

## **RELATIONAL CONTRACTING AND PROCESS DESIGN PROMOTING COOPERATION**

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### **ABSTRACT**

In Sweden as in many other countries new demands have led to the set-up of public committees and research projects for scrutinizing the construction sector. The main conclusions are that traditional models for managing the building process do not match the nature of today's fast-track, uncertain and complex projects. Since 2004 there is also a government appointed Committee in Sweden dealing with these matters. It is interesting to notice that the Committee has already given prominence to Lean Construction ideas and concepts as a model for the future of the Swedish construction sector.

New ideas and innovative concepts for the development of the construction process in huge projects which are extremely quick, uncertain and complex have been tested by the Swedish mining company LKAB at a pelletizing plant project described in this paper. The project is procured as a partnering project on DB (Design and Build) basis and with transparent remuneration form. The expectations and demands from the client concerning targets regarding time, cost and functions are set high. Advanced design models such as 3D, 4D and VR has been used to support a concurrent engineering design and construction process.

This paper will mainly deal with the relational contracting aspects. Especially, how the contracting model affects the process design. The results of the study presented are based on a field survey case study carried through by the authors.

### **KEY WORDS**

Procurement models, project types, lean contracting, relational contracting, field survey, process design.

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## INTRODUCTION

Many of the problems in the construction sector have their roots in the use of inappropriate contracting models. A well thought usage and development of existing contracting models is therefore central for the possibilities of achieving a more effective construction process. Contracting models should accordingly be grouped according to how different combinations of performance, remuneration and cooperation models interact with the process design. Within Lean Construction it is also often stressed that the increase of quick, uncertain and complex projects require changes in how projects are contracted and managed. In the article “Contracting for Lean performance: contracts and the Lean construction team”, Miles and Ballard (1997) discusses the needs of developed contracting models facilitating and supporting the need of achieving a more behaviour oriented (relational contracting) construction process.

Today, construction projects in Sweden are still mostly contracted using transactional oriented procurement models, giving the actors in the design and construction phases few incentives for innovations and cooperation in order to improve the project execution. Furthermore, the stakeholders often lack a common view on project targets and the process design is often based on principles that assume activities to be independent and sequential. The project management is focused more on control rather than execution.

In reality activities are often interdependent and in fast-track project the pressure on interaction between activities increases. This enhances the value of good cooperation and coordination between different stakeholders in order to avoid sub-optimization causing large amounts of waste at the construction site (Josephson and Saukkorppi, 2005). The partnering patch for more relational oriented cooperation has up to now been very little applied in Sweden, compared with e.g. the development in UK (Bennet and Jayes, 1998). However, there is a growing interest within the Swedish construction sector to apply new theories and ideas, such as partnering and Lean Construction, in order to achieve a more efficient construction process.

This paper deals with the interaction between external conditions (the project context), the procurement process and the selected strategy for project execution (process design). First, we will discuss how the project context is affecting the choice of contracting model. Secondly, some findings from a field survey case study will be presented in order to illustrate how the actual studied project environment, with high expectations upon short lead time, economy and functions, have affected the strategy for project execution.

## INTERACTION BETWEEN PROJECT CONTEXT AND CONTRACTING

### CONTRACTING IN SWEDEN

A contract model should be defined with regard to the interaction of the *performance* model defining the distribution of responsibility, the *remuneration* (compensation) form and the model of *cooperation* (Toolanen, 2004). In Sweden there are three generic performance forms dependant upon how the responsibility of the design is distributed between the client and the contractors; the DBB (design – bid – build), the DB (design – build) and the Construction management (CM) forms. At a typical Swedish DBB project, the client is responsible for the design and selects a prime contractor who procures and coordinates subcontractors for the construction phase. In a DB project the contractor is responsible for most the design process. In a CM project the client or a client representative is responsible for the design and procures and coordinates all subcontractors. These generic performance forms are subdivided into six

sub forms dependent on more specific details of the sharing of responsibilities (Toolanen & Olofsson, 2005).

The by far greatest part of the construction projects in Sweden have Fixed price basis for remuneration. This is probably one of the biggest sources for litigation when handling quick, dynamic and complex projects where the initial project program, upon which the selection of the contractor is based on, often has to be revised due to dynamically occurred changes. Cost reimbursable forms (transparent) are either with some incentives or without. The latter form is mostly used in smaller projects within reconstruction and maintenance where the scope of work is not always well defined. For bigger projects the incentive based cost reimbursable form predominates. The incentive is mainly based upon sharing savings and overflows of the target cost.

Explicit partnering concepts for cooperation according to models set up mainly in UK have, up to now, been very little practised in Sweden. The reason for that can be discussed and argued but is probably due to cultural and conservative attitudes among the clients. However a parallel model to partnering, based upon mutual strategic considerations, has been used by project execution since decades in Sweden. In those, the partners can make a lot of deals in order to improve the working climate and trust in order to find prerequisites for long term business cooperation.

#### **RECOMMENDATIONS FOR CONTRACTING**

Toolanen (2004) has studied how the decision environment, defined according to Table 1, affects the choice of performance, remuneration and cooperation forms when contracting. Project types often named *quick, uncertain and complex* are best represented by the abbreviations R & T, U and S. For said types of projects were transparent remuneration forms with incentives and partnering as cooperation form (relational contracting) strongly recommended by a majority of the respondents in the study carried through. It is also obvious that the uses of transparent compensation forms and of relational oriented cooperation forms, such as partnering, are highly interacting (Toolanen 2004, Toolanen, et.al. 2005).

#### **FIELD SURVEY CASE STUDY OF THE MK3 PROJECT**

##### **THE PROJECT**

LKAB, a Swedish company owning iron ore mines and delivering its products especially to European steel mills, decided in December 2004 to build a new pelletizing plant (MK3) in the north of Sweden. The MK3 project is a large and technically complex project with an overall budget of about 350 million USD. It consists of a dressing plant, a pelletizing mill and a loading/unloading depot for a yearly capacity of 2.5 million tons of pellets. The target lead time from the decision by the LKAB board to the first production of iron ore pellets is about 22 months which is roughly 6-8 months shorter than comparable projects conducted in the past. Table 2 presents the quantities of some strategic construction parts.

The MK3 project context has components, according to Table 1, of resource and time limitations (R&T) and uncertainties (U) in the design. Due to considerations regarding procurement and project execution issues for an effective execution of the MK3 project, and also of other future projects, there are also strategic (S) considerations to be regarded by the client. LKAB is currently facing a total investment program of approximately 2 Billion USD to increase and to secure the future production volumes.

*Table 1: Interaction between decision environment (project context) and the choice of performance, remuneration and cooperation forms (Toolanen 2004)*

Decision environment		Most recommended contracting modes		
Abbr.	Description	Performance	Remuneration	Cooperation
N	Normal, <i>design and construction</i> can be time-wise separated, <i>no lack of bidders</i>	DBB - forms	Fixed price	Transactional oriented
R	Resource critical, <i>design and construction can be time-wise separated, risk for lack of bidders</i>	DBB - forms	Fixed price	Transactional oriented
T	Time critical, <i>short lead-time, design and construction has to be parallel, no lack of bidders</i>	DB - forms	Fixed price	Transactional oriented
R&T	Resource and Time critical, <i>short lead-time, design and construction has to be parallel, risk for lack of bidders</i>	DB - forms	Transparent	Partnering concepts
U	Uncertainty, <i>risk for late changes and redesign, uncertainty in the build. program</i>	DB - forms	Transparent	Partnering concepts
S	Strategically, <i>client interested to promote innovations, long-term thinking</i>	DB - forms	Transparent	Partnering concepts

*Table 2: Rough quantities of some strategic construction parts in the MK3 project*

Construction parts	Quantity	Truckloads
Steel Construction	7 500 tons	210
Reinforcing bars	2 000 tons	80
Concrete, casted on site	56 600 tons	3 700
Concrete, prefabricated	18 000 tons	540
Roofing and walling material	5 500 m <sup>3</sup>	195
Wood material	550 m <sup>3</sup>	36
Process equipment	9 700 tons	1 370

LKAB initiated the procurement procedure by producing an inquiry consisting of layout drawings, descriptions and estimation of quantities to get a basis for the procurement and also for the internal LKAB decision procedure. Thus, a request for bidding was sent to invited contractors in September 2004. In it was stated that the procurement model was to be based on DB performance form, on cost reimbursable remuneration with incentives and that the project was planned to be executed as a *partnering* project, i.e. the project was procured according to the recommendations according to Table 1.

A conditional contract for the construction was finalized with the contractor NCC four weeks after the distribution of the inquiry. The civil works at site were started immediately after the LKAB board decision to invest in the project in November 2004.

**DESIGN OF THE FIELD SURVEY CASE STUDY**

**Model of the process design**

In this field survey case study, regarding the process design of the MK 3 project, is used a system model according to figure 1 to describe main aspects of the overall process design. The model used is based upon a model of second generation partnering according to *Seven Pillars of partnering* (Bennet, J., Jayes, S, 1998).

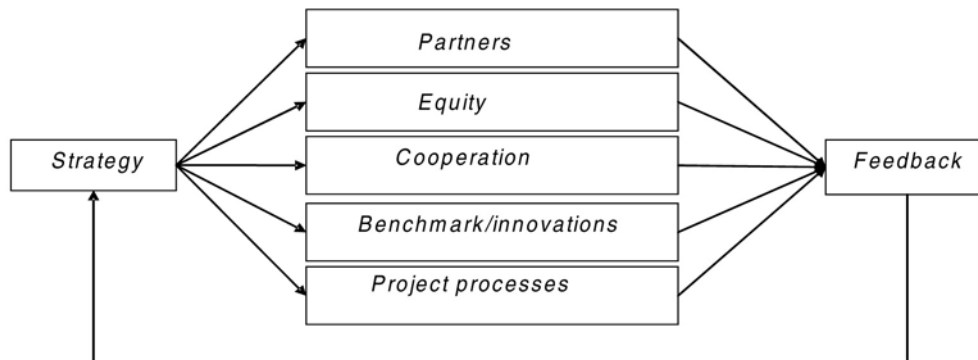


Figure 1: Model for evaluation of the process design components in the MK 3 project

**Methodology**

The field survey case study was conducted by collecting information through:

- Interviews with key personal representing the client, the contractor and major consultants active in the MK3 project.
- Participating as an observer in planning meetings and partnering work shops.
- An enquiry study.

The information collected has been used as a basis for evaluating the different components (*pillars*) according to the system model used.

As the model used, according to figure 1, for describing the main components of partnering represents a simplification of a complex reality with lot of interactions and interdependencies the results should only be regarded as indications and not generic and approved facts (The system view).

### **The inquiry study**

An inquiry study was carried through in October 2005. The inquiry form consisted of 35 questions/statements regarding different aspects concerning the construction process. The respondents had to submit their opinion, by using a scale 1 to 6, to statements presented. The questions/statements were based on main characteristics concerning the different components (*pillars*) of the system model used according to Figure 1. The characteristics were also briefly described in the inquiry form according to the following:

*Strategy* - The overall strategy should define the main goals for the project and also define the main processes and methods to achieve the set goals.

*Project processes* – The procurement model used in the MK3 project sets the overall framework for the process design (*basic rules of the game*). It is then very important for the partners in a relational oriented project to establish *project processes* supporting the achievement of the targets set out in the strategy of the project. Thus the project process pillar is mainly dealing with techniques and structures for how *product design, procurement, quality, supply chains*, et cetera are managed. Furthermore, the complexity and time pressure in projects such as MK3 leads to a situation where the design and construction processes have to occur almost simultaneously. This increases the need of effective coordination and communication between stakeholders.

The *partners* pillar deals with the set up of the strategic team for the project. In the MK 3 project, the invitation for civil works was directed to big construction companies and there was not foreseen in the inquiry to have other partners than the client and the main contractor as formalized partnering members.

*Equity* - The *equity* pillar deals with creating strategic and long term thinking in a partnering project. This question is also linked to the investments in technology and training of people.

*Cooperation* - An effective partnering process requires good cooperation among companies and peoples involved in a project. A basic presumption for cooperation is that trust exists among humans involved and that conditions are present for a continuous development of trust. A goal for a partnering organization is to try to act as a *virtual company/lean enterprise* that is externally interpreted to be homogenous, effective and integrated even if it is based upon resources from different companies and with differing competencies. This pillar can often be improved through teambuilding activities, a common IT strategy and use of information and communication technology. An effective partnering process is also highly dependent upon high technical and social competence among the stakeholders.

*Innovation/Benchmark* - Innovations and benchmarks are basic techniques in order to achieve continuous improvements in a project. Innovations in this sense are applications, products or methods that are new for the group being. An important prerequisite for innovations is to establish a creative and encouraging environment for an innovative behavior.

The survey was answered by 23 representatives active in the MK3 project at management level as clients, consultants and contractors. The results of the inquiry study has been evaluated through calculation of mean values for the different categories (clients, contractors and

consultants) with regard to the different questions/statements and also for the sets of questions/statements chosen to represent the different components acc. to figure 1. The results (indications) got from the inquiry study, the interviews and from the observations are briefly presented in this paper.

## **RESULTS OF THE FIELD SURVEY CASE STUDY**

### **Regarding strategy**

While starting the MK 3 project a document (*the Partnering Charter*) was jointly signed by the client, the prime contractor and consultants. The partnering charter stated the most important goals, policies and procedures to be achieved in the project according to the following aspects.

#### *Cooperation/partnering process:*

- Transparency, high standard of ethics, motivation and engagement, open minded atmosphere and sharing of knowledge.
- Secure achievement of the *hard goals* regarding time, function and economy
- Secure the cooperation among the stakeholders
- Focus on overall project goals, avoid sub-optimizing

#### *Functions and working conditions:*

- No accidents causing absence from work during construction
- Create good and safe conditions for operation and maintenance
- Secure conditions required for achieving scheduled production quantities and quality

#### *Economy:*

- transparency and continuous improvements
- reasonable profit margins for all involved
- follow the budget

#### *Time schedule:*

- start of commercial production Oct 1st 2006

### **Regarding project processes**

The MK3 project addresses the issues concerning the design of project processes primarily by the use of 3D and virtual reality (VR) to communicate and coordinate the design in a concurrent engineering design approach and by a joint planning system for the project.



### The design process

The use of visualization (VR models) is found to be an useful tool in a relational oriented project as MK3. It supports collaborative working methods such as concurrent engineering where communication, sharing of information and coordination of multidisciplinary design teams has been identified as important factors in Lean design (Womack, et al. 1990).

Besides being an excellent tool in design coordination VR has been used in the review and decision process throughout the whole MK3 project (see figure 3). The review process using VR as a mean to communicate the design intents has included a number of stakeholders in the project in a range from corporate executives to end users such as persons becoming responsible for the future plant operations and maintenance.

The design process of the MK3 project has had the following design priorities:

- the design of the pelletizing process
- the plant layout (the plant and its surroundings)
- the construction of the buildings sheltering the process equipment

This leads to a situation where the focus is on the assembling and functionality of the process equipment in the plant instead of the actual building.

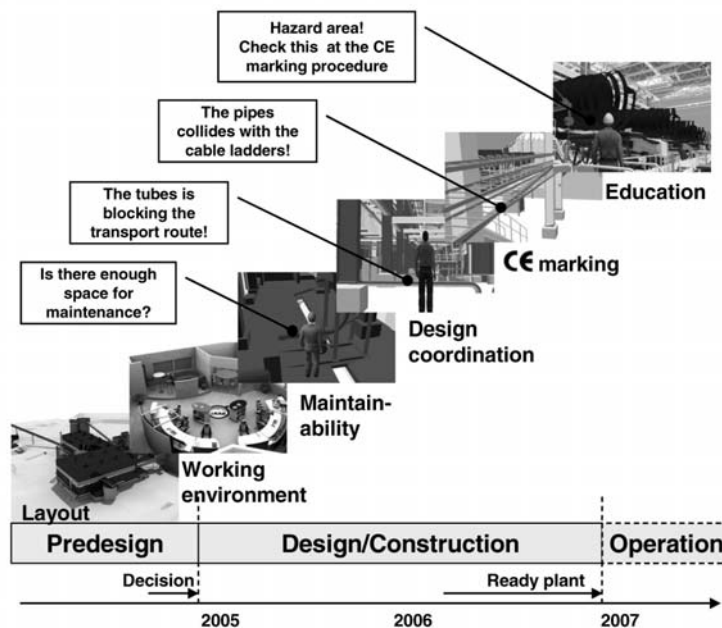


Figure 3. Benefits from the design process in the MK3 project, (Olofsson et al. 2006).

All design of subsystems occurs simultaneously in a concurrent design environment. Most of the information that makes up the VR model in the design and review process of the plant originates from 3D CAD models developed by multidisciplinary design teams. These teams work together to meet the common project targets set up by the partnering group. Figure 4 outlines the concurrent and iterative design process in the MK3 project.



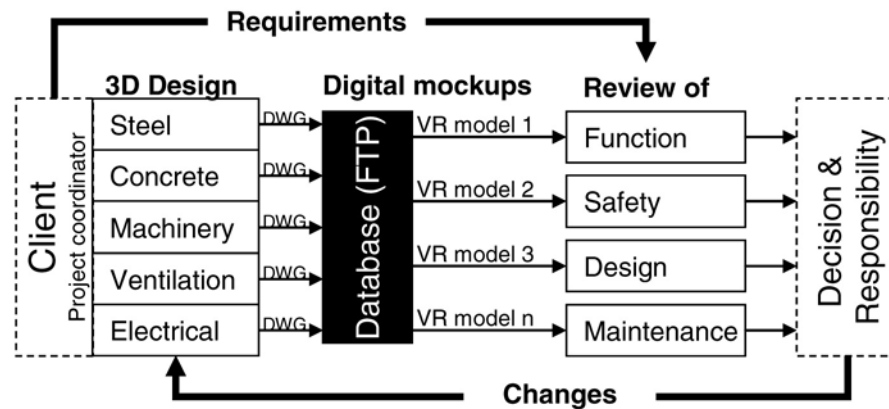


Figure 4. An iterative design process using VR models (digital mock-ups) in the MK 3 project.

The project coordinator is responsible for the overall design process while the functional design teams are responsible for the design of the subsystems in the plant, i.e. process equipment, building structure, installations et cetera. They provide input data to the *VR database* where a VR consultant, working for the client manages all the VR data and also makes updated VR prototypes accessible for everyone to use in the project.

The provided VR prototypes, denoted VR1 to VRn, are also used in the design review meetings that take place once every fortnight. Errors discovered during these design review meetings are immediately delegated to the design teams concerned. Errors, design changes that have been addressed are logged and later confirmed in the next meeting. Decisions on major changes in the design are taken after conducting a risk analysis regarding achievement of the main goals in the project.

However, the greatest value for the client by using a VR supported concurrent engineering process comes from the ability to supervise, interact and provide input to the design teams in the review process during the entire design and construction process.

#### *The planning system*

In order to ensure a good coordination of all the activities during the construction process it was a decision by the main partners of the MK 3 project to invest in and to use Primavera as a common planning platform. The master schedule is based upon delivery of detailed descriptions of every single activity from the main subcontractors responsible for installations, process equipment and civil works (see figure 5). With this arrangement it has been found necessary to establish a centralized planning department in order to manage the system due to all the tremendous amount of information. The main features expected using the common planning systems were:

- one Master consolidated from all main delivers
- each Equipment specified from Design to Commissioning
- inter Project relationships gives control & understanding

- overview per subproject / system / area / equipment etc.
- linked Training activities to each system / equipment
- well defined structures gives accurate reports
- *on time* analysis enabling faster decision making

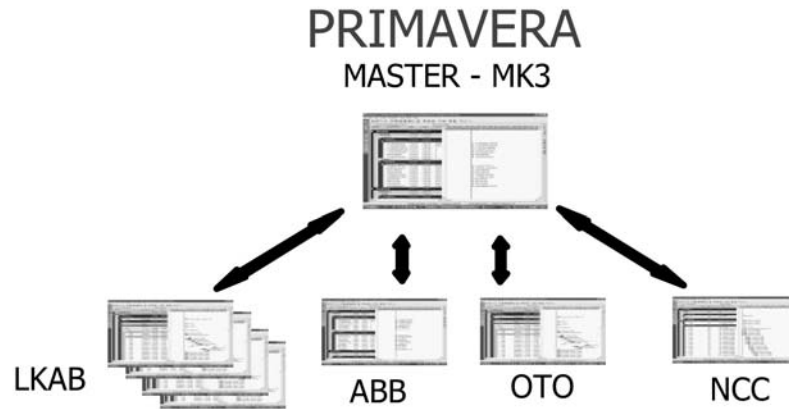


Figure 5. The Primavera planning structure

The main lessons learned from the MK 3 project regarding the design of the project processes are:

- a large majority of the stakeholders regard the use of 3D visualization (VR) to be the most important innovation in the MK 3 project
- the VR models have been utilized in a very creative way as a tool to improve the design process in order to achieve the functional goals of the project
- visualization and concurrent engineering methods improves cooperation and coordination in the project as it gives the stakeholders a possibility to better understand, communicate and share information about design intents
- the cooperative relational contracting environment has considerably improved and made the concurrent engineering process more effective
- it required initially a long time to learn and to utilize the planning system in order to get the desired output
- the planning has been criticized by many stakeholders to be too detailed, centralized and cause a situation of more *push* than *pull*

### Regarding partners

The lessons learned from the MK 3 project regarding the partners pillar are mainly:

- The group is considered to have been too limited according to the majority of the respondents of the inquiry study. The partnering group should have been enlarged to incorporate some strategic important subcontractors and main suppliers.

### **Regarding equity**

The lessons learned from the MK 3 project regarding the equity pillar are:

- The relational oriented structure established by partnering and the transparent remuneration with incentives are by a majority regarded to be favorable for reaching the overall goals of lead time, functions foreseen and also for achieving the economical goals compared to a traditional transactional contracted project
- Long term oriented investments in training of the human resources have not been regarded in a satisfactory way in this first partnering project.
- The incentives in the project have been important for creating a focus on the overall project goals. However, the incentives are not been considered fair by all of the involved members in the project.

### **Regarding cooperation**

The lessons learned from the MK 3 project regarding the cooperation/integration are:

- A 3D Cad strategy including the use of visualization (VR) enabling coordination have been established in an useful way in the project
- team building activities have been carried out to improve trust and cooperation and a big majority of the respondents in the inquiry study are satisfied by the way cooperation has developed in the project

### **Regarding innovations/benchmarks**

The lessons learned from the MK 3 project regarding the innovations/benchmarks are:

- The main innovations found in the project are the establishment of the partnering structure for cooperation and the 3D Cad VR as process tools
- Besides these innovations, there are no other project processes that can be named as innovations

## **CONCLUSIONS**

The choice of an appropriate procurement model is a very important task for a client to consider when planning for the execution of a project. The contracting mode establishes the *basic rules of the game*. The two extremes are the transactional oriented and the relational oriented models of contracting. In cases of quick, uncertain and complex projects, the client should choose a relational oriented contracting model based upon transparency, cooperation and strategic

considerations. Thus should the choice of remuneration and cooperation forms promote transparency and trust. The selection of performance model is the least dramatic choice in relational oriented contracts since it is mainly a question of contractual responsibility of joint design resources needed in the project.

The members in a relational oriented project have to take a joint responsibility to establish a common strategy to achieve the project goals in the process design. The results from the MK3 project illustrate the difficulties to find a perfect balance between *pillars* such as innovation, partners, cooperation/integration and equity when designing the main project processes in a pilot project as the MK3.

In the case study presented in this paper, the client LKAB decided to choose a procurement model with transparent remuneration and with partnering as a cooperation model. The results from the inquiry study carried through shows that a majority of the stakeholders are convinced that this has been a determining factor to achieve the targets regarding time, functions and economy in the MK 3 project. A majority of the respondents are also very satisfied with how the cooperation between the different professions has developed and how that has improved the overall efficiency in the project. To this has also the multidisciplinary iterative design process contributed in many ways. Said process had been quite impossible to implement, without losses of time and money, if the project had been executed in an old transactional oriented manner.

It is also important to find process tools promoting communication, sharing of information and cooperation among all the stakeholders involved. In the MK 3 project the use of 3D CAD and VR was a new experience for the most of the involved actors. A large majority of the respondents in the inquiry meant that this was also a major key for the success achieved in the project. According to the project coordinator, the relational contracting environment has facilitated the concurrent engineering process. For example, design changes have mostly been done from a *what is best for the project* perspective. Contrary to this, design changes in transactional contracted projects often lead to tedious re-negotiations of the contract and sub optimizing. Furthermore, the concurrent environment and the use of 3D and digital mockups (VR models) have dramatically increased the communication and the efficiency in the design review and coordination process. As an example, the number of engineering staff in the project coordination office was halved compared to a similar previous project where only 2D drawings were produced. This is in line with Womack's findings comparing mass production design with lean design: *Do a better job faster with less effort* (Womack, et al., 1990).

To conclude, the study shows quite clear that in an uncertain project context and in one for the client unfavourable competition situation at the market, short lead time (quick project) and complexity, relational oriented contracting with transparent remuneration are to be recommended. Relational oriented contracting are also shown to support Lean design methods such as concurrent engineering where simultaneous development, multidisciplinary teamwork and communication between stakeholders are key elements.

Following the positive experience gained of the project MK 3 presented in this study, the client LKAB has recently decided to go on using the same procurement model when contracting for new projects.

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