the Gudrun project. The first and perhaps most interesting factor is that they are both fairly well-staffed projects, and both projects are quite successful and a lot of focus and time has been spent on keeping costs down. This is interesting in relation to the planning of other megaprojects. The cost of megaprojects is very big. Hence the risk of eventual budget overruns is also big. If the cases of ATLAS and Gudrun are anything to go by, staffing large and costly megaprojects properly could be a way to mitigate potential cost overruns. For large construction projects, such as the Gudrun platform, the management of the project is only a fraction of the total budget. For the Gudrun project, it is less than 5%, and for ATLAS, it is arguably 0% as it is not ATLAS that pays for it.

Increasing the management budget will, in the large scale of things, be a small cost if this increase can make the project deliver on or below budget. If a relatively small increase in management leads to better budget forecasting, it will make it easier for companies to plan ahead. It will also free up funds, giving companies the possibility of spending money they would otherwise have earmarked as “reserve money” for other projects. It may also make companies less susceptible to opportunistic behavior, as they would have the necessary competence to identify what a real claim is and what opportunistic behavior is. This is an interesting observation. Merrow has also observed that megaprojects tend to outsource and downsize the technical expertise (Merrow 2011). When companies outsource everything, they will still need to retain personnel with the necessary technical competence to limit opportunistic behavior. The lack of such personnel is a cause of cost increases (Jergeas 2008).

This is, however, not the same as saying that project managers should be hiring people left and right. More people do not automatically mean saving money. In the Gudrun project interviews, the importance of having the right people for the job was communicated. In a large organization like Statoil, priorities will shift between projects. Some projects will be well-staffed and some will not. Finding the correct amount of people working on a project will depend on many different factors, and putting together a successful megaproject team will rely on several conditions, such as: timing of team formation, size of the team, recruitment, importance of continuity, team leadership, and development of robust megaproject teams (Merrow 2011). Identifying exactly how megaprojects should be staffed by using these criteria is not within the scope of this study, but is definitely something that should be looked further into. Also, having well-staffed projects is not only a benefit for companies. It also has benefits from a social and economic point of view, as more people will be working and paying taxes. This is not relevant for this study, but it is definitely an added bonus.

There are, however, some problems with adequately staffing megaprojects. There are more megaprojects than ever before, and a history of continuous downsizing does not leave companies with a lot of options (Ibid). However, seeing how the well-staffed projects are able to operate should be an incentive for staffing up projects, and companies that correctly man up their megaprojects could see big rewards in the next 10 years.

Another interesting point about the staffing of ATLAS and Gudrun is the way that the staffing is used. In Statoil, it was used to trim the scope down and take on contractual fights in order to decrease opportunistic behavior. ATLAS personnel also worked on decreasing opportunistic behavior, but the staffing in ATLAS also served more as a knowledge base for the suppliers. If they had problems, they could come to ATLAS and ask for help. ATLAS would gladly give it. Both ways serve as means to stop contract growth, albeit slightly differently.

It is also clear from the comparison between ATLAS and Gudrun is that if you give contractors a way to increase contract growth, they will use it. This is seen both in the interface system and change system of Gudrun. It does not matter if a process is intended for other things. If contractors can use it to be opportunistic and put forth claims during the project life cycle, they will. This has happened in the Gudrun project, where the interface

management system was designed to help contractors exchange technical information. One of the contractors used this system so that it could make claims on Statoil through the change management system. People at Statoil mentioned that this was all part of the game and was expected. As mentioned earlier in this study, ATLAS has no such system. It relies only on dialogue with its contractors. As a result of this, it does to some extent weed out the smaller and opportunistically motivated requests. While systems like the interface and change management systems of Statoil are necessary to ensure project progress, it is important to be aware of the price they come with. For projects that have to rely on such systems, great learning can be taken from the Gudrun project. The cost of its rigid change management and its willingness to take on the necessary contractual fights is small compared with the cost of a contractor that manages to gain a contract growth of 60%.

From a procurement point of view, ATLAS and Gudrun have both had bad results with tenders that receive offers from only one or two companies. As they both use EPC fixed-price contracts, this is no surprise, as EPC fixed-price contracts, with only one supplier, are expensive (Merrow 2011). As a consequence of this, they both train or help companies to be able to submit an offer if possible. This is done in order to make sure that they receive at least three offers. This approach has worked well for both Statoil and CERN, so it is perhaps something that companies in similar situations should consider if it is possible. It is important to know that by doing this, there will be more demand to manage the particular contract. This will especially be a good approach if the chances of similar contracts in the future are high. In the procurement process, the more complete the scope of work is, the less contractual discussion there will be. When leaving some of the design to contractors, it gives the contractors a way to enter into discussion about what changes are further development of the scope of work, and what changes are concept changes. Also, the more complete the scope of work is, the bigger the demand for accurate technical specifications will be. For a scope that is 100% complete, all changes will be concept changes and will have a cost. This can also be looked at from the other point of view. If the technical specifications are vague, then the scope of work should not be 100% complete. Arguably, technical specifications and scope of work go hand in hand. The more complete one of them is, the more complete the other one should be.

An interesting observation in the comparison is the difference in the level of integration. Statoil has outsourced everything, while ATLAS does all the integration in-house. This has allowed ATLAS to take an extremely cost-driven approach. Gudrun has also been cost-driven, but nowhere near the same extent as ATLAS. In ATLAS, there was simply no more money, and compromises with the schedule had to be made in order to keep costs within agreed contracts. However, in Gudrun, some contract growth was expected and budgeted for. This can be seen in the diagram on the right. With a high level of integration, companies can afford to be extremely cost-driven. ATLAS did so, and was about 10% off on a 13-year-old budget estimation that took neither inflation nor currency changes into account.

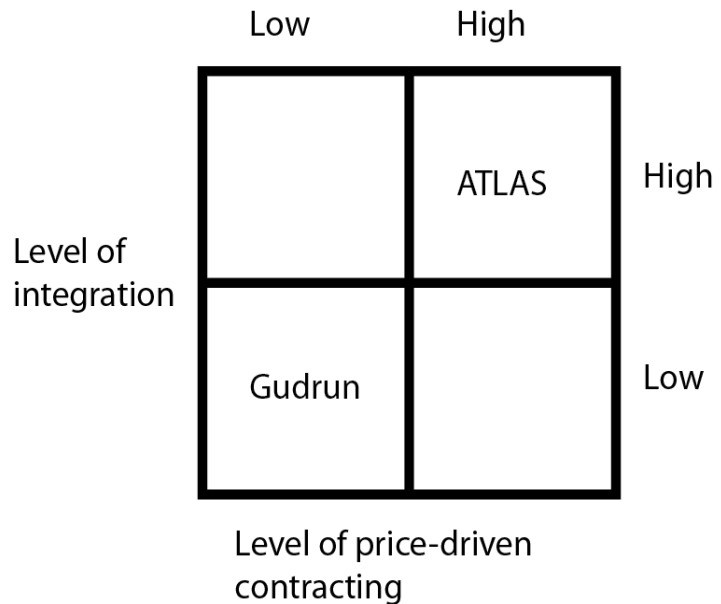


Figure 5.5 1: Integration vs. price-driven contracts

6. Conclusions

This study set out to find out the differences and similarities of the ATLAS project and the Gudrun project, and what conclusions could be drawn from those differences and similarities. The cases were presented, and through the analysis, the differences and similarities were identified and discussed. For that reason, I will not go through the specific differences and similarities in this section, but rather focus on what conclusions and experiences can be drawn.

The first is regarding the staffing of megaprojects. Based on the findings of this study, there is an indication that there should be an adequate level of staffing for megaprojects, especially when the cost of management personnel is relatively small compared with the total cost of the project. The exact amount is difficult to identify, as it depends on the project. From the two cases, it seems that by having enough people working on the project, the necessary contractual fights can be taken. As a result, companies will more easily be able to identify the cases where contractors act in an opportunistic manner compared with the cases where contractors actually have legitimate claims. The result will be that total cost overruns can be kept down. This may also lead to better budget forecasting in the future.

The second is that with when leaving part of the design to contractors, it gives the contractors an opportunity to make money. There will be a need for processes and tools in order to deal with inevitable changes and claims that will come. One alternative to this is to design everything in-house. The downside of this will be that projects will be more vulnerable to change. The advantage will be that companies have more control if the technical specifications are correct in the first place. Another possible way to mitigate contractor opportunism is to use mixed contracts.

The third contribution is that there is an indication that the more that integration can be done in-house, the more cost-driven companies can allow themselves to be. Companies that do all the integration themselves can afford to be extremely cost-driven. If problems occur, they will always have the possibility of picking up the extra slack themselves.

When it comes to the question of how change and interface management affects contract growth and opportunistic behavior by contractors, the findings of this study indicate that

contractors will use the change and interface management system for what it is worth. They will act opportunistically and do their best to increase contract growth. The opportunistic behavior can be combatted with rigid change management and refusing to accept claims and changes that are not absolutely necessary. Companies that try this approach should be aware that contractors might get desperate if they don't get the contract growth they have expected.

6.1. Future research

There are several ways that future research based on this study could go. One possibly interesting study could be to look at contract growth in large projects that have management teams with a lot of technical competence versus large projects that have management teams without a lot of technical competence. In a study of this type, it would be interesting to see how much contract growth the different projects experienced.

Another possibility is to look further into the staffing aspect of megaprojects. It would be hard to find out a specific process for estimating the correct amount of staffed people, as this would be project dependent. However, finding out if there will be less cost overruns for megaprojects with high levels of staffing in projects is something that really should be investigated further as it could save organizations money or at least give better estimations when it comes to project costs. This study indicates that there is such a link, but as this study only had two cases, it will be hard to make a generalization. It would be interesting to conduct a study with a higher number of megaprojects as case studies to see if it would come up with similar findings.

7. Bibliography

- Autio, E., Bianchi-Streit, M. & Hameri, A.-P., 2003. Technology transfer and technological learning through CERN's procurement activity.
- Berry, D., Towill, D.R. & Wadsley, N., 1994. Supply Chain Management in the Electronics Products Industry. *International Journal of Physical Distribution & Logistics Management*, 24(10), pp.20-32.
- Brady, T. & Maylor, H., 2010. The improvement paradox in project contexts: A clue to the way forward? *International Journal of Project Management*, 28(8), pp.787-795.
- Brennan, R. & Turnbull, P.W., 1999. Adaptive Behavior in Buyer-Supplier Relationships. *Industrial Marketing Management*, 495, pp.481-495.
- Brockmann, C., 2009. MEGA-PROJECTS: GETTING THE JOB DONE (2000).
- Caldwell, N.D., Roehrich, J.K. & Davies, A.C., 2009. Procuring complex performance in construction: London Heathrow Terminal 5 and a Private Finance Initiative hospital. *Journal of Purchasing and Supply Management*, 15(3), pp.178-186.
- De Camprieu, R., Desbiens, J. & Feixue, Y., 2007. "Cultural" differences in project risk perception: An empirical comparison of China and Canada. *International Journal of Project Management*, 25(7), pp.683-693. Available at:
- Carr, A.S. & Pearson, J.N., 1999. Strategically managed buyer-supplier relationships and performance outcomes. *Journal of Operations Management*.
- Cheung, S.O. et al., 2011. Developing a trust inventory for construction contracting. *International Journal of Project Management*, 29(2), pp.184-196. Available at:
- Choi, T.Y. et al., 2002. Supplier-Supplier Relationships and Their Implications for Buyer-Supplier Relationships. *IEEE Transactions on Engineering Management*, 49(2), pp.119-130.
- Croom, S., Romano, P. & Giannakis, M., 2000. Supply chain management: an analytical framework for critical literature review. *European Journal of Purchasing & Supply Management*, 6.
- Davies, A. & Brady, T., 2000. Organisational capabilities and learning in complex product systems: towards repeatable solutions. *Research Policy*, 29(7-8), pp.931-953.

- Ellram, L.M., 1991. Supply chain management: The industrial organisation perspective. *International Journal of Physical Distribution and Logistics Management*, 21(1), pp.13-22.
- Ellram, L.M. & Carr, A., 1994. Strategic purchasing : A history and review of the literature. *Journal of Supply Chain Management*.
- Fellows, R. & Liu, A., 2008. *Research Methods for Construction*. John Wiley & Sons.
- Fine, C.H. & Whitney, D.E., 1999. Is The Make-Buy Decision Process a Core Competence., *Logistics in the information age*, (February), 1-31.
- Fiori, C. & Kovaka, M., 2005. Defining Megaprojects: Learning from Construction at the Edge of Experience. *Construction Research Congress* (480).
- Flyvbjerg, B., 2007. *Megaproject Policy and Planning: Problems, Causes, Cures*. Aalborg Universitet
- Flyvbjerg, B., Bruzelius, N. & Rothengatter, W., 2003. *Megaprojects and Risk: An Anatomy of Ambition*, Cambridge University Press.
- Frazier, G.L., Spekman, R.E. & O'Neal, C.R., 1988. Just-In-Time Exchange Relationships in Industrial Markets. *Journal of Marketing*, 52(4), pp.52-67.
- Hobday, M., 1998. Product Complexity , Innovation and Industrial Organisation. *University Business*, (June), pp.689-710.
- Iyer, K., Chaphalkar, N. & Joshi, G., 2008. Understanding time delay disputes in construction contracts. *International Journal of Project Management*, 26(2), pp.174-184.
- Jergeas, G., 2008. Analysis of the Front-End Loading of Alberta Mega Oil Sands Projects. *Project Management Journal*, 39(4), pp.95-104.
- La Londe, B.J. & Masters, J.M., 1994. Emerging Logistics Strategies: Blueprints for the Next Century. *International Journal of Physical Distribution & Logistics Management*, 24(7), pp.35-47.
- Mentzer, J.T. et al., 2001. Defining Supply Chain Management. *Journal of Business Logistics*, 22(2), pp.1-25.
- Merrow, E.W., 2011. *Industrial Megaprojects: Concepts, Strategies and Practices for Success* 1st ed., John Wiley & Sons.
- Miles, M.B. & Huberman, A.M., 1994. *Qualitative Data Analysis.*, Thousand Oaks Sage Publications..

- Miller, R. et al., 1995. Innovation in Complex Systems Industries: the Case of Flight Simulation. *Industrial and Corporate Change*, 4(2), pp.363-400.
- Morris, P., 1994. *The Management of Projects*, Thomas Telford.
- Nordberg, M. & Verbeke, A., 1999. Management of High Technology Contracts: The Case of CERN. *Technology innovation entrepreneurship and competitive strategy series*.
- Patton, M.Q., 2002. *Qualitative Research & Evaluation Methods*. *Qualitative Inquiry*
- Pinto, J.K., Slevin, D.P. & English, B., 2009. Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management*, 27(6), pp.638-648.
- Polonsky, M.J. & Waller, D.S., 2006. *Designing and Managing a Research Project*. Sage Publications Ltd.
- Prahalad, C.K. & Hamel, G., 1990. The Core Competence and the Corporation. *Harvard Business Review*, 68(3), pp.79-91.
- Schensul, S.L., Schensul, J.J. & LeCompte, M.D., 1999. *Essential Ethnographic Methods*. (p. 318). Altamira Press
- Shenhar, a. J. & Bonen, Z., 1997. The new taxonomy of systems: toward an adaptive systems engineering framework. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 27(2), pp.137-145.
- Shuen, A., 1995. *Technology Sourcing and Learning Strategies in the Semiconductor Industry*. PhD dissertation UCB, 26(3), pp.688-689.
- Sofka, W. & Grimpe, C., 2008. The Fit Between Coopetition and Open Innovation Strategies – Keep Your Friends Close and Your Enemies Closer? In *International Conference on Management of Technology 2008*.
- Spekman, R., 1988. Strategic supplier selection: Understanding long-term buyer relationships. *Business Horizons*, 31(4), pp.75-81.
- Tan, K.C., 2001. A framework of supply chain management literature. *European Journal of Purchasing & Supply Management*, 7.
- Tan, K.C., Kannan, V.R. & Handfield, R.B., 1998. Supply chain management: Supplier performance and firm performance. *Journal of Supply Chain Management*, 34(3), pp.2-9.
- Teece, D.J., 2010. Williamson's Impact on the Theory and Practice of Management. *California Management Review*, 52(2), pp.167-176.

- Turner, J.R. & Simister, S.J., 2001. Project contract management and a theory of organization. *International Journal of Project Management*, 19, pp.457-464.
- Villmo, H.B., 2010. *Planning in Megaprojects: Planning and risk management*.
- Williamson, O., 1975. *Markets and Hierarchies: Analysis and Antitrust Implications*, Free Press.
- Williamson, O., 1985. *The Economic Institutions of Capitalism*, F. Press, ed., Free Press.
- Williamson, O., 2002. The Theory of the Firm as Governance Structure: From Choice to Contract. *Journal of Economic Perspectives*, 16(3), pp.171-195.
- Williamson, O., 1984. The incentive limits of firms: A comparative institutional assessment of bureaucracy. *Review Of World Economics*, 120(4), pp.736-763.
- Williamson, O., 1979. Transaction-Cost Economics: The Governance of Contractual Relations P. J. Buckley & J. Michie, eds. *Journal of Law and Economics*, 22(2), pp.233-261.

8. Appendix

Appendix 1: Interview guide

For the first round of interviews, I would start all interviews by presenting myself and explaining why I was conducting interviews. I then presented the main topics I would like to address during. They were the following:

- Interface management
- Change management
- Opportunism

I asked if the interviewee was familiar with these terms, and if they were not, I explained it to them.

I would then ask the interviewee to explain his or her job in order to get them talking and comfortable. I then asked them to explain how interface management was handled in the project. I did not interrupt the interviewees when they were talking, and if I had follow-up questions or needed clarifications I made a note of it so I could come back to it later. I asked questions, such as: “Earlier you mentioned X, can you expand on this issue?” and “Have I understood you correctly if ...”. I asked questions about how the different topics were handled in the project, and what improvements could be done to improve the current system. I also identified some questions in advance that specifically targeted the interviewee’s field in the project. I used this procedure for all the aforementioned topics.

Before concluding the interview, I would ask if there was anything we had not talked about that could be of importance, bearing in mind the topics mentioned in the beginning of the interview.

The second round of interviews followed the same procedure. For this round of interviews, I added procurement policy to the list of topics, and identified some smaller areas within the other topics where I wished to pursue matters further.

Appendix 2: Pictures from Sleipner and ATLAS

Picture from Sleipner:



Picture from ATLAS cavern:

