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PROJECTS AS DISTRIBUTED COGNITIVE ACTIONS

- THE MANAGEMENT OF TWO PUBLIC BUILDING PROJECTS

Heikki Lonka

TEKNILLINEN KORKEAKOULU
TEKNISKA HÖGSKOLAN
HELSINKI UNIVERSITY OF TECHNOLOGY
TECHNISCHE UNIVERSITÄT HELSINKI
UNIVERSITE DE TECHNOLOGIE D’HELSINKI

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Helsinki University of Technology
Department of Industrial Management
Laboratory of Work Psychology and Leadership
P.O. Box 5500
FIN-02015 TKK, Finland
Tel. +35894512846
Fax. +35894513095
Internet: http://www.tuta.hut.fi

E-mail: heikki.lonka@vaasa.fi
+358405775588

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Picture: Laura Lonka 2007 “A broken school”

Valopaino
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“To treat the world as an indifferent flow of information to be processed by individuals each on her own terms is to loose sight of how individuals are formed and how they function…there is no such thing as human nature independent of culture”

Jerome Bruner

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According to distributed cognition intelligence is not a property of an individual but a property of groups or networks of individuals. My group or mini-network has been the PROLAB-project of Vaasa University. Many of the ideas and methods in this thesis were created in cooperation with Marja Naaranoja, Päivi Haapalainen, Josu Takala, Maija Alasalmi, and many others working in the PROLAB project. I am grateful to TEKES (the National Technology Agency of Finland), the Town of Vaasa, the Town of Varkaus, YIT, and many other organizations for supporting the project.

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Finally, I wish to thank my family, my wife Anja and my daughters Anna and Laura. Without their love and patience it would have been impossible for me to do the work. One day my daughters will be old enough to read this thesis and understand why their father had to write it.

Helsinki, March 2007

Heikki Lonka

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HELSINKI UNIVERSITY OF TECHNOLOGY	ABSTRACT OF THE DOCTORAL THESIS

Author and name of the thesis:
Heikki Lonka

Projects as distributed cognitive actions. The management of two public building projects.

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Department of Industrial Engineering and Management. Laboratory of Work Psychology and Leadership

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The Learning Organisation TU-53

Inspector:
Prof. Ali Jaafari and Prof. Päivi Häkkinen

Instructor:
Prof. Matti Vartiainen

This is a comparative case study of two public building projects.

This research studies projects as distributed cognitive actions. *Distributed cognition* studies human cognition as a shared activity, not as a property of a single individual. In distributed cognition several agents share cognitive resources of symbolic knowledge, plans, and goals, to accomplish something that one agent could not achieve alone. Many concepts of distributed cognition can be applied to studies of project management: *transactive memory, communities of practice, social networks, weak links,* and *knowledge brokers,* to mention only a few.

The aim of this study was to find out whether the problems of project knowledge management could be explained by using the distributive cognitive approach and how project success factors could be better understood and described by studying projects as distributed cognitive actions. For this aim a method was created where analysis was based on qualitative, retrospective interviews of the project participants and on the documents produced. There were three research questions:

1) What do the documents and other artifacts produced tell about the collective activity which produced them?
2) How can the *changes* during the two projects be described as *dynamism of the social network*?
3) What were the factors behind the projects' success or failure?

The research was build around two different studies. The first study was a case study of a school renovation. There were qualitative interviews (N=15) and documents (N=534). The second study was a case study of a service centre renovation project using qualitative interviews (N=21) and documents (N=2367). The projects were studied phase by phase and the network links in each phase described.

It was found that the projects can be studied as distributed cognitive systems. The main findings were:

- There was a direct relation between the quality of distributed cognitive action and project success or failure.
- The quality of the artifacts and the way they were used was essential to project success.
- The quality of network action was an essential prerequisite for project success.
- For the first time projects were described as distributed cognitive actions in a way which explained the project success and failure.

TEKNILLINEN KORKEAKOULU	VÄITÖSKIRJAN TIIVISTELMÄ

Tekijä ja työn aihe:
Heikki Lonka
Projektit hajautettuina kognitiivisina toimintoina. Kahden julkisen rakennushankkeen tutkimus.

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Työn tarkastaja:
Prof. Ali Jaafari ja Prof. Päivi Häkkinen

Työn valvoja:
prof. Matti Vartiainen

Kyseessä on kahden julkisen rakennushankkeen vertaileva tapaustutkimus.

Tämä väitöskirja tutkii kahta julkista rakennushanketta hajautettuina kognitiivisina toimintoina. *Hajautettu kognitio* tutkii inhimillistä ajattelua jaettuna toimintana, ei pelkästään yksilön ominaisuutena. Hajautetussa kognitiossa useammat toimijat jakavat älyllisiä resursseja, kuten symbolista tietoa, suunnitelmia ja tavoitteita päästäkseen lopputuloksiin, joita kukaan yksin ei voisi saavuttaa. Monia hajautetun kognition käsitteitä voidaan soveltaa projektinjohtamisessa: mm. *transaktiivista muistia, käytäntöyhteisöjä, heikkoja sidoksia* ja *tiedonvälittäjiä.*

Tämän tutkimuksen tarkoituksena on selvittää, voidaanko projektien tiedonhallinnan ongelmia selittää käyttämällä hajautetun kognition käsitteitä ja kunka projektien onnistumiseen vaikuttavia tekijöitä voitaisiin paremmin ymmärtää ja kuvata tutkimalla projekteja hajauttetuina kognitiivisina toimintoina. Tätä tarkoitusta varten on luotu metodi, jossa analyysi perustuu retrospektiivisiin projektien osallisten haastatteluihin ja projektien tuottamiin dokumentteihin. Tutkimus-kysymyksiä on kolme:

1) Mitä projektien eri vaiheissa tuotetut dokumentit ja artefaktit kertovat kollektiivisesta toiminnasta, joka ne on tuottanut?
2) Voidaanko kahden projektin aikana tapahtuneet muutokset kuvata sosiaalisen verkoston dynaamisina muutoksina?
3) Mitkä tekijät vaikuttivat projektien onnistumisiin ja epäonnistumisiin?

Tutkimus muodostuu kahdesta erillisestä tapaustutkimuksesta. Ensimmäinen on koulun peruskorjaus. Kvalitatiivinen analyysi perustuu haastatteluihin (N=15) ja asiakirjoihin (N=534). Toinen on palvelukeskuksen peruskorjaus. Materiaali koostuu haastatteluista (N=21) ja asiakirjoista (N=2367). Molemmat hankkeet on tutkittu vaihe vaiheelta ja kunkin vaiheen verkostolinkit on kuvattu.

Tutkimuksessa havaittiin, että rakennusprojekteja voidaan tutkia hajautettuina kognitiivisina järjestelminä. Seuraavat johtopäätelmät voitiin tehdä:

- Hajautetun kognitiivisen toiminnan laadulla oli yhteys projektien onnistumiseen.
- Tuotettujen artefaktien laatu ja käyttötapa vaikutti hankkeiden onnistumiseen.
- Verkoston toiminnan korkea laatu oli välttämätön edellytys projektien onnistumiselle.
- Ensimmäistä kertaa projekteja voitiin kuvata hajautettuna kognitiivisena toimintana tavalla, joka selitti niiden onnistumisen ja epäonnistumisen.

1 Introduction

1.1 Pieces on the table

I was shocked. How could we fail so badly? I had never been in a more disastrous building project.

We were sitting in the principal's room of Hakala School: the principal, an art teacher, the vice principal, and myself in the fall of 1999. As the construction management chief I was the person responsible for this wrecked building project. After the construction work started, structures seriously damaged by moisture were found. Even the interior dry walls were infected by mold. This mold was so poisonous that all the walls had to be removed. There were also problems with the exterior walls, the roof and the floor, to mention just a few. More than 300.000 euros of extra resources were needed. Should the plans be trimmed again of all extras? We had done that once already, when the budget overran in the design phase. Should we apply for more money once more? Who would take the responsibility?

I tried to ease the atmosphere a bit by using a metaphor. I said that this is like flying an airplane and finding out that there is not enough fuel to reach the destination. Should we throw some stuff out or could we refuel the plane in mid-air? The atmosphere was not eased. Afterwards the principal called the city school planner and said that he was going to contact the press in this matter. The art teacher thought of throwing the book at me. Why had we taken off without checking the fuel first? At that moment I was not aware of all these feelings and intentions, but they were later revealed to me through interviews.

Why did I use the metaphor? First of all, I was trying to express the desperate nature of the situation we were in. There were no good alternatives. On the other hand, I was trying to create an atmosphere of trust and team spirit. We were enclosed in the same plane and the only way to survive was to stick together.

The tactics worked. Little by little the discussion started to include shared strategies and plans for future actions. First, we should draw a map of where we were. Then we needed to figure out all the choices we had, what was important for the vision and what was not. What were the chances of getting more money and how should that matter be best approached? The principal later described his feelings as follows: "There were pieces on the table and feelings as well…It was a straight discussion, horribly straight. It was a test of team trust. Even though there were strong threats to the cooperation, we never ended up with personal antipathies. The team could take it."

This was a turning point in the project's life. After that moment we knew where we were and what the task at hand was. But what was most important: we knew each other and there was a feeling of trust and mutual loyalty. The school did not contact the press, but decided to trust the team instead.

1.2 Research started

The project had started three and a half years previously. It took a crisis before we came to our senses. Why were those three and a half years wasted? I became interested in the issue and thought of investigating it. At the same time I was in a professional development program. We were asked to find a problem to study in our field of work and the problem of the school renovation looked like a suitable one. I knew from the project management literature that lots of successful projects are studied and used as an example for others to follow. Would it not be much more interesting to study a failed project? My own life experiences have shown me that we learn more from our mistakes than from our successes. A success is often only a prelude to a failure.

First we studied the costs, because they were easily available (See Appendix 1). We went through the papers with the site team. The extra costs, which were all together 22% of the total costs, were divided into three groups. The first and smallest group consisted of the normal extra work related to renovation projects. These were 2,7%. The second, largest group (16%) consisted of unexpected costs; this meant the work that should have been done anyway, but which was not detected until during the project. These costs are related to the quality of the project management. The third group of extra costs, 3,4%, were totally needless costs which indicate a complete lack of project management. Already finished structures had to be torn down, etc. These costs amounted to 74.000 euros. With this amount of money an expert could have been hired for several years to conduct the research needed!

There were feedback meetings and the project team analyzed the costs. It looked like most of the costs were related to lack of knowledge management (KM) and insufficient coordination of the project team. Not enough time and other resources were used in the planning stage. Also lots of time in the planning stage was used for changing the plans and cutting down costs to keep the project within the budget that was already tight. Many of the objects eliminated from the plans had to be done after all during the implementation phase.

The biggest problem was that at the beginning the renovated building was not seen as a serious mold and damp case. Though there had been problems with the building during its whole life cycle, the problems were not dealt with and their seriousness was not recognized. One cue was that the personnel were becoming ill. The design team knew about some damaged parts but no systematic mapping was made. When the real work started these problems were found. Even the inner walls were covered with mold. The team was unable to handle and connect the information and interpret any strong or weak signals of the problems.

Many similar projects are known: renovation of the National Museum, the Art Museum of Turku, Kiasma (Museum of Modern Art in Helsinki); this list could be continued for a very long time. It seems to be that managing a building project is impossible. But is it really so? Why do projects fail?

1.3 Introduction to the research

1.3.1 The aim of the thesis

The aim of this thesis is to study factors related to project success and failure. This is done by comparing two public building projects: one more or less failed project (Case 1: Hakala School renovation) and one which can be considered to a certain extent a successful one (Case 2: Kangas Service Center renovation).

1.3.2 Introduction to the research subject

In real life there are very few successful projects, if success is defined by fulfilling the demands of the “triple constraint”: time, money, and meeting the specifications of the project deliverable. Only a fraction of projects fulfill all three at the same time (Frame 1997).

To fulfill the triple constraint is not enough. A project is a failure if the project deliverable cannot serve its purpose during its life-span or enhance the client’s business. In this latter, wider perspective the project success is not a self-evident issue. The Channel Tunnel is an economic disaster for the organizations running it but still, but the building of it made a European dream come true.

If one wants to make a project successful, there are many systems and methods of project management available. In fact, in many cases failure would have been avoided if even the basic methods of project management had been applied. It is very typical of public sector projects that there are no project plans written or any other project control system used. However, there are plenty of examples where even the proper use of project management methods has not helped.

If the application of a certain method guaranteed the success of a project, it would be widely used, and there would be no need to write a thesis like this one. The answer to the problem has to be on a higher level. If there is nothing wrong with the methods as such, the following questions arise:

- are project management methods properly *used*?
- are project management methods properly *understood*?
- is the *very nature of project work* properly understood?

The project management literature approach to projects is simple. Projects are temporary organizations reaching for a certain goal. They are tools for solving certain problems. After the problem is defined, it is split into manageable entities. The more complicated the problem is, the more entities are needed. If the amount of entities is big enough, complicated control- and information-processing systems are needed. In the information age even the simplest building project includes huge amounts of information and demands a very complex system for handling it. This leads to highly complicated systems which are bound to collapse, due to the complexity of the network and too many internal dependencies as a consequence of it.

The idea of splitting the world into manageable entities has its origin in the *dualistic* world-view of Western culture (Nonaka & Takeuchi 1995). The other alternative is a *holistic* world-view where mind and body, subject and object are not separated from each other. The latter approach is gaining ground in knowledge management and quite recently also in project management. The holistic approach to project management means that we do not try to solve problems by analyzing them but by *synthesizing* them and by *experiencing* them.

This is why the methods of this thesis are qualitative ones and only two cases are studied. The theoretical background is one of *distributed cognition*. Distributed cognition studies human intelligent action as a shared process distributed to a system of people and their intelligent tools. According to this thesis, projects are temporary work systems coordinated by their social structures consisting of people. Among many other things

projects can be seen as distributed cognitive actions and they can be studied as such

1.3.3 Structure of the thesis

Chapter 1 is an introduction to the research in form of a vignette from one of the two cases, an introduction to the research subject, and overall description of the research structure.

Chapter 2 comprises a literature review of theories and concepts which could explain *project success or failure*. In section 2.1 project success and risks affecting success or failure are analyzed against the larger project environment. The methods of *risk management*, *project-based learning,* and *project knowledge management* as a means of avoiding failure are described. If the reader is familiar with the project management literature and already knows these concepts, he can skip sections 2.1.1 – 2.1.5 and go directly to section 2.1.6 where there is an analysis of why the traditional methods of project management have not been able to prevent project failures. They are based on individualistic and mentalist assumptions called "*acquisition metaphor of mind*". Social aspects of knowing are neglected, and this is why theories cannot work. An interesting case study is presented in section 2.1.7.

Chapter 2.2 is an intermediate chapter, where an alternative approach to meaning making is described. According to an approach based on the works of Peirce (1931-58) and Bruner (1990) meaning making is not a matter of social psychology. All meaning making is *culturally mediated*, and this is why approaches based on information processing or individual cognition cannot explain it.

Chapter 2.3 describes *distributed cognition* as a means of culturally mediated negotiation of meaning. Distributed cognition is used as a general concept and it is widened to include such fields of research as theory of *conceptual artifacts*, *sociology of knowledge*, *communities of practice*, and *social networks*. In section 2.3.1 theories of educational psychology are presented. These theories are important sources of inspiration to this thesis, but learning as such is not its subject matter. In section 2.3.2 theories of *team cognition* are described. However, they cannot be seen as part of distributed cognition due to cognitivist, information-processing bias.

Chapter 2.4 is a short *summary* of the literature research.

Chapter 3 describes the research construct of this thesis. Because this thesis is more hypothesis building than hypothesis testing, the *abductive mode of inference* is chosen. The fundamental research question is: *how can project success factors be understood and described better by studying projects as distributed cognitive actions*. This understanding is built on *social network analysis* based on *qualitative* material, collected retrospectively and covering the whole life-span of the projects studied. Based on this analysis, a method for better project knowledge management is suggested. Three detailed research questions are constructed based on the fundamental question.

Chapter 4 describes the results. In Chapter 4.1 there is a full description of Hakala School renovation (Case 1), including the analysis of documents and analysis of the interviews. A network model is based on the interviews. Kangas Service Center renovation (Case 2) is described and analyzed in a similar manner in Chapter 4.2. Chapter 4.3 is a cross-case analysis of the two cases.

Chapter 5 tries to answer the research questions of Chapter 3. A model for better project knowledge management is presented based on the findings of the research. Managerial implications and an evaluation of the research ends this chapter.

2 Theoretical background

2.1 Project environment and project success

This chapter concentrates on the issue of project success or failure. It will address the following questions:

- What is a project?
- What is a successful project like?
- Is risk management a way to make projects successful?
- Can risks be avoided by learning?
- Can learning be enhanced by project knowledge management?
- Are there some new approaches which could be applied to make projects successful?

First, project management as an art and as an object of research will be introduced. Then the concepts of project success and failure will be described. Two methods of avoiding project failure are outlined: *project risk management* and *project-based learning*. *Knowledge management* and issues of *competencies* will be presented. After these considerations an interesting case study of construction crisis will be introduced. In the end of this chapter an analysis will be made of different approaches of human cognition and learning and how they are applied in project management studies.

2.1.1 Management of projects and organizations

The dictionary definition of an organization is "A group of persons organized for a particular purpose" (http://www.answers.com/topic/organization). The word "organization" comes from the Greek word *organon*, meaning a tool or an instrument (Morgan 1996: 15).

The most common definition of a project is that it is a temporary organization reaching for a defined goal. Hunting parties of our ancestors were projects: they were temporary undertakings aiming at obtaining meat for the community. As long as there have been human beings – or human societies – there have been projects. There have been large, complex projects as well: the pyramids, the Great Wall of China, to mention just a few. (Frame 1995)

But what is the *management* of projects? Project management can be defined as "the process of controlling achievement of the project objectives" (Munns & Bjeirmi 1996). By definition, management has something to do with control.

Project management did not become a subject of serious study before the middle of the last century. The experience of war and big projects of the 1950's and 1960's (e.g. The Polaris program of the US Navy and the Apollo program) made clear that more serious attention had to be given to the management of complex projects (Wideman 1995; Nikander 2002). The same complexity of environment made old methods of management of organizations obsolete. In a dynamic environment more flexible structures and methods were needed. The idea of cross-functional teams working in project configurations was introduced. (Partington 1996; Nikander 2002)

By the 1980's project management had become a discipline of its own. Two organizations were founded, one in the United States (Project Management Institute) and the other in the United Kingdom (Association of Project Managers). They both give certificates to project-management practitioners. Two journals started in the 1980's: International Journal of Project Management (UK) and Project Management Journal (USA). Both institutions have also published their versions of *the project management body of knowledge* (PMBOK 1996; Curling 1995). From early on, project management has been seen both as an art and a science.

The field of project management is large and diverse. There is the traditional world of major projects in the construction and aerospace industries. The new, emerging area has been the new product development projects of the manufacturing, computer, and process industries, and organizational change projects in any large or medium-sized organizations. Project management has become the cure for all ills. Most management gurus swear to its name. The successor of machine bureaucracy seems to be project-team organization. (Partington 1996; Morgan 1996)

There is the delicate relationship and division of power between the functionalist parent organization and the project teams. Different versions of matrix-organization are seen as one solution to the problem. It is not simple to balance routine and innovation in an organization (Frame 1995). Organizations can vary in their level of bureaucracy, but so can the project teams. In fact, much of the new project management can be seen as an over-bureaucratization of projects. (Partington 1996). Control systems applied in more traditional functional organizations have been introduced to the more or less anarchistic world of projects.

It seems that the key problem with project management and project management studies is the diversity and amount of issues handled. Projects are organizations, albeit temporary, and they carry all the characteristics of an organization: they have staff, they have an organization, budget, information system, inner politics, and so on. In addition to that, projects have their special characteristics due to their strict orientation to goal, and their limited time perspective. In a way, all projects are unique (Frame 1995: 6). Anything said about organizations in general can be applied to projects. If one wants to know everything about projects, one has to know everything about organizations first. Admitting that this is impossible, this study concentrates on the special characteristics of projects, keeping in mind that public building projects always take place in an organizational setting. The latter is the background of this study, not its focus.

What makes projects special is their limited time-span and their orientation towards a specific goal. The goal and the time-span constitute the objectives of project management. There are three objectives so commonly mentioned that they have been given a name: *a triple constraint*. These three are time, money, and the specifications describing the project deliverable (Frame 1995: 6; Martinsuo, Aalto & Artto 2003; Salminen, Lanning & Roiha 1997). An array of tools have been developed to assist project managers to cope with the triple constraint. There are computer-assisted scheduling tools (PERT/CPM, GANTT), budgets, cost estimates, and systems to monitor human and material resources. The most difficult to manage is the third constraint, specifications. These are notoriously difficult to establish and monitor (Frame 1995: 7).

According to Frame (1997), only a small fraction (less than 20%) of projects satisfy the triple constraint. One-third have cost overruns, one-third have difficulty meeting specifications, and two-thirds have schedule slippages. This is why Frame (1997) labels time as the killer constraint. Whatever happens with the other two constraints, it always has consequences on the project schedule.

Where do public building projects fall in these considerations? My fifteen years of experience in public building would tell that “overbureaucratization” is hardly a proper term for describing public sector projects. A good example are the two projects studied. The projects produced a huge amount of information. However, there were no project management plans made and there were serious defects in the project management methodology used. This is very typical of all construction projects in Finland, public or other: either there are no project management plans or they are highly insufficient (Naaranoja, Haapalainen & Lonka 2005; Naaranoja, Jäväjä, Haapalainen & Lonka 2005). Public construction projects are not seen as projects, but as tasks executed by the line-organization.

In section 4.3.3 the two projects studied are analyzed in relation to the triple constraint.

2.1.2 What is a successful project like?

Who knows how many slaves had to die before pyramid of Kheops was finished? Can one say that pyramid A is better than pyramid B, because less slaves died building it?

These questions show how difficult it is to measure project success. There is a long tradition of project management literature and a lot has been written about project success, but still there is no agreement on definition of project success (Baccarini 1999; Crawford 2000; Tan 1996). There are lots of studies on *success factors*, but very few about *success criteria* (Tan 1996). This is a pity, because success factors cannot be evaluated if the actual concept of success is not defined.

Success criteria

The same project can be perceived as a successful one by some stakeholders, while others consider it a failure. There are as many success criteria as there are points-of-view (Crawford

2000). An architect considers it from an aesthetic point-of-view, an engineer from the technical point-of-view, and an accountant is only interested in the amount of money spent (Shenhar, Levy & Dvir 1997). As the example of the pyramids shows, success criteria change as a function of time (Baccarini 1999; Munns & Bjeirmi 1996; Shenhar, Levy & Dvir 1997).

There is one distinction most authors (Baccarini 1999; Munns & Bjeirmi 1996; Shenhar, Levy & Dvir 1997) agree on. The successful execution of the project phase from planning to handover should be distinguished from the overall success of the project including the project utilization period. There are lots of projects, which were failures in terms of budget or time management, but which have been very beneficial to the client, as well as projects which were completed on time and within the budget, but which were no good for anybody after their implementation (Frame 1995: 21). These two aspects of success are called *project* (product) *success* and *project management* success.

Table 2.1: Four success categories

	project management success	project management failure
project success	**type 1** no doubt about success	**type 2** potentially successful
project failure	**type 3** short term success	**type 4** no doubt about failure

All projects can be divided into four categories:

Project type 1. The project is successfully completed within the limits of triple constraint. All the project goals are reached. After the project handover it fulfils all the clients' needs now and in the foreseeable future. There is no doubt about success in any of the criteria.

Project type 2. The project is delayed or it exceeds its budget, but the client is able to make good and profitable use of it. In the short term there is embarrassment and inconvenience, when more money is needed or the client has to reschedule his activities. When time passes and the profitability of the endeavor is imminent, all this will be forgotten. The only exception is, of course, the case when the project is so late or so expensive that it can no longer be used. In the latter case the breakdown in project management must be extreme. (Munns & Bjeirmi 1996)

Project type 3. The project implementation process is produced on time, within budget, and according to scope, but either it is not used in the way it was planned, is not used at all, or it is grossly underused. The final deliverable does not address the customers' needs, or it meets with customer resistance (Frame 1995: 21), it can not be marketed, or it does not get its return on investment to the client The importance of project management success is of no value to anybody except the project team. The project team should have discovered the potential for failure and informed the client. (Munns & Bjeirmi 1996)

Project type 4. The project is not successfully completed within the limits of triple constraint. The project goals are not reached. After the project handover the client's needs are not fulfilled now nor in the foreseeable future. There is no doubt about failure in any of the criteria.

As can be concluded from the analysis above, success criteria are hierarchical and they change as a function of time. Project success is more important than project management success and it has longer lasting effects. (Baccarini 1999; Munns & Bjeirmi 1996; Shenhar, Levy & Dvir 1997) Of course, this is the big picture. No human action is totally successful or completely failed. Theoretically, these four categories exist, but in real life there is great variation in the degree of failure and success in each category. The staff of Hakala School are pleased with their present work environment. After all, it is much better than it was *before* the renovation. It is very difficult for them to imagine how the environment *might have been* if the project management had been executed properly.

It is very typical of public sector projects that the project success criteria are missing or their fulfillment is not analyzed after the project is delivered (Naaranoja, Haapalainen & Lonka 2005). As a consequence, many projects fall into categories 3 or 4, i.e. they can be successful according to short-term criteria, but very often fail to fulfill the long-term customer needs. The two projects will be analyzed from this perspective in section 4.3.3.

Shenhar, Levy & Dvir (1997) studied project managers' concepts of project success. They distributed structured questionnaires to 182 project managers of industrial (construction, electronics, computers, mechanical, aerospace, and chemical) projects in Israel. The response rate was 70%.

Shenhar et al. (1997) assumed that there would be three dimensions: "meeting design goals", "impact on the customer", and "benefits to the organization". However, the factor analysis revealed four dimensions (Shenhar et al. 1997):

- *Project efficiency:* the efficiency with which the project has been managed. This includes both the effectiveness (meeting time and budget goals) as well as quality of the project management.

- *Impact on customer:* meeting customer requirements, the amount of user/customer satisfaction.
- *Business and direct success:* impact on the organization. This includes increase in sales, income, and profits and gained market share.
- *Preparing for the future:* preparing organizational and technical infrastructure for the future. This is a long-term dimension aimed at exploring new opportunities, ideas, innovations, products, skills, core competencies, etc.

Different dimensions are more important at different times. During project execution the project efficiency dimension is the most important: it is the only measurable dimension at that time. Once the project is finished the importance of this dimension declines. After about a year it is completely irrelevant. After project completion the impact on the customer becomes the central issue. Business success can be judged later and preparing for the future only after three or even five years.

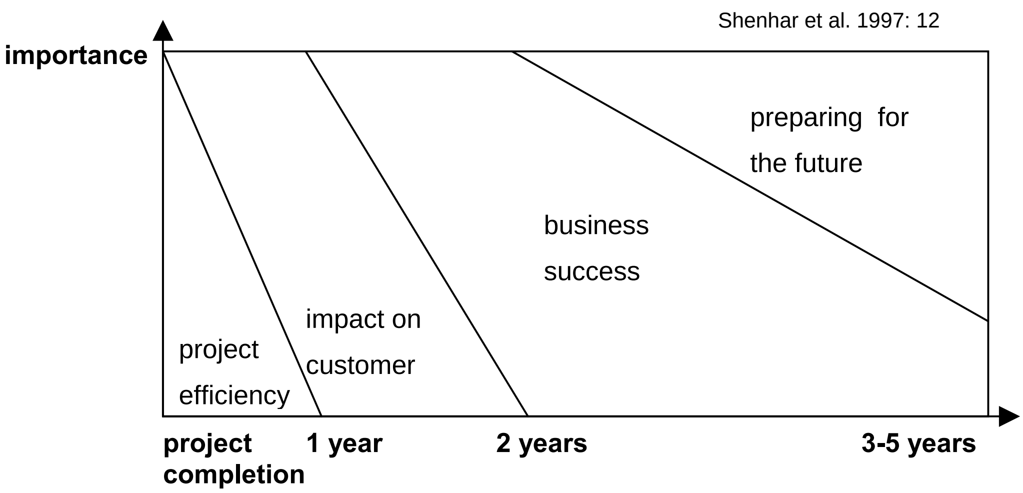

Figure 2.1: Success perspectives

In the first, conceptual stage of the project the issues relating to the project goal (preparing for the future) should be dealt with. This is an important duty of the project sponsors or the top management (Baccarini 1999; Munns & Bjeirmi 1996; Shenhar, Levy & Dvir 1997).

In the planning stage the focus should be on the project purpose and outputs (business success and impact on the customer). The project stage should concentrate on inputs (project efficiency). In handover the focus should move back to the project purpose and in the utilization stage it should be on the project purpose or the project goal. The closedown evaluation deals with the project goal. There are cycles of action and evaluation going on. This is similar to plan-do-check-act-cycle of quality management or double-loop learning of cybernetics (Morgan 1996; Oakland 1995).

There is a big difference in the way matters concerning the future of the customer organizations are handled in public building projects. Usually they are neglected, but there are exceptions (Naaranoja, Haapalainen & Lonka 2005). It is typical of successful projects that these matters are taken seriously, as will be shown later in Chapter 4.

According to a literature review by Artto, Dietrich, and Ikonen (2002), evaluation of success depends on the perspective of the stakeholder. They see several important success domains:

1. Technical performance, project functionality, client satisfaction, and technical and financial performance of the deliverable for the sponsor/customer
2. Project management: within budget, on schedule, and according to technical specification
3. Suppliers commercial performance: commercial benefit for the project service providers
4. Learning that the project stakeholders acquire

In the synthesis of Artto et al. (2002) the perspective of the project deliverable and project action are included, but there is an important addition: the benefits for the larger project network. Projects often cross organizational borders and network operations have to be based on mutual benefit and trust. Learning is one way to prepare for the future and in this sense the models of Shenhar, Levy & Dvir (1997) and Artto et al. (2002) are similar. Artto et al. (2002) consider the models of project success criteria as being very close to the four perspectives of Balance Scorecard by Kaplan & Norton (1996).

Project success is not a simple issue. It has several dimensions, which are time-related and hierarchically organized. The project success depends on the definition of the project goals. If the goals are not defined well enough, it is very difficult to say whether the project succeeded or not. Many project managers and many project teams rush into the execution phase without asking enough questions first (Frame 1995: 50-51). Poorly defined goals make the execution difficult when choices should be made between alternative types of actions. The poor definition of goals has dual negative consequences: it makes it difficult to evaluate the project outcome, and it makes the achievement of the project outcome more difficult. However, the ability to define success does not mean that it is achieved. It is a necessary, albeit insufficient condition for the achievement of success.

It is typical of public building projects that client needs are taken for granted and not studied carefully (Naaranoja, Haapalainen & Lonka 2005). For decades the planning of schools and other institutions was based on very strict regulations by the state. This led to a culture of negligence: the users were not listened to because the rules dictated all the actions. This culture has lasted even after the deregulation of public building. Only recently have project definition plans, where clients needs are described, become instruments of creative design. There seems to be a connection between the quality of the project definition plan and the project success, as will be shown in Chapter 4.

All construction projects are successful in retrospect. A lot of effort is put into the project and this makes the parties eager to accept the finished project. After all, all the effort would be wasted if the project was proven to be a failure. It is also difficult to imagine what the end result would have been if the project had been handled properly. Budget problems and wasted money are soon forgotten in public projects, where the users do not need to worry about the investment costs. People admit failure only if the failure is so obvious that it cannot be denied by any means: e.g. if the building collapses or if it is so damaged that it cannot be used at all.

Success factors

Project *success factors* are the factors contributing to the project success. Success factors and success criteria are often confused with each other (Crawford 2000). The success criteria are related to success factors: the proper definition of the success criteria is one of the most essential success factors. However, there are other success factors as well. Crawford (2000) analyzed and compared 13 different studies concerning success factors. She grouped similar factors and ranked them according to the number of times they were mentioned across the 13 studies (Crawford 2000: 4):

- Planning (integrative)
- Monitoring and controlling (integrative)
- Team selection
- Technical performance
- Communication
- Leadership
- Strategic direction
- Team development
- Monitoring and controlling (risk)
- Organizational support
- Stakeholder management (other)
- Organizational structure
- Project definition
- Stakeholder management (client)

The Project Implementation Profile (PIP)-model by Pinto and Slevin (Pinto & Mantel 1990) is one set of success factors often referred to and it was included in Crawford's analysis. From a sample of 418 Project Management Institute (PMI) members rating the factors given, they obtained ten critical factors for project success:

1) **Project Mission:** Initial clearly defined goals and general directions.

2) **Top Management Support:** Willingness of top management to provide the necessary resources and authority/power for project success.

3) **Project Schedule Plan:** A detailed specification of the individual action steps for project implementation.

4) **Client Consultation:** Communication, consultation, and the active listening to all impacted parties.

5) **Personnel:** Recruitment, selection, and training of the necessary personnel for the project team.

6) **Technical Tasks:** Availability of the required technology and expertise to accomplish the specific technical action steps.

7) **Client Acceptance:** The act of "selling" the final project to its ultimate intended users.

8) **Monitoring and feedback:** Timely provision of comprehensive control information at each stage in the implementation process.

9) **Communication:** The provision of an appropriate network and necessary data to all key actors in the project implementation.

10) **Trouble-shooting:** Ability to handle unexpected crises and deviations from the plan

Most of the success factors of PIP-model concentrate on the project management success. However, project mission, top management support, client consultation, and client acceptance are heavily related to the project success. These success factors cannot be met if the project is not seen as a useful one for the end-user and/or if it is not accepted by the sponsors. The two projects are analyzed by using PIP-model in section 5.2.4.

If the success factors mentioned above are all met, there is good reason to believe that the project will be successful beyond doubt. There are some success factors which are more important than others, and they are called *key* or *critical success factors* (Clarke 1999). The critical success factors are factors which are necessary, *and* sufficient conditions for the achievement of project success. They ultimately determine how successful a project is. At least scheduling, budgeting, and goal setting are considered critical success factors (Salminen, Lanning & Roiha 1997), but there are others as well.

Projects are unique, and so are the success factors. There are always unforeseen incidents which may ruin the project. "It is the things we did not think about that cause us grief!" (Hartman 1997: 18). A good example of this kind of incident is the problem with mold and moisture in Hakala (Case 1). The building industry has a tendency to apply ad hoc methodology in risk management: problems are dealt with in order of appearance and proactive methods are seldom applied. The same seems to apply to public sector organizations in general.

Summary

Project success is a very complicated matter. First of all, project success criteria and project success factors are two different things. Success criteria vary depending on the time perspective. From the *project management* point-of-view it is enough to fulfill the triple constraint of time, money, and specifications. From the *project* point-of-view the impact on customers and on their future capacities is of much greater importance.

There are many success factors depending on the project. Most important are the *critical success factors,* of which scheduling, budgeting, and goal setting are considered the most important. What makes critical success factors important are their downside: if one of them is not met, one can be quite sure that the project will be a failure to some extent. They all represent a *risk*.

2.1.3 Project risks and their management

Risk management

Project success factors and risks are related to each other. When certain risks materialize, projects fail. Project failure is the biggest risk of any project. Failure is very seldom a consequence of a single risk, often many risks have to materialize in an unfavorable manner before the project fails. Risk management is one of the key success factors in any project.

A broad definition of risk is that it is an uncertainty, which may have undesirable consequences (Hansen & Millar 1997; Nikander 2002). Some of these undesirable consequences may have a brighter side: the risk may be a source of profit or an opportunity to one who has the best capacity to carry the risk (Artto 2001; Kähkönen 1997). This is called *risk allocation*.

It can be easily seen that there is a connection between risks and success factors. A risk is an *uncertainty* related to success factors. “Uncertainty becomes a risk when the perceived significance of an uncertain event become critical” (Hansen & Millar 1997: 256). *Problem* is a risk which has materialized (Nikander 2002), there is no level of uncertainty about it. The source which causes a risk is called a *risk factor* (Nikander 2002). The art of risk management is based on the ability to analyze uncertainties and respond to them if necessary.

Wright (1997: 131) has explained the key concepts of risk management in the following way:

A project	is executed in order to achieve certain
project objectives	which are defined in terms of schedule, budget, performance of system developed, etc. A deviation from achieving the target objectives is defined as a consequence. A risk scenario starts with
project hazards	which may lead to
consequences	measured as outcome severity and probability of occurrence. The measure is called risk and is used to categorize the effect of each hazard into
risk classes	in order to decide whether to
ignore, monitor or mitigate	the risk(s)

In other words, project risk management includes the following processes (PMBOK 1996, Artto 1997a: 4; Nikander 2002):

- risk identification
- risk estimation
- risk response development
- risk control

There are three task units in each stage: input, tools, and output. In risk identification tools like brainstorming, checklists, historical data, interviews, and scenario building are used. In risk estimation the probability and the impact of each risk identified is analyzed. In response development a risk management plan is created and in the control stage it is updated. (Artto 1997a; Nikander 2002)

The whole process of project risk management seems very simple and easily executed. Still a majority of projects fail to some extent. What makes risk management in projects so difficult?

Project risk management is as difficult as project management in general. Project risk management covers all the areas of project management. Every aspect of a project can be approached from the risk perspective. The main task of the project manager is to avoid risks. Or to put it in other words: “Risk…is the only reason why managers are needed” (Wearne 1997: 105). If no risks are realized, the project has succeeded.

The allocation of risks is of vital importance for all who operate in a market economy. It is very difficult to raise the funds needed for a project if the risks are not analyzed or there is no risk allocation plan. However, this is not the case in the public sector in Finland. Projects get their budget money whether they have risk allocation plans or not. Cities cannot go bankrupt and they can carry huge risks. This has led to a culture of negligence. There were no risk management plans in either of the projects studied. If there is no risk management, unidentified and fatal risks may occur and projects fail as a consequence of this negligence.

The fact that no risk management plans were written does not mean that there was no risk management. The informants analyzed risks in retrospect and talked about risk control strategies. Nothing was written down, because top management was not interested in such matters. In the public sector there seems to be an ad hoc risk management culture on the operational level.

The problem of specifications: what are the needs?

According to the project risk management literature, there are certain risks which are more dominant than others. As was mentioned above, to meet the specifications is the toughest challenge of project management (Frame 1995). Specifications describe the project objectives and the project product so that the project product pleases the end-user. If this does not happen, the project is a failure. To fail in describing specifications and/or in meeting them is a risk factor (Chapman & Ward 1997; Wearne 1997; Wright 1997). In software development projects over 56% of errors are due to faults in the requirement specification and correcting them absorbs 82% of the maintenance effort (Hansen & Millar 1997: 258, referring to DeMarco 1982). The same seems to apply to the construction industry (Hansen & Millar 1997).

The problem of poor specification seems to have two roots: poor definition of project scope (Artto 1997b; Artto 2001; Frame 1995; Hansen & Millar 1997; Salminen, Lanning & Roiha 1997; Wearne 1997; Wright 1997) and poor articulation of client needs (Artto 1997b; Frame 1995; Hansen & Millar 1997; Salminen, Lanning & Roiha 1997). The problem of poor project scope is almost self-evident: by definition, projects live for their goals and if the goals are not clearly focused, how can projects be focused either? If there is no clear goal, it is impossible to plan resources or actions properly. According to Standish Group study (Artto 1997b: 356-357) 52,7% of American software projects cost 187% of their original cost estimates and only 42% have their originally proposed features and functions. The reasons for unfavorable project outcomes were:

- no clear definition about objectives or scope
- incomplete or insufficient follow up or control
- no user involvement, no management support

The problems in the construction industry are similar (Artto 1997b).

According to Salminen, Lanning & Roiha (1997) the risks in change projects are:

- top management support
- participation
- communication
- resources
- goal setting
- problem area specific skills

Frame (1995: 117) describes several pitfalls in defining needs. First and foremost, a client need is not a very clearly defined object. Most needs are fuzzy and they need to be articulated. Needs are dynamic: they often change as a function of time. It is easy to misunderstand needs, because it is not clear even for the users themselves what their needs are. There may even be “hidden agendas” (Wright 1997). Humans have a tendency to avoid uncertainty (Wright 1997), and we may rush into to solutions prematurely before articulating the needs properly (Frame 1995: 120-121).

There are also situations when the end-users are not present, but represented by somebody else (Wright 1997). User participation was an issue in both projects. The renovations took place in working organizations and the number of staff in both institutions made the direct participation of everybody impossible.

The selection of part-time or full-time user representatives is very typical of public sector building projects. Hospitals often hire full-time specialists for this kind of purposes, because there is a continuous renovation process going on in central hospitals. However, this often leads to the birth of a new profession separated from its own professional culture and organization and more socialized to the design professions. The same kind of phenomena could be seen in the projects studied as well.

There are usually multiple end-users and this is why different needs have to be analyzed and sorted into a *need hierarchy* before proceeding. We may also have the tendency to interfere with the process and apply the *father-knows-best* approach to needs. Needs articulation should be done in close cooperation with end-users and in an atmosphere of mutual respect and trust. (Frame 1995: 120-132)

It is almost as difficult to define project *requirements* based on needs as it is to articulate needs. The requirements fall into two categories: the *functional* requirements and *technical* requirements (Frame 1995: 134). The former should be clearly understood by the user, the latter are unlikely to be understood. The needs are translated into requirements. Requirements define the project team’s obligations to the end-user. The project should form a continuous chain from project goals to technical requirements:

$$\boxed{\text{goal}} \rightarrow \boxed{\text{needs}} \rightarrow \boxed{\text{functional requirements}} \rightarrow \boxed{\text{technical requirements}}$$

The same chain can also be seen as a chain of risk factors: if there is no definite goal, it is difficult to articulate the needs, which leads to poorly defined functional requirements, and finally obsolete technical requirements. Each link in the chain can be an independent risk factor itself: even well analyzed needs can lead to poorly defined requirements.

Requirements may be imprecise or ambiguous. This may lead to a situation where two people can look at the same sentence and still disagree on what it means. (Frame 1995: 137) One reason behind this phenomenon lies in the nature of human language. *Human language* is ambiguous by nature (Frame 1995: 137; Hansen & Millar 1997; Hartman 1997). Hartman (1997:16) gives a good example:

> *"To illustrate this point, consider the word 'function'. Does it mean someone's job, a celebration of formal occasion, a process, a part of software algorithm, is it something to do with object oriented programming? In one company recently there was big debate on this word. The definitions were numerous."*

There are plenty of examples of this kind of misunderstandings in the two cases that are analyzed in this study. People seem to be very confident about their own interpretation of language and blind to the possibility that different interpretations exist.

Language is not the only problem concerning human cooperation. We may try to avoid conflicts due to *groupthink* or other *consensus-seeking team phenomena* which may lead to too loosely phrased requirements (Frame 1995; Hansen & Millar 1997; Halman & Keizer 1997). Too flexible specifications may result in chaotic project planning and control and increase the likelihood of time and cost overruns. On the other hand, too strict specifications may kill the creativity and make adaptation to later changes of environment difficult. One solution offered to the problems of team work and communication is *prototyping* (Frame 1995: 154-156; Wright 1997). It allows dynamic development of requirements together with the end-user and in a manner understandable to them. A good example of prototyping are model rooms which were used in Kangas renovation (Case 2).

Project environment

The problems and risk factors inside the team have been discussed in earlier chapters. There is another, even bigger source of disturbance and risk outside the project. The *project environment* affects the project and most of the problems inside the project have their origin in the project environment. Projects are constantly adapting to their environment (Karlsen & Elvenes 1997). Project environment can be divided into two parts: immediate task environment and indirect general environment.

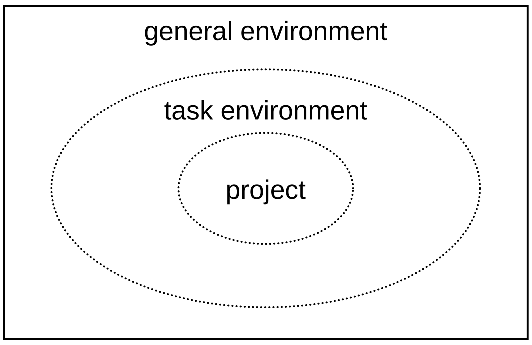

Figure 2.2 The project environment (Karlsen & Elvenes 1997: 335)

The task environment includes actors and stakeholders who create, develop, and supply the project with the necessary resources: customers, users, contractors, consultants, trade unions partners, interest groups, and so on. The general environment is formed by elements and factors which are not contacted on a day-to-day basis: technological factors, demographic factors, political factors, cultural factors, and so on. (Karlsen & Elvenes 1997)

A project is a system composed of subsystems that operate within a larger system or environment, and interact with other subsystems. There are boundaries and links between the different elements in the system. These boundaries are flexible and differ individually. (Karlsen & Elvenes 1997)

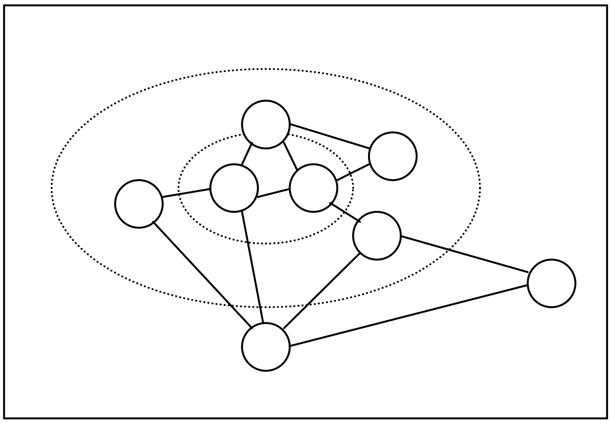

Figure 2.3 The subsystem network (Karlsen & Elvenes 1997: 335)

Projects are networks or systems of networks of socially distributed actors, and this has increased the risks (Hansen & Millar 1997). To avoid this, different kind of barriers are build around projects. These walls prevent the environment interfering with project processes. However, it is impossible to isolate the system from its environment. Some kind of interaction is needed. This happens through boundary-crossing or through different kinds of mediators. (Karlsen & Elvenes 1997)

Karlsen and Elvenes (1997: 337) define *environmental uncertainty* as imperfect conditions for rational behavior generated by the environment. The greater the environmental uncertainty, the more difficult it is for the project manager to be proactive and preplan actions. Project organizations have to cope with rather than avoid uncertainty and interdependence. The project cannot be isolated from its environment, its members have to recognize their dependence on each other and on other actors in the project network. Projects are open systems. (Jaafari 2003b)

Karlsen and Elvenes (1997) describe several dimensions which affect the environmental uncertainty. *Complexity* of the environment refers to the heterogeneity, range, and number of actors, *routineness* to the level of formalization or institutionalization of the environment, *interconnectedness* to the level of organization, *dynamics* to the nature of change over time and the predictability of change, and *resource scarcity*.

What is the level of environmental uncertainty in the public sector? The first assumption would be that the public sector represents a very stable environment. However, the complexity of the public sector has increased in the new millennium. Due to rapid changes during and after the turbulence of the national economy in the early 1990's, the public sector environment has become increasingly unstable. There is an increasing number of actors. A high level of institutionalization has been typical of cities, but it is diminishing when new structures (teams, projects, new public management) challenge the old regime. The public sector has to deal with uncertainty and interdependence.

Summary

It was shown in this chapter that project success is closely related to project risks. If risks are managed and controlled, failure can be avoided. A project is a successful one if no fatal risks materialize in an unfavorable manner. The greatest sources of fatal risks are related to poor definition of clients´ needs and the poor quality of project specification as a consequence of that. These can be called internal risks. Another group of fatal risks are related to the changing project environment. These can be called external risks. Project managers and project teams have to analyze their environment and learn to adapt to it. Boundary-crossing through different kind of mediators is a means of interacting with the environment.

The only way to adapt to the environment is through learning (Karlsen and Elvenes 1997; Kähkönen 1997). The clients differ and making acquaintance with their varying needs is also a learning experience. The analysis of the two projects in Chapter 4 focuses on the boundary-crossing actors and elements and how they were used in project risk management, project knowledge management, and in adaptation to the environment.

2.1.4 Project-based learning

As was shown in the previous chapter, risk management is an essential project success factor. There are two main sources of risks: internal and external ones. The external risks are related to the project environment and they are avoided by reacting to changes in the project environment and by adapting to changes. The internal risks are ones related to poor definition of the clients´ needs and poor quality of specifications. Through learning both types of risks can be managed. In this chapter project learning and project-based learning are introduced as a means of project risk management.

Organizations adapt to their environment through learning (Arthur, DeFillippi & Jones 2001; Morgan 1996; Senge 1994) and projects are no exception (Jaafari 2003a; Jaafari 2003b; Karlsen & Elvenes 1997; Keegan & Turner 2001; Sense 2004). Organizational learning can be distinguished from individual learning. Individual learning occurs when a person acquires new ideas or skills, whereas organizational learning takes place when new routines get institutionalized or new information acquired in an organization (Keegan & Turner 2001: 78).

Projects are one means of learning for organizations, and this is called *project-based learning*. In project based learning real-world projects are used as vehicles for creating a context for individual and organizational learning (Ayas & Zeniuk 2001; DeFillippi 2001). Project-based learning is a subset of organizational learning practices (Keegan & Turner 2001).

The sociotechnical school analyses individual and organizational learning against the perspective of a larger environment (Vartiainen, Ruuska & Kasvi 2003, referring to Emery 1967; Morgan 1996). According to the sociotechnical school, there are four kinds of environments and four kinds of learning respectively. In a *peaceful, random* environment no complex learning is needed. All action is based on existing routines. Even the learning capabilities of a worm are sufficient. In a *peaceful, clustered* environment disturbances are predictable and interdependent. There are more options for action, but all the options are routine-like. Learning is *first order learning*. In first order learning no organizational learning is needed, individual learning will do.

There are several systems competing with each other in a *disturbed, reacting* environment. In such an environment the organization needs a strategy. Its operations have effects on its competitors. Decisions have to be made between different options. This is called *second order learning*. Individual learning is not enough in that kind of environment, the whole organization has to acquire new skills.

In a *turbulent* environment different systems affect each other. The environment is changing in an earthquake-like manner. No old methods can be applied, the whole organization is facing a dead-end if it cannot recreate itself. New, creative alternatives are needed for survival. This is called *third order learning*. (Vartiainen, Ruuska & Kasvi 2003: 40-41)

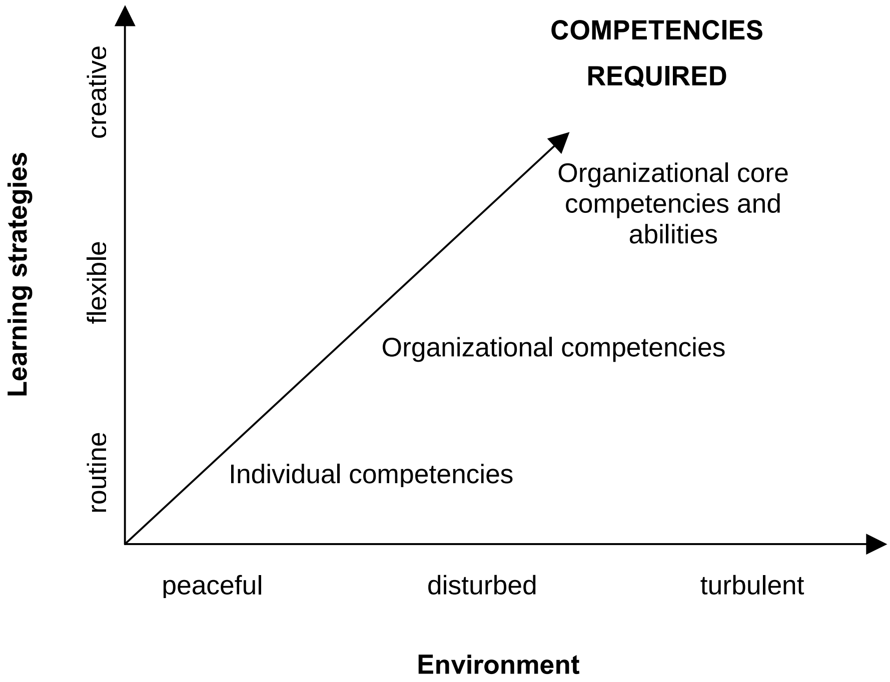

Figure 2.4 Organizational learning in different environments (Vartiainen, Ruuska & Kasvi 2003: 40)

According to Jaafari (2003a; 2003b) organizations in a complex environment try to reduce the environmental complexity through innovation and by leveraging their human capital. Jaafari (2003a; 2003b) classifies organizations into five categories: alert, focused, responsive, capable, and creative-dynamic. Creative-dynamic organizations have the capacity to take on risky, innovative projects and bring relevant business case risks down to a manageable level. The focus on project management has to be on creativity and clever approaches to complexity reduction.

Jaafari (2003a; 2003b) describes four different project management models: the *ad hoc* model of accidental project managers, the *bureaucratic* model of many public sector projects, the *normative* model of traditional project management, and the *creative-reflective* model of creative-dynamic organizations. Ad hoc and bureaucratic models are applied irrespective of the nature of the project, they are the traditional, obvious ways of doing things. However, they may lead to either too high or too low capacity of complexity reduction. Normative and creative-reflective models are applied consciously and depending on the situation. In a relatively stable environment where complexity is not too high, the routine methods of PMBOK (1996; Project Manager’s Body of Knowledge) will do, but in a more turbulent environment or at the edge of chaos empowerment and reliance on people´s self-referential skills and ability to change have to be applied in a self-organized manner.

Jaafari is addressing some very basic qualities of human cognition. To be able to act effectively, we have to apply methods appropriate to a given situation and environment. If we fail to do this, mistakes will happen (see discussion about competencies in section 2.1.5.)

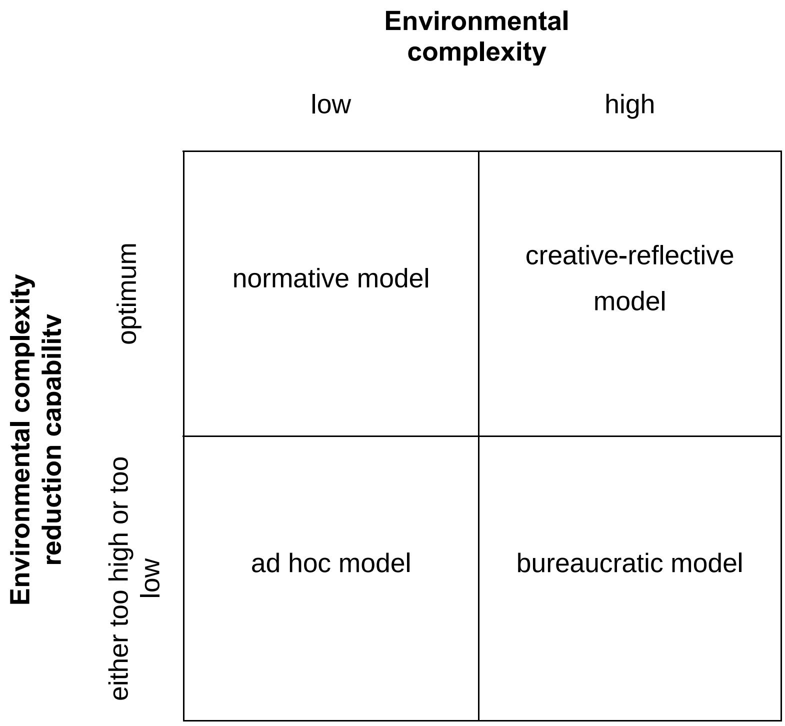

Figure 2.5 Broad classification of project management models by Jaafari (2003a)

Public sector building is traditionally considered a peaceful environment, where routine learning capacities will do. However, this is not the case in Finland anymore. Due to deregulation and new client demands, the old methods will not do anymore. Mold and moisture problems are one example. Before the 1990's these problems were neglected and then suddenly they became a national health issue. People will not accept occupational health hazards anymore in the way they did before. Public building projects have moved to a turbulent environment where creative learning strategies are required.

Of Jaafari's (2003a) project management models the ad hoc model is the one used in public building projects (Naaranoja, Haapalainen & Lonka 2005). If environmental complexity increases, the bureaucratic model is applied instead. However, in the present environment these models lack the environmental complexity reduction capability needed and disasters happen, as will be shown in Chapter 4.

Projects learn through experience (Karlsen & Elvenes 1997; Turner, Keegan & Crawford 2000). They interact with their environment, and through the interaction they get information. Learning can be seen as a process of updating information and exchanging information with the environment (Karlsen & Elvenes 1997). There are two modes of learning, known as *single-loop* and *double loop learning* (Argyris & Schön 1978; Morgan 1996). Single loop learning in a project means comparing the actions with the norms, rules, and practices which have been institutionalized as the common way of doing projects (Karlsen & Elvenes 1997: 339). Project planning and control systems are a typical example of single-loop learning. In a stable environment they do the job, but they are of little avail in a turbulent and changing environment. In a changing environment self-reflection is needed and even basic assumptions have to be questioned. This is called double-loop learning. By searching for alternative solutions and practices, a project can cope with the uncertainty created by the environment. Projects have to learn to learn to survive in the ever-changing project environment.

Reflective practices are an essential part of learning (Ayas & Zeniuk 2001; DeFillippi 2001; Edmondson, Bohmer & Pisano 2001; Karlsen & Elvenes 1997; Keegan & Turner 2001; Schön 1983; Vartiainen, Ruuska & Kasvi 2003). To reflect in action is “to question old beliefs and assumptions, to have open and candid conversation, to develop awareness of how our own actions create the systemic structures which produce our problems, to unlearn old ways of doing things and to let go of old habits” (Ayas & Zeniuk 2001: 63). The idea of project based-learning is to use projects as vehicles for reflection-in-action.

However, this does not happen easily. There are strong organizational forces prohibiting reflective practices. One cannot easily change organizational culture. Schein (1985) argues that it is impossible, we can only set a stage for culture to evolve. People who try to change culture may become isolated or misunderstood, because they differ so much from mainstream culture (Ayas & Zeniuk 2001; Keegan & Turner 2001). The power-distance between managers and project workers may inhibit open discussion (Edmondson, Bohmer & Pisano 2001). Learning is not a natural outcome of projects, and the assumption that learning happens randomly and uninhibitedly during the project is wrong (Ayas & Zeniuk 2001; Sense 2004). The temporary nature of project organizations and their strict schedules prevent learning. Keegan and Turner (2001) analyzed 19 project-based organizations and found that learning was deferred indefinitely due to short-term pressures.

In the public sector the culture is often strong, and people trying to change it become easily isolated. The power-distance or distance between professions disturb communication in a highly institutionalized environment (for more on institutionalization, see section 2.3.3). The short-term pressures in bureaucratic or ad hoc organizations easily prevent learning. The factors prohibiting learning are even stronger in public projects.

To enable project-based learning in organizations, Ayas & Zeniuk (2001: 64-65) suggest the following model:

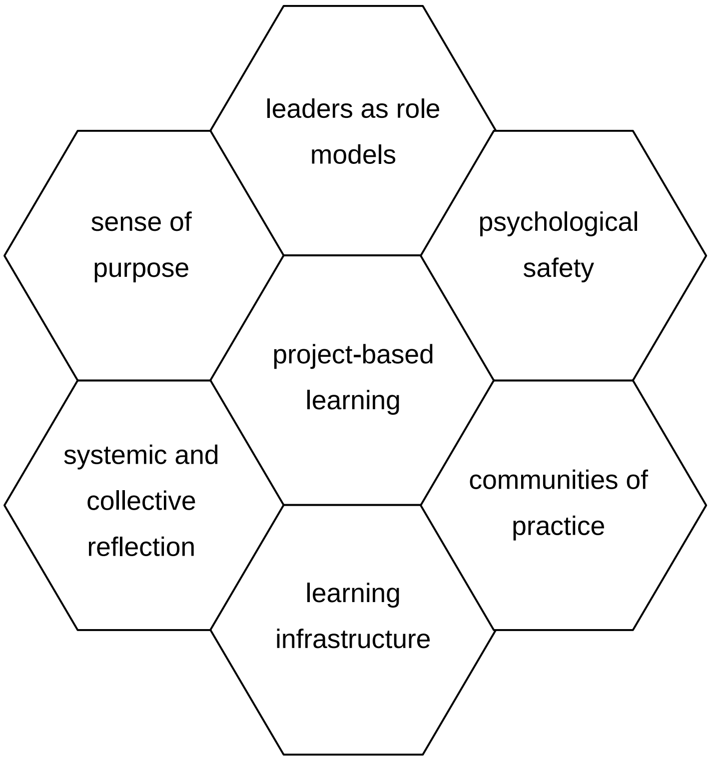

Figure 2.6 Distinguishing features of project-based learning according to Ayas & Zeniuk (2001: 64-65)

- there is a *sense of purpose* and clarity of both long- and short-term objectives
- the project environment offers *psychological safety* and there is a commitment to tell the truth
- there is a *learning infrastructure* and a balance between emerging and formal structures
- there are *communities of practice*[1] that cross project boundaries
- *leaders set the tone* for learning and model the reflective behavior
- there is a *systemic and collective reflection*: problems and mistakes are opportunities for learning

If project-based learning is needed, the project has to be deliberately designed to do so (Arthur, DeFillippi & Jones 2001; Edmondson, Bohmer & Pisano 2001). Arthur, DeFillippi & Jones

[1] Community of practice (COP) will be defined later in Chapter 2.3.4

(2001) provide a model for this. The project members have to invest their “career capital” and the sponsoring company has to invest its non-financial “company capital” into the project. From a performance perspective project success depends on the *exploitation* of these capitals, but from the learning perspective it depends on the *exploration* of new learning avenues for both the organization and the project participants.

Psychological safety created by leadership is essential for learning. Without it people will not dare to express themselves freely (Ayas & Zeniuk 2001; Edmondson, Bohmer & Pisano 2001). In a study by Edmondson, Bohmer & Pisano (2001) the learning curve of surgical teams, which were explicitly managed for learning was much steeper and this was not explained by any other factor. The most important aspect was that leaders behaved as role models, were accessible, asked for input, and admitted their own mistakes openly.

People have to be challenged to learn by inspiring leaders. The short-term goals of the project may prohibit commitment to long-term goals. Therefore a shared vision and an ability to translate emerging ideas into workable goals and empowerment are needed. Project members should be encouraged to cross boundaries. The basic assumption of project-based learning is that learning is social, it is engagement in practice and deals with boundaries (Ayas & Zeniuk 2001: 71). A learning project network is a prerequisite for project success.

Projects also learn from each other (see section 2.1.5, and Fong 2003). In project-based organizations or *project companies* (Artto 2001) it is essential to have managerial processes which ensure organizational learning (Artto, Dietrich & Ikonen 2002). In the world of projects, where team members belong to different organizations or do not have steady jobs, it is a challenge for a project company to organize learning (Artto 2001; Artto, Martinsuo & Aalto 2001; Martinsuo, Aalto & Artto 2003; Vartiainen, Ruuska & Kasvi 2003).

Summary

Project success is highly dependable on project risk management. There are two kinds of risk factors: external ones and internal ones. The former are related to project external environment, the latter to the a project´s inner environment. The only way to manage these risks is through adaptation to changes in both environments. This happens by learning.

The problem with public building projects is that the learning strategies are made for stable environments. In the present, turbulent environments these will not do anymore. In order to learn, projects have to be designed to learn. The traditional ad hoc and bureaucratic models of project management have to be abandoned and creative-reflective models be applied instead. Creative-reflective models are based on reflective practices, double-loop learning, and psychological safety and have many features typical to knowledge management practices. It could be concluded that project knowledge management is an essential success factor.

2.1.5 The management of project information and knowledge

Project risk management is the most important success factor. All risk management strategies are based on adaptation to changes in the project environment. What makes the project environment turbulent and changing is the constant flow of new information. Adaptation to changes happens through learning and through project knowledge management. Knowledge management is an important part of any project today. In this chapter the overall characteristics of knowledge management will be described. Three different perspectives of knowledge management will be introduced: the information technology perspective, the human resources perspective, and the knowledge creation perspective. Finally, the individual aspect of knowledge management will be discussed in a section describing different approaches to competencies.

The problem of knowledge management has existed since long before industrial revolution. Craftsmen had to pass their know-how to their apprentices, workers had to exchange ideas, children had to be taught the tricks of the family trade. However, it was not until the Information Age of the 1990's that knowledge management became an object of interest among the practitioners and scholars of organization studies (Hansen, Nohria & Tierney 1999). Knowledge management is described as any process or practice of creating, acquiring, capturing, sharing, and using knowledge to enhance learning and performance in organizations (Carrillo 2005; Egbu, Lee, Boyd, Xiao & Chinyo 2005; Wilson, Jackson & Hughes 2005).

Before 1995 knowledge management was more or less a synonym for information systems supporting decision making (Brandon 2005; Malhotra 2000). After 1995 the focus shifted to human aspects of knowledge when Nonaka & Takeuchi (1995) presented their SECI model of *socialization, externalization, combination*, and *internalization* (Brandon 2005). It was based on concepts of *tacit* and *explicit knowledge* originally introduced by Polanyi (1958). Experts may know more than they can tell, and this is called tacit knowledge. It has to be made explicit before it can be widely used (Hakkarainen, Palonen, Paavola & Lehtinen 2004). Explicit knowledge is universal and coded, whereas tacit knowledge can only be conveyed in a personal face to face –contact (Koskinen, Pihlanto & Vanharanta 2003).

After 1995 there have been two different perspectives to knowledge management. These are the information processing (or information technology/IT) perspective and the Human Resources Management perspective (Carrillo 2005; Malhotra 2000). There is also the integrated perspective, where the two are combined (Carrillo 2005). The original work of Nonaka & Takeuchi (1995) falls into the latter category.

The IT perspective sees knowledge as a commodity and as a property of an individual, whereas the human perspective considers knowledge as a social phenomenon shared by different individuals (Ahonen, Engeström & Virkkunen 2000; Bresnen, Edelman, Newell, Scarborough & Swan 2003; Malhotra 2000; Ruuska 2005). These two perspectives lead to two different knowledge strategies: either one applies *codification* strategy based on documentation or *personalization* strategy based on human interaction (Hansen, Nohria & Tierney 1999).

The traditional bureaucratic models of public organizations are based on codification strategy. It is interesting to notice, however, that public building projects rely more on ad hoc models of personalization strategy (Naaranoja, Haapalainen & Lonka 2005). Public building projects are like any building projects and they are affected by the ad hoc traditions of the construction industry. The personalization strategy often includes “we do it the way we did last time” –kind of thinking, which may lead to disastrous consequences in a changing environment, as will be shown in Chapter 4.

Project knowledge management: information technology perspective

Project knowledge management is a sub-category of general knowledge management. According to Kasvi, Vartiainen & Hailikari (2003: 571-572), what makes knowledge management in projects challenging is their limited time-span and organizationally and geographically dispersed membership. Information systems are typically decentralized and this leads to knowledge fragmentation and loss of organizational learning. The result is a minor and tangled accumulation of knowledge.

There are standards such as “A Guide to Project Management Body of Knowledge” (PMBOK 1996). They are mainly based on very rationalistic assumptions (Ruuska 2005). The knowledge areas defined in them are multiple: management of integration, scope, time, cost, quality, human resources, communications, risk, and procurement. They do not mention the concept of knowledge management. The underlying assumption of knowledge management is the one of IT perspective dealing with explicit knowledge.

The same applies to the majority of project management literature in the last millennium. Of all the topics in the PMBOK, the management of information has received the widest attention in articles in journals and in conference papers (Kasvi et al. 2003; Urli & Urli 2000; Zobel & Wearne 2000). Kloppenborg & Opfer (2002) researched 3554 articles from 1960 to 2000. They found that before 1990 the focus of research was in topics like computer software, design-to-cost, lifecycle costing, risk management, and quality management. There were some human resource matters like team-building as well. In the 1980´s expert systems and knowledge-based systems (KBS) appeared. One could say that before 1990 the research reflected the rationalistic assumptions of the standards. In the 1990´s there was a growing trend of human resource research interested in team building, leadership development, and motivation. However, when Kloppenborg & Opfer (2002) analyzed future trends, the human resource perspective of knowledge management was not included. It looks like project management practitioners have not traditionally been interested in knowledge management or knowledge creation: these terms seem to be missing from their vocabulary (Bresnen, Edelman, Newell, Scarborough & Swan 2003; Urli & Urli 2000; Zobel & Wearne 2000). According to Kasvi et al.

(2003) “in spite of increasing prevalence of project work, literature and research on project knowledge management or learning project organizations are still sparse”.

Hameri (1997) studied the communication network of a project by following the traces of electronic communication. He knew precisely who had communicated with whom and when, but he did not have any idea of the content of the information exchanged. There is an analogy to cognitive neuroscience (Anderson 1995). One can tell where and how information moves, but there is very little knowledge of the content of thought. Hameri would have had a splendid opportunity to ask the “nodes” (project workers) what they were doing by giving them a diary to fill in or by interviewing them. He did not do it, because according to him it would have been too laborious and the reliability would have been low. Hameri and many other researchers approach information management as a purely technical matter.

Another example is an article by Back & Moreau (2001). In their view information management is “data management, document management, and information sharing”. Information may be shared “electronically in integrated systems, transferred by mouth, or lost in the notes scribbled on a file folder” (Back & Moreau 2001). Information has no human context; it is just raw material.

However, according to Back and Moreau (2001), there are many problems facing the manager of information. Functional organizations create “information silos”, isolated areas of information disconnected from each other. The solution to this problem is complete integration through “object-oriented programming, knowledge-based systems, database management systems, computer-aided design and visual computing, local area networking, artificial intelligence, dynamic simulation, and robotics.” (Back & Moreau 2001). The problem is that in the world of temporary organizations systems are outdated before they are even implemented. Back and Moreau (2001) see information access which requires a person as time consuming, and it should be rejected.

It took a long time before information technology was adapted in the construction industry and even longer before it was a standard tool in the public sector. In the late 1990’s, when the Hakala project (Case 1) was carried out, it was not used widely, but during the Kangas renovation (Case 2) the breakthrough had taken place already, as will be presented in Chapters 3 and 4.

Project knowledge management: human resources perspective

As can be seen, Back and Moreau (2001) and many other researchers of project management approach information and knowledge from a very technical point-of-view. According to their view, information and knowledge are technical problems and nothing more. Bresnen, Edelman, Newell, Scarborough & Swan (2003) call this a *cognitive model* of knowledge management. Typical of this approach is the emphasis on explicit knowledge and predilection for knowledge codification through technology. According to Bresnen et al. this assumption is not backed up by empirical studies. It is a moot question whether it is relevant at all. All information has a tacit dimension, the explicit dimension is only “a tip of the iceberg of the entire body of knowledge” (Fernie, Green, Weller & Newcombe 2003: 179). The other model of knowledge management is the community model (Bresnen et al. 2003). It focuses on “the tacit dimension of knowledge and, in particular, its embeddedness or stickiness within particular social groupings” (Bresnen et al.: 159). To have tacit knowledge from someone else means having a *shared mental model* or system of meaning. The management knowledge includes a sha*red meaning* embedded in a social structure, e.g. a social network.

In the new millennium there has been a growing interest in the human resource perspective of project knowledge management. Two fields of research interested in these matters have been described earlier: *risk management* and *project-based learning*. In the field of *new product development* (NPD) the human factors concerning the project team and learning have been an important topic (Brown & Eisenhardt 1995; Cooper 1998). NPD is most concerned about the problem of learning inside a single project and between projects. For these purposes a *learning project model* is developed (Simola, Hakonen, Nurmela, Rantamäki, Hakonen, Hulkko & Vartiainen 1998; Simola, Hakonen, Rantamäki, Hakonen, Hulkko & Vartiainen 1997; Vartiainen, Hakonen, Rantamäki, Simola & Kokko 1999; Vartiainen, Hakonen, Simola, Kokko & Rantamäki 1999; Vartiainen, Ruuska & Kasvi 2003). The model is mainly based on human resources strategies, workshops, reviews, and team work assessments. Between-project learning and knowledge management inside the parent organization are central issues in *project portfolio management* as well (Artto, Martinsuo & Aalto 2001; Artto 2001).

Construction projects bear resemblance to NPD-projects in the sense that every building is unique. Every design process carries characteristics of prototype making. However, the problems of between project learning are neglected. The time frames are strict and profit margins low, so there is a hurry to start a new project before the last one is analyzed properly (Egbu, Lee, Boyd, Xiao & Chinyio 2005).

The concept of tacit knowledge is becoming one of the key concepts in project management. It has challenged the traditional cognitive and explicit approaches to project management (Bresnen, Edelman, Newell, Scarborough & Swan 2003; Fernie, Green, Weller & Newcombe 2003; Koskinen, Pihlanto & Vanharanta 2003). Tacit knowledge cannot be transferred through information systems, it demands a face-to-face contact between individuals (Egbu, Lee, Boyd, Xiao & Chinyio 2005). Some method of *knowledge sharing* is needed. *Project networks* become important (Blackburn 2002). There are many kinds of networks or other social organizations. One most often referred to is *community of practice* (Wenger 1998; Bresnen, Edelman, Newell, Scarborough & Swan 2003; Garrety, Robertson & Badham 2003; Ruuska 2005). Ruuska (2005: 10) defines community of practice as an informal social structure, which is “a group of people with a shared interest to a certain domain of knowledge, sharing knowledge and experiences and creating a shared understanding by interacting both face-to-face and virtually on an ongoing basis”.

Information technology approach to construction industry was originally only interested in documentation and “library systems” and it was not before the late 1990’s as the focus moved to knowledge management (Davidson & Dimitrijevic 2005). Today there is a lot of research on human resources perspective of knowledge management in construction industry.

Project knowledge management: knowledge creation perspective

The original book of Nonaka & Takeuchi (1995) was actually talking about *knowledge creation*. There has been some articles, where models of knowledge creation in the project environment are introduced. One example is the knowledge management cycle by Liebowitz & Megbolugbe (2003: 193). It includes “knowledge identification and capture, knowledge sharing, knowledge application, and knowledge creation. Once the critical knowledge is identified and captured, it is typically shared with others. Those individuals then apply this knowledge and internalize it to their situation, which in turn creates new knowledge. This ‘new’ knowledge is then captured, shared, applied, and then the cycle continues.”

According to Kasvi, Vartiainen & Hailikari (2003: 572) project knowledge management consists of four groups of activities:

1. Knowledge creation, for example collection, combination, and refinement.
2. Knowledge administration, for example storage, organization, and retrieval.
3. Knowledge dissemination within and outside the project.
4. Knowledge utilization and productization, for example integration into products and decisions, and application in other projects.

Fong (2003) studied multidisciplinary project teams in construction industry. His model has five steps (p. 483):

1. Boundary crossing between team members of different disciplines or between different organizations. Here boundary objects, drawings or conversations, are needed.
2. Knowledge sharing through interpersonal communication.
3. Knowledge creation through interaction and communication in different social networks often aided by published materials.
4. Knowledge integration by combining the different perspectives and knowledge of various disciplines in the design decision-making process.
5. Collective project learning where professionals learn from past projects, even failed ones. It is essential to support an individual’s critical problem solving and reflection processes.

Fong (2003) found *concurrent* and *sequential transfer* of knowledge between projects. In concurrent transfer a project transfers knowledge from an existing project; in sequential transfer the knowledge was transferred from a past project to a subsequent project. Central to inter-project learning was a certain degree of repetitiveness between projects. As important was the *boundary-crossing* over hierarchical and professional boundaries. (Fong 2003: 484)

In the construction industry sequential transfer is more common, but concurrent transfer is not completely missing either. Contractors, clients, and consultants analyze past projects and circulate experiences. Among construction workers and sub-contractors this seldom happens (Knauseder & Josephson 2005). Between-project learning is not well organized, it is more based on personalization strategy than on codification strategy.

According to Fong (2003) knowledge is generated when individuals draw resources from their knowledge repositories in problem-solving situations. Once the knowledge needed is found, it is combined with other knowledge in knowledge integration. These knowledge sharing and generation processes are repeated until sufficient knowledge is found. If design problems are familiar, team members can use existing knowledge. However, continuous changes in regulations, technologies, and customer needs call for constant improvements. (Fong 2003: 485)

The three models described above bear similar features. There are differences, though. Liebowitz & Megbolugbe (2003) are describing an organizational change process and to them a hierarchical approach is essential. Kasvi, Vartiainen & Hailikari (2003) are interested in new product development. They have integrated the IT and human resources perspectives and this is why databases are an important part of their model. Fong (2003) describes very practical situations in construction teams and his approach is most deeply rooted in the human resources perspective.

All the three models see knowledge as something people work on together, it has become objectified to some extent. Here Fong’s (2003) approach is interesting: he talks about boundary objects as a means of creating knowledge. These boundary objects can be tangible, but they can be discussions or other conceptual artifacts as well. However, these objects are not knowledge *per se*, they are mediating artifacts in the process of knowledge creation.

There are boundary objects used in public building projects. Examples of these are model rooms, activity cards, excursions, and ICT tools like virtual models (Naaranoja, Haapalainen & Lonka 2005). All of these were used in the projects studied, as will be discussed later in Chapter 4.

Competencies

Competencies are a consequence of internalized knowledge. Knowledge gets internalized in the process of learning. Learning creates competencies. Knowledge is of no use if it does not lead to more competent action.

Competence management literature is partly overlapping with knowledge management literature (Ruuska 2005:25). There are two sorts of competencies: individual and organizational competencies (Artto 2000). *Organizational core competencies* are seen as corporate assets and a means of implementing strategy (Hamel & Pralahad 1994). Artto (2000) is very skeptical about neglecting individual competencies in project-based firms. Processes cannot run smoothly if people´s competencies are not valued or taken care of.

Individual competencies are seen as a set of *attributes* a person has (Ruuska 2005; Sandberg 2000; Vartiainen, Ruuska & Kasvi 2003). An example is the set of competencies by Crawford (1997):

Dimensions of Competence (Crawford 1997: 25)

Knowledge (qualifications) **+** ***Skills*** (ability to do a task)	**Input Competencies:**	the knowledge and understanding, skills and abilities that a person brings to a job.
+	**+**	
Core Personality Characteristics (Motives + Traits + Self-Concept)	**Process Competencies:**	the core personality characteristics underlying a person´s capability to do a job.
+	**+**	
Demonstrable performance in accordance with occupational / professional / organizational Competency Standards	**Output Competencies:**	the ability to perform the activities within an occupational area to the levels of performance expected in employment.

It often happens that a person's input competencies and process competencies do not match her output competencies, i.e. a person performs less or more effectively than could be concluded from her knowledge, skills, and personal characteristics. There are environmental factors (i.e. organizational setting) and individual factors (stress) which could explain the difference. However, even if these factors are ruled out, there still remains a gap between a person's competence and her performance. One explanation could be that people apply their competencies in a different manner depending on the environment and the situation. Experts need *strategic or metaconceptual skills* to be competent (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 29) in different situations.

Crawford talks about *skills* and competencies. Hakkarainen, Palonen, Paavola & Lehtinen (2004: 25) define competencies as "systems or clusters of skills that rely on professional knowledge of one's field". These sets of skills can be roughly divided into two categories: *domain specific skills* and *generic skills*. Domain specific skills are skills related to the subject matter, they form the core of one's expertise. Generic skills are cognitive competencies needed in various tasks or situations: language skills, social skills, technical skills, computer skills, to mention just a few. Hakkarainen et al. (2004: 28) found in their study of project work that expertise developed within a practical work activity and was not a direct consequence of formal education. Formal education could not produce *task-specific* or *situation-specific skills* and competencies. Specific skills have to be defined in relation to the specific tasks people are dealing with. According to Hakkarainen et al. (2004: 28), "an important challenge of the knowledge society is to develop more general expertise that allows one to deal with novel and unanticipated situations and engage in horizontal learning within a multi-professional environment".

Expertise is the possession of a well-organized body of domain-specific knowledge which an expert uses to solve complex problems (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 17). Novices have to work hard and make conscious decisions when experts can rely on their *automated skills*. Novices have to use lots of cognitive energy in situations where experts can proceed with ease. However, this will not apply to all situations.

There are problems which call for *rule-based activities* and are solved by applying routine procedures and rules. Sometimes there are problems which are so novel that they require setting goals, planning activities, making decisions, and analyzing solutions. These *knowledge level activities* require a great deal of cognitive resources and processing capacities. To be able to work efficiently an expert needs domain-specific knowledge which tells him what level of activity is needed in different problem-solving situations. (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 28-29; Seamster, Redding & Kaempf 2000).

The latter considerations are the ones where experts often fail. They apply routine solutions, where more complicated ones were needed. Human beings have a *functional fixation* (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 23; Duncker 1945): we become very easily fixated on only one interpretation or method. If we have a hammer, all problems look like nails. We also have *confirmation bias* (Hakkarainen, Lonka & Lipponen 2004: 38-40; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 23; Busby 1999; Saariluoma 1990; Tversky & Kahneman

1974; Wason 1968): we try to overcome the limitations of our processing capacity by only looking for information which supports our expectations and present views.

An important part of a person's set of competencies is her ability to analyse the environment and apply her skills accordingly. If she fails and undervalues the environmental complexity, she uses automated skills and rule-based routine activities when generic skills and knowledge-based activities would have been needed. In an opposite case (often the case with novices) energy and resources are wasted in higher level activities, when automated skills would have been enough.

This dual character of expertise has an influence in the way we study competencies. The environmental and actor oriented perspectives have to be included. There are basically two ways to approach competence: the *rationalistic* one and the *interpretative* or *phenomenographical* one (Sandberg 2000; Ruuska 2005; Vartiainen, Ruuska & Kasvi 2003). In a rationalistic approach competencies are seen as the set of attributes (e.g. knowledge and skills) needed to accomplish a particular task or perform a particular work. This often leads to long lists of operationalized attributes, which give an overly simple and narrow descriptions of work which do not adequately describe the complexity of work performance. They often confirm the researcher's own model of competence and do not capture the worker's competence (Sandberg 2000: 11). They emphasize individual competence, because the assumption is that individuals possess competence (Ruuska 2005: 29). They are based on a dualistic view of reality: human being and reality - work and worker - are separated from each other. Explicit knowledge is more important than tacit knowledge. Rationalism is also based on an objective view of the reality, according to which there is objective reality outside the human consciousness. Work achieved by a person is seen as separate from her understanding of the work (Ruuska 2005: 29).

The interpretative approach is not based on dualism but on phenomenology: person and world are "inextricably related through persons' lived experience of the world" (Sandberg 2000: 11; Berger & Luckmann 1966; Marton 1981). Work and worker are not separated from each other, but seen as an entity through workers' experience of the work. Competence is therefore context-bound and related to the community where the work takes place. Instead of individual competencies there are collective competencies, which are not related to individuals, but reside in groups of individuals, in their common goals, and shared meaning systems (Ruuska 2005).

Public employment processes in Finland are based on a rationalistic approach. A person is hired, if she possesses a certain set of attributes (or formal qualifications). In higher offices there are sometimes more thorough methods used, where a person's capacity to work as member of a team is tested. However, both the public sector and the construction industry believe in individual competencies and domain specific skills. The ability to learn and interact with others are not seen as important skills. If actors lack generic skills and the ability to cooperate with others, there will be problems with the project knowledge management as a consequence.

Summary

The most important project success factors: the ability to manage risks, to adapt to changes in the environment, and to learn all depend on the knowledge management strategy chosen.

There are two perspectives to knowledge management: the *information processing perspective* and *human resources perspective*. There are two strategies of knowledge management used respectively: *codification* strategy or *personification* strategy. In the new millennium there has been growing interest among project management scholars in *tacit knowledge* and a *community approach* to knowledge management. Communities of practice, other networks, and knowledge creation in them are the subject matter of the latest research papers.

Expertise is the possession of a well-organized body of domain-specific knowledge which an expert uses to solve complex problems. Novices have to work hard and make conscious decisions when experts can rely on their *automated skills*. Expertise includes domain-specific knowledge and generic skills. To be able to work efficiently an expert needs *strategic or metaconceptual skills,* which tell him what level of activity is needed in different problem-solving situations.

There are two ways to approach *competencies*: the *rationalistic* and the *interpretative* approach. In the interpretative approach work and the worker are seen to constitute one entity through the lived experience of work.

2.1.6 Project management and the three metaphors of learning

Project risk management is a critical project success factor. The most important risks are related to the adaptation to the project´s internal and external environment. For the adaptation to happen, learning is essential. To enhance learning, the project´s knowledge management should be handled properly. Project knowledge management should include more than the information technology perspective alone, it should be focused on knowledge creation instead of pure information processing. This seldom happens. Why have project managers neglected the human side of knowledge management? An answer to this question will be sketched in this chapter.

Hakkarainen, Palonen, Paavola & Lehtinen (2004: 28-29) describe three levels of activities: *skill*, *rule,* and *knowledge* level. At the skill level, information is processed automatically, and no control is needed in converting information into action. This is not cognitively very demanding and we are able to carry out parallel activities very rapidly. Rule-based activities are needed for dealing with familiar and expected problem situations. They are partially automated and only partially conscious control is needed. This control is constrained by the cognitive processing capacity. A great deal of processing capacity is needed on the knowledge level, where controlled and conscious problem solving relies on existing and new information. At this level we set goals, plan activities, make decisions, and analyze solutions. At this level problems may occur due to the limited capacity of working memory.

Most of the project management literature describes situations where the issue is transformation of data into information and information into action. This happens when raw data is used to create work-breakdown structures or budgets. No higher intelligence is needed, even machines can do it if they are given the right algorithms. The action of converting data into information or operational procedures can be described as a *skill level* or *rule-based activity*. This is what the Project Manager’s Body of Knowledge (PMBOK 1996) is about. Most of the PMBOK includes simplified and standardized rules through which the action is controlled. Following fixed procedures, quality systems, standard tools of project management, or action based on tacit knowledge represent rule-based action. They are based on the *crystallized knowledge* (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 141; Bereiter & Scardamalia 1993) needed in solving routine problems.

Intelligent action is action that is based on understanding of the prerequisites of action on a theoretical level. Understanding is a precondition for intelligent action (Bereiter 2002a: 112). If action is intelligent, the participants can choose different modes of action depending on their contemplation of the facts, theories, or tools involved. *Fluid knowledge* is derived from collective resources and exploratory activities. Intelligent action based on fluid knowledge is needed in solving novel problems. In knowledge communities fluid knowledge is transformed into crystallized knowledge. This circle of knowledge creation is described in Nonaka’s and Takeuchi’s (1995) spiral of knowledge creation. Without this conversion the participants would be unable to function due to cognitive overload. (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 141)

According to my own experience the normative model of the public sector and the contractual procedures of the construction industry both include the idea that it is enough to go by the book. If mistakes happen, they are either caused by somebody who did not follow instructions or contracts, or they are caused by inevitable and unforeseen outside circumstances. Instead of actively analysing the environment and looking for weak signals, public sector construction projects are more interested in searching for both scapegoats and explanations after disasters have happened. This attitude was prevalent among many actors in the two cases analysed in this study, as will be shown in Chapter 4.

Acquisition metaphor

Project managers seem to be completely unaware of the importance of knowledge sharing or at least they greatly underestimated its importance. One explanation for this phenomenon could be the “folk theory” of mind and learning called “acquisition metaphor “ (Sfard 1998; Paavola & Hakkarainen 2001; Hakkarainen, Lonka & Lipponen 2004). According to this theory knowledge is understood as a property or capacity of an individual mind. The process of forming knowledge from information takes place inside people’s heads. The only activity needed between individuals is the transfer of information or raw data.

The acquisition metaphor is based on the original assumption of cognitive science that human intelligent activity can be understood by studying mental processes and knowledge structures within the human mind. These processes were believed to be symbolic in nature, to rely on propositional knowledge, and to follow the rules of propositional logic. Early cognitive science consisted of mentalist, cognitivist, and individualist assumptions. (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 6-7; Bruner 1990)

According to the acquisition metaphor it would be enough if only the right people with the right education and the right properties are selected for projects and if these individuals are connected to each other through information channels. However, this is not the case. Projects with top experts have failed. Human thinking is very defective and deduction mistakes are common (Tversky & Kahneman 1974). The capacity of working memory is very limited (Miller 1956; Saariluoma 1990). We have difficulties in dealing with situations with multiple variables. Stress, depression, and circumstances can affect our thinking (Kobasa, Maddi & Kahn 1982). We may succeed on a good day but there are not necessarily plenty of them.

According to the acquisition metaphor the only thing needed between individuals would be some means of communication through which these knowledge creation units are connected to each other. The emphasis is on the input needed for a single individual to process information. Teams are groups of individuals working together in the same room. If a well-trained team has enough time for problem solving, it will end up with a good solution. The decision making literature is, however, filled with opposite examples (Parkin 1996). Tension between the team members may destroy the teamwork, but also too much consensus may be bad and lead to “groupthink” -situations (Fink, Beak & Kenneth 1971; Janis 1982; Janis & Mann 1977). The thinking of a team is as problematic as the thinking of an individual: we do not examine all the possibilities, but take the first solution not asking enough questions first. We do not have enough processing capacity (Busby 1999; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 7).

Cognitive studies on expertise have provided lots of evidence which have proven our common-sense notions of human competence wrong. No computer system can handle the amount of information needed to solve complex problems effectively. It is not a question of computational power but the necessity to represent the vast amount of information in a usable form. A cognitive system needs a way to constrain the variety of alternative actions. It does this relying on the knowledge of which alternative is likely to lead to desirable outcomes. The human mind relies on external structures of knowledge that help an individual to overcome the limitations of computing capacity. The core of human intelligence is embedded in historically developed tools and practices. A vast body of cultural knowledge is needed for intelligent action. (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 6-7)

The participation metaphor and the knowledge creation metaphor

There is another metaphor better serving the purpose of knowledge sharing: "the participation metaphor" (Sfard 1998; Hakkarainen, Lonka & Lipponen 2004; Hakkarainen, Palonen, Paavola & Lehtinen 2004; Paavola & Hakkarainen 2001). According to this, the focus is on knowing (activity) and not on the products (knowledge). Knowledge does not exist in individual minds, it is a product of participation in cultural practices. Knowing is distributed among individuals and their intelligent tools. Knowledge is "situated" in networks of distributed activities of participation. Communities of practice are one example of such networks.

An important part of learning is the process in which we become members of the expert culture (Hakkarainen, Lonka & Lipponen 2004; Hakkarainen, Palonen, Paavola & Lehtinen 2004; Lave & Wenger 1991) or socialization (Berger & Luckmann 1966; Huysman 2004). Lave and Wenger (1991) describe this process by "legitimate peripheral participation". This is how tacit knowledge (or "sticky" knowledge: Nonaka & Takeuchi 1995; Palonen 2003; Polanyi 1958) is transferred and adopted when students and apprentices follow how their masters work (Fong 2003). In this process they learn the tricks of the trade, but at the same time they adopt the role-specific institutional knowledge of that particular profession (Berger & Luckmann 1966; Hakkarainen, Palonen, Paavola & Lehtinen 2004; Lave & Wenger 1991).

Innovative knowledge communities (IKC: Hakkarainen, Palonen, Paavola & Lehtinen 2004: 140) are a form of community of practice aimed at the creation of new knowledge. Knowledge creation is a third metaphor of learning, if the first two were the acquisition and participation metaphors. The idea of knowledge creation is based on three different frameworks: Nonaka and Takeuchi's (1995) model of knowledge creation, Engeström's (1999) theory of expansive learning, and Bereiter's (2002a) theory of knowledge building. Examples of IKC's are research teams, product development, or marketing teams. They develop shared objects, which are reflections on signs of contradictions in current practices. Unlike other communities of practice, IKC's are deliberately designed, but they share the same informal (or semi-informal: Ruuska 2005) character.

There is a field of research interested in these matters. *Distributed cognition* is a relatively new field of research. It studies human cognition as a shared activity, not as a property of a single individual (Salomon 1993a; Perkins 1993). According to Oatley (1990: 102), distributed cognition can be described "as several agents sharing cognitive resources of symbolic knowledge, plans, and goals, to accomplish something that one agent could not achieve alone". Oatley gives credit to Edwin Hutchins (1991; 1995) for introducing the concept of distributed cognition.

Distributed cognition sees man and his tools as an inseparable entity (Cole & Engeström 1993; Hakkarainen, Lonka & Lipponen 2004; Latour 1993; 1999a; 1999b). It looks at the ways experts work together (Hutchins 1995; Wenger 1998) and create knowledge (Bereiter 2002a; Cole & Engeström 1993; Hakkarainen, Lonka & Lipponen 2004; Hakkarainen, Palonen, Paavola &

Lehtinen 2004; Nonaka & Takeuchi 1995). It sees networks as a way to organize modern work (Palonen 2003).

This approach is very seldom, if ever, applied to projects (Blackburn 2002). This may be due to the fact that project management research has become a field of its own. If a new concept has not emerged from project management itself, it will take a long time before it appears in the project management literature. The ideology of project management is heavily based on the acquisition metaphor and the “folk psychology” concept of intelligent action.

Summary

Projects fail because their risk management is not handled properly. To be able to avoid risks in both internal and external project environment, projects should learn. To enhance learning a new approach to project knowledge management is needed. Projects should focus more on human resources and knowledge creation perspectives of knowledge management, as much on tacit as explicit knowledge.

One explanation why this is not the case is the inadequate understanding of the true nature of intelligent action. This is due to the “folk theory” of mind and learning called acquisition metaphor, which lays too much stress on the properties and the capacities of the individual mind. Possibly more adequate metaphors in turbulent modern environments would be the participation and knowledge creation metaphors of learning.

2.1.7 A case study of construction crisis by Loosemore

Before leaving the field of project management studies, it would be enlightening to illustrate the findings with an example from a real-life environment. A case study of project crisis has been chosen for the purpose.

Project knowledge management and project competencies have been studied by using quantitative methods (Ruuska 2005: 38). However, there are some exceptions. A study by Loosemore (1998a; 1998b; 1998c) was one of the few qualitative case studies of project crisis to be found in the project management journals. It will be described in detail here, because it is a good example of this kind of study. It shows that knowledge management can be studied on a team level and that qualitative methods are very suitable.

The phenomena described earlier could be found from Loosemore’s articles. They show the effects of different knowledge management strategies. Risks described in theoretical articles were materialized as predicted.

The research scope of Loosemore’s study

The aim of Loosemore’s study was to investigate the crisis management process in a construction context and identify problems facing project managers in such situations (Loosemore 1998b: 139). After a pilot study Loosemore researched and analyzed four building projects. The aim of his study was to find the communication patterns existing in a crisis and to study different phases of the crisis.

Loosemore's methods

In the pilot study he delivered diaries to project members during a pre-contract meeting. When a crisis arose, people were asked to write down any interaction data, formal or informal. After the crisis the diaries were collected back and compared to produce a map of the interactions. This map was used as basis for structured retrospective interviews after the crisis. There were also interviews during the crisis. (Loosemore 1998c)

Four case studies were undertaken. More were not needed, because the behavioral patterns started to repeat themselves and saturation point was reached. Diaries were delivered to project members in the first meeting. They were given to those who were permanently involved in the project on a day-to-day basis. This included the client's and contractor's quantity surveyors, the architect, project manager, structural and service engineers, site manager, and the clerk of works. (Loosemore 1998c)

According to Loosemore, diaries were used because the problem with retrospectively collected interactional data is that memory limitations reduce the reliability of the data and people tend to remember emotional periods more easily (Loosemore 1998c). [2]

It can be assumed that people remember the hectic periods better. In a study of crisis the emotionally loaded periods are more interesting than life in the middle of routines. Loosemore asked his informants to stop using diaries after the crisis was over. There might have been problems with the recall of sensitive data if he had been studying communication patterns during the whole lifespan of the project.

If Loosemore had studied the information records only, he would have missed all the rich informal data. Diaries enabled him to gather both formal and informal information while it was still fresh in the respondents' minds. (Loosemore 1998c) Are diaries a good source of formal communication data? There is serious doubt. People record only their point-of-view, which can be highly biased, even if it deals with explicit data. Communication data would have contained interesting material, which - compared with informal data from diaries - would have given an even better picture.

In the pilot study the researcher relied upon being informed of any crisis by the respondents. In the heat of the crisis the researcher was of low priority to the informants and unlikely to be

[2] Here Loosemore is referring to a study by Bernard et al. (1982). However, Bernard does not refer to emotional periods in his study of communicational data. His study is one of the first ones on the use of e-mail. A group of 57 e-mail users was followed at the New Jersey Institute of Technology. The participants could not remember to whom they had send messages or from whom they had received them. They could recall only the overall pattern of communication, i.e. who were the most popular actors in the network.

informed of it. In the pilot study Loosemore had been afraid of the Hawthorne effect and appeared only during the crisis. Paradoxically, this was a cause of the Hawthorne effect, because the researcher was associated with bad news. (Loosemore 1998c)

In the final study the researcher was more proactive and repeatedly contacted all the project members. This also led to better relationships with the respondents and engendered a sense of trust. Greater prominence was achieved through nonparticipant observations. Behavioral data was collected before and after the crisis in monthly site meetings and at ad hoc meetings. All this led to more reliable results. (Loosemore 1998c)

The diaries were cross-referenced and a longitudinal map of communications was produced. The structure of communications was analyzed using social network analysis (SNA). This was used in retrospective interviews with each person featured in the reaction network. Interviews were semi-structured and tailored to each respondent. All the interviews were taped (Loosemore 1998c). Diary and network data relating to each network interaction was analyzed using content analysis and categorized into their component parts. The aim was not to produce a definite model of crisis but a grounded theory of construction crisis behavior. (Loosemore 1998a)

What did Loosemore find out?

Crises were characterized by instability and change. Change points and events immediately before the crisis were interesting. There were two kinds of change: from positive to negative and the opposite. Communications in positive periods were supportive and problem oriented. Communications in negative periods were obstructive and selfish. Typical of the change was that it coincided with a major event. Those who reacted to the first event manufactured change events. (Loosemore 1998a)

There were early warning signs, but people did not react to them. Insensitivity was related to the need to maintain the status-quo. This resistance to change magnified the costs of the crisis. As the cost of resistance accumulated, the more difficult it became to admit these losses. The resistance to change grew even bigger. Parties driving change became increasingly forceful in pursuing it and the situation escalated. Negative phases had a tendency to deepen rapidly and become increasingly difficult to stop. (Loosemore 1998a)

Insensitivity to change was an even bigger problem during the positive periods. People tended to be blinded by euphoria and became insensitive to emerging problems. The idea was to prolong the positive period, but actually it was shortened and negative change was made more likely. Positive periods would have been prolonged if the emerging problems had been discussed and dealt with. (Loosemore 1998a)

“Thus, it appears that in contrast to negative phases of behavior, which are self-perpetuating and robust, positive phases are fragile and easily destroyed.” (Loosemore 1998a: 120) Processes were characterized by accumulations of releases of tension. The best way to maintain stability is to encourage mutual sensitivity to the needs of others, open communication and a sense of collective responsibility. This was demonstrated by one of the cases where no phases can be found. In this case the architect was sensitive and responsive to the contractor's needs and emotions. Equally important was the contractor's will to make the project a success. Both acted proactively and did not exploit each other's misfortunes. (Loosemore 1998a)

Discussion on Loosemore's findings

There were some industry-related factors which magnified these phenomena. Each crisis demanded extra resources. The responsibility of supplying them was determined by contractual agreements, which tended to allocate the responsibility to one party instead of sharing it. This had several problematic effects (Loosemore 1998b):

- There was little collective responsibility.
- There were distinct losers and winners and problems arouse when people tried to ensure that resource redistributions went in their favor.
- Contractual documents became more important and differences in their interpretation emerged.

The low margins of the industry made people more sensitive to money-making situations and threatening situations, thus magnifying the conflicts between people. Insensitive, irrational and extreme behavior was more likely. When collective responsibility and teamwork were needed, they were less likely to occur. (Loosemore 1998b)

There was increased communication and teamwork in the early stages of crisis but it was aimed at identifying rather than eroding differences. Many informal coalitions were formed. They were aimed at manipulating resource movements, by:

- interpreting documents
- silence
- bluffing
- threats
- warnings
- deliberate acts of escalation

More energy was invested in negotiations and the emotional costs of compromise increased. There was a danger of accidental escalation. (Loosemore 1998b)

However, there was an opposite case, where crisis presented an opportunity to increase cohesion and efficiency. The parties had a constructive attitude and used the crisis as an opportunity to demonstrate their commitment and sensitivity to each other's interests. Team members saw each other in a positive light and energies were focused on progressive tasks. In the end, the positive momentum was difficult to break. (Loosemore 1998b)

Communication was an important mechanism, which reduced uncertainty and re-established equilibrium. However, when this mechanism was most needed, a crisis created conditions which made it less likely. When there was uncertainty over responsibility, information became a source of power and it was closely guarded. Groups imposed strong norms and cut down information channels. (Loosemore 1998b)

There was also a huge flood of information. The supply and demand of information focused on certain key people and this caused bottlenecks of information. These key people either stuck to the formal procedures or became increasingly informal. Both coping strategies were disastrous. Formal strategy lowered the flow of information and the informal strategy created a disjointed organization. A balance between control and open communication would have been a better strategy. (Loosemore 1998b)

According to Loosemore, construction crisis can be seen as an opportunity as well as a threat. By encouraging mutual sensitivity and collective responsibility they can increase cohesion instead of destroying it. (Loosemore 1998b)

If one wants to understand what the knowledge management problems in a project are, Loosemore's study provides a better model than quantitative articles, because he describes how *knowledge* is actually derived from information through shared action. He also describes situations when this does not happen. Especially in crisis, when there is too much information, the information channels may get blocked because of rivalry and disputes about money, and the creation of knowledge becomes impossible.

In Loosemore's cases things went fine in a routine manner until the crisis occurred. In the crisis a different kind of mode, intelligent action, would have been needed. The system could not handle a situation where intelligent action was needed, because it was not designed for it.

An interesting feature in Loosemore's cases was the participants' tendency to avoid knowledge creation. If possible, the problematic situations were seen as consequences of poor information circulation and the solution to the problem was better control of the information flow. In crisis situations no time or resources were invested in knowledge sharing. The participants tried to keep this activity at the lowest possible level. This lead to an information overflow and blocks in the flow of information due to overheating of the information channels. Sometimes the flow of information was deliberately blocked to avoid the overheating. The results may be interpreted so that the narrow channels could not handle the situation, and - for obvious reasons - broader channels were needed. However, people stuck to the old model of operation, choked the channels, and disasters happened.

Was Loosemore's study valid?

From the point-of-view of this study, there were some interesting methodological issues in Loosemore´s studies. As he himself admits, diaries seemed to be problematic, retrospective interviews gave better results. The use of the SNA did not offer much. Qualitative methods were more useful. In Loosemore's cases the flow of information was blocked in the crisis.

Crises are highly emotional, sensitive and contentious events. People hide information, because it is a source of power in negotiations. People were more willing to confide in the retrospective interviews. There were problems with these interviews as well. If the emotional impact after the crisis persisted, the informants' perspectives were biased and not rational. An air of trust, impartiality, integrity and confidentiality was important. (Loosemore 1998c)

There were some industry-related problems as well. The learning effect made the timing of the research an important consideration. There are low margins in the construction industry. The crisis would repeatedly fall on the same shoulders. People were working at their maximum capacity and did not want to spend too much time working on research-related activities. On the other hand, there were lots of people who played a very peripheral role. It was also difficult to tell when a crisis would arise. (Loosemore 1998c)

2.1.8 Summary

The aim of this chapter was to find out why do projects fail and what a successful project is like. It was found that:

1. Only a fraction of projects satisfy the *triple constraint* of time, money and specifications. (section 2.1.1)
2. The concept of project success can be divided into two parts: short-term *project management success* and long-term *project success*. Project management success is not a necessary precondition of project success, even failed projects can produce good end-results. However, it is very difficult to reach long-term project success if project management fails. (section 2.1.2)
3. Project *success criteria* and project *success factors* are two different things. Project success criteria are related to project goals: under what conditions a project can be called a successful one. To understand project goals, i.e. to understand project success, criteria is one key success factor. There are plenty of other success factors described in the project management literature. (section 2.1.2)
4. If success factors are not met, the project is likely to become a failure. This is called a *risk*. Risk is an uncertainty, which may have undesirable consequences. One of the biggest risks is unclear definition of project goals or user needs. Risk can also be related to the project environment, which may be turbulently changing. (section 2.1.3)
5. In a turbulent environment the only way to adapt to the environment and to control risks is through learning. In *project-based learning* projects are used as vessels of individual and organizational learning. In project-based learning *reflective practices*

are an essential prerequisite for learning. In addition to that, a learning infrastructure in form of *double-loop learning* has to be adopted and there has to be *psychological safety* created by leaders before learning can take place. Project learning is a *social phenomenon*. (section 2.1.4)

6. There are two perspectives to knowledge management: the *information processing perspective* and *human resources perspective*. There are two strategies of knowledge management used respectively: *codification* strategy or *personification* strategy. In the new millennium there has been growing interest among project management scholars in *tacit knowledge* and a *community approach* to knowledge management. Communities of practice, other networks, and knowledge creation in them are the subject matter of the latest research papers. (section 2.1.5)

7. *Expertise* is the possession of a well-organized body of domain-specific knowledge which an expert uses to solve complex problems. Novices have to work hard and make conscious decisions when experts can rely on their *automated skills*. Expertise includes domain-specific knowledge and generic skills. To be able to work efficiently an expert needs *strategic or metaconceptual skills,* which tell him what level of activity is needed in different problem-solving situations. There are two ways to approach *competencies*: the *rationalistic* and the *interpretative* approach. In the interpretative approach work and the worker are seen to constitute one entity through the lived experience of work. (section 2.1.5)

8. The reason why project management studies has not traditionally been interested in tacit knowledge, human resources perspective of knowledge management, or interpretative approach to competencies is its adherence to a folk theory of mind called "*acquisition metaphor*". According to this theory, knowledge is a property of an individual mind. The social aspects of knowing are neglected due to mentalist, individualist and cognitivist bias. Metaphors better serving learning in the project environment are the participation metaphor or knowledge creation metaphor. (section 2.1.6)

9. A field of research which is interested in social aspects of knowledge is *distributed cognitive studies*. Distributed cognition takes place when several agents share cognitive resources of symbolic knowledge to accomplish something that one agent could not do alone. The whole idea is so near project management ideology and principles that it is amazing that it has never been widely applied to project management studies. (section 2.1.6)

10. Loosemore´s study of construction crisis demonstrated methodologically what might be a good approach to find out how distributed cognition works in a real-life environment. Retrospective interviews and qualitative analyses revealed more about the social network action than quantitative methods. (section 2.1.7)

Projects fail when unfavorable risks materialize. The biggest risk factors are related to the project environment. To adapt to the environment and to avoid failure, a single project has to learn. Learning inside a project is a collective effort, the project team has to learn, it is not enough if only individuals learn. In order to learn, project members have to communicate and share knowledge. Projects consist of distributed actors. Projects can be studied as distributed cognitive actions, where the quality of communication is critical to project success.

Project work has dual characteristics. In a stable environment a normative model of project management will do. Experts can rely on their vast array of domain-specific, automated skills. Rule-based activities of PMBOK and quality systems are sufficient. Knowledge is in crystallized form and IT-systems are capable of handling it. The focus is on individual cognition. Rationalistic approach to competencies and acquisition metaphor approach to learning explain the phenomena well enough.

In a turbulent environment a creative-reflective model of project management is needed. In novel situations task-specific skills are essential. Generic skills of experts are of great value when knowledge-based activities are needed in creation of fluid knowledge. Knowledge management is based on human resources perspective where tacit knowledge is essential. Participation or knowledge creation metaphors of learning and interpretative approach to competencies are needed to properly understand the phenomena. The focus has to be shifted from individual to distributed cognitive level.

Neither of these two models are better than the other. They both can be applied to various degrees in project management depending on the situation and the project environment. However, the very definition of projects as novel undertakings make the creative-reflective model more proper in today's vicious project environment. The domain-specific skills of an architect or an engineer are not sufficient conditions for success, they are more or less prerequisites for joining the game. Project success or failure depends on the individuals' ability to join their forces together and exceed their individual capacities by using distributed cognitive strategies.

2.2 Information, knowledge, and meaning

Adaptation to the environment is essential to project risk management. To be successful a project team has to be able to analyze environmental information and process it properly. In other words: it has to learn. To enhance learning and to process information properly, a project needs a knowledge management strategy. The strategy has to include more than just information processing or IT-perspective; human resources or knowledge creation perspectives are even more important. Distributed cognitive studies are interested in these matters.

The ability to handle knowledge is essential to project success. To be successful a project has to be able to process information, create knowledge, and to give it a meaning. Before going any further some of the fundamental epistemological concepts have to be defined. First, the concepts of data, information, and knowledge and their relations will be defined. After that there is a short discussion of meaning making: how information is transferred into knowledge in the process of meaning making. Narratives play an important role in this process.

This chapter is essential because many authors see meaning making as a fundamental aspect of knowledge management (Malhotra 2000) and project management (Frame 1995; Hansen & Millar 1997; Hartman 1997). Human language is ambiguous by nature and this causes a risk to all interaction based on language.

2.2.1 What is information and what is knowledge?

In everyday language we talk about “data”, “information”, “knowledge”, and “wisdom” (Tuomi 1999: 235; Lillrank 2003: 693) when we refer to a human or humans as cognitive actors. The field of philosophy studying these matters is epistemology. The classical description of knowledge by Plato is “a well justified true belief” (Nonaka & Takeuchi 1995; Niiniluoto 1984). By saying this he wanted to separate knowledge from mere guessing or belief. However, knowledge is approached here from a knowledge management perspective, not from a purely epistemological perspective. The classical definition is much too restrictive in a knowledge-based economy (Bereiter 2002a).

“Data” and “information” are often used as synonyms of “knowledge”. However, these words have different meanings (Cong & Pandya 2003). *Data* are raw facts. To become *information* data have to be processed. Decisions can only be made based on information. *Knowledge*, on the other hand, is meaningful information. Knowledge is derived from information. It depends on interpretation whether we are talking about data, information, or knowledge. What makes a difference between data and information is their *organization* and what makes a difference between information and knowledge is their *interpretation* (Bhatt 2001). Knowledge is the understanding one gains through experience, reasoning, intuition, and learning. We expand our knowledge when others share their knowledge with us. New knowledge is born when we combine our knowledge with the knowledge of others. Wisdom and insight can be included in the definition of knowledge. *Wisdom* is the utilization of accumulated knowledge. (Cong & Pandya 2003)

Lillrank (2003) defines information in a hierarchic manner. According to him, data are symbolic representations of entities, properties, and their states. They have content and form that allow storage, transfer, and retrieval. Data are turned into information by giving them meaning and context. Thus information includes data, meaning, and context. The difference between information and knowledge is in their way of approaching the world. Information reveals how the world *is*, knowledge tells how it *works.* Lillrank (2003) is interested in information’s ability to elicit meaning. Meaning is a function of data and their context. This can be formalized as $M=f(D,C)$ where M is meaning of data, D is data, C is context, and f is the relevant knowledge of how the world works in this framework. By means of f an actor can assign meaning to the piece of data and turn it into information. This happens in a communicative act or sensemaking process where the meaning is negotiated with other agents. Negotiation in an informal, open system is needed if data, context, and the knowledge function are fuzzy, otherwise formal, closed systems can be used as a means of assigning meaning to information.

Perkins (1993) is also more interested in the way information is used or processed than its content. His perspective is called *the access framework.* Access characteristics are divided into four categories. *Knowledge* concerns what kind of knowledge is available: procedural knowledge, facts, strategies, or routines. *Representation* concerns how the knowledge is represented. *Retrieval* concerns how effectively knowledge can be found. *Construction* concerns the system's capacity to create new knowledge structures from pieces of knowledge.

There seems to be no agreement on definitions of "data", "information", "knowledge", or "wisdom" (Tuomi 1999: 235-238; Perkins 1993; Cong & Pandya 2003; Lillrank 2003). However, there are some aspects that all of the authors share. Whether information or knowledge are seen as separate concepts or not, the transformation of data to knowledge or information happens when meaning is given to them. This happens in a shared action, where meaning is negotiated or constructed together with other actors. To improve the processes of project knowledge management one should concentrate on the concept of meaning.

2.2.2 How is meaning given to information?

The field of science studying meaning is called *semantics* (Niiniluoto 2000: 14). The meaning of the word "meaning" varies in different languages. There are at least 22 different interpretations for this word in English language (Niiniluoto 2000: 17). A very simple form of semantics is the one found in ordinary dictionaries where the conventional meanings and uses of words are described. The Stoic philosophers of Antique made the distinction between the expressions of a language and the objects they were referring to. The nature of language is triadic or three-dimensional: there are the written or spoken *form* of a sign, the object or incident it is *referring to* and the concept or *meaning* it expresses. (Niiniluoto 2000: 16; fig. 2.7)

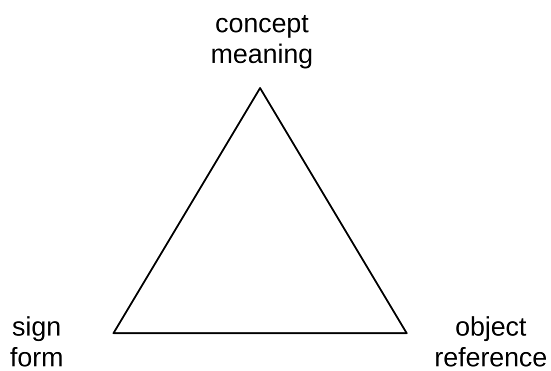

Figure 2.7 Sign, object, and meaning according to Stoic philosophers (Niiniluoto 2000:16)

Of all different schools of semantics one of the most interesting is *pragmatism* founded by Charles Sanders Peirce (1839-1914). According to pragmatism the meaning of a concept is the same as its effects on our actions (Niiniluoto 2000: 19), or in Peirce's words "the true meaning of any product of the intellect lies in whatever unitary determination it would impart to practical conduct under any and every conceivable circumstance, supposing such conduct to be guided by reflection carried to an ultimate limit" (Peirce CP 6.490).

However, philosophy is never that simple. According to Peirce a sign includes three different elements*: the sign* itself, *the object,* and *the interpretant* (fig. 2.8). An interpretant is the effect the sign has on the receiver. The effect can be a feeling, a thought, or an act. A sign is a sign if 1) it refers to something in some way, and 2) if it has an effect on the receiver. The relation between these three elements is based on a common principle, a habit, or a convention. It belongs to the class of *thirdness*, a class of orderly, lawful, goal-seeking, or habitual things (Veivo 2000: 131). The receiver needs an presupposition or some kind of an idea as to what the sign represents for an effect to take place.

> "A sign, or *representamen*, is something which stands to somebody for something in some respect or capacity. It addresses somebody that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the *interpretant* of the first sign." (Peirce, CP 2.228)

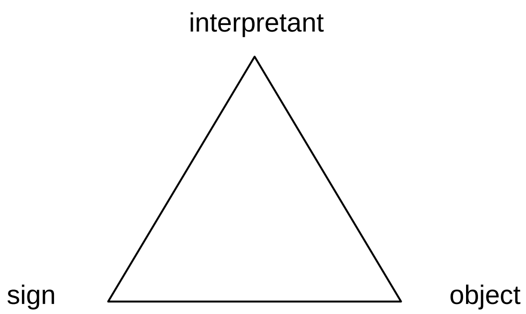

Figure 2.8 The elements of a sign according to Peirce

An interpretant can be a sign itself and can create another interpretant. This can lead to a series of interrelated interpretations called *semiosis*, which can be an endless process. However, the process comes to an end if the interpretation of a sign stabilizes and becomes established. If new information or experience appears and challenges the interpretation, the semiosis begins again.

What is interesting in Peirce's thinking is the very open definition of signs. They can be anything if they fulfill the criteria of representing something and having on effect on somebody. It can be a person as well. A solicitor can be a sign if he represents a reconstruct of an incident (object) to the judge in order to influence her decisions (interpretant). (Veivo 2000: 131; Peirce C.P. 1.553)

Following Peirce, Umberto Eco (Veivo 2000: 138-139) assumes that the meaning of a sign is based on purely cultural conventions, not on the relationship between the reality and a sign. The meaning is situated in the culture, in the regular, and public, interpretations of signs. Even individual experiences or beliefs are relevant only if they are coded in the culture.

According to Bruner (1990), meaning is a tough case even for cognitive science. The original idea of cognitive revolution was to bring mind and meaning back to human science (Bruner 1990). However, very soon the interest shifted from construction of meaning to the processing of information, and meaning was not on agenda anymore. Computing became the model of mind and in place of meaning became the concept of computability. According to Bruner (1990) information does not bear meaning, because in computational terms meaning is already included in messages. Information can deal with meaning in dictionary sense only: accessing stored lexical information according to a coded address. Such a system needs advance planning and precise rules. It cannot cope with vagueness, polysemy, or metaphors. There is no place for "mind" in such a system, if mind means intentional states like believing, desiring, intending, or grasping a meaning. (Bruner 1990)

As Bruner says (1990:12): "To treat the world as an indifferent flow of information to be processed by individuals each on her own terms is to loose sight of how individuals are formed and how they function…there is no such thing as human nature independent of culture". We share the meaning before and after transfer of information, because it is already "there", embedded in language and culture (Vygotsky 1978; Veivo 2000). Meaning is public and shared by definition.

The power of narratives

Our culturally adapted life is based on shared meanings and shared modes for negotiating differences in meaning and interpretations. Bruner (1990) describes how this negotiation takes place by means of *narratives*. Narratives are not needed if things proceed in an ordinary fashion. We have theories of mind called "folk psychology" or "common sense": normative descriptions of what makes human beings "tick", what one can expect situations to be like, what our minds and those of others are like, what are possible modes of life, and so on. We believe (or "know") that world is organized in a certain way; that we want certain things; that people hold believes about the past and future. We believe in the coherence of all these beliefs that people should not want "irrational" things. We have very strong opinions about how things *should be* and how one *should behave*.

These beliefs are also called *mental models* (Senge 1994). They are "deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action" (Senge 1994: 8). Mental models can be simple generalizations ("all contractors are greedy"), or complex theories. Mental models are active, they shape how we act (Senge 1994: 175).

If the rules are broken, narratives are constructed. We need some kind of an explanation of why things are not the way they should be. Narratives are stories which bring the world together again. They give a reason or meaning for the deviation from canonical cultural patterns (Bruner 1990, Hakkarainen, Lonka & Lipponen 2004). In the world of narratives, no explanation is needed for the ordinary or routine, only the non-routine or deviation need an explanation or special meaning. The greater the deviation, the more meaning-making is needed.

What is typical of narratives is that they are sequential. They have a plot, they are composed of a unique set of events, mental states, happenings, and human beings as actors. It does not matter whether narratives are "real" or "imaginary", they still have the same explanatory power. Narratives are shared cultural property. They are formed by tradition and share some common features. For example, they have dramatic quality. Kenneth Burke (Burke 1945 in Bruner 1990: 50) describes this dramatic quality as a pentad of an Actor, an Action, A Goal, a Scene, and an Instrument – plus Trouble. Trouble describes an imbalance between other members of the pentad. An Action toward a Goal in a particular Scene is in imbalance when Don Quixote attacks the windmills. (Bruner 1990)

Narratives have a moral status. They explain deviations from moral values and commitments. They also have an epistemic status, because they explain deviations from cultural conventions in terms of individual intentional states. They answer questions like: "Why did he do things he didn't want to do?" Narratives mediate between the world of culture and the world of beliefs, desires and hopes. (Bruner 1990)

It can easily be seen that projects have the dramatic qualities described by Burke. There is an actor (the project team or project manager), there is action (project work), a goal (part of a definition of a project!), a scene (the organizational setting), and there are instruments (the project management tools). And – inevitably – there is the trouble.

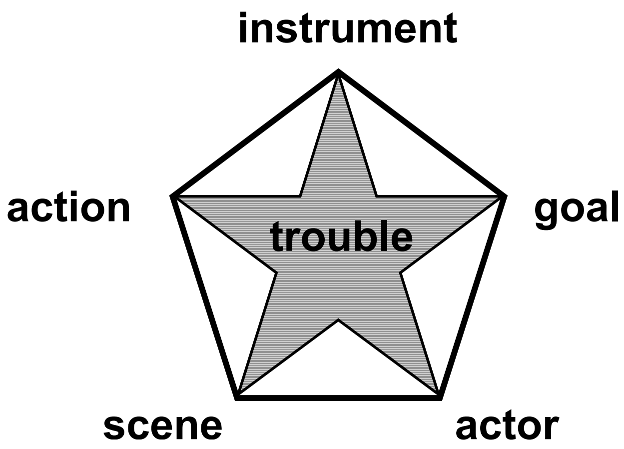

Figure 2.9 Burke's pentad (according to Bruner 1990: 50)

As Frame (1995) describes, the very definition of a project as a temporary organization leads to a situation where most of the resources are borrowed, and this leads to inherent conflicts with the rest of the organization. Poor definition of the goal leads to windmill fighting as well. Most of the project work is often efforts to restore the balance. Restoring the balance is the basic subject matter of all project reports and project meetings, because there is never balance. This is why projects produce lots of narratives. By collecting and analyzing these narratives we learn a lot about projects. The qualitative inquiry is a very suitable method for project studies.

2.2.3 Summary

The ability to adapt to the environment and thus manage the risks of a project is an essential project success factor. The adaptation happens through learning and by managing the project knowledge. It is not enough to manage information only like the information technology perspective to knowledge management would suggest. The human perspective and knowledge creation perspectives to knowledge management are as – or even more – important. In a turbulent modern environment, even in a public sector building project, data has to be processed into information, meaning has to be given to information, and knowledge has to be created in the act of meaning making.

Meaning making cannot be seen as information processing or matter of individual psychology. Meanings exist, they are always meanings of a given culture. They can only be changed through negotiation, which is mediated by culture.

This is why approaches based on the "folk theory of mind" cannot explain problems in knowledge management. The information processing perspective to knowledge management is fundamentally limited, because it cannot deal with cultural mediation. The human resources perspective is better, but it can also be approached from a very individual perspective: individuals discussing the meanings and making deliberate agreements on different meanings.

In this thesis distributed cognition is chosen as the theory on which the studies of project success factors will be based, for the following reasons:

1. There are no mentalistic or individualistic assumptions.
2. Distributed cognition can explain and describe the methods of cultural mediation.
3. Practical implications can easily be based on the concept of distributed cognition.

If adaptation to the environment through learning is an essential project success factor, distributed cognitive studies cover all the fields necessary to enhance adaptation and learning. There is hardly any other field of studies better serving the purpose. Better methods of project management based on distributed cognition should make projects more successful.

2.3 Distributed cognition and the disciplines related to it

Project knowledge management based on a human resources perspective and on knowledge creation is an essential project success factor. By managing knowledge properly and by learning projects can adapt to their environment and avoid risks. Distributed cognition is a field of study best serving the purpose of knowledge creation and learning in projects. In this chapter a general description of distributed cognition will be given. Its theoretical background and its connections to other theories or concepts will be analyzed.

As a concept distributed cognition is not new. One can find its origins in the writings of the turn-of-the-century psychologists and philosophers like Dewey or Wundt (Salomon 1993a: xiii; Cole & Engeström 1993). As a modern school of psychology it was born among the scholars of educational psychology, cognitive psychology, anthropology, and sociology in the early 1990's (Salomon 1993a, Dillenbourg, Baker, Blaye & O'Malley 1996: 193). To understand its background one has to be familiar with the development of psychology and educational studies.

Distributed cognition is a wide and not well defined concept. The word can be used in many ways. "Distributed cognition" refers to a phenomena and to a school of psychology at the same time. Distributed cognition is "a process or state in which cognitive resources are shared socially in order to extend individual cognitive resources" (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 242). It is also "an approach that emphasizes how cognition is distributed among minds or between minds and artifacts" (ibid. p. 243).

As an approach, is distributed cognition a field of psychology? Psychology differs from the other social sciences (e.g anthropology or sociology) in seeking to explain the mental processes and behavior of individuals. Distributed cognition could be seen from the individual point-of-view as a field of psychology studying how individuals use the help of the other individuals and shared artifacts to extend their resources. However, it can also be seen from the sociological point-of-view as a structure formed by several individuals. The term is often used as a synonym for "collective mind" (ibid. p. 234).

The idea that collaboration is a basic form of human activity and a good way to learn has a long history among education and psychology (Lipponen, Hakkarainen & Paavola 2004: 31).There are several fields of psychology and education science interested in the way people share mental resources and form shared understanding of the reality.

There are theories which have psychological, individual approach. *Constructivism* sees learners, not teachers as responsible for learning. *Team cognition* studies shared information processing among members of a small group. *Collaborative learning* is a term for a variety of approaches in education that involve joint intellectual effort by students or students and teachers. However, there are collaborative learning studies which emphasize social or cultural rather than individual aspects of learning.

There are theories which see the sharing of mental resources as social or cultural phenomena. *Situated cognition* is a movement inside educational psychology studying learning in real-life environment. *Cultural psychology* is a field of psychology which assumes the idea that culture and mind are inseparable and that cultural traditions and social practices regulate and transform the human psyche. *Distirbuted cognition* can be seen as closely related to these two approaches.

There are also *social theories* (theoretical frameworks explaining and analyzing social patterns and social structures) and concepts which deal with knowledge management issues and can be seen as related to the distributed cognitive approach.

Theory of dyads and triads or *microsociology* studies smallest human formations: pairs and groups of three or more. *Social constructionism*[3] is a theory studying the ways in which individuals and groups participate in the creation of their perceived reality. *Social network* is a social structure formed by individuals or organizations. *Social network analysis* studies social networks by using methods created in the field of applied mathematics called *network theory*. *Communities of practice* are one form of informal social networks. Community of practise is also an important concept of situated cognition.

2.3.1 Educational psychology: from individual to group perspective

There has been major paradigmatic shifts in psychology during the last century. The first half of the century was dominated by *behaviorism*. It stated that psychology did not have to use terms such as consciousness, mind, or images. The change of human behavior was enough. The methods of rewarding good behavior and concentrating on stimulus-response chains is still widely practiced. (Kirschner, Martens & Strijbos 2004: 4-5)

Behaviorism stated that one cannot study mental processes, because they are not directly observable or measurable. However, the stimulus-response chains of complex behavior, like language acquisition, were extremely complicated and contrived. Behaviorism was found too restricted to explain all phenomena. The link between stimulus and response could not be seen as straightforward. *Cognitive psychology* was born as a reaction to behaviorism. According to cognitive psychology one can go inside “the black box” and study cognitions directly. Mental processes that operate on the stimuli presented to the perceptual and cognitive systems can and should be studied, because they determine whether or not response is made and what it is like. According to cognitive psychology mental structures are formed by representations of concepts and their mutual relations. Learning is a change in the mental structures of the learner. The goals of learning processes are important and instruction should be based on them. (Kirschner, Martens & Strijbos 2004: 5)

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[3] Also *social constructivism*. However, the term is not used here, because it might get confused with the philosophy of learning called *constructivism* or *socio-constructivism*.

Constructivism is a philosophy of learning based on the idea that knowledge is constructed by the learner and the learners are active in seeking meaning. Learning must be situated in a rich, real-world-like context for the constructive process to occur. (Kirschner, Martens & Strijbos 2004: 6) *Socio-constructivist* approach is interested in how social interaction affects individual cognitive development. Based on Piaget's work this approach studies "cognitive conflicts" in peer interaction. Disagreements with other children offer alternatives to one's own thinking. The necessary resolutions guide the children to higher-level resolutions and intellectual progress is thus facilitated through conflict of perspectives. This neopiagetian approach is often criticized of describing interaction in individual terms only. (Littleton & Häkkinen 1999: 22; Dillenbourg, Baker, Blaye & O'Malley 1996: 190; Häkkinen & Arvaja 1999: 208)

Socio-cultural approach is based on the work of Russian psychologist and theorist Lev Vygotsky (1978). Like socio-constructivism it is interested in the relationship of individual cognitive development and social interaction. However, according to socio-cultural perspective an individual's development takes place first on social, inter-psychological level and then in the individual, intra-psychological level in the process of *internalization*. Unlike socio-constructivist approach, the socio-cultural approach has an asymmetric composition: an individual development happens with the aid of a more competent other, either a teacher or a more competent peer. (Dillenbourg et al. 1996: 192, Knopp 2004: 19). Through this activity the cognitive resources of the whole society, its cultural heritage, cultural tools, and practices become properties of an individual. Of the cultural tools the language is the most important, it is the "tool of the tools" (Vygotsky 1978, Baker, Hansen, Joiner & Traum 1999: 44-45). Individual cognitive development is seen as a process of internalizing socially mediated knowledge (Littleton & Häkkinen 1999: 24). Social constructivism can still be seen as an *individual theory* of learning, whereas socio-cultural approach is a *social theory* of learning. (Stahl 2004: 56).

Vygotsky created a very famous concept when he described the development of children: *the zone for proximal development* (ZPD). ZPD refers to abilities not yet possessed by individuals, but which can be activated in interaction between a teacher and a student or between an individual and her environment (Vygotsky 1978). Hakkarainen, Lonka & Lipponen (2004) have developed this idea into three laws of cultural psychology:

Fundamental laws of cultural psychology (Hakkarainen et al. 2004:125) [4]

First law: ***Learning and skills are products of action, not its prerequisites. (Leontjev, 1978)***

Second law: ***All complicated cultural skills emerge first on social level and only after that on individual psychological level. (Vygotsky 1981; performance comes before competence)***

Third law: ***With the aid of external scaffolding (conceptual, emotional, social) an individual can enhance her intellectual performance. When skills develop an individual can gradually diminish her dependence of the external scaffolding and perform tasks independently. (Wood, Bruner & Ross 1976; Mahn & John-Steiner 2002)***

Later developments of Vygotsky's ideas have gone even further from this "scaffolding" interpretation of ZPD. Activity theory sees zone of proximal development as the distance between the everyday actions of individuals and the historically new form of societal action that can be collectively generated. The work of this *cultural-historical approach* aims at processes of social transformation and go beyond the realm of education. (Lave & Wenger 1991: 49; Engeström 1987: 174; Cole & Engeström 1993)

Cultural psychology created by Vygotsky and his followers is a participation metaphor approach to learning (Sfard 1998; see Chapter 2.1.6). Learning happens through participation in cultural practices. Thinking and reasoning take place in particular situations, learning and cognition are situated (Littleton & Häkkinen 1999: 27). Human cognition and learning are embedded in specific contexts (Brown, Collins & Duguid 1989). Cultural knowledge is also embedded in different kinds of artifacts, it is *mediated* by signs and artefacts (Säljö 1996, Littleton & Häkkinen 1999: 27, Cole & Engeström 1993, Hutchins 1995, Hakkarainen, Lonka & Lipponen 2004, Hakkarainen, Palonen, Paavola & Lehtinen 2004: 65; see section 2.3.3 "Material and conceptual artifacts").

According to the *situated cognition* learning is a matter of participation in a social process of *enculturation* (Brown et al. 1989), *legitimate peripheral participation* (Lave & Wenger 1991) or *cognitive apprenticeship* (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 59). Expertise develops as one becomes a member of expert culture and of *communities of practice* (see section 2.3.5 "Communities of practice")

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[4] The references are from Hakkarainen et al. (2004), and are not my references. They are included here in case the reader is interested in making acquaintance with them.

For situated cognition theory the environment was an integral part of cognitive activity, not only a setting for individual, context-independent cognitive processes to occur (Dillenbourg, Baker, Blaye & O'Malley 1996: 193). This lead to the idea of *distributed cognition* (See section 2.3.3). According to the distributed cognitive approach the unit of analysis is not the individual, it is some larger entity: person plus his immediate surroundings (Perkins 1993), the group (Hutchins 1995), or larger social processes (Salomon 1993a: xiv-xv; Dillenbourg et al. 1996: 193). Cognition can be distributed socially and physically. Intelligence is not a property of mind. It is seen as something which is *accomplished* rather than *possessed* (Pea 1993: 50). Intelligence action is a result of interaction with culturally developed tools and social environment (Knopp 2004:22). Instead of simply learning, groups should create knowledge together by solving problems, by originating new thoughts, and by advancing communal knowledge in a process of *knowledge building* (Bereiter 2002b, Hakkarainen, Palonen, Paavola & Lehtinen 2004: 117). Hakkarainen and colleagues have developed a model of *progressive-inquiry learning* (Hakkarainen, Lonka & Lipponen 2004, Muukkonen, Hakkarainen & Lakkala 1999) elements of which are:

- Creating context
- Engaging in question-driven inquiry
- Generating working theories
- Critical evaluation
- Searching deepening knowledge
- Generating subordinate questions
- Developing new working theories

Collaborative learning is an umbrella term for a variety of approaches in eduation that involve joint intellectual effort by students or students and teachers. Three different theoretical positions can be found: socio-constructivist, socio-cultural and distributed cognitive (Dillenbourg et al. 1996: 190). Originally the theories of collaborative learning were interested in how individuals function in a group. In cognitive psychology social interaction was seen more as a background for individual activity than a as a focus of research in itself. The goal of the research was to find out whether collaborative learning was more effective than learning alone. It was done by controlling several independent variables (size and composition of the group, nature of the task, communication media, and so on). Causal links between the effects and the conditions of collaboration were impossible to establish, because the variables interacted with each other. In the early 1990's the group itself became unit of analysis and the research became more process-oriented. It concentrated on understanding the role which variables play in mediating interaction. (Dillenbourg, Baker, Blaye & O'Malley 1996: 189)

At the same time there were new technologies available. Computers and internet made the research and practice of collaborative learning much easier. Technology-supported asynchronous collaboration among teams distributed geographically had been studied for a long time. The management and sharing of knowledge by using groupware was called computer-supported cooperative work (CSCW). It was a source of inspiration for designers, practitioners, and researchers of computer-supported collaborative learning (CSCL). Today CSCL approach is dominant in the field of collaborative learning. (Lipponen, Hakkarainen & Paavola 2004:31-32)

There is no agreement on the definition of the terms “collaborative learning” or CSCL (Dillenbourg, Baker, Blaye & O’Malley 1996, Dillenbourg 1999, Lipponen, Hakkarainen & Paavola 2004, Stahl 2004, Knopp 2004, Littleton & Häkkinen 1999). The broadest albeit unsatisfactory definition of collaboration is that it is “a *situation* in which *two or more* people learn or attempt to learn something *together*” (Dillenbourg 1999:2; italics in original). There is a debate on “coordination” versus “collaboration”. According to Roschelle and Teaschley (1995; Dillenbourg et al. 1996: 190) the distinction is clear: cooperative work “is accomplished by the division of labor among participants, as an activity where each person is responsible for a portion of the problem solving…” whereas collaboration involves the “…mutual engagement of participants in a coordinated effort to solve the problem together.”

The aim of this chapter was to find methods which would enhance project learning. By definition it is a matter of group or organizational learning and social theories of learning are more interesting than the individual theories of learning (Stahl 2004: 56). Collaborative learning and especially the concepts often related to it - socio-cultural approach, situated learning and distributed cognition – offer a lot to project studies. The unit of analysis is not the individual but the group.

From educational point-of-view the participation metaphor approach can be criticized. The aim of all education is to enhance individual development. If the group learns does it necessary mean that individuals learn? Zone of proximal development has asymmetrical composition and no benefits are seen in reciprocal cooperation. However, heterogeneous compositions might be beneficial as well. Novices may introduce novel ideas and different or even conflicting knowledge bases would offer better grounds for learning or decision making (Hutchins 1991, Janis 1982).

Many of the concepts created by scholars of collaborative learning are well applicable to project studies. Cognitive apprenticeship as a way to become a member of community of practice is one way to describe how project teams are formed (Ruuska 2005). Learning in projects is a very practical matter and situated cognition is the most natural way to approach it. Construction industry is one of the oldest human trades and it is loaded with culturally developed tools.

However, the aim of this thesis is to find better methods for project management. The education of the individuals or socialization in expert cultures is not its focus. Participation metaphor and distributed cognition are applicable, because they can be used to explain how projects learn and how different kinds of artifacts are used in an effective manner. Whether these concepts are feasible in the field of education or even fulfill the criteria of “justified true belief” is out of the scope of this very pragmatic endeavor. Computer-supported collaborative learning is something which works well in classrooms, but nothing like it was available in the two projects studied. It may take a long time before collaborative techniques are applied in public building projects.

The recent development of educational psychology has definitely been a source of inspiration for this thesis, but learning as such is not its subject matter.

2.3.2 Team cognition

There has been a lots of research on small groups in *social psychology*. Social psychology is interested in how people interact with each other in face-to-face contacts and what kind of an impact our behavior has on others (Fiske & Goodwin 1996). The small group setting has been a prominent part of this research early on. The other field interested in these matters is *social cognition*. It studies the ways humans process social data and how our cognitive processes affect each other. Sometimes groups are even seen as information processing units. Social cognition can be defined as social processes related to acquisition, storage, transmission, and use of information for the purpose of creating a group level intellectual product (Fiore & Schooler 2004: 138). *Shared cognition* theories describe how processes on the *intra*individual level are dependent on and interact with processes at the *inter*individual level (Fiore & Schooler 2004: 137-138).

Team cognition is the name for all fields of research studying how team cognition contributes to effective team performance (Salas & Fiore 2004: 3). What is typical of disciplines interested in team cognition is “the notion that shared information processing among group members has both inter- and intraindividual outcomes, whereby constructs such as encoding, storage, and retrieval of information are thought to be equally applicable to both individuals and groups” (Salas & Fiore 2004: 4).

Metacognition is an important part of team cognition. Metacognition is a person’s conception of her own cognitive processes. Metacognition can be seen as a version of lay psychology or “folk theory of mind”. Metacognition of groups “is the way group members understand how groups process information and perform cognitive tasks” (Hinsz 2004: 53). *A mental model* is a person’s mental representation and belief about a system or some other phenomenon. Mental models allow us to generate descriptions of a system and make predictions about future system states (Fiore & Schooler 2004: 138). In a group setting a mental model is an individual’s mental representation and beliefs about the group and the individual’s interaction with the group with a focus on possible outcomes of that interaction (Hinsz 2004: 40). According to Hinsz (2004: 53) these mental representations occur at the level of the individual and in the minds of individuals, there is no group level representations or *group mind*.

The research on team cognition concentrates on mental models and how they are *shared* among team members (Rentsch & Woehr 2004). A *shared model of a team task* includes problem structure, the roles and skills of the team members, and the awareness that each member of the team possesses this knowledge (Fiore & Schooler 2004: 139).

According to team member schema similarity (TMSS), mental models (or schemas) of team members are not necessarily similar. *Congruence* describes how identical they are, *accuracy* how similar they are to the target value or “true score”. If there is high congruence, team members are likely to engage in constructive task behaviors. The social relations model (SRM) studies different perceptions and effects from actor, participant, and relationship perspectives. The *actor effect* represents the response a person elicits with respect to a variety of partners. The *partner effect* represents the response a person elicits from a variety of partners. The *relationship effect* reflects an individual’s behavior towards another specific individual (Rentsch & Woehr 2004: 19).

According to Macmillan, Entin & Serfaty (2004), an effective team must act as some kind of an *information-processing unit*. Team cognition differs from individual cognition, because each member is an individual information processor. That is why communication is needed between individuals. This may cause “*communication overhead*”, because communication requires time and cognitive resources. Macmillan et al. (2004) suggest that team structure and organization should be well planned to avoid extra communication. Teams apply *implicit* and *explicit coordination* (Espinosa, Lerch & Kraut 2004; Macmillan, Entin & Serfaty 2004). Explicit coordination requires communication over plans, actions, and responsibilities, whereas implicit coordination refers to team members´ capability to act in concert without overt communication. Effective teams seem to alternate between explicit and implicit coordination.

Problem solving is said to require an adequate problem definition. Experts in a certain field spend a considerable amount of time representing a problem before solving it (Fiore & Schooler 2004). Research has shown that this is very seldom the case (Fiore & Schooler 2004:135). The first stage in the problem solving is the identification of the problem. In teams this means that all team members have to be aware of the problem. Only after this can the problem be conceptualized, i.e. described and diagnosed (Fiore & Schooler 2004). External representational tools can act as scaffolding for building a shared problem model (Fiore & Schooler 2004).

There is an analogy between early cognitive science and team cognition. They both study information processing units (Fiore & Salas 2004: 235). In neuroscience there are attempts to understand how the variety of sensory channels connected by the brain can produce consciousness. This is called a *binding problem*. The same problem appears in team cognition. Synchronized actions of team members are a necessary prerequisite of excellent team performance (Fiore & Salas 2004: 235). Early writers of team cognition talked about *team mind* or *collective mind*. Today the shared team consciousness is described by words such as awareness or metacognition. According to Fiore & Salas (2004), the binding mechanism of a team bringing coordination to its actions is team cognition.

Hakkarainen, Palonen, Paavola & Lehtinen (2004) give credit to mainstream cognitive science for rigorous experimental research and a rich body of knowledge concerning how the human mind works. However, it has mentalistic and cognitivist presuppositions which are not all swept away by the situated and distributed aspects of cognition. There is still a *cognitivist bias* to be seen. When referring to studies of expertise Hakkarainen, Palonen, Paavola & Lehtinen (2004: 7-8, referring to studies of expertise) claim that the cognitivist bias is manifested in the tendencies:

1. to pay too much attention to mental processes and events rather than concrete activities taking place within sociocultural context and situations
2. to focus on mental representations rather than various external representations, tools and knowledge embedded in the environment that people are using to manage their limited cognitive resources
3. to assume that intellectual processes follow a short timescale of almost instantaneous reasoning processes (e.g. one thinking session) rather than extended across expanded periods of time
4. to presume that intellectual activity takes place at the level of the individual agent, and is primarily dependent on her mental capacities, rather than distributed across several agents and dependent on characteristics of their social organization, such as division of labor, tools and distribution of knowledge and competence across several agents
5. to study processes from the viewpoint of an individual's cognition

Team cognition seems to be able to explain many phenomena related to meaning making in projects. Metacognition, mental models, and theories of coordination can well be applied in the project environment. But what is a project team as an information-processing unit? Is it a set of individuals as processors somehow connected to each other? The question of group mind or group awareness seems to divide the authors. How can several people become one?

Team cognition studies seem to be unable to approach matters of human culture and its importance as the mediator of human thinking (Bruner 1990). The mental model of computer metaphor alone cannot explain all the phenomena studied and the scholars of team cognition seem to be ready to admit this when they introduce concepts like team mind or team awareness.

Team cognition studies differ from distributed cognitive studies. Team cognition looks at expertise from a distance. The role of an expert and her skills are not an object of interest. What do people bring into groups? The analysis of project action should be based on the project network as a whole, including the individuals' roles in it, the artifacts produced, and it should be done in relation to the subject matter. The qualitative approach would better serve the purpose of studying social networks in action than the methods applied by team cognition.

2.3.3 Distributed cognition

In order to be successful, projects have to learn. This happens through knowledge creation and culturally mediated expert action. Knowledge creation and culturally mediated action are key objects of interest for distributed cognitive studies. The basic concepts of distributed cognition are already explained in section 2.3.1. In this section there is a more thorough analysis of the key concepts.

Background

As a term “distributed cognition” is relatively new, but the phenomenon has been around for a long time. It can be traced back to the writings of Wilhelm Wundt and L. S. Vygotsky (Cole & Engeström 1993). The founder of modern psychology, Wilhelm Wundt, divided psychology into two categories: “physiological psychology”, studying immediate experiences using experimental method, and the study of “higher psychological functions”. The former can be studied in a laboratory, but when the latter is studied different methods have to be applied: ethnography, folklore, and linguistics. (Cole & Engeström 1993: 2)

The Russian psychologists Vygotsky and Luria took Wundt’s distinction between the two psychologies seriously. According to them, what separates human beings from animals is mediation through artifacts. Unlike Wundt, they aspired to create a unified psychology with cultural mediation and reached the assumption that cognition is a distributed phenomenon. (Cole & Engeström 1993: 11)

Vygotsky’s cultural-historical theory places individuals’ cognitions *within* the social and cultural context instead of *interacting with* it. This context not only has a strong impact on our individual thinking, but one could also argue “that social processes should be treated *as* cognitions” (Salomon 1993a: xiv). This leads to a reconsideration of the whole concept of cognition.

Distributed cognition can be divided into two main categories: *socially distributed cognition* and *physically distributed cognition*. In physically distributed cognition a person as an actor is enlarged to include the intelligent tools she uses. The object of study is not person *solo* but *person plus* (Perkins 1993; Hakkarainen, Lonka & Lipponen 2004). Socially distributed cognition enlarges this sphere even further: other people and cultural artifacts are included (Hakkarainen et al 2004; Moreland, Argote & Krishnan 1996). This thesis concentrates more on socially distributed cognition. However, physical artifacts are often important carriers of socially shared phenomena and thus they cannot be completely separated from studies of socially distributed cognition. There is an example, the *actor-network theory* (ANT), where the physical tools and artifacts play an important role (Latour 1993; 1999a; 1999b; Law 1994).

Scaffolding and skills

An obvious conclusion made from the three laws of cultural psychology (section 2.3.1) is that the skills offered by the team and the intelligent artifacts are more important than the skills of an individual team member. Thus the general skills needed to exploit the external scaffolding are more important than the specific skills. Without the help an individual gets from the scaffolding, she has to rely on her own skills only, and this is usually not enough.

What makes difference between an expert project manager and a novice are the skills and knowledge the expert has gathered. In a project team an expert can offer external scaffolding for novices. The expert needs scaffolding herself, if she encounters new problems or challenges. One part of this scaffolding are the intelligent artifacts which carry the knowledge and are shared by all team members. The quality of the conceptual, emotional, and social scaffolding a project can offer to the team members is an important project success factor. It is the essential framework needed for project learning.

However, in the studies of project competencies (see section 2.1.5) the emphasis is on individual skills, not on the competencies a project possesses. There is a difference between the rationalistic and the interpretative approach to competence. The latter does not separate work from the worker but see the two as an entity. The very concept of tacit knowledge includes the idea of knowledge transfer between the team members. The interpretative approach to competence is in accordance with the three laws of cultural psychology.

Strong and weak distributed cognition

Is there a danger of going too far in these considerations and rejecting the idea of individual competencies and skills completely and studying the team competencies only? The unit of analysis has been the key issue of distributed cognition (Knopp 2004).

There are two schools of distributed cognition: weak and strong. *Weak distributed cognition* sees the human being in the centre. She is the actor, but her cognition is supported by the distributed means of other people, tools, and artifacts. *Strong distributed cognition* goes even further: the whole system of cognitions is radically distributed and a single actor is not a proper object of study (Hakkarainen, Lonka & Lipponen 2004). “Proper unit of psychological analysis should be the *joint socially mediated activity* in a cultural context” (Salomon 1993a, xv).

Those who speak for weak distributed cognition say that individuals have built social systems and produced all artifacts. An individual cannot be moved from the centre of the picture. Proponents of strong distributed cognition answer that no social system or human culture is built alone, they are all built step by step during thousands of generations. They go even further and accuse weak distributed cognition of being based on false heuristics called *the centralized mindset* (Resnick 1994). We humans have a tendency to see all complex systems and organizations built and designed by a central actor or organizer, even when this is not the case. When we look at a flock of birds or at ants we conclude that they must have a leader, when actually this is *not* the case (Hutchins 1995). Because of the centralized mindset we are often blind to *self-organized phenomena*.

The way people approach public organizations is a good example of the centralized mindset. Public organizations are often seen as centrally organized line-organizations. However, what is typical to public organizations is their self-organized structure, where political bodies and official machinery are delicately balanced in a very complicated manner. There is no single individual in charge of anything.

The dividing issue between strong and weak distributed cognition is the individual’s role in intelligent activity. This issue is fascinating and crucial in the research of distributed cognition. Should the idea of an individual actor be completely rejected and sociocultural phenomena be studied only? The idea would be against common sense (Ruuska 2005: 35), but this is no reason to reject it. Most of the authors address this issue, especially those interested in educational matters (Hakkarainen, Palonen, Paavola & Lehtinen 2004; Salomon 1993b). It looks like most cognitive scientists would be ready to accept the concept of weak distributed cognition to varying extents. However, there are still lots of cognitivist and mentalistic biases to be found among cognitive scientists.

According to Hakkarainen, Palonen, Paavola & Lehtinen (2004: 8) there is a great deal of tension between different approaches and as a solution they propose an integration of approaches that examine human cognition as an individual, communal, or organizational phenomenon. They try to “understand relations and inter-linkages between cognitive and sociocultural approaches” (p.8) and study “the complex and reciprocal relations between individual and collective competences” (p.9). Instead of making a choice between strong and weak distributed cognition they choose both and use them as two separate approaches to the same phenomenon of human intelligent activity. However, there is no assimilation in their approach. The two different angles are preserved. Salomon (1993b: 120-125) comes to the same conclusion by suggesting that the two (the whole system and its parts) work interactively. Distributed cognitions leave cognitive residues to individuals in the form of improved competencies. The improved capacities of individuals affect the system as a whole and this explains how the distributed cognitive system develops over time.

There have been attempts to create one unified approach to human cognition. One very interesting one is by Hutchins (1997). By the time he was developing the concept of distributed cognition based on his observations on the work of a navigation team, he was “fascinated by the nearly perfect mirror symmetry” of two books: Vygotsky’s “Mind in Society” (1978) and Minsky’s “Society of Mind” (1985).

What is the unit of analysis in cognitive science? A unit of analysis should not leave things inexplicable. One should find “a system of systems that can dynamically configure itself to bring sub-systems into coordination to accomplish various functions” (Hutchins 1997: 4). In some cases the traditionally assumed boundaries of the individual are right, in some other phenomena they span too much or too little. “A process is not cognitive simply by virtue of the fact that it happens in a brain, nor is one un-cognitive by virtue of the fact that it happens in the interaction of many brains” (p.4).

Hutchins (1997) found many examples where the cognitive processes normally associated with individuals were implemented in a group of individuals: decision making (Janis 1982), organizations (Morgan 1996: 73-118), and science (Kitcher 1993). If the mind is used as a metaphor of a society or a group, why not use the language of social groups to describe what is happening in a mind? If the mind is seen as a system of sub-systems, this would mean that “the cognition of an individual is distributed cognition too” (Hutchins 1997: 12).

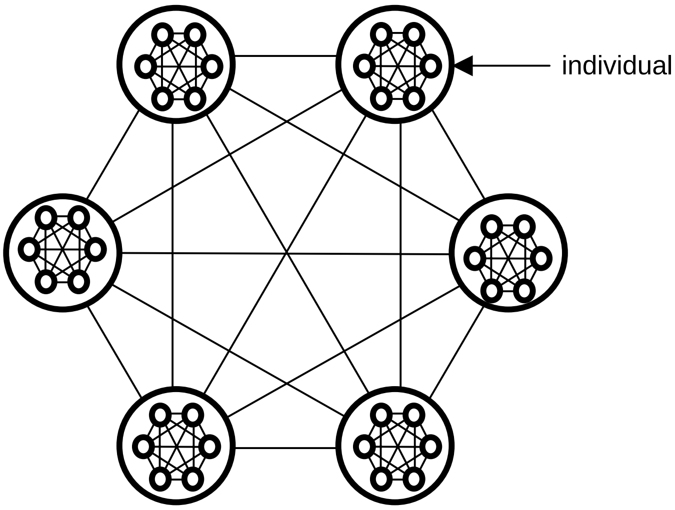


Fig 2.10 “Society of societies of mind” or system-subsystem-structure of distributed cognition by Hutchins (1997)

These “societies of mind” reside and develop in a community of similar societies of mind. Complex patterns arise in the interactions among individuals, patterns which are new to one or all of the participants. Once having been developed these patterns are appropriated by individuals (Hutchins 1997: 13-17). An example is Vygotsky’s (1978) concept of the zone of proximal development. An interesting question is how the decision is made as to which sub-system to use? Hutchins (1997) offers some kind of biological maturation as a solution. The fundamental cognitive processes are thus self-organized.

To really assimilate the two approaches - weak and the strong distributed cognition – the boundary between an individual and his environment should be removed completely and the two should be studied as an interrelated system. There is no boundary anymore between the individual and society, there is a mirror instead that reflects the same, socially created phenomena.

Hutchins’ metaphor has an analogy in intelligent physical networks. They can be constructed in two different ways. Either all intelligence is placed in a central unit, which controls a set of "stupid" sensors and devices, or the intelligence is distributed to a network of several intelligent devices which all have a central unit, memory, sensors, and so on. Devices act independently and in mutual cooperation, but there is often a central monitoring unit as well. The distributed way to organize a network resembles Hutchins "society of societies of mind". The whole is built into all parts, which can communicate with each other. Hutchins (1991) has even simulated this phenomena and the results confirm his hypothesis. In his test the cognitive properties of groups could be produced by an interaction between structures internal to individuals and structures external to individuals (Hutchins 1991: 306).

What is typical of a network is that the links are more important than the nodes. If one wants to understand how a network functions, one should study the links, not the nodes (Barabási 2002). More important than the processing capacities of an individual are her previous network connections. If the network is studied only as a whole without paying attention to the history of individual network history, the properties of the network cannot be analyzed (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 153 and 162). A man is a sum of her previous connections.

The studies dealing with the competencies needed in the new network society (Hakkarainen, Palonen, Paavola & Lehtinen 2004; Vartiainen, Kokko & Hakonen 2004) pay a lot of attention to general skills: the ability to co-operate, engage in social interaction, master foreign languages, and so on. Technical skills are considered very relational and context-specific. What is needed today are general experts capable of dealing with novel and unanticipated situations (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 28 and 32).

The project work is shared between individuals in a network formed by people, artifacts, and tools (Blackburn 2002; Parkin 1996). By only looking at individuals one gets nowhere. All learning takes place on the team level first and only after that on an individual level. However, the whole concept of project management includes the idea that there is a central organizer, *a project manager*. This may be one reason why distributed cognition is not a well known theme in the project management literature. In order to be successful, a project has to learn. The most important task of a project manager is to make sure that the learning scaffolding exists and works properly.

Material and conceptual artifacts

Project learning takes place through an external scaffolding formed by the social structure and intelligent artifacts. Intelligent artifacts are important tools of project knowledge management. They preserve shared knowledge and shared skills and through them the knowledge and skills can be activated. Socially distributed cognition is thus *mediated* through artifacts. These artifacts can be roughly divided into two categories: *material* and *conceptual artifacts*. (Hakkarainen, Lonka & Lipponen 2004: 246-277; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 123-133)

Theories or designs are typical examples of conceptual artifacts. According to Bereiter (Bereiter 2002a; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 123), an increasing amount of human work focuses on conceptual artifacts rather than physical things. Conceptual artifacts have a history, they are created and shared by the community. They have tool-like characteristics and they can be used to explain phenomena or to create new artifacts, conceptual or other. They are means through which the distributive cognition works. We build knowledge through working together with these artifacts and new knowledge becomes embedded in them (Bereiter 2002a).

The new knowledge can be embedded in material artifacts as well. There are many smart tools used in science or navigation (Hutchins 1995), just to give a few examples. Scientific methods and instruments have had a great impact on the development of science (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 128). The creation of artifacts and mediation through artifacts is something very typical to human beings (Cole & Engeström 1993).

Material and conceptual artifacts can get transformed into each other. The activity system by Engeström (Cole & Engeström 1993) is one example, the knowledge-creation spiral by Nonaka & Takeuchi (1995) another. In activity theory this often happens through contradictions and disturbances (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 129). There is a continuum of different knowledge objects from abstract concepts to more concrete ones (ibid:130). *Primary artifacts* are tools and practices directly used by humans. *Secondary artifacts* are symbolic externalizations of primary artifacts. They are embedded in socially shared practices, in organizations, and in shared ideas. *Tertiary artifacts* mediate between primary and secondary artifacts. The theoretical artifacts created by science belong to this category. They are sources of change and transformation and they can explain things and help in understanding them (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 132; Wartofsky 1979).

Summary

The fundamental laws of cultural psychology (Hakkarainen, Lonka & Lipponen 2004) state that all complicated cultural skills emerge first on social level and only after that on individual psychological level and with the aid of *external scaffolding* (conceptual, emotional, social) an individual can enhance her intellectual performance. One part of this scaffolding are the *intelligent artifacts* which carry the knowledge and are shared by all team members. The quality of the conceptual, emotional, and social scaffolding a project can offer to the team members is an important project success factor. It is the essential framework needed for project learning. The most important task of a project manager is to make sure that the learning scaffolding exists and works properly.

Project work is full of examples of both material and conceptual artifacts. Most of the time the project work is done by using designs, time-tables, cost estimates, and other secondary artifacts. But how deeply are things handled on deeper level using tertiary artifacts? According to Engeström (Engeström 1999; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 128) there has not been enough research on the creation and use of artifacts.

A proper method for such research is qualitative inquiry. By collecting all physical artifacts and by interviewing project participants about the use of artifacts a picture of project external scaffolding can be made. This is in accordance with the interpretative approach to competencies. The phenomenological question of how actors experience their work and themselves as an entity is more interesting than mere analysis of the use of certain technologies.

Intelligent artifacts are important tools of project knowledge management. They preserve shared knowledge and shared skills and through them the knowledge and skills can be activated. Socially distributed cognition is thus *mediated* through artifacts. The quality and the use of both material and conceptual artifacts are important project success factors. Project learning and project knowledge management are mediated through the artifacts. Project work can be improved by developing better artifacts and by using them more effectively.

2.3.4 Social theories and distributed cognition

Organizations are instruments created to achieve other ends. Organizations last as long as there are goals to achieve. Projects are organizations with a fixed time-span, they are *temporary organizations*. However, they are organizations and this should be kept in mind. There has to be a system for making decisions, a way to delegate tasks to individuals, or to set boundaries (Argyris & Schön 1978). The way we arrange these things affects the way we perform our shared cognitive activities.

Theoretical frameworks explaining and analyzing social patterns and social structures are called *social theories* (Stahl 2004: 56). In the following some of these frameworks will be described, theories which can be seen as related to the concept of distributed cognition and project life. The starting point of these theories is not the centralized point of order, they see organization more as a socially constructed, self-organized phenomenon.

According to Wenger (1998: 15) *social theories of meaning* are closely related to *theories of practice* and *expertise*. On the opposite axis are the *theories of power*, which are related to *theories of social structure* and *identity* (Wenger 1998: 15). Socially distributed cognition deals with the issues related to meaning, and this is why social theories of meaning are close to it. One important theory of meaning, *sociology of knowledge* or *social constructionism* by Berger & Luckmann (1966) will be presented later in this chapter.

However, there are theories related to social structure which come close to distributed cognition. They are *theories of collectivity* (Wenger 1998:14). Theories of collectivity are interested in the formation of social configurations, both local and global. Distributed cognition is a theory of collective meaning making and issues concerning collectivity have been part of its research. Of the many theories of social psychology the theory of *social networks* has been the subject matter of many studies of distributed cognition (Palonen 2003; Hakkarainen, Palonen, Paavola & Lehtinen 2004).

The theory of social networks is presented in section 2.3.5. When discussing social networks the issues of power and social structure come very close. In the following one important theory of power related to social networks is presented: *the theory of dyads and triads*.

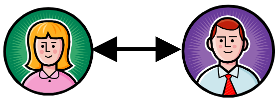


Figure 2.11 A dyad

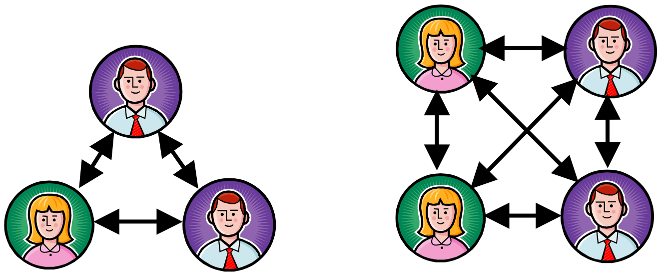


Figure 2.12 Two examples of triads

Dyads and triads

Social life is organized in dyads (pairs; fig. 2.11) and triads (groups of more than two; fig. 2.12). The difference between a dyad and triad is described by Simmel (1958; Berger & Luckmann 1966: 71; Krackhardt 1999). According to Simmel, there are three factors which make triads different from dyads:

1) Dyads preserve the *individuality* of both players. In a dyad the other party cannot be outvoted by others, so she does not have to suppress her interest to that of the others.

2) In dyads the parties have better *bargaining power*. In a dyad a party has the chance to withdraw in case her demands are not met. In a triad this would lead to isolation from the others.

3) Conflicts are more easily managed and dissolved in a triad. In dyads *conflicts easily escalate*, and positions harden. In triads the mere presence of the third party moderates such positions.

Simmel's three triadic forces contribute to the group's survival and identity. They do this at the expense of the individual, who has to deal with less freedom, less independence, and more constraints as a member of a group (Krackhardt 1999). The third party can have divisive forces under two conditions:

1) *Tertius Gaudens*, in which the two other parties have a weak relationship and are mainly related to each other through the third party. The third party can take advantage of conflicts.

2) *Divide et Impera*, where the third party actively separates the two to maintain supremacy.

Simmel was interested in dyads and triads (cliques). Larger blocks played a minor role. The most fundamental was the shift from dyad to triad; further expansion did not modify the group any further. (Krackhardt 1999: 186)

Sociology of knowledge or social constructionism

Projects are temporary organizations often put up in a haste. Project plans often describe the project organization in a very sketchy manner. More important than the official, written description of organization are the participants´ underlying assumptions of it. A project manager and team members have to know these assumptions if they want to succeed.

According to social constructionism all organizations are born in a self-organized process called *institutionalization*. To survive everyday human interactions we need routines and scripts. They save our energy for more important considerations. This is the simplest form of institutionalization. We construct social structure and then act upon it. Later, these structures become objectified, they become reality. Certain institutions become even *reified*, we forget their human origin (the catholic church, marriage; Berger & Luckmann 1966; Huysman 2004; Scott 1995).

The level of institutionalization varies. Certain societies are more institutionalized than others. In such societies one shared structure becomes impossible to maintain and rival institutions or realities (sub-universes of meaning) appear. This happens when the division of labor increases and subcultures of experts are born. This rival action can be accepted if it is not a threat to the existing reality. Otherwise it will be either destroyed or melted. Modern societies are pluralistic and they accept the existence of the sub-universes. Intellectuals live in these sub-universes of expert cultures as some kind of outcasts. (Berger & Luckmann 1966)

According to Berger and Luckmann (1966), we create the social world and this social world thus becomes objectified: we perceive social phenomena like we perceive objects in nature. In the course of socialization this objectified social world is retrojected into our consciousness. We have created the social world but we ourselves are creations of the social world. “The product acts back upon the producer” (Berger & Luckmann 1966, p.78).

Unlike animals, human beings are open, but this openness is a problem. That is why we have created the social world which defines us. The animal in us does not disappear in society. However, society has an effect on our biology. An example of this are differences in the expected lifetime or sexual behavior (Berger & Luckmann 1966, pp. 203-204). Society also shapes our mental structures. The appropriation of cultural tools has changed the way we think or process information. Learning to read and write has had on immense effect on human thinking. We live in a world on paper. (Olson 1994; Hakkarainen, Lonka & Lipponen 2004)

The project life, the artifacts produced, the papers written are not only tools for achievement of the project objectives, they *are* the project. Through these artifacts the project has a life of its own. Even more, these artifacts and social creations *form* the reality to the people in the project.

They define the world were the team lives, and there is no place outside it for the project team. The project becomes a prison, but an invisible one for the team. Invisible, because from inside it is impossible to see the limitations the project life sets on the team.

What is the role of an individual in this theory? In this frame of thought one is not interested in what a person *is*, but what he *represents*. In the socially constructed world a person is what she represents, she has a socially constructed identity. Intelligent actions are more dependent on the socially constructed identity than on the biological properties of an individual.

The process in which newcomers become members of expert subcultures or sub-universes of meaning is very important for both newcomers and to the subculture itself. Institutionalization means “that types of behavior in types of situations are connected to types of actors”. (Berger & Luckmann 1966, pp. 85-87; Huysman 2004). Institutions are represented in roles. A judge represents the law-institution. There are other representations like language and artifacts, but roles are the most important. Knowledge is socially distributed. Certain roles require access to certain knowledge deposits, but it is as important to know which roles possess what role-specific knowledge. Society exists when individuals are aware of it and the individual’s consciousness has a social origin (Berger & Luckmann 1966). Personality is a social construct needed and developed for the purposes of the modern division of labor (Eskola 1985).

According to Berger and Luckmann (1966), we become members of society in the process of primary socialization. This takes place in our families by our parents or by other significant others. Primary socialization stays, there is no world outside it to us. A secondary socialization is needed when we later become members of other institutional sub-universes like certain expert cultures. A secondary socialization is based on primary socialization and there are no significant others needed. The relationships between teachers and pupils are much more vague. Secondary socialization is not as permanent as primary socialization and it can be swept away if necessary. However, the strength of a secondary socialization varies. Certain sub-cultures demand more loyalty than others. This may lead to conflicts between what is adopted in the primary socialization and what is demanded in a secondary socialization (religious groups or certain professions as examples). There may also be conflicts between expert sub-cultures when they fight for power and possession of the right knowledge.

Fragmentation is often seen as a major problem in the field of project management in general and in building projects especially. The architectural profession is a good example. Architects were first educated only by apprenticeship. This tradition lasted in Great Britain well into the 1930´s. The architectural profession wanted deliberately to define itself as a group of independent gentlemen, detached both from clients and constructors. (Crinson & Lubbock 1994; Hindle & Rwelamila 1998)

Institutionalization leads to a very rigid structure of organizations. Their origin is in the mists of history and the reason for their existence is long forgotten. There is a demand for independent action. Modern organizations cannot survive without some kind of a counter-action of sub-cultures. There are two structures which serve this purpose: informal networks of experts and projects or teams. Communities of practice can be both networks and teams or projects. (Garrety, Robertson & Badham 2003; Huysman 2004; Wenger 1998, Wenger, McDermott & Snyder 2002)

Summary

Projects are temporary organizations. Teams are often formed in haste, and there is a certain amount of power plays inside the team and between the team and the outside organization. This is a natural result of the fact that most of the project results are temporary, borrowed from somewhere else (Frame 1995). The research of projects as social organizations should concentrate on the ties inside and outside the team. As the theory of dyads and triads suggests, the situation is not stable. It changes dynamically when each party tries to overcome the others or attract them to cooperation. This kind of dynamism is very typical of public organizations which are ruled by political parties and professional organizations. It could be assumed that a certain amount of dynamism inside a project team is good and prevents groupthink phenomena, but too much dynamism makes a project unstable.

Members of the team do not come from nowhere. They are members of different organizations and institutions. Problems arise when the socialization to these other institutions is stronger than the team members' socialization to the project. This will affect their commitment to the project objectives. The fact that the members of the team are members of their specialist sub-cultures should be kept in mind when projects are studied. It is an important factor having an effect on how the system self-organizes itself.

There is a way to overcome the problem of institutionalization and the rigidity it exerts on projects. Through reflective practices (section 2.1.4) it is possible to unlearn old ways and to let go of old habits. This is not easy and it consumes lots of time and energy. A successful team will discuss these matters and invest in reflective practices if necessary.

2.3.5 Social structures supporting learning

Organizations are rigid products of institutionalization that may hinder project learning. Professions and other subgroups working in them form sub-universes of their own which partly overlap organizational borders (Brown & Duguid 1991; Fong 2003). There are continuous conflicts between different realities and fighting for power (Berger & Luckmann 1966; Law 1994). Because of their centralized mindset, actors, especially those in management, try to cure the conflicts by methods which make them even worse: by using force, by persecution or by giving more and more canonical orders (Brown & Duguid 1991; Senge 1994). Experts are allowed to work within very strict limits and in their interior war they make sure that nobody exceeds those limits. This kills all circulation of knowledge inside organizations. External formality that comes from the organization may be enhanced by the internal formality that comes from the expert communities (Ruuska 2005: 184) in a very counterproductive manner.

Project organizations have been one solution to this problem. If a certain task involving the use of different kinds of knowledge and the collaboration of experts from different fields has to be done, a project organization is formed. There are several ways to do it (Garrety, Robertson & Badham 2003). The leadership can be given to a certain group of experts (projects assigned to the functional section of a larger organization) or then a *pure project organization* is formed. A combination of these two is a *matrix* organization, where the experts still belong to their home organizations, but the project is controlled by a project manager. The general idea in all project organizations is to bypass the problem of different realities by forming one shared project reality. This seldom works, because people are not socialized to the project context, they preserve their original roles as members of their home communities. Projects are temporary organizations by definition and they have to borrow resources from the larger organizations. This is a source of continuous conflict (Frame 1995). Many project teams can be seen as abstractions (Ruuska 2005: 172). The situation is, of course, better if it is a question of a long lasting, big project where a pure project organization is used.

According to social constructionism organizations seem to prevent learning, not enhance it. In section 2.1.4 some methods of overcoming these problems were described. There are also social structures which support learning. These learning networks are often larger than the project organization itself and even larger than the parent organizations.

Networks (Barabási 2002)

Networks are platforms for any other forms of organization. Before going to social networks or any other special networks, it is good to have an overview of the general theory of networks.

Network theory studies all kinds of networks: air traffic networks, computer networks, social networks, to mention just a few. Typical to a network is that it is formed by nodes and links connecting the nodes. The basic type of a network is a *random network*, where nodes and links are evenly distributed. Highway network is a typical example of a random network. The problem with a random network is that one has to go through many links to get from one place to another. This is called *network distance*: the amount of links between two places.

The degree of separation describes the overall quality of a network: how many links there are on average between two randomly chosen points. The degree of separation in a social network of all human beings is six. Every individual on the planet Earth is six links away from any other person (on average). The degree of separation of the internet is nineteen: any two internet sites are nineteen links or “clicks” away from each other (on average). This is possible, because these networks are not random: there are short-cuts which make the world smaller (fig 2.13).

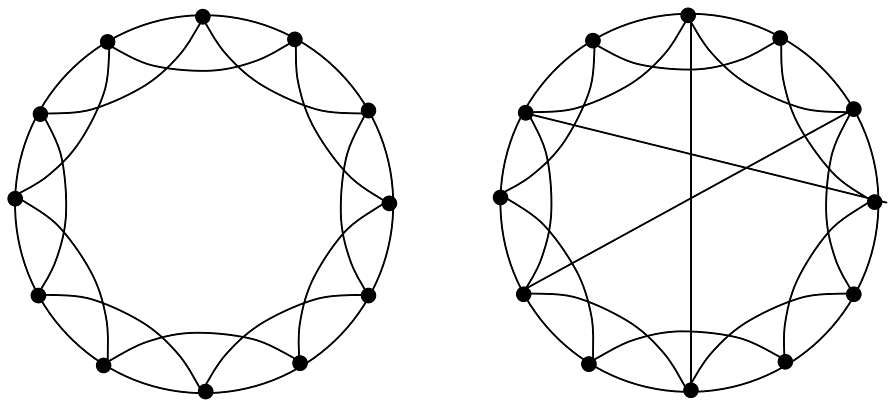


Figure 2.13. Short-cuts make the separation smaller in a network (Barabási 2002: 51)

Social networks and the internet have a small degree of separation, because they have “hubs”: super-nodes to which there is a link from most of the other nodes. A network based on few hubs and plenty of nodes with only a few links is called *a scale-free network*. Air traffic network is a typical example of a scale-free network. There are hubs like Heathrow and Paris De Gaulle and lots of unimportant small airports. If you can get to Heathrow from one of the small airports, you can get to almost anywhere from there. The internet is another example of a scale-free network.

Scale-free networks are not as vulnerable as other networks. If any one of the small nodes collapses, it does not affect the larger network. If one of the hubs collapses, the other hubs can take its place. Scale-free network collapses only if most of the hubs collapse at the same time. This is a very rare incident, if the probability of a collapse is the same for all the nodes.

A hub is born on a random basis, there is usually nothing special in the node itself. The longer the node has been around, the more network ties it has collected. If a node has collected lots of ties already, all the others want to be connected to it, to make their own position in the network better (“winner takes all”). The hubs are most probably the oldest nodes in the network.

Social network theory

The world of knowledge is populated by institutions, roles, informal communities, projects, and so on. According to the centralized mindset there is no way out of this jungle: it is not possible to imagine an organization or any center which could bring order to this chaos. However, self-organized processes rely on a system’s capacity to somehow reorganize itself. This organization is called *the social network*.

People need knowledge and information and they get it through their personal, *intentional networks*. These personal networks have become more important than institutional ones (Hakkarainen, Lonka & Lipponen 2004; Nardi, Whittaker & Schwarz 2000). They are egocentric by nature and cross organizational boundaries. Nardi et al. (2000) use the term intentional, because these networks are deliberately created, maintained, and from time-to-time activated by individuals. When networks are in the phase of pure maintenance, the ties are weak, even though kept in good repair by feeding them on a regular basis. When a need for resources appears, the network is activated and may lead to a project and stronger ties. After the project is over, the ties become weak again. The strength and weakness of ties are not so much stable properties of an intentional network as they are variable manifestations of ongoing processes of network activation

There are different kinds of networks inside an organization (Ruuska 2005: 59, referring to Krackhardt & Hanson 1993): e.g. *advice networks* (who helps whom), *trust networks* (for distribution of delicate information and trust in a crisis), *communication networks* (discussion about work-related matters), or some other kind of informal networks. Networks are looser than *communities*. In a network mutual meaning making is not necessary. For the purposes of knowledge creation, people belong to different communities and from them they get resources, support, and through them they learn. These communities can be professional communities, teams, communities of practice, virtual communities, etc (Ruuska 2005).

The problem with this kind of a self-organized network or a community is that they are not evenly distributed, but are clustered and have *structural holes* (Burt 1992; 1999; Moreland 1999) which prevent the flow of information. People on both sides of this kind of hole may not be aware of the possibilities of mutually beneficial cooperation. What is needed are *knowledge brokers*, persons who can fill such gaps. They escort people over the holes and build connections. These *information gatekeepers* have important roles in their own communities and in the network as a whole. They are often members of several communities.

Granovetter (1973) introduced the theory of weak ties in a network. All links in a network are not similar with regard to their strength. He found four characteristics in social network links which vary: *the amount of time, emotional intensity, intimacy* (mutual confiding), and *reciprocal services*. Granovetter concluded that if ties between members of a network are divided into two categories, strong and weak (and of course, absent) ones, the bridging ties between the clusters have to be weak ties. Strong ties exist inside the clusters and the clusters are connected with each other by weak ties. One of his examples was the job market: people get employed through their acquaintances, not through their closest friends. Acquaintances opened them up to a much larger base of information.

Palonen, Hakkarainen, Talvitie, and Lehtinen (2003) have pulled together the characteristics of strong and weak links based on the theories by Nonaka and Takeuchi (1995), Granovetter (1973), Hansen (1999) and Barabási (2002). The synthesis is presented in Table 2.2.

Table 2.2: Nature of information sharing and strength of links in networks (Palonen et al. 2003: 277).

Characteristic of knowledge exchange	**Strong tie**	**Weak tie**
Information flow	Redundant and reciprocal	Non-redundant and often asymmetric
The nature of knowledge exchanged	Usually complex	Simple or well-defined
Form of knowledge	Often non-codified or tacit	Often codified and transferable
Relation to knowledge environment	Context-bound, i.e. a part of larger knowledge structure	Often context-free and independently understandable
Type of communication	“Thick”, including chunks, expert terms, and scripts	“Thin” and widely understandable
Management of network connections	Usually takes up a lot of resources	Not so many resources needed

Strong links are typically links between the members of the same community. The members of the community have strong mutual relationships and they know each other well. They share the same language, and even complicated matters can be easily explained to others. Tacit knowledge is easier to transfer inside the community. The quality of links is more important than their quantity. (Hakkarainen, Lonka & Lipponen 2004; Palonen et al. 2003).

Important information in communities and in other small groups is the knowledge of who knows what and who has what abilities. This is called *transactive memory* (Hakkarainen, Lonka & Lipponen 2004; Moreland, Argote & Krishnan 1996; Moreland 1999; Palonen 2003; Wenger 1983). Transactive memory enables the group to divide labor and memory functions more effectively, each member of the group can concentrate on her special area. Members of the group use each other as an extension of their own memory (Stasser, Stewart & Wittenbaum 1995). This communal *metaknowledge* helps the information search, memory storage, and retrieval (Palonen 2003) of both the group and its individual members. Without transactive memory the knowledge *everybody knows* might be overemphasized in groups (Hakkarainen, Lonka & Lipponen 2004).

Strong links inside the community and transactive memory have their downsides, though. Members of the group may rely on each other too much and not develop their own capabilities and thus become “free riders” (Palonen 2003; Moreland 1999). If the links inside the group are too strong and the links outside non-existent, soon the same knowledge circulates inside the group. This may lead to the groupthink phenomenon (Janis & Mann 1977; Janis 1982; Palonen 2003). Weak links and knowledge brokers are needed so that groups get new ideas and innovations (Granovetter 1973; Hakkarainen, Lonka & Lipponen 2004; Palonen 2003). Weak links serve the same purpose in the life between groups as does transactive memory inside groups: they make specialization possible and enhance the knowledge flow and exchange between groups and individuals.

It looks like homogenous networks could not work and that small groups work better if their members have a different but partially overlapping expertise (Hutchins 1995; Palonen 2003). The same seems to apply to the network as a whole. Integration is needed for the deeper processing and diversity of circulation, exchange, and creation of knowledge.

Networks consist of human and non-human actors. In the actor-network theory (ANT: Latour 1993; 1999a; 1999b; Law 1994; Blackburn 2002; Palonen 2003; Parkin 1996) these both form a dynamic interactive network of influences. They form clusters which try to define the situation in terms favorable to their own interests, enroll other actors to their point-of-view, and thus control other actors' reactions to events. The network is controlled by these powerful "centers of translation" or "centers of ordering". They channel, select and manipulate the flow of interactive processes, information, and technology.

Intelligence is not purely an individual property. It is distributed to a system of colleagues and tools around an individual. These help us exceed the limits of our own intelligence (Hakkarainen, Lonka & Lipponen 2004). Distributed cognition does not study intelligent individuals but intelligent networks.

Networks can be studied by using statistical tools. Krebbs (2004) defines social network analysis (SNA) as the mapping and measuring of relationships and flows between people, groups, organizations, computers, or other information/knowledge processing entities. The nodes in the network are the people and groups, while the links show relationships or flows between the nodes. SNA provides both a visual and a mathematical analysis of human relationships. The analyses can vary from very mathematical to non-mathematical. Usually data for a network analysis is gathered by asking individuals to tell about their social relationships with other individuals. Relationships can represent many different things: individual evaluation (e.g. liking, disliking), moving material resources (e.g. buying, borrowing), moving non-material resources (e.g. communication, helping), official or family roles, etc. (Johansson, Mattila, Uusikylä 1995; Palonen 2003).

Where do projects fall in this web of overlaying networks? This question has seldom been asked. There are some studies of projects as actor-networks (Parkin 1996; Blackburn 2002) and SNA analysis of projects (Mead 2001). Projects are temporary organizations, often very intensive. It could be assumed that during their life-cycle they become communities of some kind. However, many weak links are typical of projects, both inside the project itself and between it and the outside world. The distributed cognition of a project takes place in the project network. If one wants to study project cognition, the mapping of a project network, its changes, and its different qualities is essential.

It would be helpful if the project manager tried to stay outside all the cliques and adopted the role of knowledge broker. It seems that it would be preferable to have many weak ties instead of a few strong ones.

Communities of practice

One special form of communities are *communities of practice.* In order to learn and share knowledge actors have formed informal groups of professionals or experts who share certain interests or activities (Wenger 1998; Wenger, McDermott & Snyder 2002; Lave & Wenger 1991; Brown & Duguid 1991; Ruuska 2005). These groups often exceed the organizational limits. Members are in direct contact with each other and they have reciprocal relationships. They develop their own rules and routines, they even have their own language or jargon. Learning leads to shared practices and tools. Narratives are important tools, they are shared stores of knowledge. Members of a community of practice are aware of who is a member and who is not and they are committed to the community's existence and upkeep. (Garrety, Robertson & Badham 2003; Hakkarainen, Lonka & Lipponen 2004; Orr 1990; Ruuska 2005; Wenger 1998)

Communities of practice are not hierarchically organized. However, they can solve problems quickly and activate many kinds of resources (Brown & Duguid 1991). Members of the community know each other's strengths and weaknesses, they also know what others know and what kinds of skills they possess. They have *metaknowledge* about their shared knowledge base formed by each other's knowledge and capacities (Hakkarainen & al. 2004; Ruuska 2005).

Whether communities of practice are institutionalized sub-universes or not is an interesting question (Berger & Luckmann 1966). They share certain characteristics like shared language and tools, but they do not get new members through a strict socialization process. However, some kind of a legitimate peripheral participation can be associated with communities of practice, but not in the sense of a deeper socialization process. The overall structure of communities of practice is so loose that they can hardly be called institutions. The research on communities of practice has shown that the level of institutionalization varies: some communities are completely informal, some can be called semi-formal, or even formal (Ruuska 2005).

Huysman (2004) argues that the informal character of communities of practice is a problem. According to her, communities of practice support externalization (sharing) of knowledge and internalization of knowledge (embedment) but they do not objectify knowledge (make it commonly accepted). This means that the parent organizations do not learn through communities of practice.

What makes the difference between community of practice and innovative knowledge communities (IKC) is their different approach to *crystallized* and *fluid knowledge* (See section 2.1.6: Hakkarainen, Palonen, Paavola & Lehtinen 2004: 141; according to Bereiter 2002a). Communities of practice function in stable (first order) environments, where knowledge is crystallized and embedded in tools and practices. IKC's environments are much more turbulent and changing second order environments where the fluid knowledge and skills have to be derived from the participant's collective knowledge resources and exploratory activities.

There are important distinctions between projects and communities of practice (Garrety, Robertson & Badham 2003). The first and fundamental distinction is that communities of practice are informal organizations, whereas projects are not. Projects are always founded by the organization, they have a legitimate status, when communities of practice have a non-canonical status (Brown & Duguid 1991). Projects are clearly instrumental, when communities of practice seldom are. Projects have a definite point when they are completed. Communities of practice usually go on as long as the members have a shared interest. Projects have no collective history and no collective future, they do not produce narratives for further use (Garrety et al. 2003; Kasvi, Vartiainen & Hailikari 2003).

There are similarities, too. Both projects and communities of practice are collections of people from different organizations or parts of an organization. The members of a project team may belong to several communities of practice (Garrety et al. 2003). A project's subject matter may overlap with a certain community of practice. This happens, e.g. if people interested in project management form a community of practice. However, it is important to notice that communities of practice and projects serve different purposes and that is why they should not be mixed with each other. In a project-based organization there may be overlapping structures of the parent organization, projects, and communities of practice (Ruuska 2005).

The transactive memory is part of a functioning team. More than social team building, members of the project team need to be acquainted with each other's abilities and knowledge (Moreland, Argote & Krishnan 1996). The project manager's major concern should be the metacognitive skills of the team.

The research on communities of practice in project-based organizations (Ruuska 2005) suggests that there is an overlap between the projects, communities of practice, and parent organizations. However, these studies concentrate on the community networks which expand over several projects and several organizations. It would tell more about the nature of project work as cognitive actions, if the unit of analysis were a single project and its relation to different communities of practice was studied. It would be interesting to know whether the overlap of a community of practice and a project can be 100%. Can a single project be a community of practice - even temporarily?

Summary: different forms of organizations compared

In Table 2.3 there is a comparison of different sorts of network organizations, communities, and projects. A random network can hardly be called an organization, because there is no goal[5], and that is why it is omitted from the table. The traditional hierarchical organization is included for means of comparison. However, the parent organizations (especially public ones) are often traditional organizations. In a matrix organization the parent organization and the project have an overlap, matrix organizations are a combination of both.

[5] In an intentional network there is a goal of an individual owner of the network, which may finally become a goal of a new project (Nardi et al 2000)

Table 2.3: Different forms of network organizations compared with projects and their parent organizations (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 145-146; Nardi, Whittaker & Schwarz 2000; Ruuska 2005: 177)

	Traditional hierarchical organization	**Project**	**Intentional network**	**Community of Practice**	**Innovative Knowledge Community**
Definition	A permanent organization for achievement of certain goals	A temporary organization for achievement of the project goals	"Egocentric" networks that arise from individuals, their communication and workplace activity	A group of people who share an interest, and who deepen knowledge of the area by interacting	A community of practice aimed at creation of new knowledge
Focus and goals	To routinely accomplish tasks and attain goals of the organization	To accomplish project objectives	To function as a resource and knowledge repository	Creation of practices that allow the community to function routinely.	Progressive problem solving for supporting knowledge creation
Organization	Deliberately designed. Formal.	Deliberately designed. Formal.	Deliberately designed by a person. Informal.	Self-managed, voluntary membership. Usually semi-formal.	Deliberately designed. Semi-formal.
Organizational support	Self-nominated source of authority.	Official nomination by parent organizations	No support.	Require recognition and legitimation of participation	Require recognition and legitimisation of participation
Coordination and facilitation	Hierarchical authority.	Project manager in charge of a project team. Level of hierarchical authority varies	Leader is organizer and a contact maker.	Depends on the level of formality. No hierarchical authority. Leader is an organizer and contact maker.	Depends on the level of formality. No hierarchical authority. Leader is organizer and a contact maker.
Activities	Organizational routines.	Project tasks.	Maintenance of the network.	Ongoing interaction. Conversations and storytelling.	Ongoing interaction. Creation of knowledge objects.
Nature of network	Strong ties. Focus is on core.	Strong ties inside core, outside ties vary	Weak ties. When ties become strong, network becomes a project.	Strong ties inside core, random and unsystematic outside	Strong ties inside core, deliberately created heterogeneous ties outside
Environment	First order. Stable parent organization	Second and first order. The importance of parent and project organization vary	Second order. Completely independent of parent organizations.	First order. Inside parent organization/s which are in stable conditions.	Second order. Parent organizations adapting to change.
Role of knowledge	Instrumental. Crystallized and embedded in tools and practices	Instrumental. Fluid knowledge transformed into crystallized form.	Instrumental. Fluid knowledge main interest	Instrumental. Crystallized and embedded in tools and practices	Creation of knowledge. Fluid knowledge transformed into crystallized form.
Distribution of competence	Asymmetric and homogenous	Asymmetric and heterogeneous	Symmetric and heterogenous	Asymmetric and homogenous	Symmetric and heterogenous
Outcomes	To secure the future existence of organization.	Project outcomes	Resources and knowledge, projects	Personal and community learning benefits	New knowledge

2.4 Summary

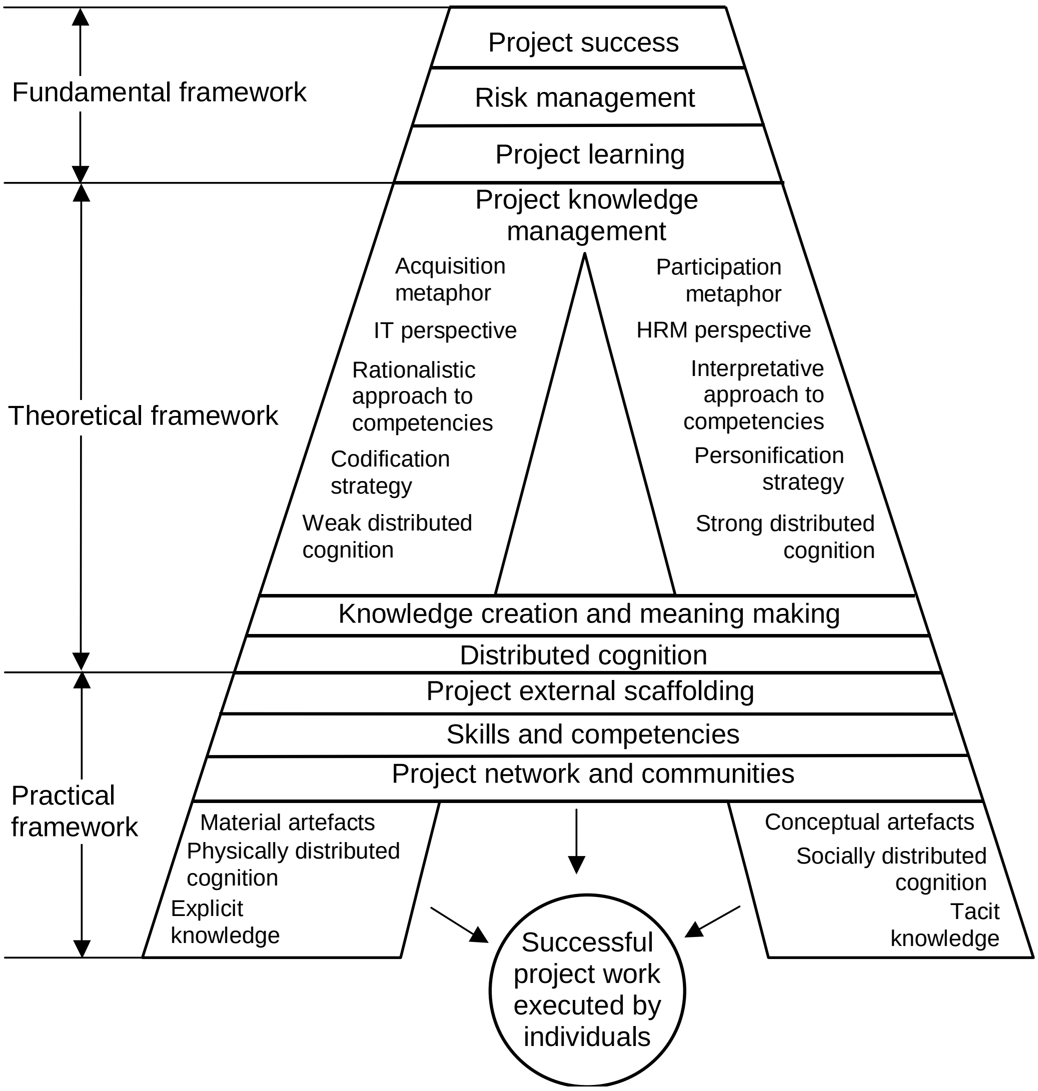


Figure 2.14. Project seen as distributed cognitive actions

This literature research aimed at studying aspects related to project failure: why projects fail and what is a successful project like. It is now possible to draw a picture of the whole theoretical framework created so far. It can be divided into three sections:

- **The fundamental framework,** including the essential factors of project success: project success factors, project risk management, and project learning.
- **The theoretical framework** needed to analyze the factors which make the projects successful: project knowledge management, knowledge creation, meaning making, and distributed cognition.

- **The practical framework** which helps to execute the project successfully: project external scaffolding, skills and competencies, project network, and communities.

The fundamental framework deals with project goals. The theoretical framework helps to understand project work and gives tools for analysis. The practical framework describes what is actually done in projects. For the projects to succeed and to reach the goals set by fundamental framework, the practical framework needs to be analyzed by using a theoretical framework. All betterment of project work has to be based on such analysis.

2.4.1 Summary of the fundamental framework

Project success is a very complicated matter. There is short-term *project management success* and long-term *project success*, i.e. how beneficial the project was to the client. The *success factors* differ from *success criteria,* and these two are often confused. (section 2.1.2)

A project is a successful one if no fatal *risks* materialize in an unfavorable manner. Most of the fatal risks are related to the project *environment*. To be successful, projects have to adapt to their environment. This happens through learning. (section 2.1.3)

The problem with public building projects is that the learning strategies are made for stable environments. In present, turbulent environments these will not do anymore. In order to learn, projects have to be designed to learn. It could be concluded that project knowledge management is an essential success factor. (section 2.1.4)

2.4.2 Summary of the theoretical framework

Traditional project management literature has not been interested in knowledge management issues from a human resources perspective (section 2.1.5). This is caused by the mentalistic, cognitivist, and individualistic biases of the project management literature. It is based on a "folk psychology“ way to approach human cognition called *acquisition metaphor* of learning. The metaphors of learning called *participation metaphor* or *knowledge creation metaphor* have seldom been applied to project management studies. They are both part of a larger concept or field of studies called *distributed cognition*. (section 2.1.6)

In a turbulent modern environment, even in a public sector building project, data has to be processed into information, meaning has to be given to information, and knowledge has to be created in the act of *meaning making*. An information processing perspective to knowledge management is fundamentally restricted, because it cannot deal with cultural mediation. A human resources perspective is better, but it can also be approached from a very individual perspective: individuals discussing the meanings and making deliberate agreements on different meanings. In this thesis *distributed cognition* is chosen as the theory on which to base the studies of project success factors for the following reasons:

- There are no mentalistic or individualistic assumptions.
- Distributed cognition can explain and describe methods of cultural mediation.
- Practical implications can easily be based on the concept of distributed cognition.

A *qualitative inquiry* based on interviews of project participants is a very suitable method of research if the object of study is the process of meaning making. Better methods of project management based on such analysis should make projects more successful. (Chapter 2.2)

2.4.3 Summary of the practical framework

Distributed cognition can be described "as several agents sharing cognitive resources of symbolic knowledge, plans, and goals, to accomplish something that one agent could not achieve alone" (Oatley 1990: 102). It can be divided into two main categories: *socially* and *physically* distributed cognition. There is also a *strong* and *weak* version of distributed cognition. The strong version does not see the individual as a feasible object of studies. The other fields of studies near distributed cognition are *sociology of knowledge* or *social constructionism*, *cultural psychology, the theory of networks*, and the concept of *communities of practice*. (sections 2.3.1, 2.3.3, 2.3.4, and 2.3.5)

It is understandable that there are no references to distributed cognition in the project management literature. Distributed cognition has not yet established its position inside the community of cognitive psychologists. The cognitivist bias is still strong (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 8), and mentalistic and computational assumptions prevalent. It will take years before distributed cognition becomes mainstream in this area.

The quality of the conceptual, emotional, and social scaffolding a project can offer to the team members is an important project success factor. It is the essential framework needed for project learning. The most important task of a project manager is to make sure that the learning scaffolding is in place and working properly. In projects this learning scaffolding consists of things like project social network, project documents, project IT-systems but also conceptual artifacts like the shared understanding of theories behind different project methods (e.g. cost estimation systems, allocation systems and so on). All these project objects can either support learning or hinder it. The part of the scaffolding this thesis concentrates on is the project social network. (section 2.3.1)

Intelligent artifacts are important tools of project knowledge management. They preserve shared knowledge and shared skills, and through them the knowledge and skills can be activated. Socially distributed cognition is thus *mediated* through artifacts. These artifacts can be roughly divided into two categories: *material* and *conceptual artifacts*. Material artefacts are tools like computer programs or even very practical tools (pencils, measures). Conceptual artifacts are non-material, like a theory of construction economy. These two are connected: the theory of construction economy is needed for creation of a computer program for cost-estimating. The quality and the use of both material and conceptual artifacts are important project success factors. Either the theory of construction economy can be wrong or the program poorly written or difficult to use. All these factors affect project learning. Project learning and project knowledge management are thus mediated through the artifacts. Project work can be improved by developing better artifacts and by using them effectively. (section 2.3.3)

The research of projects as social organizations should concentrate on the *ties* inside and outside the team. As the theory of *dyads* and *triads* suggests, the situation is not stable. It changes dynamically when each party tries to overcome the others or attract them to cooperation. This kind of dynamism is very typical of public organizations which are ruled by political parties and professional organizations. It could be assumed that a certain amount of dynamism inside a project team is good and prevents groupthink phenomena, but too much dynamism makes a project unstable. (section 2.3.4)

Projects are temporary organizations often put up in a haste. Project plans often describe the project organization in a very sketchy manner. More important than the official, written description of organization are the participants´ *underlying assumptions* of it. A project manager and team members have to know these assumptions if they want to succeed. There is a way to overcome the problem of *institutionalization* and the rigidity it produces to projects. Through *reflective practices* it is possible to unlearn old ways and to let go of old habits. This is not easy and it consumes lots of time and energy. A successful team will discuss these matters and invest in reflective practices if necessary. (section 2.3.4)

According to *social constructionism,* organizations seem to prevent learning, not enhance it. There are also social structures which support learning. These learning *networks* are often larger than project organization itself and even larger than the parent organizations. There are different kinds of networks inside an organization (Ruuska 2005: 59, referring to Krackhardt & Hanson 1993; section 2.3.5)

All links in a network are not similar with regard to their strength. *Strong ties* exist inside the clusters and the clusters are connected with each other by *weak ties*. The quality of links is more important than their quantity. Projects are temporary organizations, often very intensive. Many weak links are typical of projects, both inside the project itself and between it and the outside world. The distributed cognition of a project takes place in the project network. If one wants to study project cognition, the mapping of a project network, its changes, and its different qualities is essential. (section 2.3.5)

2.4.4 Some methodological considerations

If we look at studies of project success factors (see Crawford 2000:4 for an example), we get long lists of different factors. These factors are usually rated and the most important factors are analyzed. Some studies concentrate on single factors considered as the key success factors (e.g. competencies, see section 2.1.5). Most of the studies are based on surveys sent to project managers and project personnel. The data is then analyzed by using statistical methods.

Someone has said that if we have a hammer, all problems look like nails. The same applies to the studies of project success factors. Researchers have looked for single factors and that is what they have found. In terms of distributed cognitive action, this will not do. It is the whole frame that matters, not the bits and pieces.

Due to this bias many more studies have been made of issues on the left side of fig. 2.14 than the right side. Competencies are a good example. It is much easier to start from the rationalistic approach to competencies and make long lists of different attributes than it is to do phenomenological studies about how people feel about their work and themselves. The acquisition metaphor is related to the dualistic world-view, where everything is split into manageable entities, and this leads to hypothetic-deductive research constructs. Or if one goes back to the hammer metaphor, these research constructs have affected the world-view of the researchers.

However, these kinds of research constructs lead nowhere in the right side of fig. 2.14. The participation metaphor or interpretative approach to competencies are very difficult to study by using surveys. All intelligent action is based on understanding the prerequisites of action on a theoretical level (section 2.1.6). According to the second law of cultural psychology, complicated cultural skills emerge first on the social level (section 2.3.1). According to Hakkarainen, Palonen, Paavola & Lehtinen (2004: 7-8) we should:

- study concrete activities taking place within the sociocultural context and situations
- focus on external representations, tools, and knowledge embedded in the environment that people are using to manage their limited cognitive resources
- study intellectual processes extended across expanded periods of time
- presume that intellectual activity is distributed across several agents and dependent on the characteristics of their social organization, such as the division of labor, tools and distribution of knowledge and competence across several agents
- not study processes from the viewpoint of an individual's cognition

In other words, instead of separate entities the focus should be on the whole frame described in fig. 2.14. This leads to two conclusions:

1. Some form of ampliative inference has to be applied.
2. The research has to be based on qualitative case studies.

According to Engeström (Engeström 1999; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 128) there has not been enough research on the creation and use of artifacts. A proper method for such research is qualitative inquiry. By collecting all physical artifacts and by interviewing project participants about the use of artifacts, a picture of project external scaffolding can be made. This is in accordance with the interpretative approach to competencies. The *phenomenological* question of how actors experience their work and themselves as an entity is more interesting than mere analysis of the use of certain technologies. (section 2.3.3)

Social networks are usually studied by using the statistical method called social network analysis (SNA), or other statistical and quantitative means. They give information about the structure of the networks, but tell very little about their content. They do not deal with questions like how different kind of knowledge is handled in a network.

Networks are studied from a very limited time-perspective. Usually SNA is done from one historical point in the network's life-cycle. If we study projects as networks, this will not do. Projects are temporary organizations going through dynamic changes, and it can be concluded that the network relations change during the project life-cycle. It would take several network analyses before anything could be said about the whole life-span of a project. A certain strong link can be very important and last only a short period of time (Haapalainen, Lonka & Naaranoja 2004). This kind of tie will not necessarily show up in surveys made much later. SNA is purely a statistical method and it cannot be used in phenomenological research. Such research has to be based on qualitative inquiry and interview data. Projects should be studied either by doing several SNA:s during the life-cycle or by analyzing retrospective interviews. One should not forget artifacts produced during the process and their relationship to other material.

The final conclusion of this literature research is that there is not enough knowledge about project success factors, because:

1. In order to be successful and avoid risks, projects have to learn.
2. Learning in projects is distributed cognitive action.
3. There are no qualitative case studies where projects and their networks are approached as distributed cognitive action.

3 Research questions and construct

3.1 Research questions

The objective of this research is to find out how the problems of project knowledge management could be explained by using the distributive cognitive approach. The central question is:

> *How can project success factors be understood and described better by studying projects as distributed cognitive actions?*

For the central question to be fully answered, a topical, methodological question is needed to support it:

> *How can such description and understanding be built on a social network analysis based on qualitative material, made retrospectively, and covering the whole life-span of the two projects?*

According to Peirce´s *maxim of pragmatism,* “in order to ascertain the meaning of an intellectual conception one should consider what practical consequences might conceivably result by necessity from the truth of that conception; and the sum of these consequences will constitute the entire meaning of the conception." (Peirce, CP 5.8-9).

The aim of this study is purely pragmatic. Its aim is to understand project knowledge management in order to better manage projects and make them successful. In order to manage a project or an organization, one needs an understanding of how the object of management – the project, organization, or task - functions. As Peirce says, the consequences are that matter and they constitute the truth of the sentence. We are not looking for absolute truths here (if such things exist), rather we are looking for conceptual tools that work well enough for everyday purposes and explain most of the phenomena. The most common description of scientific knowledge, “a well justified true belief”, can be understood in the same way: the knowledge is justified if it serves its purpose. But it is still a belief of how world functions and is. This leads us to a second topical question:

> *What kinds of methods of better project knowledge management could be based on description and understanding of projects as distributed cognitive actions?*

One important definition should be made here. This is not action research. Better project knowledge management systems are not applied during the research. By comparing the two projects we try to find better ways of doing things, ways that already exist or can be learned from the two projects. By building the model of the distributed cognitive system, different methods of approaching matters are going to be analyzed and recommendations given of how things should be done, and how they should not be done, based on our understanding of distributed cognitive action. It is a matter of further research to test the recommendations presented in this dissertation.

Hypotheses themselves are very important tools for a good manager. When we deal with complicated and vast systems - which most organizations and projects are - we need a hypothesis of how those systems function and the actual acts of management are based on the hypotheses. The reality is the test of the management hypotheses. Often they are proven wrong and we build new hypotheses based on previous experience. Management and research have many similar features as human endeavors.

The central question and the topical questions are further divided into subsequent research questions based on the findings of the literature research.

3.1.1 What was the nature of the artifacts produced?

Most of the project work is done by using design artifacts and documents. They are the most important means of distributed cognitive actions (section 2.3.3). There are material and conceptual artifacts. The level of and quality of collective activity can be analyzed from these artifacts.

Research question 1 (RQ1):

What do the documents and other artifacts produced tell about the collective activity which produced them?

- What is the number of documents produced and how much information was needed to finish the project?
- How did the quantity or quality of the documents vary in different parts of the project?
- Were the documents produced during each phase fit and proper for that phase?
- What kind of primary, secondary, and tertiary artifacts were produced?
- Were there any conflicts or contradictions between different artifacts?

3.1.2 What is project network action like

The second research question is a methodological one and closely related to the first topical question.

There is no way of doing a serial study as the project proceeds. Even if a project had just started, it would take too long to study it as it goes along. A public construction project lasts five years or more and that is too long a period for any study. The only option is retrospective research.

In a retrospective study there are two different kinds of material available: the documents produced and retrospective interviews with the participants. These two can be studied separately and they can be cross-analyzed to create a picture of the dynamic network of a project. Not as a single, static network, but a network dynamically changing and reforming itself as time passes.

The artifacts form a tangible picture of the project written on paper and stored in computer memories. What kind of conclusions can be made based on that material alone? What kind of picture of the project action can be drawn based on the documents?

Not everything in projects is written on paper. It can be assumed that the most interesting, “hot” material about the successes and failures is stored only in the participants’ memories. It is also interesting to know how the participants experienced the network action, what it felt like to work inside the project network. Could these experiences be collected together and a dynamic picture of the network action be based on them?

Research question 2 (RQ2):

How can the *changes* during the two projects be described as *dynamism of the social network*?

- What were *the phases* of a project?
- What were *the nodes* and how did they change?
- Did *the quality* or *strength of the ties* change during a project?
- Were there any signs of *transactive memory* functions?
- Where was *the executive function* placed?
- Were there any signs of *structural holes*?

3.1.3 What is a successful project like?

Projects are temporary organizations created for the achievement of certain goals. The project success and its goals are intertwined matters as could be shown in section 2.1.2. The quality of the goal definition varies and so does the evaluation of the project success. The most interesting question from a distributed cognition point-of-view is the way these matters are discussed and handled during the project life-time. After all, they are the most important aspects of the project subject matter.

Research question 3 (RQ3):

What were the factors behind the projects´ success or failure?

- Were the two projects successful?
- What is a successful project like?
- What was the quality of the documents which described the project goals?
- Were there any conflicts or contradictions between different goals and what effects did these conflicting actions possibly have?
- Was there any relation between the quality of the network action and project success?

3.2 Methodological approach

3.2.1 Abduction as a mode of inquiry

In the literature research a framework was created, according to which project successes and failures can be analyzed. It looks very clear that failure or success have both something to do with the cognitive performance of the project network. The explanation for the failure cannot be found by using the mentalistic and computational models of traditional project management, but a new distributive cognitive approach has to be adapted instead. Can this hypothesis be proven? What would be the plausible mode of inference? The hypothetic - deductive mode of inference is not applicable. There is no way proving a general rule according to which things fail or succeed. As was shown in section 2.1.2, there is no clear definition of a successful project. We are in the field of social sciences and there are no definite answers.

However, inductive reasoning could be used. By studying many projects and analyzing their activities, a general framework could be described, a framework according to which the project knowledge management failures and successes would be easier to understand.

Here, the very nature of the research object sets limits to a feasible research project. Early analysis revealed that the huge amount of information and the multiple tasks performed by a vast number of people made it impossible to gather material extensive and coherent enough for inductive inference to take place. It would call for a research program, and cannot be accomplished as a single dissertation project. By using inductive reasoning it would be impossible to answer the first research question (RQ 1) about the quantity and quality of the artifacts produced. More limited goals have to be accepted.

If we are looking for general rules according to which projects fail or succeed, it is a matter of hypothesis building, not of hypothesis proving. It is the questions asked, not the answers given, which matter. A third mode of inference (in addition to *inductive* and *deductive* ones) can be chosen, a mode of inference called *abduction*. It is a form of ampliative inference originally developed by Peirce (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 159; Niiniluoto 1983: 154). It is a way of plausible reasoning, not concerned about necessities or probabilities. Abductive inference looks for good and reasonable hypotheses. It is often called the method of detectives: the starting point is a puzzling phenomenon and the aim is to find a solution or idea for a solution which would explain all the facts. It is also described as reasoning backwards, because one often starts from some effects and search for causes or explanations for them. (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 159). By using abductive reasoning, the analysis of the material is less thorough and the first research question (RQ 1) can be answered. It is enough to analyse the documents on a general level and focus on their role in the context where they were created. The same applies to the second research question (RQ 2) about the quality of the network links and action. It is sufficient to draw an overall picture of network links and their dynamism.

The classical modes of inference – deduction and induction - are related to Cartesian epistemological assumptions and their individualistic and mentalistic biases. Mind and matter are separated and mind is a processor of propositional knowledge. Man is a calculator of formal and deductive logic. There is no place for either tacit knowledge or instincts or creativeness. Peirce even claimed that deduction and induction cannot create any new idea (Peirce, C.P. 5:145; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 160).

Abduction and other forms of ampliative inference are the only means for creating new hypotheses. These hypotheses do not come out of thin air. They have their origin in the previous assumptions and beliefs of the community. These beliefs are challenged by new information or puzzling phenomena. One mode of ampliative inference is *the interrogative model of inquiry* (Hakkarainen, Lonka & Lipponen 2004: 280; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 158; Hintikka 1999). According to this we acquire new knowledge by asking questions and trying to find a better theory to work with. The development of ideas is a social process. New ideas are the results of modeling and recombination of existing ideas. Science is one and probably the most important form of distributed cognition

The third question (RQ 3) about the factors behind the project success or failure is the toughest one of the three. Even though it is question of abductive inference, there still has to be enough evidence to prove the case. If it were a murder case, one should be able to rule out alternative solutions beyond reasonable doubt. In one case there may be still plenty of other explanations for the failure. As we know from the project management literature, the failure of a project is more a rule than an exception and this leads to the conclusion that there must be several reasons for project failures, even for project knowledge management failures.

At least two cases are needed. However, if two failures are studied, two identical cases will be studied and nothing will be proven. What if the other case was not a failure, but a success, at least to some degree? If the successes and failures could both be related to similar kinds of phenomena, would not that make the case? Of course, again referring to section 2.1.2, the question of project success or failure is always a matter of some dispute. Keeping that in mind, at least by choosing a case considered to be a success, a case different from Hakala (Case 1) will be studied. The other case chosen was the Kangas Service Centre renovation project (Case 2). An explanation for this choice will be given later.

If it can be proven that most, if not all, project knowledge management deficiencies and success factors can be traced back to phenomena described by distributed cognition literature, nothing will be proven as such, but a good working hypothesis for the further research will be created instead.

The abductive inference of this thesis is as follows:

Hypotheses: The problems with project knowledge management would be easier to understand if the distributed cognitive approach was chosen instead of the mentalistic and computational one.

Evidence: The two projects can be described as a distributed cognitive activity and the problems of their knowledge management can be better explained and understood that way.

Conclusion: One could apply the distributive cognitive approach to studies of the project knowledge management problems in general.

The hypothesis is derived from the present assumptions and beliefs of the scientific community. The puzzling phenomenon contradicting the prevailing mentalistic and computational assumptions of project management is that the majority of projects failed due to defects in the project knowledge management in spite of increasing interest in knowledge management. An approach developed in other fields of research, distributed cognition, is offered as an alternative method of studying and managing projects.

3.2.2 A qualitative case study design

According to Yin (1994: 9) a case study approach has advantages in a situation where “a ‘how’ or ‘why’ question is being asked about a contemporary set of events over which the investigator has little or no control.” It can easily be deduced that case studies are very suitable for research based on abductive inference. All the research questions of this thesis are basically “how” or “why” questions. Both abductive inference and case study research are about theory building, not about theory testing.

There is a debate about the external validity of case studies (Yin 1994; Eisenhardt 1991; Creswell 1998). How can one generalize from a single case? Case studies are generalizable to theoretical propositions, not to populations or universes. A case study does not represent a sample, the investigator’s goal is not to enumerate frequencies (statistical generalization), but to *expand and generalize theories* (analytic generalization: Yin 1994:10).

For the aims of this thesis it is more important to construct a model of what happened than demonstrate the generality of what happened. In other words, internal validity is preferred. A model of what happened is needed and that model should be as precise as possible. If the findings are interesting enough, their generalizability over populations can be checked by somebody else. After all, science is also one form of distributed cognition. The whole system is based on the division of labor between researchers. The first and second research question form the basis of the picture. By creating a model of project network (RQ 2) and supporting it from the documents (RQ 1), such a model can be created.

This is not a single-case study, because material from a single case would not be rich enough for analytical generalization. This is why two cases are chosen, and these two cases are compared. The method can be described as a *comparative case method*. There is one unit of analysis: the network activity of the project team, so the study can be called *holistic multiple-case design* (Yin 1994: 39). The comparison of the two cases should produce the answer to the third research question (RQ 3) about the success factors.

The research construct chosen is very simple. All the major participants are interviewed, all the written or drawn material collected, and analyzed in chronological order. The focus is on the way relationships develop over time. This chronological order is very important. It gives a dynamic, not static, picture of what happened, unlike a single SNA-analysis or couple of SNA-analyses would have done. Finally, all the network links are analyzed in each phase of the projects. A picture is drawn of all the phases and their links. Together they form a picture of the dynamic networks of the two projects and give an answer to the second research question (RQ 2) about the dynamism of the social network.

Not all case studies are qualitative, there can be quantitative material or analysis, even surveys. However, this thesis is based on qualitative material only. Part of the analysis can be seen as containing some quantitative features, but as a whole this can be seen as *a qualitative case study* (Creswell 1998).

According to Creswell (1998) qualitative research is an "interpretative, naturalistic approach", based on multiple sources of information and narrative approach. His definition to qualitative research is:

> "Qualitative research *is an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting"*
>
> *– Creswell (1998: 15)*

In quantitative inquiry there are few variables and many cases, whereas qualitative research is based on few cases and many variables (Creswell 1998). According to Creswell (1998: 17-18), one should choose qualitative approach if:

1) the research question starts with *how* or *what*

2) the topic needs to be *explored*

3) one wants to present a *detailed view* of the topic

4) one wants to study individuals in their *natural setting*

5) one has an interest to write in a *literary or narrative style*

6) there is sufficient time and resources for *extensive data collection* and detailed data analysis of “text” information

7) the audience is receptive to qualitative research

8) the researcher is an *active learner* telling the story from the participants’ view rather than an expert passing judgments on the participants

All the things said about qualitative research serve well the aims of abductive inference and the research questions presented before. The aim of the study is to interpret the informants´ view on network action, which is a very typical goal of a qualitative inquiry. The material is mainly interviews, but the documents and their interpretation play an important role as well. The analysis of the data includes a description of the two cases. Not all analysis needs to be in literary form, qualitative studies often include tables or other non-verbal analysis of the material, and these support the case descriptions and findings.

3.3 Research environment and data collection

3.3.1 Case 1: Hakala School renovation project

Hakala is an upper-secondary school. There are 630 pupils and 52 teachers. The school was originally built in 1974. The size of the building is 7000 sq-m2 and 25650 m3.

The Hakala school renovation took place in three construction phases. The school moved from one place to another inside the building when the renovation work proceeded. At the time of the research interviews the first phase was finished and the second one had just started.

What made Hakala interesting from the team work point-of-view was that the school had taken the renovation project very seriously and invested extra resources in it. The art teacher was nominated as a part-time team member and also the rest of the staff were very actively participating. This was not common in city school projects. Usually it was the principal who attended the design and construction site meetings. The art teacher had also been a member of the original design team some 30 years ago.

As to information flows and problems related to them, Hakala was an excellent case. Hakala School renovation had been a very difficult building project. During the design phase the budget had to be doubled, because the condition of the structures was not as good as was expected. More surprises took place during the first phase of construction. The outside wall was wet, there was no insulation in the foundations, and the concrete floor was all wet from underneath. Even the interior walls were damaged by moisture from the cleaning water. It was soon found that the whole structure should have been studied more carefully during the programming phase.

Hakala was also a construction management project where the client was responsible for the coordination of the works. The building master was one of the employees of the construction management department. There was more information available to me directly from the building site compared with a general contracting project where the coordination is in the hands of a private contractor. The most important information flows took place inside the parent organization.

However, there were some doubts concerning Hakala as an ideal research case. I had been involved in the case during the design period and as head of the construction management department I was responsible for all the works. Senior and junior construction managers and the master builder were my subordinates. I attended the design meetings in fall 1997 and the meetings during the crisis of 1999. I might have a biased view of the process. Was I blind to the problems of the organization or did I put too much stress on them?

On the other hand, there were benefits also. I knew the organization and its basic structure, I did not have to ask questions of which the answers were self-evident to the informants. I knew the informants and I did not have to spend time analyzing their characters or backgrounds. The informants trusted me. Information, also sensitive information, was easily available to me. It would have been very laborious to study an outside case. I had attended only two phases and otherwise the project was taken care of by my employees.

There is a long and ongoing debate in the case study literature about the benefits and dangers of involvement (Creswell 1998). It is very typical of case studies based on one case that the involvement is deep. They take a long time and it is impossible for the researcher to stay detached from the organization she is studying.

The 15 informants interviewed were mentioned 585 times in the interviews. I was referred to 27 times, when the average for the informants was 39. I was not considered a key player by the other participants. It may be that I was not referred to because of my role as interviewer. Another explanation is that I was only involved in the later stages of the project.

3.3.2 Case 2: Kangas Service Center renovation project

The town of Varkaus reorganized the care provided for the elderly in the 1990`s. People were not put into institutions, but the services were offered at home instead. Only those in the most urgent need of care were placed in institutions like Kangas and the town hospital. Before the reorganization the town hospital had taken care of the demented and other senior citizens who needed constant care. Only terminal care was now offered by the town hospital. All others were sent to Kangas. As a result, the condition of the residents and the services offered to them in Kangas went through a profound change. In the early 1990’s 10% of the residents needed assistance on a daily basis, at the end of the decade the figure was 85%, and 80% of the residents were incapable of moving.

The renovation of the town hospital in 1996 was the first stage in the process of reorganization. It triggered the Kangas renovation, because the hospital was transformed into a purely medical institution and all the long term patients were sent to Kangas. The change in the demand made Kangas old-fashioned. It could not offer the services needed. The management of the Kangas Service Center were aware of the need for a renovation.

The hospital renovation project was also an inspiring example for the management of Kangas. The number of patients in the hospital was cut down, but the facilities were very well designed and effective. A 1:1 scale model room was used as a tool in the design process.

The Kangas service center was originally the old people’s home of Varkaus. It was built in two stages. The first part was built in 1979 and included 80 beds and a service center for the elderly living in the neighborhood. An extension was made in 1987 and there were 40 more beds and an auditorium. The rooms in the extension wing were bigger and designed for the handicapped, which the original rooms were not. The building was designed for the elderly, who were capable of moving but who needed care 24 hours a day. It had to be renovated to better serve the present clients.

There were 77 people working in Kangas. A staff of 55 took care of the residents in the departments, the kitchen staff was 13, and the rest were physiotherapists, nurses, office workers, social workers, and so on. The size of the building was 8300 sq-m2 and 27500 m3.

Kangas renovation started when the Town Chief of Social and Health matters nominated official committee for the preparation of the project definition plan. Such a plan was needed for both state and town purposes. The town applied for a state subsidy for the renovation of Kangas, but later this application was turned down and the Kangas renovation became a town project.

The town wanted to save money, and a decision was made that the construction work would be executed in an institution which was in daily use. The project had to be divided into several phases. The project started when the saunas were build in 2002. The second part included the basement, kitchen, restaurant, and wings A and D. The saunas were a separate project but the rest of the work done in 2003 and 2004 was all collected into one set of contracts and it was done by the same contractors. This phase was divided into several stages, because if such a big area was under renovation at the same time, it would have made the daily work of the service center impossible. The rest of the project was a separate contract and the bidding process took place in the beginning of 2005. The research was done in three parts, between November 2003 – December 2004, so the last phase of the project is not part of it.

There were several reasons why Kangas was chosen as an example of a successful public building project:

The *user participation* was well organized. The physiotherapist was the users’ representative in the project even before the official project had started. A lot of effort was put in getting the staff involved. There were info-corners, model rooms, meetings, groups, and so on. Also in terms of the technical staff the project was organized in an extraordinary way. The project manager was a leading designer, construction manager, and site inspector at the same time. The project definition plan was exceptionally well written.

The Kangas project was an exception among Finnish building projects. There has been a long debate in Finland about the *users' participation*, the *quality of project definition plans*, and the way the *relationship between the designers and the construction management* should be arranged. These matters have been disseminated by instruction booklets, professional training programs, industry organizations, and unions. However, this was the first time these concepts had been applied to a single building project all at once. It would be interesting to know whether these methods would work as well as the propagandists say they would.

And last but not least was the eagerness of the Varkaus people to help in the research work. They were themselves interested in finding out what they did right, what they did wrong, and how they could do it better in the future.

I knew people from Varkaus before, because I had been working there as a town architect eight years ago. The project manager and the architect were my former employees. I was in charge of the town hospital project, were we developed the idea of the 1:1 scale model room together with the Kangas project manager.

However, I did not feel that I was studying in my own backyard. After all, a long time had passed since I worked there. The model room was not invented in Varkaus, the idea might have come from somewhere else as well. I knew the people, but they were now more like acquaintances than employees to me. The people representing the users were all new acquaintances to me.

3.3.3 The documents

In Case 1 (Hakala) all the written materials related to the project were collected. This was done at the same time as the interviews. The official material from the city files was a foundation for this work. The informants were asked for materials: calendar notes, hand-written papers, and all kinds of unofficial material. Part of the material were drawings. Here an iterative method (snowball sampling) was used. If one document referred to another one, it was searched for. Saturation point was reached when no more new documents were found, but all the references were related to known material. People were willing and eager to help me.

In Case 2 (Kangas) all materials related to the project were collected as well. We asked the informants for all their computer files, e-mails, calendar notes, diaries, and all other material related to the project. Six informants saved all their Kangas project files on a CD-ROM and gave them to us. These informants were:

- the project manager
- the mechanical inspector
- the physiotherapist
- the architect

- the mechanical engineer
- the electrical engineer

These files contained some e-mails, but not all of them were saved. We also obtained diaries from three informants: the architect, electrical engineer, and mechanical engineer. These were so called project diaries used by all designers from their firms. They were used when something related to the Kangas project had been done, e.g. designs been made or meetings attended. These diaries included all the meetings and telephone calls. Three of the informants went through their calendars and wrote down all the notes they had in them about the Kangas project. Most of these were meetings of some kind, official or unofficial.

We got some written material, mainly from the first part of the project when the renovation group had gathered. They were all kinds of notes from meetings, information leaflets, etc.

3.3.4 The interviews

There are hundreds of people working in any kind of public building project. It is impossible to interview more than a fraction of them. Who are the key players in the whole process? It looked like all the problems during the actual construction work in both projects were caused by actions during the design phase. Problems which were created at the building site or which had their origin in the relationships between the client and different kinds of contractors were minor and they did not have any effect on processes outside the building site. The builders were not left out, but the focus was on the design team. None of the informants wanted to stay anonymous. However, their identities were protected by using institutions, not individuals, as the units of analysis.

Case 1: Hakala

I carried out all the interviews of Case 1 (Hakala) myself. The interviews took place in the spring of 2001. In Case 1 an iterative approach (snowball sampling) was chosen as well. The work was started from those actors whose key role was apparent. In each interview a question was asked about the importance of other actors. If somebody was mentioned often enough, she was interviewed. Thus the circle of informants was enlarged little by little when the branches of interaction were followed. This method worked out well and seemed to be in accordance with the research problem. If somebody was not mentioned by others, she could not have been an important node in the information network.

Another scaffolding constantly under construction was the informants' conception of the actual phases of the process. A process chart method was used. In the first interviews a process chart was drawn (in Appendix 2 there is an example). The chart described the whole process from the informants' point-of-view. Each chart was checked and accepted by the informant.

In the early interviews there was a lot of emphasis on what happened first and what followed. Here there were no official process charts of the building process. The structure of phases was based only on the informants' own conception of the matter. After half a dozen interviews a unanimous picture of what happened was formed. This affected the later interviews. These interviews followed the structure of the phases created in the early interviews.

In the Case 1 there were 24 interviews of 15 informants. The total time used was 33,5 hours. There are 29,5 hours on tape, because two early interviews were not taped. Here is a list of the informants, their parent organizations and their tasks in the project:

The city architect's office:

- **the city office architect:** project manager during the design phase
- **the city construction engineer:** responsible for the structural engineering design, and the client's representative in structural engineering matters
- **the budget engineer:** responsible for the city investment budget
- **the cost estimator:** prepared the cost estimates

The construction management department:

- **the senior construction manager:** project manager during the construction phase
- **the junior construction manager:** senior construction manager´s assistant
- **the master builder:** in charge of the building site

The school:

- **the principal:** involved in the most active periods, otherwise delegated his tasks to the art teacher
- **the art teacher:** the school's representative
- **the janitor:** the school's representative in facility matters

The school office:

- **the city school planner:** in charge of the project definition plan
- **the occupational health worker:** the school office's representative in occupational health matters
- **the health trustee:** employees' representative in occupational health matters

The architect's office:

- **the architect:** the main designer

The maintenance department:

- **the maintenance master builder:** in charge of minor repair works unless there is a major renovation going on

Case 2: Kangas

Case 2 (Kangas) was part of the PROLAB-research project. PROLAB (project laboratory) was a research project of the University of Vaasa. The other participants were the Town of Vaasa, the Town of Varkaus, several private consultant firms, and construction companies. In the research the project practices of project management in Finland, the UK, the USA, Germany, Australia, and New Zealand were benchmarked and new practices for preventing knowledge management failures in projects were developed by using the methods of action research. The aim was to develop an operational model that would improve the quality of operations and end results in demanding construction projects by elaborating knowledge management, decision making, and team work.

The interviews of Case 2 were made by me and another researcher of the PROLAB project. The interview schedule was designed so that we would get some kind of an idea of how people´s conception of the matters changed from one phase to another. There were three different sets of interviews. The first was in November-December 2003, when the selection of contractors was over and the first phase of construction was about to begin. The second set of interviews was in May 2004, just before the first acceptance inspection. The last interviews took place in December 2004, when the construction work was about to end.

All the major participants were interviewed: the management, representatives of the staff, the designers, project managers, inspectors, and contractors. The list of informants was based on general knowledge of the way construction projects are organized. However, the user participation was an important issue, and we interviewed more users' representatives than we would have in a normal building project. There was also a kind of an iterative method (snowball sampling) used, where we asked the informants about people who would know something about the project and whom we should interview.

In Case 2 there were 32 interviews of 21 informants. The following people were interviewed:

The town administration:

- **The Town Chief of Social and Health Matters:** handled the matters in the town organization, but did not interfere with the actual design or construction process

The facilities department:

- **The Head of the Facilities:** project manager in the beginning
- **The project manager:** the main designer and the project manager from the programming phase to the end of the project
- **The mechanical inspector:** responsible for the mechanical engineering design, client's representative in mechanical engineering matters
- **The electrical inspector:** responsible for the electrical engineering design, client's representative in electrical engineering matters
- **The janitor:** service center's representative in facility matters, but an employee of the facilities department

The Kangas Service Center:

- **The former manager:** initiated the project, but retired before the project started
- **The manager:** users' representative
- **The physiotherapist:** users' representative, secretary of the renovation committee
- **Two head nurses:** users
- **A nurse:** a user

The architect's office:

- **The architect:** assistant designer in architectural design

The assistant designers:

- **The mechanical engineer**
- **The electrical engineer**
- **The assistant electrical engineer**
- **The structural engineer**
- **The automation engineer**

The contractors:

- **The master builder**
- **The electrical contractor**
- **The mechanical contractor**

Methods

The interviews were theme interviews, where the interviewees had the possibility to express their opinions freely. Every informant was asked the following questions about every phase:

- Did you participate in this phase?
- Who were the other participants?
- What was done and what were the most important matters dealt with?
- How was the information processed and what means of communication were used?

All the interviews were taped. The reports were transcribed from the tapes. We took notes as well, but they were used as a supportive means only. The reports were written immediately after the interviews (within a week). The transcription was not done in a very precise manner. Part of the interviews were transcribed in detail and the results were compared with the other reports. The reports were so good that there was no need for a precise transcription of the whole material.

Some informants were interviewed for more than four hours on three different occasions, some for only an hour. The length of the interviews was based on the amount of information the informants could offer. If they had not been involved in many phases or they did not have a key role in them, there was no sense of lengthening the interviews.

3.4 *Analysis of data*

3.4.1 Analysis of documents

Case 1: Hakala

In Case 1 (Hakala) a long Word™-table was created where all the documents were listed in chronological order (see Appendix 3 for an example). The document type was described after each title and a short summary was added. This table was very helpful in the interviews. Very often informants had forgotten the order of events, people present in the meetings or many details which could be traced back to the documents. The table was a very good memory-aid (Jokinen & Pelkonen 1996).

There were four different kinds of documents:

Design artifacts: designs, plans, reports, timetables, statements, specs, lists, tables, cost-estimates, instructions, etc.

Official documents: minutes, memoirs, supplements, notes, decisions, permits, applications, offers, contracts, diaries, etc.

Letters: ordinary letters, fax, e-mails, announcements, invitations, etc.

Calendar notes: there was some kind of unofficial meeting, but there are no minutes or other documents.

Calendar notes and some of the official documents (minutes, notes, diaries) refer to meetings.

There are 534 incidents or documents registered:

document type	nos
Design artifacts	114
Official documents	281
Letters	81
Calendar notes	58
total	**534**

All the documents were collected and listed. A short description of each individual document was added. All the material and all the known meetings were on the list. There were 534 items on it.

The amount of design documents was low for the following reasons. The focus was on the architectural design and all the technical (mechanical and structural engineering) documents were omitted. All the documents in a certain phase are recorded as one, even though there might have been a pile of them in one bidding package. Analyzing such a package drawing by drawing would have been irrelevant to the goals of this research.

Case 2: Kangas

In Case 2 we copied all the files into one combined folder. The basis of that folder were the files of the project manager. We wanted to save his originals and add only files he did not have on his computer. There were 1175 files and 548 Mb of data in the project manager´s CD-ROM. Next we copied the architects files. We destroyed the files which had already been on the project manager' s CD-ROM. We did the same to all the CD-ROMs. In the end we had a folder of 2400 files (see Appendix 4 for an example of the folder) and 1240 Mb of data. The CD-ROMs contained 3200 files and 1850 Mb of data altogether, so 800 files and more than 600 Mb of data was shared. Here are the contents of each CD-ROM:

The informant	**amount of files**	**amount of data**
the project manager	1175 files	548 Mb
the architect	786 files	402 Mb
the mechanical inspector	378 files	417 Mb
the mechanical engineer	295 files	417 Mb
the electrical engineer	566 files	438 Mb
Σ	3200 files	1854 Mb
combined folder	2400 files	1240 Mb

However, there was a problem with the electrical engineer's CD-ROM. Somehow in the process of copying files, they were all given the same date. We could not use those files, and they were omitted. There were 252 files and 132 Mb data destroyed in this way. Luckily, they are only 10% of the total amount of information.

The physiotherapist had only 100 files on her CD-ROM. There was the same problem with her files: most of them had the same date. Her files were opened and included to the combined data manually.

The project manager had 213 calendar notes, the electrical inspector 109 notes, the physiotherapist 221 notes, the electrical and the mechanical engineers 24 notes together, and the architect 33 notes. Together there were 600 calendar notes, but when these were compared one by one, and the same meetings were omitted, there were 450 meetings or incidents (telephone calls, etc.) left.

There were very few files and calendar notes before 2000. It was difficult to say whether they could be related to the project. All the false dates were from the period when the files were copied, which was November-December 2004. We decided to study the period January 2000 – October 2004. The rest of the files and notes were ignored. The amount of data from this period was 890 Mb; there were 1991 files, and 376 calendar notes. We could date this material. Of course, the date of a file may have differed from the date when it was created or used, or from the date of the incident it described (e.g. minutes). We believe that the lag was not more than a month usually. However, it would have been impossible to go through all 890 Mb and check the dates. We decided to trust the information we could get from the folders.

At this stage the type of file was of interest, not its content. This information was easily available, because we knew the file formats. There were eight different kinds of files:

- text files: doc, rtf, dot
- drawings: dwg, dgn, ac$, rml, dmp, dxf, PLT, log
- pictures, presentations: tif, jpg, ppt, bmp, gif
- e-mails: txt, eml, htm, doc
- acrobat: pdf, mcl
- schedules: pdf, mcl
- excel: xls

E-mails were not all in eml- or htm-format, part of them were in doc- or txt-format. Some of those files could be interpreted as e-mails by their name ("Mailsomething"), but many were just opened and checked. Pdf-files were important means of communication: the users did not have CAD-programs, so drawings were sent to them as pdf-files. There were 28 files where the format was unknown to us.

From the period between January 2000 and October 2004 there were 2367 files or calendar notes:

document type	**pcs**
text files	640
drawings	597
pictures, presentations	145
e-mails	277
pdf-files	145
schedules	17
excel-files	142
calendar notes	376
unknown type	28
total	**2367**

Comparison of Cases 1 and 2

There was two different methods used in the analysis of documents. The form of the documents in Case 1 (Hakala) was uniform: they were all written or printed on paper. In Case 2 (Kangas) the form of the documents differed, because they were mainly computer files. However, there is a way to build a connection between the two databases. The form is related to the content. Word documents are used to write official documents and CAD-programs are used to create design documents. Of course, some programs can be used for many purposes. In the following table there is a coarse comparison of the two sets of documents:

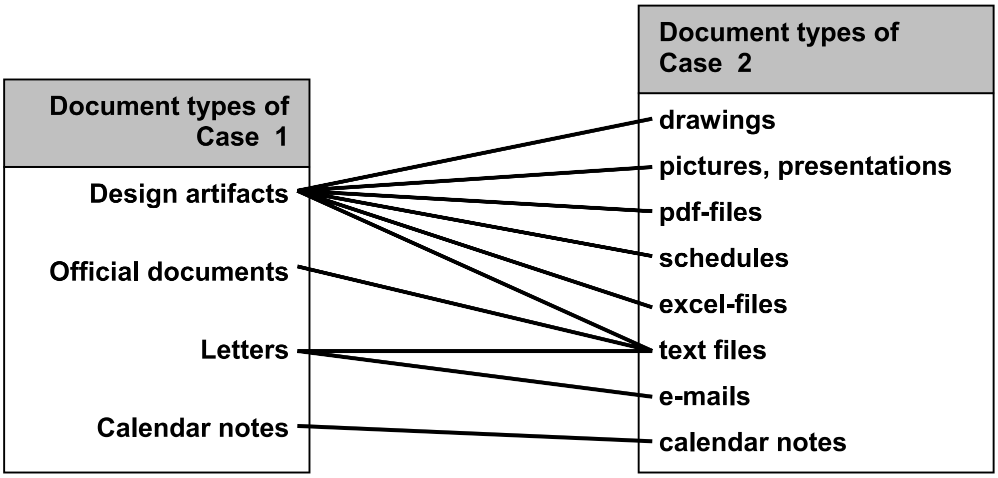


Fig 3.1 Comparison of the two sets of documents

The text files are the most difficult ones to compare as can be seen from fig. 3.1. They can be design artifacts, official documents or letters. Calendar notes refer to the very same type of documents in both cases. Letters can be send as text files or e-mails. The rest of the file types refer to design artifacts only.

To make a separation between the different uses of text files in Case 2 would have meant analysis of 640 documents. Because the material was used to analyze the actions on a very general level the more thorough analysis was not needed. In Case 2 the category of design artifacts could have been used instead of the different file types. However, interesting information about the use of different kinds of artifacts in different phases would have been lost. The slight unbalance between the two databases was acceptable. In the analysis of the different phases (Chapters 4.1.2 and 4.2.2) all the relevant material was analyzed by using qualitative methods and the form of the document did not matter.

3.4.2 Analysis of interview data

File structure based on the informants' conception of phases

The official phases of a typical building project are:

- definition of the needs
- project definition
- selection of the designers
- design
- selection of the contractors
- construction
- delivery

Case 1: Hakala

The informants' concept of phases did not follow the official phases of the building project in Case 1 (Hakala) interviews. People talked about certain themes and crossed over from one phase to another. Often there was no relation to time, or the informants had to be reminded of the right timing by using the documents. Based on the process charts (see Appendix 2) an initial sketch of the story could be drawn. The later interviews confirmed this initial picture.

After forming a skeleton of the story, the interviews were easier. The informants could easily base their memories on it. It was easy for the informants to remember the active periods, but the passive periods they easily forgot. To most of the informants it was difficult to believe the fact that one whole year had passed between the first visit and the actual start of the project.

All this is in accordance with the theories of the constructional nature of the human memory (Anderson 1995; Loftus 1979). People use memory data as raw material and reconstruct the conscious memories from that. This process can and will be affected by new information and it can even be manipulated. This is why it was important to discuss matters freely with the informants and give them time to make a reconstruction of the phases by themselves.

The time spent in each individual phase varied and it was in no relation to the actual time passed in different activities. The longest period talked about was the life span of the building from the construction of the original building to the beginning of the design process. This phase is called "the maintenance period".

There were two short periods that almost all the informants mentioned. These critical incidents (Flanagan 1954) were two visits. The first one actually launched the whole project, when people from the city school office visited the school and learnt that it was in bad need of a major renovation. The other one encountered by fewer informants, but of which their memories were even more vivid, was the visit by an official from the provincial government agency. He criticized the programming of the project and this launched a design trimming process. The other phases varied in length between these two extremes.

The informants could describe 13 phases in Case 1 (Hakala):

- maintenance and health problems during the life span of the building: mentioned by 12 informants
- city school planner and occupational health worker visited the school: 10 informants
- programming: 10 informants
- team formation: 9 informants
- design meetings of fall 1997: 9 informants
- a provincial school official visits the school: 6 informants
- trimming of the design: 11 informants
- design meetings of fall 1998: 8 informants
- preparation for the construction work: 7 informants

- work started on site in summer 1999: 7 informants
- the crisis of fall 1999 and the way out of it: 12 informants
- work on site: 9 informants
- moving in and out between phases and/or overall analysis of the project: 8 informants

The analysis of the process presupposed a chronological presentation of all the interviews. For this purpose all interviews by a single informant were organized chronologically and then cut into sections, each concerning one phase. Each section was stored in a different file. The material produced by a single informant contained 4 to 13 files, depending on how many phases the informant could remember or could talk about. There were 15 informants and 118 files, so the average informant talked about 8 phases.

All the 118 files were gathered together in chronological order, and thus one story of the whole process was created. This story and the list of documents were the raw material for the later analysis.

If we cross-table these 118 files, we get the following picture:

Table 3.1: The file structure of Case 1 (Hakala)

file structure	maintenance	visit	programming	team forming	design '97	prov. visit	trim	design '98	preparation	work starts	crisis '99	work at site	moving/analysi	amount of files
art teacher	■	■	■	■	■	■	■	■	■	■	■	■	■	13
city office architect	■	■	■	■	■	■	■	■	■	■	■	■	■	13
principal	■	■	■	■	■	■	■	■	■		■	■	■	12
janitor	■	■	■		■	■	■			■	■	■	■	10
city school planner	■	■	■	■	■	■	■	■			■	■		10
cost estimator	■	■	■	■	■	■	■	■			■			9
occupational health worker	■	■	■	■				■		■	■			7
junior construction manager	■						■	■	■	■	■	■		7
health trustee	■	■			■		■	■			■		■	7
architect	■		■	■	■		■				■			6
city construction engineer				■	■		■			■	■		■	6
senior construction manager							■		■		■	■	■	5
master builder			■						■	■		■	■	5
maintenance master builder	■	■		■					■					4
budget engineer	■	■	■									■		4
amount of files	12	10	10	9	9	6	11	8	7	7	12	9	8	118

As can be seen, the saturation point was soon reached. It was difficult to find informants who could tell more about the project than the first 10 informants.

Case 2: Kangas

The Kangas project was a slightly different case. It looks like there was no big difference between the informants´ way of seeing things and the official way of dividing the project into phases.

However, there were a few exceptions. The definition of the needs was not seen as a separate phase, it was part of the project definition. There was a group inside the service centre before the official project definition committee, preparing for the definition of the needs. It was called the renovation group. The project definition phase was divided into two parts: the one before and one after the representatives of the Ministry had visited Kangas. They are different phases, because the content of the work changed and the team members as well. The visit by the Ministry was the only critical incident we could find in the project´s history. The construction work was divided into two, and this division was somewhat similar to the division of the construction work. We get nine phases altogether. This division into phases was later confirmed from the documents. The amount of phases the informants could remember in Case 2 (Kangas) were:

- the renovation group: remembered by 5 informants
- the project definition committee #1: 5 informants
- a visit by the Ministry: 6 informants
- the project definition committee #2: 14 informants
- the selection of the designers: 10 informants
- the design: 17 informants
- the selection of the contractors: 16 informants
- the first phase of construction: 13 informants
- the second phase of construction: 11 informants

The material produced by a single informant contained 1 to 9 files depending on how many phases the informant could remember or could talk about. There were 21 informants and 97 files, so the average informant talked about 5 phases.

If we cross-table those 97 files of Case 2, we get the following picture:

Table 3.2: The file structure of Case 2 (Kangas)

file structure	renovation group	project plan 1	Ministry visit	project plan 2	selection of des.	design	selection of contr.	phase 1	phase 2	amount of files
A former manager	■	■		■		■				4
B town chief of soc/health		■	■	■			■			4
C head of facilities	■	■	■	■	■	■	■	■		8
D manager		■	■	■	■	■	■	■	■	8
E physiotherapist	■	■	■	■	■	■	■	■	■	9
F head nurse 1				■		■	■			3
G head nurse 2	■			■		■	■	■		5
H project manager		■	■	■	■	■	■	■	■	8
I mechanical inspector				■	■	■	■	■	■	6
J electrical inspector	■		■	■	■	■	■	■	■	8
K architect				■	■	■	■	■	■	6
L mechanical engineer				■	■	■	■	■	■	6
M electrical engineer				■	■	■	■	■	■	6
N ass. electrical engineer						■				1
O structural engineer						■				1
P automation engineer					■	■				2
Q master builder							■	■	■	3
R electrical contractor						■			■	2
S mechanical contractor							■	■	■	3
T nurse							■	■		2
U janitor				■		■	■	■	■	5
amount of files	5	5	6	14	10	17	16	13	11	97

Units of analysis

After arranging the interviews in chronological order, the foundation for the analysis of the dynamic network was laid. The phases were based on interviews and documents. What was still missing was the unit of analysis. There were two choices. Either each person was considered a node, or then nodes were the organizations (Palonen 2003: in her study both were used).

Using individuals as units of analysis in a study like this is rather problematic. We are talking about very sensitive matters between people. For research ethical reasons it was better to study the organizations and fade the individuals into the background. There was another reason for this. There were not enough references to individuals. There were very few individuals who were mentioned many times in all phases. It would have been very questionable to draw conclusions about somebody’s participation based on a single remark.

Case 1: Hakala

After the decision was made that organizations would be chosen as the units of analysis, the following question was, of course, which organizations to choose. This problem was solved in a natural way. The informants represented the following organizations in Case 1 (Hakala):

- The school (principal, art teacher, janitor)
- The city school office (city school planner, occupational health worker, health trustee)
- The city architect's office (city office architect,cost estimator, budget engineer, city structural engineer)
- The architect's office (architect)
- The construction management (senior construction manager, junior construction manager, master builder)
- The maintenance department (maintenance master builder)

There were certain organizations, the members of which were not interviewed, but which should have been included. There was the *provincial school office*, even though it was represented by one person who appeared only once in the project's history. However, the appearance, or the visit, had important consequences. Another missing group of organizations were the *assistant designers*.

There were some problems with respect to the persons and the organizations. The art teacher's role was so dominant that it was often difficult to hide her behind the organization. The same applied to the architect. He was a representative of his office, but he is still referred to as "the architect".

The health trustee was not working in the city school office, but she was in such close cooperation with the school office that she was included on its staff.

Case 2: Kangas The informants represented the following organizations in Case 2 (Kangas):

- The management of Kangas service center (physiotherapist, former manager, manager, Town Chief of Social and Health Matters)
- The staff (nurse, head nurses)
- The facilities department (head of facilities, project manager, mechanical inspector, electrical inspector)
- The assistant designers (mechanical engineer, electrical engineer, assistant electrical engineer, structural engineer)
- The architect's office (architect)
- The contractors (master builder, electrical contractor, mechanical contractor)

The physiotherapist was considered to be a member of the management, because as a secretary of the committee and as the users' representative in the relationships with other organizations, she represented the management.

There were certain organizational members who were not interviewed but who could have been included. There was the *Ministry*, even though it was represented by only two persons who appeared once in the projects´ history. However, that appearance, or visit, had important consequences. Other organizations omitted were the *town administration* and *the customers*.

There were some problems with respect to to the persons and the organizations. The roles of the project manager and the physiotherapist were so dominant that it was often difficult to hide them behind their organizations. The same applied to the architect. She was a representative of the architect’s office, but still she is referred to as “the architect”.

Quality of the network links

What was looked for in each phase was connections to other organizations. The basis of the analysis was the description of weak and strong ties presented in section 2.3.5 (Table 2.2: Palonen et al. 2003: 277). I added a third kind of link – a problematic link – to the original categories and the analysis was done by using three kinds of links:

- weak links
- strong links
- contradictionary or problematic links

A problematic link was any link that existed but did not serve its purpose. There may have been a contradiction in the way different parties perceived the link or other problems. That was why these links were called *problematic* or *contradictory* links. These links were not mentioned in the literature of SNA, because such phenomena are impossible to analyze by the means of SNA.

I used the terms “contradiction” and “problematic” when talking about these links because they were somehow ambivalent. It seemed to be typical of these links that there was a difference in expectations. Different parties had different aspirations in terms of these links. Contractual problems were typical examples. If there was an agreement on outcomes and responsibilities, there was no contractual problem unless one of the parties was manipulative or wanted to use the contract for some other purposes than what was its original intent. The relationship between the school and the city architect’s office in Case 1 (Hakala) was contradictory because of different expectations of the outcomes. The school *should not* have interfered with the design solutions and the experts *should* have studied the moisture problems. The rules or mental models were broken and the description of the links had dramatic, narrative qualities (Bruner 1990; see section 2.2.2).

I soon found that three kinds of links were not enough. Some of the problematic links were more important than others. There may have been constant interaction between two parties, and still things were not going fine. Somebody may have met somebody else for only a short period of time, but that was enough for problems to occur. I had to divide problematic or contradictory links into two categories:

- strong problematic links
- weak problematic links

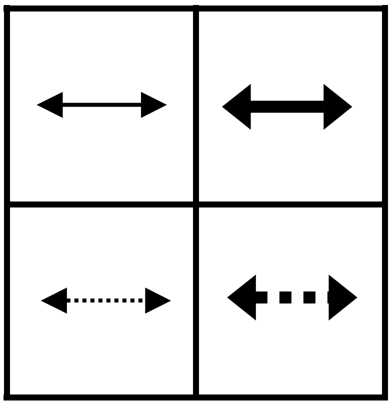
In the following table the different links and their symbols are shown:

Table 3.3: Different links.

weak strong

non-problematic or non-contradictory

problematic or contradictory



Special attention was paid to how the mold and moisture problems were dealt with in Case 1 (Hakala). According to the informants, the inability to understand the importance of mold and moisture was considered the biggest mistake the Hakala team made. In Case 2 (Kangas) the interesting object was the user participation, which was considered the main reason for success by the informants.

Analysis of the links

The last thing to do before the model was finished was to analyze the whole material phase by phase. Each individual phase was analyzed first by collecting all the material describing it: the interview files from that phase and the documents produced during that phase. From this material anything that was said or written about relationships between any two organizations in a particular phase was looked for. The focus was in matters concerning the project, the relationships in other matters were left outside the analysis. Of course, these two are often difficult to separate: problems in the project reflected other relationships and vice versa.

These findings were collected in one table (see Appendix 5 for an example), where there was a description of each link as seen by:

- outsiders
- both parties

Each link was then analyzed and named as belonging to one of the four categories. The fifth category was, of course, a missing link. If there are six participants in a phase, there are fifteen possible links between them. If there are five participants, there are ten possible links, and so on.

After a phase was analyzed, a picture was drawn of all the links in that particular phase by using the symbols shown above. There were twelve phases and twelve pictures describing them. These twelve pictures form a motion picture which describes the dynamic network of the Hakala project (Case 1).

There was a meeting arranged in Hakala School on the 16th of December 2004, where findings were explained to the informants. Ten of the fifteen informants were present. All the key actors were present. The interviews of the people who were absent had been shorter than the interviews of those who were present. Findings were presented phase by phase, link by link. The informants agreed and confirmed that the network dynamics presented were in accordance with their own experience.

There was another meeting arranged in the Kangas Service Center on the 3rd of May 2005 where the findings were described to the informants. Ten of the 21 informants were present. None of the contractors was present, and only one of the assistant designers: the mechanical engineer. All the key actors from the city organization were present. Again, the findings were presented phase by phase and the informants agreed and confirmed that the network dynamics presented were in accordance with their own experience.

4 Results

In this chapter the two cases are analyzed separately. In the end there is a short cross-case analysis comparing the two cases.

After all the phases are analyzed link by link, a full picture of what happened in both cases can be formed. In this chapter the findings will be presented.

First a little will be told about the whole process of designing and building the projects by using the documents (RQ1). They give us a good picture of the active and passive periods. After that both cases will be described phase by phase (RQ2).

The description of each phase consists of:

- a short history of the phase based on the documents and the interviews
- a picture of network links as an illustration of that phase
- conclusions

The analysis of the phases is by far the longest part of this report. It has been written here in its entirety. Appendices 6 and 8 give a thorough description of the qualitative analyses of the network links. The analyses are based on the interviews and supported by the information from the documents. Descriptions of the phases are in the main text, because they are the most important part of the narrative report. They form the case description and without them the reader would have no means of evaluating whether the links are analyzed in the right manner. There are also lots of details, some of which may seem irrelevant. However, they form a rich, lifelike picture typical of case study narrative.

Finally a short summary will be given of the network links and a description of their overall dynamics: how many links there were in each phase, how many links each participant had, what kind of links they were, how the links changed over time, and what the network dynamism was like. In the end there is an analysis of the lessons learned from the case.

The cross-case analysis follows the structure of the case analysis: first the documents produced by each case (RQ 1) will be compared and then the results of the network analysis (RQ2) will be cross-examined. In the end of the chapter there is an answer to the third research question about the project success (RQ3).

4.1 *Description of the Hakala project (Case 1) as a dynamic network*

4.1.1 Documents show the level of activity (RQ1)

If it is assumed that a socially shared cognitive system would resemble a biological cognitive system, the documents or incidents could be described as activities in a neural network. This idea was tested by drawing a graph from all the documents (fig 4.1). In the chart the amount of incidents taking place or documents produced in a given time-period describe the activity of the system as a function of time. The graph shows the intensity of action in every month of the project. One could say that this graph describes the active periods of the shared "neural" system and the peaks in it refer to an active period in the system.

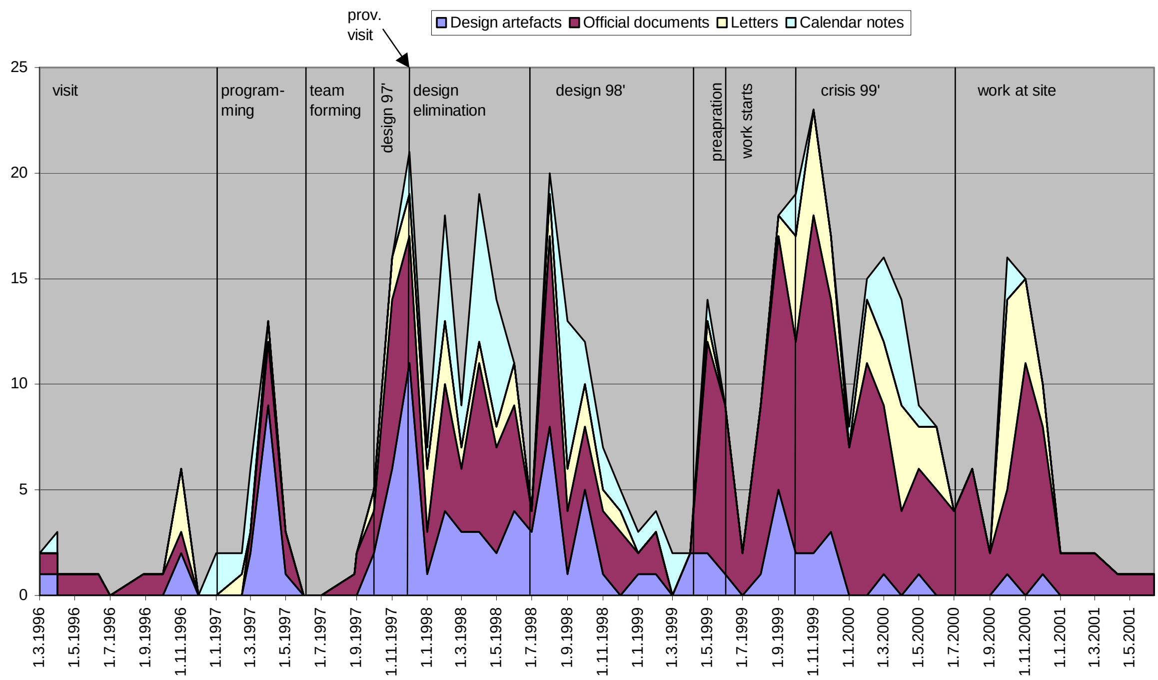


Figure 4.1 The production of documents over phases in Case 1 (Hakala)

This graph revealed some interesting phenomena. There was a big variance in the activity level of the project. If we keep in mind that there are 20-21 working days in a month, there were months when only one document was produced and months when 18 documents were produced. In the latter case some activity took place almost every day.

A month is called *active* if more than one document was produced every second day. It is called *highly active* if something happened every day.

The active periods were (highly active in **bold**):

month	**number of documents**
April 1997	13
November 1997	16
December 1997	**21**
February 1998	**18**
April 1998	**19**
May 1998	14
June 1998	11
August 1998	**20**
September 1998	13
October 1998	12
May 1999	14
September 1999	**18**
October 1999	**19**
November 1999	**23**
December 1999	17
February 2000	15
March 2000	16
April 2000	14
October 2000	16
November 2000	15
December 2000	10

There were 21 active or highly active months of the 65 months of project time. There were only two active summer months and they were June 1998 and August 1998. During the summer of 1998 most of the design was supposed to be done.

Every year there was an active period in the fall. In eleven cases out of 21 there was an active period in either September, October, November, or December. The reasons for these were:

Fall 1997	⇒ design meetings
	⇒ provincial school official visited the school
Fall 1998	⇒ design deadline
Fall 1999	⇒ the crisis of fall 1999 and its resolution
Fall 2000	⇒ first phase was finished and delivered

There seemed to be a systemic reason that made the fall more active than the spring periods. It may be that every year the start of the budget period is in the beginning of the year and it takes time before decisions turn into action. There were no active periods in any January. It is usually wise to start renovation work during the summer, which means that the fall is the most active time in the construction work. A conclusion was made that the system had a tendency to get overheated and then go into a period of hibernation and these cycles were related to the seasons of the year for various reasons.

What happened during highly active periods?

December 1997	⇒	design meetings
	⇒	the provincial school official visited the school
February 1998	⇒	trimming of the design
April 1998	⇒	trimming of the design, construction management department joined the team
August 1998	⇒	design scheduled to be ready
September 1999	⇒	work started
October 1999	⇒	the crisis of fall 1999 and its resolution
November 1999	⇒	the crisis of fall 1999 and its resolution

In December 1997 it was discovered that the programming had not been done well and the project had to be re-programmed. The active period of February 1998 was a direct consequence of this. In April 1998 there was an active period because the designs were not as ready as they were supposed to be and they had to be worked on. When the building site started in 1999, the real state of affairs was discovered and the project had to be redesigned.

So it looked like the highly active period was always a response to some kind of crisis. The only exception was August 1998, when all the designs were finished.

The years 1996 and 1997 formed an interesting period. The project started in February 1996, when the city school planner and the occupational health worker visited the school. After that, nothing happened before 1997. It was difficult for all informants to later admit that a whole year had passed between the visit and the actual work. Everybody thought that the visit took place sometime late in 1996. The lower peak in November 1996 describes the research work the maintenance department had ordered. The design team was never told about it. The peak of April 1997 describes the intensive programming period. After that nothing happened before the fall.

As to the quality of documents produced during the active periods, three different types could be found. During programming in April 1997 only design drawings and official documents were produced. It was a very intensive process when there was no time for meetings or letters. During the design period from the fall of 1997 to the fall of 1998 there were four to five active periods when designs, official documents, letters and calendar notes were produced simultaneously.

During the construction work the pattern changed. First, the amount of official documents increased and this was followed by a growth in the number of letters and calendar notes. Hardly any design artifacts were produced during this period. There were many occasions when only official documents were produced.

The active periods in the chart were in accordance with the experience of the informants. The division of phases constructed with informants in the interviews followed the active periods in the chart. The overall impression was that not much time was spent in the early parts of the project and a lot of time was spent in the later parts. This was true especially in terms of the amount of interaction. Official documents, letters, and calendar notes show the amount of interaction. Most of them were produced in the latter half of the project. The majority of the designs were produced in the first half of it.

This raises an interesting question. Is it so that we first design something and then spend a lots of time trying to figure out what we have designed? My personal experience would suggest that this is the way things are done in the building industry in Finland. However, this is one case only, and further research will be needed if we want to confirm this finding.

4.1.2 Network links in the Hakala project (Case 1; RQ2)

Link symbols used in the network illustrations are explained in Table 3.3 at the end of section 3.4.2.

Phase 1: The maintenance period

This period was included, because during this time lots of information on structural and health problems was collected and even documented, but were later ignored. The informants talked a lot about these problems, but also about the organization of maintenance work and the programming of works. Many of the later unhappy incidents had their roots in the systemic problems created during the maintenance phase. The organization and the system created during the maintenance period was the setting of the project.

There were 58 documents (docs 3-60[6]) from the period between 1978-1996. Most of these were official documents related to small repair works. Towards the end of the period there were more and more documents concerning plans and cost estimates for a larger renovation. There were no calendar notes from this period.

The school was built in 1975 (doc 4: a report). Two of the informants –the architect and art teacher – took part in the actual design and construction of the school. The art teacher was the school's representative in the design team. Sketches for the school were drawn on her living-room carpet.

Originally the school was not a city school. Before the 1980's most Finnish secondary schools were private schools built by communities who owned them. When the comprehensive school system was founded most of them became municipal property. Hakala was one of these former private schools.

---

[6] refers to the number of document on the documents list

The original school design was based on the philosophy of an open school. In the original building there were no walls between the classrooms. Light came through the windows far away from the centre of the building and from the skylights. Because of this wide mass the roof had to be flat. A wide mass with a flat roof is a very inexpensive structure. One reason behind the inexpensive design solution may have been the fact that the community which owned the school was not a wealthy one.

The art teacher still remembered her amazement when she visited the building site for the first time:

> *"There was a big pond here. I thought I had come to the wrong place. … I wondered whether the coming building would ever stay dry without moisture problems. Even then they should have done it in a different way, there was information available."*
>
> *– the art teacher*

The idea of an open school did not work out. The school had to be divided into separate classrooms. This, of course, meant that in the centre of the building there would be many rooms with very little daylight. The dividing walls were not made of high quality materials. They were made of gypsum board and covered with plastic. These kinds of materials would not last long in a school.

Small and large repairs were done by the maintenance department in the city facilities department. Plans and repair lists were prepared together with the school office.

Despite the fact that the responsibility for the city facilities was in the hands of the facility department, the school had to become active in these matters. The problems with leaks and the general condition of the structure forced the school to fight for bigger repairs.

Something was done in 1985, when all the windows were replaced and the leaking exterior cladding was resealed. For the first time larger works at the school were mentioned in documents in the spring of 1989. There were two different proposals. The school board asked for a new roof and a plan was made for new arrangements in the administrative section and in some of the classrooms.

Finally, the roof was repaired in 1992, but the interior works were forgotten and the school disappeared from the budget lists. This was due to the recession in the national economy in the early 1990's. The school reappeared on the budget lists several times in the first half of the 90's, but nothing happened. Finally in 1995 the school board sent a long letter where it described the bad conditions and asked for greater renovation of the whole structure. In spite of the renovation, the roof was leaking again.

> *"There had been many failed repairs. The roofs leaked in spite of the continuous repairs."*
>
> *– the principal*

Finally Hakala got back on to the lists. In fall 1995 an amount of 60.000 euros was reserved for the classrooms, 170.000 for the science classrooms, and 110.000 for an extension to the teachers' room. The works were planned to take place in 1998-99. A larger renovation was not mentioned.

Most of the city and its suburbs were build in the 1970's. Many schools and other buildings were just as poorly built as Hakala. By the end of the 1990's they were all in bad need of repair. The national economic recession of the early 1990's meant that all renovations were postponed and there was less money for maintenance. The facility department tried to work on the problem, but they soon gave up (link 3 in fig. 4.2). The problems exceeded all the available resources.

Another rising problem was mold and moisture. By the latter half of the 1990's so many people became ill because of mold that there was no way of denying the fact that the city was suffering from a serious sick-building syndrome. The school office, together with the occupational health and the city architect's office, founded a mold and moisture committee which mapped all the buildings. The committee produced a process chart which told who should react to the mold and moisture problems. However, cooperation was not working, because the city architect's office was not investing enough resources and did not take the matter as seriously as the school office would have wanted (link 4 in fig. 4.2).

The school office and the maintenance tried to minimize their efforts. Matters were handled on paper only, and representatives of the school office had not even visited the school (link 1 in fig. 4.2). The same applied to the relationship between the maintenance and the city architect's office. The maintenance department took care of facilities independently. If there was a need, it contacted the city architect's office. Both parties tried to minimize the time and energy needed. The maintenance department preferred to work alone, and the city architect's office was busy with bigger problems. However, the end result was a group of problematic buildings employing them both (link 6 in fig. 4.2). Here we can see in operation a systemic archetype called *shifting the burden* (Senge 1995: 380): by trying to minimize effort, it was maximized. Only emerging situations were reacted to and no time or resources were invested in preventive actions or investigations. The more emerging situations there were, the less resources were given to preventive actions, and this led to an increase in the amount of emergencies.

In the field of educational work there was a reorganization in the school in the 1990's. The school adopted a new system for administration. The impulse for this new order came from one of the parents who was a business consultant and gave a lecture about the benefits of empowerment and delegation. This was a moment of enlightenment for the principal. He shared all his responsibilities with the others. Teams were founded. Even key functions like the planning of the timetable were delegated to the vice principal. A junior high school of 650 pupils from 20 different countries is a very demanding pedagogical and managerial environment. Despite the fact that the school was working with very challenging pupils, it had an excellent educational reputation. This may have been partly due to the team spirit adopted.

Network links

Link symbols explained in Table 3.3

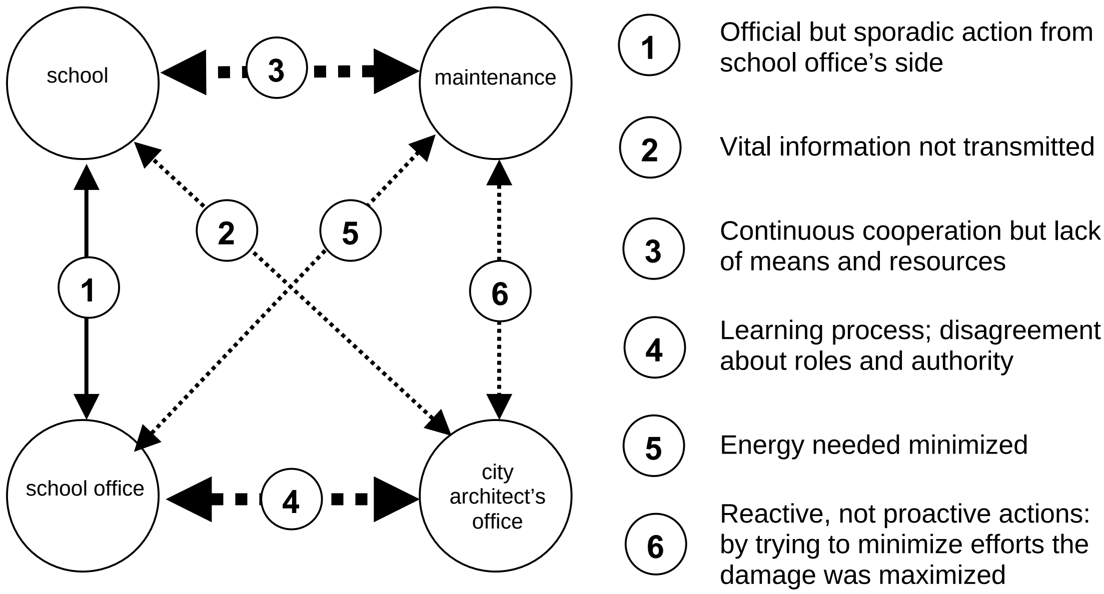


Figure 4.2. Network links in phase 1

Summary of phase 1

There was a contradiction in the relationships between the school and the other key actors. Officially the school was a tenant and it was served by a network, but actually it was a subordinate of a centralized system. Officially the city believed in a team system and networks, but actually it relied on a line organization.

Inside the school the cooperation between the teams and different actors was very fluent. Problems arose when the school needed help from outside. The city organization was not based on empowerment. There was an inevitable clash between these two realities. People inside the school realized this and this is why they often used unofficial channels.

Phase 2: The school office visits the school

The city school planner and occupational health worker visited the school on the 7th of February 1996. The original reason for the visit is not clear, but the visitors stayed long and studied the whole building with the principal and the art teacher. After the inspection there was a lunch at the school, where matters were discussed.

During this visit representatives of the school office realized for the first time how bad the general condition of the building was. It needed a major repair. Visitors were horrified by the illegal repairs and solutions made by the maintenance department and the school together. The memories were still vivid:

“When we went there we were terrified by the changes in the plan and by the poor condition. For a school of its age it shouldn’t have been in that condition. …We stayed there for a long time with the occupational health worker contemplating: we were shocked. Can we get funds for this? We had many similar cases…The visit took a long time. We ate at the school."

– the city school planner

The principal had also a strong recollection of what happened. For the first time he realized that the school had the chance of a bigger renovation. Everybody seemed to agree that this was the point when the renovation project was born (link 1 in fig. 4.3).

“*They came and stayed longer than was planned. They saw as much as was possible without breaking the structures. They said that this was a disaster and it would cost at least 3,3 million. This opened our eyes. The sum sounded enormous. I had no idea of what a full-scale renovation costs. After that we started to talk about a full renovation here, not any more about just fixing things. It was a culmination point when the desire for bigger things started to become a real possibility."*

– *the principal*

Even though the school office’s visit was considered a starting point for the project, it seemed that nothing happened for a long time. The informants did not talk a lot about the year 1996. However, according to the documents things happened and many of the incidents had consequences later.

There were only 16 documents from the period between February-December 1996 (docs 61-76). Four of these were documents related to the renovation works in the apartment wing. There was a health inspection, an asbestos mapping and a budget proposal for the school year 1997-98. The latter document was interesting: for the first time the amount of money (18 million) could be related to a large investment. In November a survey of the general condition[7] was made by a private consultant. This kind of survey is a standard procedure before a large renovation. The consultant visited the school and interviewed the staff. The report and the visit were dated the 20th of November 1996.

In November another consultant visited the school. There had been leaks in the new roof and the maintenance department hired a consultant in order to file a warranty claim. It looks like these two consultants – the one making the general survey and the other one studying the roof – did not know about each other’s work. In the report on the general condition the probable

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[7] A survey of the general condition is a process of examining the whole building, its structures and systems, interviewing the users and facility managers and finally writing a report of the findings. The survey report and the survey itself are often confused.

cause for leaks in the cafeteria ceiling was condensation, whereas the other consultant found that it was caused by a mistake in a sheeting detail.

The most important thing that happened to the project in 1996 was that it got its first cost estimates. Later these estimates played an important role. However, they were based on very vague information about the user's needs or the actual condition of the structures. The foundation of the project was laid on guesses rather than on facts or studies.

Mold and moisture problems were an important motivation for the whole project. However, no organized search for the sources of mold and moisture was organized. There was no team and everybody relied on information from the report on the general condition of the structures. The report contained very little information about mold and moisture. The consultant working on the survey of the general condition thought that his report would only be one source of information when decisions are made, not the final truth about the matters. The school office was disappointed (link 2 in fig. 4.3).

After the project was established, the system had problems reorganizing itself. Maintenance projects went on living their own life and information gathered during them was not analyzed or transferred to the project (link 3 in fig. 4.3). The first cost estimate was made, but it was not based on any study. A general survey of structures was made, not as a part of a project, but as an independent task. It looked like it took a long time before the existence of the project was accepted as a fact. At the end of the year everything was ready for the renovation project: it was on the lists, the structures were studied and a decision was made that a more extensive renovation was needed. The next step would be the programming of the actual project.

Network links

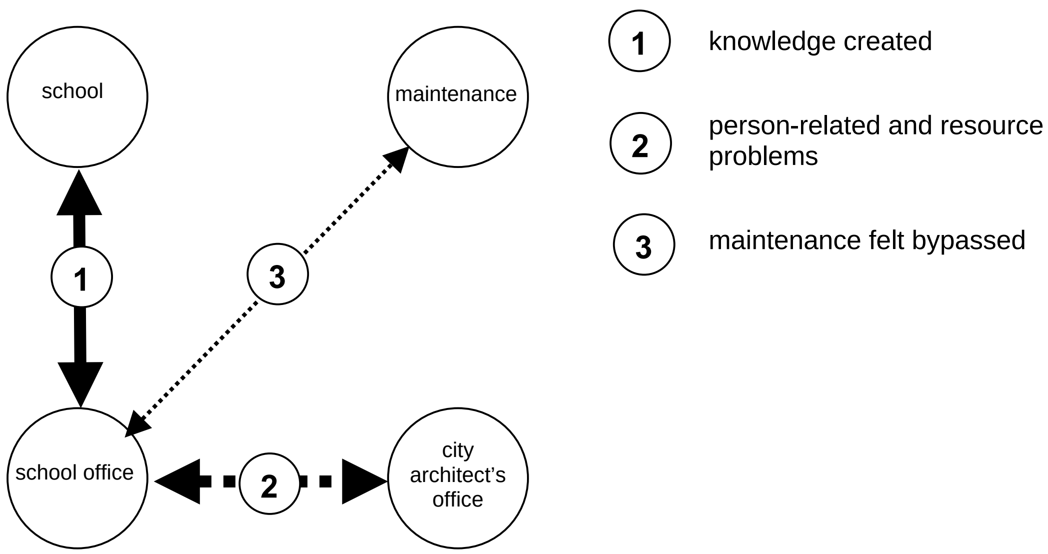


Figure 4.3. Network links in phase 2

Summary of phase 2

The informants had problems in timing the visit. Many informants remembered that it took place late in 1996 or early 1997. This was due to the fact that nothing happened in the project during 1996. Nobody was in charge of it or worked on it. The project popped up sporadically a couple of times during the year, but otherwise it was forgotten.

It seems that there was no management of projects. The facility department was a multi-project organization but it was not organized as such. No decision was made about starting a single project. Projects were launched accidentally, there was no systematic analysis of their causes. Once they were started they were not immediately organized, nor were decisions made about their goals, or the resources needed.

Phase 3: The programming

Nothing happened to the project before mid-February 1997. Then a very intensive period of programming started. An architect was hired and the first plans were made. An application for a state subsidy was sent to the provincial school office at the end of April. The project definition plan was an appendix to the application. The application and the project definition plan were approved by the city's educational and technical boards before they were sent to the provincial school office.

There were 23 documents from the period between February-May 1997 (docs 77-99). An architect was hired for the task. The decision about the architect's commission was not made until the 9th of April (doc. 89), but the architect's offer is dated the 10th of March. There was a meeting at Hakala on March 6th. The first sketches were signed on the 21st of March (doc. 85), so the work was started somewhere between the principal's letter and the 6th of March.

We can conclude that the actual programming process did not take more than a month and a half. The informants talked about a two to three week period. The city office architect was in charge of the process, but he was on leave between the 10th of March and the 15th of March and again between the 31st of March and the 5th of April. During the programming phase he was present for only two weeks. There were meetings at the school, but no minutes were taken.

The budget was based on multiplying the area by the average costs of a normal renovation. The method did not include any extensions or bigger room arrangements. This put the designers and the school people into an almost desperate situation. There was no way of fulfilling all the needs. The city resources were limited in the late 1990's and this situation had its effects on the design process. However, the city architect's office lost its fight against the rising expenses. The final figure at the end of April was 4,4 million euros (doc. 90). In addition to that, there was a sum of 0,2 million euros for furniture and equipment (doc. 93).

The core team was created during this period. The architect and the art teacher started their cooperation. The school began to realize that it had to take charge of the project. All the important plan solutions and designs were made. Whether the participants understood it or not, they had created a project. The project definition plan was not the only result of the cooperation. The team formed by the architect and the art teacher was formed during the programming and it lasted to the very end of the project (link 3 in fig. 4.4).

The final project definition plan was a compromise. The classrooms on the first floor were all 40 square meters each, so all the interior walls were moved. The kitchen was extended, the corridors were changed into classrooms, there was a new library and a new shop.

The project definition plan itself was a very sketchy document. The text was only 4 pages long, following strictly the structure of the instruction booklet of the Ministry of Education. It was a list of short answers to the questions asked in the booklet. Most of the interesting material was in the appendix. However, the material was mainly plans, not analysis of the existing situation. The only document with any analytical content was the survey report. However, these plans - especially the architect’s drawings - had a great impact on the project. All the fundamental solutions were there already. The biggest changes to the plans took place in the trimming of the design in 1998.

The cause behind all ills was the lack of time. The timing, on the other hand, had its origin in the way the bureaucracy worked. It took some time to start the work after the state had given the green light to the project. After that a deadline for the final application was so near that everything had to be done in an extreme hurry.

After the architect was chosen, the city architect’s office tried to minimize the time invested in the project. There were many other projects going on and if there was a good consultant in charge, the office directed its efforts to more problematic projects (links 2 and 6 in fig. 4.4). This is typical of multi-project organizations: people are involved in many projects at the same time and they work whole-heartedly on a single project only for a good reason. Otherwise they keep their energies on a routine level. The exception here was the art teacher. She was totally committed to the needs of this very school and wanted to sacrifice her spare time in addition to her own full-time teaching job.

The urgency had very interesting and twofold consequences. The school office could react somehow (links 1, 4, and 5 in fig. 4.4), but the lack of resources in the city architect’s office meant that they did not have time to do anything and that was why they were side-stepped (links 2, 4, and 6 in fig. 4.4). All the key actors said that they were not present when most of the work was done. It looked like both offices considered the project definition plan as an official document needed to get state money and nothing more. The architect and the art teacher were responsible for any essential content. The problem was that these two approached the plan from their own interests. The overall quality and content was not checked by the project management. Or who was the project manager if it was neither of the offices? The school and the architect took over. The project dropped into their hands and it looked like they enjoyed the situation. The spirit in the core team was good, and it was only endangered from time to time by the pressures to keep within the budget.

The problem was that the new core team did not possess the skills to detect the hidden problems caused by moisture. This would have demanded special skills and cooperation between different kinds of experts.

The situation resembled the one that had lasted for years during the maintenance period. The school was present and it knew pretty much what was going on, but it lacked the resources or knowledge to do anything. The experts performed sporadic interventions, which often caused more harm than good.

After the project definition plan was finished, the whole project went back into a state of hibernation. Nothing happened before fall 1997. The design process restarted in October 1997.

Network links

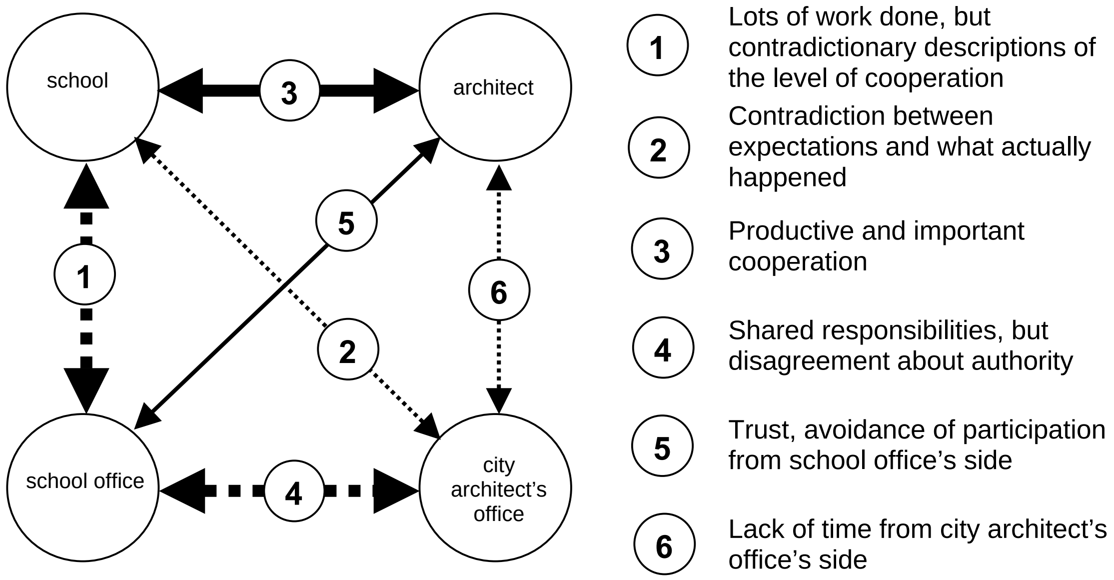


Figure 4.4. Network links in phase 3

Summary of phase 3

This phase was a short and intensive one. Only the key participants remembered it well, the others had only vague ideas of what happened. However, the period was crucial to the whole project. The project got its final budget, state subsidies were applied for, and the most important design decisions were made. Later it was very difficult to change anything.

All the good and all the bad things seemed to have their origin in the phase. In a sense, the programming was a failure. The project team missed the most important feature of the whole project. It could not perceive the fact that the whole building was seriously impaired by mold and moisture. Later this led to changes in the plans and budget overrun.

The project definition plan was based on repairing the existing structures. There was need for an extension and for further rearrangement of the rooms, but these needs were neglected. The budgeting was made hastily a year before and it was based on the idea that the renovation would be limited to repair of the existing structures only. However, the project definition plan and the design drawings attached to it contained all the fundamental arrangements and laid a foundation for the whole project.

Phase 4: The team was formed

In the spring of 1997 the school board decided that the art teacher would be granted a salary compensation as long as the project lasted. She was thus nominated as the school's official representative in the project.

The engineering consultants were chosen in September and the architect in October. The structural engineer was chosen in early November. The time period studied here was from May 1997 to October 1997.

The nomination of the art teacher was not a common procedure in city projects, because teachers usually get paid for pedagogical work only. The principal is usually the one responsible for this kind of work. However, principals have many other responsibilities as well and participation in projects may suffer.

> *"The matter of hiring the art teacher had a great symbolic value to the working community as a manifestation of will. Usually it is the principal who gets paid for work other than school work and that is why matters of this kind are considered his responsibility. However, principals do not have time to concentrate on these matters and they do not have the professional skills the art teacher has. She could read and interpret designs to others."*
>
> *– the principal*

The art teacher was also seen as a mediator of information.

> *"It is important that there is one person who possesses all the knowledge. The art teacher has mediated the design teams ideas to the teachers and vice versa."*
>
> *– the principal*

The school was wise to invest the art teacher's time in the project as it got the upper hand in the struggle for project management because of this investment. The decision to nominate the art teacher to the project was the most important managerial decision made by the school. In self-organized processes like this construction project, the resources given to the different actors are important factors.

More than just remembering a certain time period, the informants talked about the way the team was formed and also about later incidents and the team's performance during the whole life-span of the project. There was some ambivalence in the relationships between the school and the architect. The architect's office was the original designer of the school. There were moisture problems in the school, so there was a question as to whether the same architect should be chosen again. On the other hand, the school had a good impression of the architect himself and that was why they did not oppose his selection (link 1 in fig. 4.5). The same applied to the school office (link 6 in fig. 4.5)

The architect himself saw the contract as a problematic one (link 4 in fig. 4.5). There was much more work than was anticipated because of the poor condition of the structures and the division of the work into three consequent phases. The problems with the design contracts were the reason for the later problems between the architect and the assistant designers (link 5 in fig. 4.5). The architect had to make alterations and the assistant designers had problems with the constant changes to plans. This affected the schedule and led to more disputes.

Network links

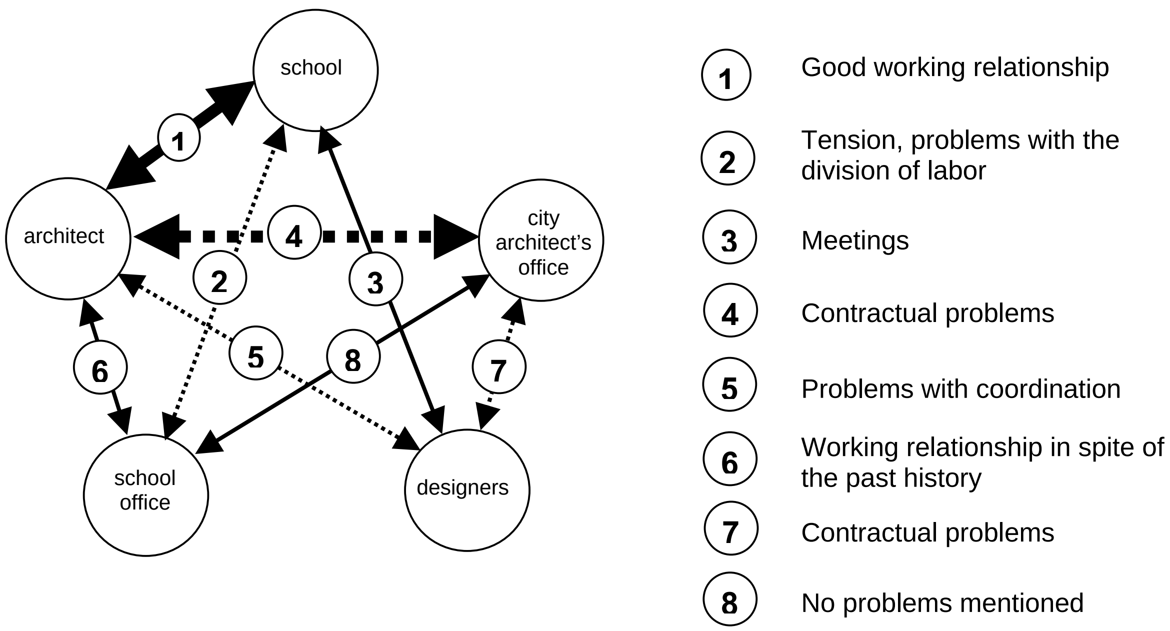


Figure 4.5. Network links in phase 4

Summary of phase 4

The team that was already formed in the previous phase got officially nominated. The core team was formed by the architect and the art teacher. Nearest to them were the janitor and the other designers.

Officially, the appointment of designers was in the hands of the city architect's office. However, it seemed that the other participants were active in the selection process. The team formation was seen as a shared and important process by everybody.

In this phase the informants talked about the team itself and how it worked, not only about its forming. When they talked about the selection of a person they talked about her later action as well. This reflective approach made people very willing to express their feelings, but in a balanced way. They did not want to take sides. This was explained by the nature of the project.

Things went bad later in the project, but the informants did not want to blame the team for it. The mistakes had been made before the team was chosen.

Phase 5: The design meetings of fall 1997

After the designers were chosen by the beginning of October 1997, the design work could start. There were unofficial meetings, but only one official design meeting on October 24th in the city architect's office (doc. 109). The meeting was a critical incident (Flanagan 1954) and the informants remembered it well. This was the moment when I entered the project as a new construction management chief ("construction" in fig. 4.6). In the meeting I expressed doubts about the budget. I thought it was too small compared with the size of the project. I also wondered why the structures and systems had not been studied more carefully. Without thorough investigations the budget was based more on wishes than on facts. In the meeting the decision was made to investigate radon, moisture, asbestos, and the condition of the piping and plumbing. The school agreed.

There was a certain routine applied to the design of schools and this routine was followed in the Hakala case. However, there was something extraordinary in the Hakala case: the school had invested more resources in the design and they were more active than usual (link 2 in fig. 4.6). This caused changes in the delicate balance between the city architect's office and the architect. It was the city architect's office which officially ran the projects, but in practice it was the designing architect (link 9 in fig. 4.6). When a new player entered the field, people had problems recognizing who was who.

There was some rivalry as to who would represent the client. The school wanted the moisture problems to be dealt with, but the city architect's office did not listened to the school (link 2 in fig. 4.6). There was a common belief that schools were trying to exaggerate their needs and that is why the city architect's office was needed to keep the balance and to make sure that the city's money was not wasted. The mold and moisture problems were seen only as a way of begging for more money. The school was not listened to.

Things got even more complicated when it came to the mechanical design. The city architect's office had special departments for those matters and the departments were even more detached from the client than the architect's department. Some of them even tried to keep a distance from the school and saw their duties as purely technical ones. This was recognized from the school's side and there was an atmosphere of tension and distrust between the school and the specialists of the city architect's office (link 2 in fig. 4.6). Again, the school was not listened to.

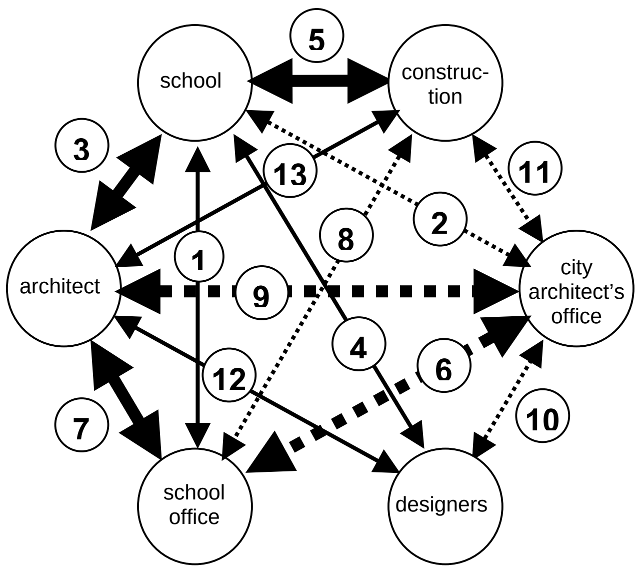
There was a long and good history of cooperation between the school office and the city architect's office. They both shared the same perspective on school projects: their responsibility was to look after the city money and balance the needs of different schools. This had led to good personal relationships as well.

However, in this phase there was tension also. The design meetings raised the question of the overall level of project management in the project and this led to emotionally loaded discussions between the school office and the city architect’s office (link 6 in fig. 4.6).

The city architect’s office’s role as a project manager was not openly discussed and this led to problems. In relation to the construction management the problem was the opposite: there was an open discussion going on about the role of project management in the design phase and in the construction phase. This discussion lead to some tension, and feelings of guilt when I as the construction management chief accused the city architect’s office of underestimating the expenses (link 11 in fig. 4.6).

There was not much taking place in the fall of 1997. The design team was formed and it started its work by collecting material. Discussion was started about the size and the type of kitchen (doc. 110). First proposals for the yard and a cost estimate were made (doc. 118).

Network links



1 Normal, routine relationship
2 Rivalry over the position as a clients´ representative, distrust
3 Reciprocal and active cooperation
4 Good collaboration
5 Shared interests
6 Shared history, but emotionally loaded discussions
7 Trust and openness
8 Questions in the air
9 Conflict between reality and expectations
10 Conflict between reality and expectations
11 Tension prevented open discussion
12 Meetings
13 Routine relationship

Figure 4.6. Network links in phase 5

Summary of phase 5

There was a problematic triangle in the phase: the one formed by the architect (and other designers), the school, and the city architect’s office. The fact that the school was more deeply involved than normal had caused similar effects in the programming phase, but now these problems were more open to everybody. There was not enough discussion about each role in the new situation and the metacognitive level was blocked. Another problem arose from the role of the city architect's office and the construction management as rival project managers.

There were lots of features of a community of practice (Wenger 1998) in the cooperation between the school office and the architect. The architect was specialized in school design and he attended a Ministry of Education work-group on design issues (shared language, membership of the same "pedagogical" community). Through him the school office got lots of new information (shared concepts). The information was applied together in the design of the science class (shared project).

There was a problem on the metacognitive level during this period. There was no shared model of project management. The city architect's office saw design *as* project management, and thus the architect as solely responsible for the design phase. Others saw project management as many other things as well, and the city architect's office as responsible for the whole field of the project management.

We can see *a centralized mindset* (Resnick 1994) working here. As a matter of fact, the system was *a self-organized one*. The architect and the art teacher were working on the project in deep collaboration, but there were many other processes as well, processes which were not in the hands of the school or the architect office. Because everybody assumed that somebody had to manage the whole project and officially this somebody was the city architect's office, they were seen as the executive body. The city architect's office had difficulties recognizing the situation, because it was not supported by any real-life facts: they could not invest enough resources to the project. However, when somebody else tried to take the role of a project manager (i.e. the construction management department) they resisted it.

Each individual saw their own narrow role, but nobody was able to view the bigger picture. Everybody assumed there would be "a hand of God" somewhere hiding in the process. No such executive body actually existed. Everything was based on networked expertise that did not work out.

To be able to deal with the situation, an open discussion between all the actors about the *metalevel* system would have been needed. The discussion was blocked by institutional courtesy and the fact that the actors did not want to invest energy on this level unless it was absolutely necessary. Usually this means some kind of a crisis.

Phase 6: The provincial visit

The phase included mainly a meeting in the principal's office and the discussions that followed it. There were no minutes of this unofficial meeting. From what I remember the principal, the city office architect, janitor, assistant worker from the school office, and myself were present on this occasion. An official from the provincial school office visited the school and expressed the province's disappointment with the project definition plan that the city had sent to the provincial office (links 4, 6, and 8 in fig. 4.7). He was worried about the size of the budget and the fact that the mold and moisture problems were neglected.

Most of those who were present had strong memories of the occasion. Also many others had heard about it. The informants remembered the visit itself, but they also analyzed its content and consequences reflecting the occasion to the later incidents. This was one of the “critical incidents” (Flanagan 1954) of the project. The criticism expressed by the provincial official hit hard to some of the team members.

On the actual occasion in the principal’s office the principal felt that the school and himself were outsiders allowed to observe a dispute between the other parties. However, the principal saw this as “a learning experience”. It is interesting to notice that the official from the provincial school office wanted the gathering to take place at the school and not in the school office or the city architect’s office. Did he see the school’s role as being more important than the city representatives did (link 4 in fig. 4.7)? It may have been that in smaller towns schools were active parties and he assumed that the same would apply to the city as well.

The link between the school office and the city architect’s office was historically a strong one, but there were bad moments as well (link 5 in fig. 4.7). One of these was the question of moisture and mold. This issue arose once again when the provincial official accused the city of forgetting these problems. After all, the state support was basically “mold money” meant for moisture renovations in the first instance.

The cooperation with the provincial school office was very important to the school office. Through the provincial school office the renovation money was delivered to the city. The relationship had been good on many levels. However, this time the provincial office seemed to suspect the city of foul play (link 6 in fig. 4.7). They thought that the original application and program were deliberately underestimated to get the project through and the city would raise its demand later.

No such dishonesty can be seen. The program was put together in haste and there were some obvious flaws in it, but there was no bad will or manipulation. The centralized mindset can be seen in the province’s thinking. Because there were flaws and somebody must have been capable and in charge, this must have been her deliberate action.

The city architect’s office tried to raise the state support after it had understood that there was not enough money. As this was not possible, it started to trim the plans instead of increasing the budget. There was not enough money for all the things planned and this problem had to be solved somehow. The city architect’s office was deaf to the criticism which is natural in crisis situations (links 2, 5, 7, and 8 in fig. 4.7).

Network links

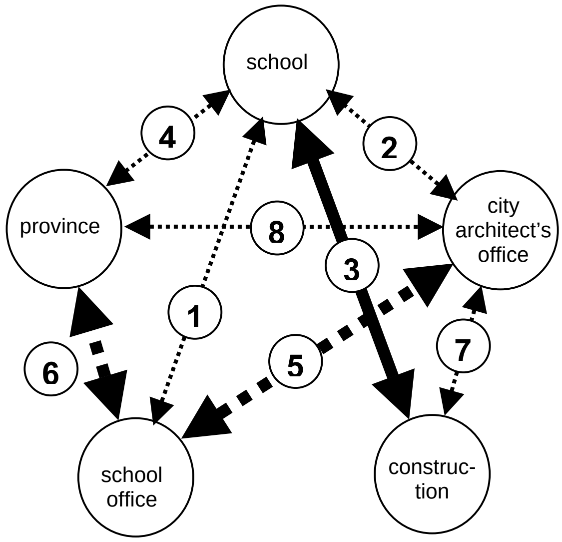


Figure 4.7. Network links in phase 6

1 Disagreement about responsibilities
2 Disagreement about roles
3 Two challengers of the old regime
4 Contradictionary interpretations about the nature of the tie
5 Disagreement about moisture problems
6 Suspicion of foul play on the province's side
7 Tension because of accusations
8 City has to obey and trim the plans

Summary of phase 6

We can call the phase a provincial intervention. The representative of the state expressed his disappointment in the city's actions. This intervention had consequences for the whole project network. The only strong link that was preserved was the one between the construction management and the school (link 3 in fig. 4.7). These two parties shared the state's opinion: they were not pleased with the project. Almost all the other (seven out of eight) network links were in a state of contradiction. Everybody tried to avoid being accused, and this led to contradictory interpretations of relationships and network links between different actors. Nobody wanted to be blamed for what had happened. This is typical in a construction crisis (Loosemore 1998 a-c).

For the first time in the project's history it had reached the level of crisis.

Phase 7: The trimming of the design

This was the period from the provincial visit in November 1997 to the summer of 1998. There were 119 documents from this period. They were mainly material related to the design process. After a slow start the design process gained speed. The kitchen was designed and a cost estimate made (doc. 123). A decision was made to hire an interior decorator (docs 137 and 173).

The construction management began to plan the division of the construction work into three or four phases (docs 167 and 168). A decision was made to have a temporary barracks on the school yard for five classes (doc. 169 and 181; link 5 in fig. 4.8). I had some meetings with the art teacher on how the school should be used in the evenings by other users (docs 149-151).

This led to nothing in terms of design, but it had an effect on the school thinking. The school realized that it was an important part of the community and it should offer spaces to people living around it as some kind of a communal learning center.

Several reports were made by different consultants. More asbestos was found than expected (doc. 199). The exterior drainage needed more repair (229). Finally, the city architect's office made an analysis (doc. 217) which showed that there were pressures to raise the budget. The degree of renovation should be higher than expected, all the fixtures had to be replaced, the auditorium should be renovated, more furnace rooms were needed, the technical systems (ventilation, electrical, heating, pipes, plumbing, and so on) were in worse condition than expected, and more of them had to be replaced. There were more new electrical systems needed than anticipated. All this meant 1,5 million more in expenses.

After the provincial visit it was obvious that no more state money was available. The designs had to be trimmed to fit the budget. The city architect's office became very active in this matter. It felt that it was responsible for the contradiction between the budget and the needs. The plans were changed. More walls were preserved than planned (doc. 153). This led to a design solution where the big classrooms on the second floor were not made smaller as had been planned. The school would have needed smaller rooms, because there were lots of immigrants among the pupils and they needed small classrooms for their language and religion classes. The windows were removed from the corridors (doc. 207) and several other changes were carried out.

However, it was not possible to save a total of 1,5 million and it was decided that the city would repair the auditorium at its own expense (doc. 206). The total cost estimated at this point was 6 million euros. The money applied for from the state was 4,4 million and 1,5 million was at the city's expense.

The informants remembered this period well and they could describe the network links in an elaborate manner. The trimming of the design had a serious effect on the project later and that was why many informants juxtaposed the decisions made with the future consequences. The trimming of the design caused stress and tension to relations between the different parties.

The tie between the school and the city architect´s office was the most complicated and contradictory link in the phase. After the provincial officer's visit the city architect's office was activated and it took its role as a project manager seriously. Soon the school found itself in opposition to the office in almost everything (link 2 in fig. 4.8). There was disagreement about who was in charge of the design process, should things be investigated or not, how the plans should be trimmed, and so on.

The situation inside the city architect's office did not help the situation. There was no clear division of power inside the office, and it was questionable as to who wanted the plans to be trimmed and who was in charge of the whole project. The only thing everybody seemed to agree on was that behind the problems was the fact that the state would not give any more money, and if the city had to use too much of its own money on the renovation, it would be an embarrassment for the whole office.

It looked like the school had a very independent status in terms of the assistant design and the designers (link 4 in fig. 4.8). There were meetings at the school, where the experts from the city architect's office were not present. This came from the office's policy that they would not invest their own resources on design if an outside designer was hired. When somebody had to represent a client, there was a vacuum of power, which was easily filled by the user's representatives. In this case it happened easily, because the school could offer extra resources for the task.

Network links

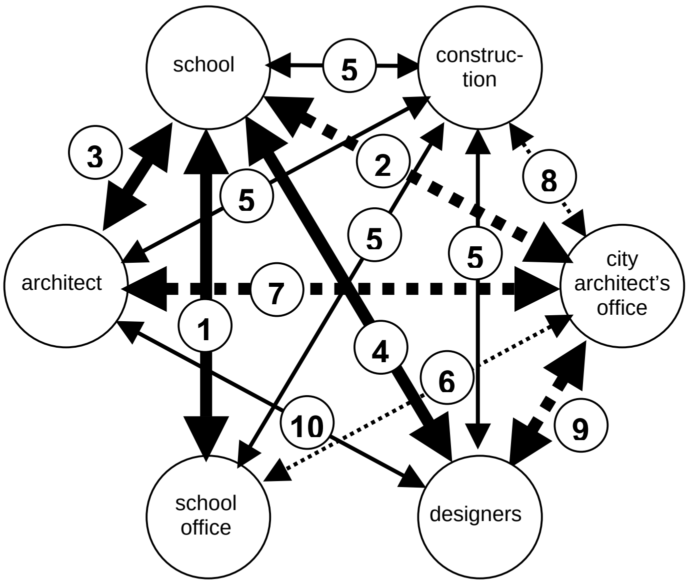


Figure 4.8. Network links in phase 7

1 The school office supports the school

2 The school is in opposition to the office's actions. Disagreements about the project management

3 The architect is on the school's side

4 The school becomes the client's representative in design matters

5 Routine action

6 Avoidance of responsibilities on the school office's side

7 Architect has to submit to the trimming decisions

8 Disagreements about the project management

9 Disagreements about the project management

10 Routine action

Summary of phase 7

In sum, the city architect's office took its role as a leader seriously, after a long period of not doing so. This led to a situation where all its links to other parties became problematic (links 2, 6,7, 8, and 9 in fig. 4.8). The others became confused: they did not know how they should behave in the new situation. The school could preserve its role as a dominant player in the field. It organized a counter-attack, and this made its links strong (links 1, 3, and 4 in fig. 4.8). The construction management was a new actor in the network and it had weak links to the other parties (link(s) 5 in fig. 4.8).

What was remarkable was that once more the moisture problems were put aside. The city architect's office had its hands full because of the budget problems and it could not concentrate on anything else. It postponed the problem to later stages of the project. The school, on the other hand, tried to do its best to preserve as much as possible of the original plan. It had to give up in its fight for the better investigations of structures.

As to the design, remarkable changes were made. New smaller classrooms were removed from the plans and the plan of the second floor resembled more and more the plan of the existing building. This was the main strategy used to minimize the budget: to make as few changes as possible to the existing building.

Phase 8: The design period of winter 1998-1999

This was an intermediate period. Design went on in a routine manner after the trimming was over. These quiet, unnoticed phases are those when most of the work is usually done. There were 67 documents from this period. In the spring of 1999 the designs should have been ready for the work to start at the end of the school year. During this period all the designs were made, the building permit (doc. 249) was applied for and everything was made ready for the bidding rounds. However, the period lasted a bit too long, and there was not quite enough time for the bidding.

Everybody thought that the city office architect was the project manager, because he was the chairperson of the design meetings. He himself saw chairing as his only role in the project. Otherwise he considered his own and the city architect's office's role as one of supervisor or observer. They managed the project through the minutes and statements. This lead to confusion about the project management: was the art teacher in charge of the project or was it the office architect (links 2, 8, and 9 in fig. 4.9)?

Network links

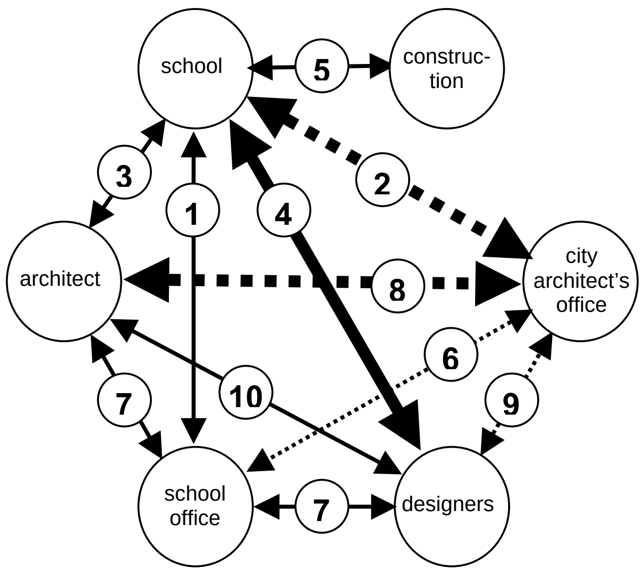


Figure 4.9. Network links in phase 8

1 Participation through statements

2 Mutual suspicion after trimming process

3 Routine action on weekly basis

4 Routine action on weekly or monthly basis

5 Planning of phases together

6 School office worried about moisture

7 Participation through statements

8 Different interpretations about the office's role as a supervisor

9 Different interpretations about the office's role as a supervisor

10 The school carried responsibility for this tie

Summary of phase 8

This seemed to be a quiet period of ordinary design work. This may have been one reason why designers and other professionals were not talking much about it and the ones who talked more were those who were encountering this kind of work for the first time. These quiet but busy periods are necessary for all systems. A system cannot be on a high energy level all the time. The balance between actors is formed during the intense periods and this situation continues during the intermediate periods.

The school had taken the role of actual project manager and everybody else quietly accepted the fact. The other parties invested as little as possible in the process (links 1, 5, 6, 7, 9, and 10 in fig. 4.10). There was an obvious reason for this: the others had plenty of other projects going on at the same time. As long as there were no problems with the budget, they had no reason to interfere.

However, there was hidden tension beneath the quiet surface, tension which would later cause some devastating consequences.

Phase 9: Preparation for the construction work

This was a short period in spring 1999 when construction management took charge of the project. The designs were finished and they went on to the bidding process. The construction management was rather annoyed about the late arrival of the drawings (link(s) 4 in fig. 4.10). It did not have enough time to study the designs properly. There was no main contractor, but the construction management was responsible for the coordination of the works.

At the beginning of the year one of the former actors, the maintenance department, returned to the site. They were needed to build the temporary classrooms into the shop. The construction management selected the contractors (docs 300-302, 307, 308). The site team was created and the kick-off meeting was arranged at the building site (doc. 309).

Network links

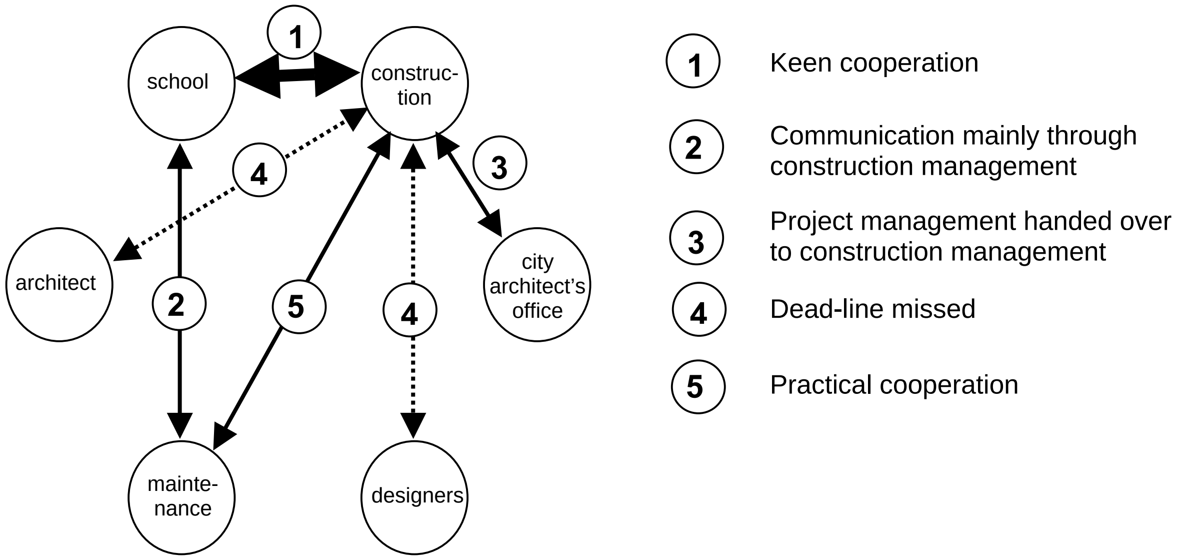


Figure 4.10. Network links in phase 9

Summary of phase 9

A new project manager took over. The construction management created links to all actors (links 1, 3, 4, and 5 in fig. 4.10). Some of these were complicated: the design work was late and this caused problems. There was no tension between the school and the construction management. The two were not in a competitive situation, because there was a natural division of labor: the school took care of the design decisions and the construction management was in charge of the works.

Phase 10: The work starts at the site

Summer 1999 was a hibernation period in the life of the project, at least as far as what can be gathered from the informants' memories of it. The designers were busy during the design phase and when that was done they seemed to abandon the project. The same happened with the school office and the city architect's office. The only active parties left were the construction management and the school (link 5 in fig. 4.11). Work started slowly during the summer of 1999. There was a first official site meeting on the 14th of June (doc. 315). A temporary building was brought to the schoolyard (doc. 318). The first signs of mold were detected (doc. 331). The relation between the school and the city architect's office became extremely difficult when mold was detected and analyzed in a laboratory (link 2 in fig. 4.11). The city architect's office refused to give the results to the school. The art teacher had to contact the laboratory to get the information. Clouds were slowly gathering over the project once more.

Network links

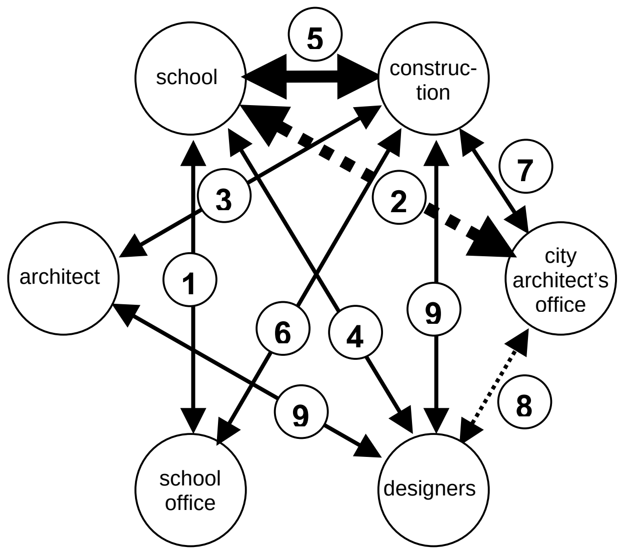


Figure 4.11. Network links in phase 10

1 Formal relationship

2 Founding of mold traumatized the relationship

3 Visits at site, meetings

4 The art teacher contacts the designers if necessary

5 Many problems solved together, investigation of mold and moisture

6 Office accepts and is pleased with the cooperation between the school and the construction m.

7 The office kept at distance

8 The distance caused problems to this tie

9 Meetings

Summary of phase 10

The project was taken over by two actors: the school and the construction management. They were active project managers in keen cooperation. Others tried to avoid interfering by all possible means. They were busy elsewhere in other projects and had no resources allocated to the Hakala project. However, problems appeared when the first signs of mold were detected from the building site.

The role of the architect was interesting. He should have been active at the beginning of the work, but was not mentioned at all.

Phase 11: The crisis of fall 1999 and its resolution

The news about the detection of mold at the building side had spread rapidly and had had devastating effects on the project and its network relationships (see Appendix 6, phase 11, description of links 2, 6, and 9). Mold in dry walls was mentioned for the first time in a site meeting on the 31st of August (doc. 331) and samples were gathered between September 2nd and 6th (docs 332-334). On the 15th of September the demolition of all the interior walls was ordered (doc. 336). In the site meeting on the 28th of September of (doc. 347) there was a discussion about the methods used and about the need for further investigations. On the 29th of September rain water poured in from the roof (doc. 348) and later it was found out that the exterior walls were leaking as well. What was supposed to be a normal renovation turned out to be a serious mold and moisture project.

This had effects on the budget as well. More money would be needed if everything planned were to be done. There was a meeting in the principal's room on the 8th of October (doc. 353) in which the matter was discussed between the art teacher, principal, vice principal, and myself. Should something be trimmed away from the plans once more?

The principal described the situation in an elaborate but accurate manner: “There were pieces on the table and feelings as well…It was a straight discussion, horribly straight”. I remember how important it was for me to describe the difficult situation as accurately as possible. It made the school angry, but they appreciated my honest way of expressing things. As the principal says, “it was a test of the team trust”. The situation forced us to go through the whole project and reprogram it. What was important and what was not, what could we afford? Our daring endeavor succeeded, trust was increased due to the honesty. “Even though there were strong threats to the cooperation, we never ended up in personal antipathies” said the principal, “The team could take it.” (link 4 in fig. 4.12)

Not everybody shared the principal’s interpretation. The art teacher saw the construction management as the main source of the budget cuts when she described the meeting. After all, it was promised that the school would get all the money it needed in case something like mold was detected. “I was close to throwing a book at you”, she recalled (see also Appendix 6, phase 11, description of link 4).

After the meeting the principal called the city school planner and contemplated the possibility of going to the press and making the matter public. However, the school decided to trust the team and keep the problem a domestic matter. A visit was made to a school in another city and there new ideas about pedagogical equipment arose (doc. 360). By the end of October there was another meeting at the school attended by the city school planner and it was decided that more money would be applied for (doc. 364). An estimate was made by the city architect’s office of the extra expenses (doc. 384). An additional 340.000 euros was needed.

Major parts of the project had to be redesigned. A new roof structure and new interior walls had to be built. The floor structure needed to be studied for mold and moisture. As the junior construction manager described it: “Structure after structure, detail after detail needed to be investigated and after all these investigations doubts remained about the extent of the destruction.”

The extent of the destruction was unknown, but so were the solutions to the problems as well. Was there a solution were the rebuilding work could be limited to a smaller number of structures or should larger parts of the structures be rebuilt? “We always ended up doing the latter”, the junior construction manager recalled. “There was neither enough information nor resources. On the other hand, there was plenty of information. It was difficult to find people who had their feet on the ground.”

The junior construction manager was not part of the previous design team. He could not understand why the structure had not been investigated any better before the construction period. “It was so painful when one was investigating during the construction”. However, he had good memories about the chaotic period. People had to cooperate somehow to survive from day to day. There were shared problems, but no accusations. “The problems were like a dear child uniting everybody.”

The City Mayor visited the site on the 2nd of December with the head of the facilities department. The whole team was present (doc. 393). By that time the most difficult decisions had been made and the mayor promised that lack of money would be no problem. I remember how he talked about other city projects which had been almost as disastrous and wondered whether anything could be done for the project management of city projects.

The team continued the struggle with mold throughout the spring. The exterior walls needed to be studied and the floor structure was a source of a continuous discussion. Mold problems were a new issue at that time and the construction management had not dealt with them before to this extent. There was a lack of knowledge. It was the art teacher who started to read about the matter. It looked like nobody had anything against this. “The art teacher has carried the most painful burden” was the principal’s interpretation. “It is easier to do things when somebody else takes responsibility. The junior and the senior construction manager willingly listen to the art teacher’s expertise and ask her, a teacher who knows about bacteria. This saves their honor.” (see Appendix 6, phase 11, description of link 2)

Here we see transactive memory in action (Moreland 1999; Moreland, Argote & Krishnan 1996). A new question arose and the team had to decide who would take care of it and acquire more knowledge. The art teacher became an expert in these matters, because she was the most suitable person and the others had their hands full of everyday tasks. The institutional roles had no place here: it was only a matter of who gained expertise in a specific problem.

There was disagreement about the project management between the school office and the city architect’s office (link 6 in fig. 4.12). The school office would have liked to establish a board for every large project, where the school and different parties would have been represented, whereas the city architect’s office preferred a “leaner” organization. According to the city architect’s office, if more money was needed in the construction phase because of surprises, it was just poured in. The school office would have liked to have had a tighter approach to budgeting and cost management and to move all the decisions about money to the proposed project board.

There were two different approaches to the project management: the *ad hoc* model of the city architect’s office and the more systematic (or bureaucratic) model of the school office. Behind the *ad hoc* –model there was the assumption that one cannot budget renovation projects properly.

The city architect’s office was responsible for the design budget. It hired all the designers and paid their bills. The city architect’s office did this during the whole life-span of the project. This made things complicated during the construction period, when the construction management was in charge of the works (link 9 in fig. 4.12). If more designs or alterations were needed, it had to ask the city architect’s office to order them from the designers. This complicated system had its origin in history. In earlier times it was the city architect's office that was the designer and no outside consultants were used. Later, when outside consultants were used on a regular basis, the city architect's office still stuck to its role as the one responsible for the quality of the design work. There was also the suspicion that the construction management would not pay enough for the designers or would misuse its power somehow.

In the Hakala case there was a lot of work in changing the plans and lots of redesign work. This was a source of disagreement (link 8 in fig. 4.12). The city architect's office was not willing to pay more money to the architect for the extra work. The missing resources affected the architect's ability to serve the other designers and the construction management (as a result the link 12 in fig. 4.12 became problematic and the link between the architect and the designers is missing). According to the construction management the architect office should have been paid more for the extra design work needed (they became allies: link 11 in fig. 4.12). After all, compared with the size of the project, the amounts needed were small. The system was turned against its original purpose. The city architect's office looked at the design money separately and lost the big picture. One should not separate the design from the construction process. Everything should be considered as part of a larger whole.

This period lasted to the summer of 2000, when the first phase of renovation was delivered and it produced more documents (over 150) than any other phase: investigation: reports, minutes, decisions, meetings, designs. It looked like the design and the construction were done all at once in a half year period.

However, after the fall the project had reorganized itself, everyone was accustomed to the situation in which problems were solved as they appeared. This approval of the situation eased the tensions inside the project team and opened the discussion. Nobody needed to blame others anymore. The most important thing for everybody was to have the school repaired. For the first time in the project history there was an effective team and a good team spirit.

Network links

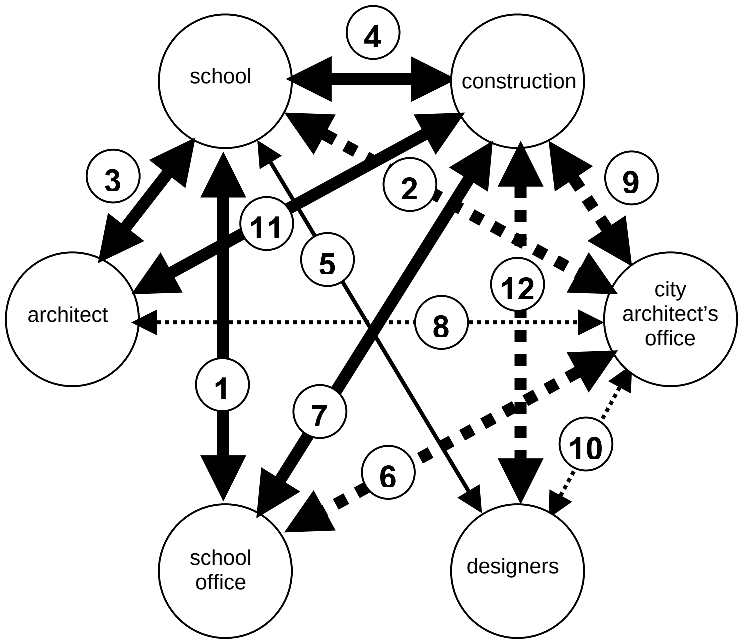


Figure 4.12. Network links in phase 11

1. The office helped and school was grateful
2. There was exchange of information, but the mold problem cast a shadow over the tie
3. Mutual feeling of trust could last even disputes
4. An alliance born in the middle of crisis
5. Cooperation on a routine basis
6. Cooperation, but fundamental disagreement about the approach to project management
7. Joint efforts to raise more money
8. Disagreement about extra work
9. Division between design and construction problematic
10. Disagreement about extra work
11. Difficult problems solved together on daily basis
12. Poor quality of design work

Summary of phase 11

This was a crucial phase in the project. The finding of mold and severe problems in almost all structures led to the reprogramming of the project and to a new approach to its management. This had an effect on many of the relationships in the project.

There were mainly strong links. However, there was a polarizing effect: the strong links got even stronger, the weak links became strong ones, but the problematic links became even more problematic. The school and the construction management were the two hubs of this miniature network (Barabasí 2002). All their links were strong ones. However, some of them were contradictionary. The city architect's office was their counter-universe: it had only problematic links.

It looked like for the first time in the history of the project that the majority of the informants talked about a true team-spirit. Disagreements were not on a personal level: matters were discussed frankly, knowledge was shared at many levels and innovations were made. A crisis was needed before everybody woke up and invested enough resources in the project. The focus was not only on the issues at hand, but also future problems and the client's needs were discussed thoroughly.

Phase 12: The work on site

After the first phase of construction work had been accomplished and most of the mold and moisture problems solved, the project got back on track. However, all building projects have their problems, and the rest of the project was not an exception. These problems were typical of any renovation project. After the first phase was finished, everybody knew what to expect from the following phases. The roof was still a problem (doc. 537), and more money was needed. Other financial pits were the home economics classroom (docs 534,535), the shop (doc. 505), the dentist’s room (docs 501-503), and the auditorium (docs 510, 520). There were lots of documents referring to planning and design orders. It looked like the design process went on during the whole construction period.

There was a dispute between the school office and the construction management over money and the school had to act as a mediator (links 1, 4, and 6 in fig. 4.13). The new integrated classroom system was designed by the school and the city architect’s office (link 2 in fig. 4.13). The interior designer became frustrated when the school disagreed on many important decisions (link 5 in fig. 4.13).

In October 2000 the construction project was topped off with a celebration (doc. 494). Everybody was pleased with what had been achieved. This is typical of most construction projects: whatever problems there have been, in retrospect they are forgotten and the only thing which matters is the end result.

Network links

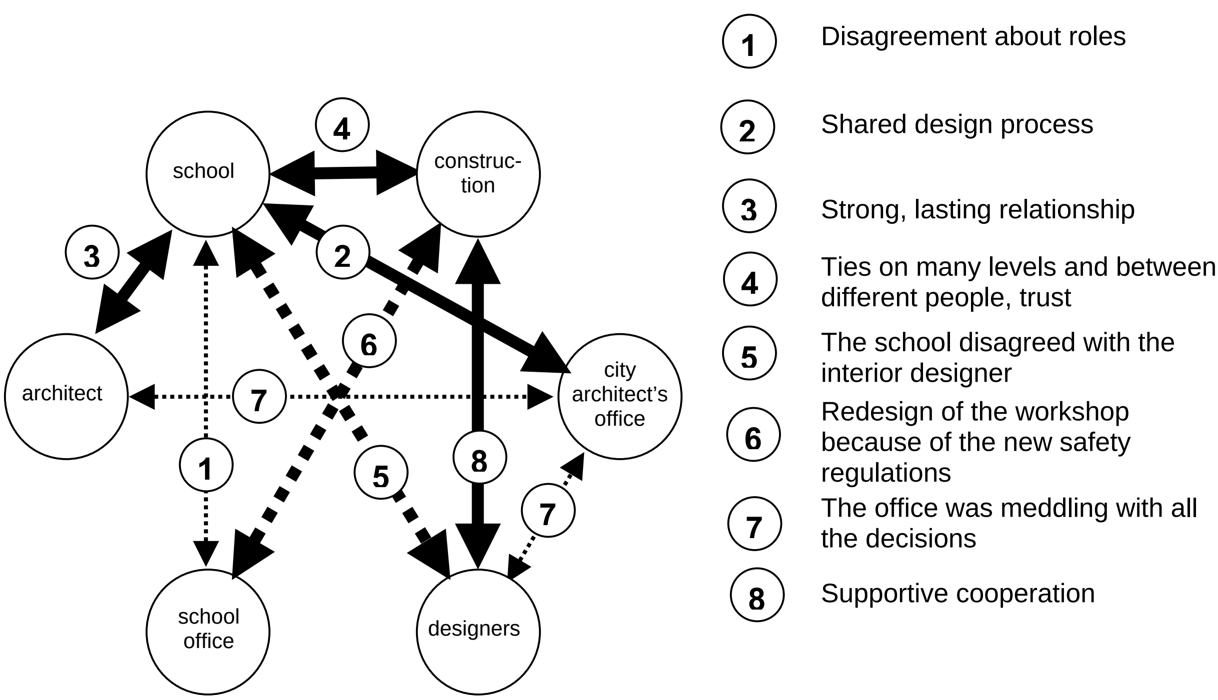


Figure 4.13. Network links in phase 12

Summary of phase 12

During the interviews, this period was still going on. It was remarkable that the informants talked more about incidents a year before than things that had just happened. In some of the interviews daily issues were discussed, but not in a very dominant manner. This shows how strong critical incidents (Flanagan 1954) are for the informants' recollection. The other explanation is that people were able to analyze the past and distinguish between what is important and what is not.

It was evident that the fall of 1999 was a turning point in the project's life and the ties born in the crisis lasted for the rest of the project. The crisis was a moment of change, and friends and foes were chosen during this intensive turbulence of crisis. The school and the construction management stayed as key figures for the rest of the project (link 4 in fig. 4.13). This may have been the case in an ordinary building project as well, especially in one where the construction work was done in phases in the middle of active school work. The city architect's office could not decide whether it was still part of the team or not. Its approach was normative and institutional (Berger & Luckmann 1966; Scott 1995), and this kept it outside the core team.

Comparative analysis of the network links in Case 1 (Hakala; RQ2)

In Appendix 7 there is a table where all the links described in the previous chapters are collected. Some conclusions can be drawn from the table. It looked like the strong links increased towards the end of the project. This was supposed to happen when the network got older (Barabasí 2002). The strong, non-problematic links were typical between certain actors and they stayed throughout the project. Good examples of this were the links between the school and the architect and between the school and the construction management. The strong, problematic links were also typical of some relationships. The ties between the city architect's office and the school office or the city architect's office and the architect were characterized by strong, problematic links.

An analysis can be made of the dynamism of the network. We can analyze two qualities of the links: their *strength* - whether the links were weak or strong - and *contradiction* - whether the links were problematic or non-problematic - and how these two qualities changed during the life-span of the project. The third factor was the *density* of the network: how many links there were compared to all possible links.

Depending on the phase, there were four to six nodes in the network, so the number of possible links varied between six and fifteen. Six to fifteen links is not a large sample, but if all the links in different phases were counted, there were 141 possible links in the project during its life-span.

The strength of links in a given phase is the ratio between the strong and weak links. The contradiction of links in a given phase is the ratio between the problematic and the non-problematic links. The density of the network in a given phase is the amount of existing links compared to the amount of possible links. The result is shown in the following chart (fig. 4.14).

The missing links were excluded when calculating the strength of the links and the contradiction of the links (missing link: two actors participate the same phase, but there is no link between them: see section 3.4.2).

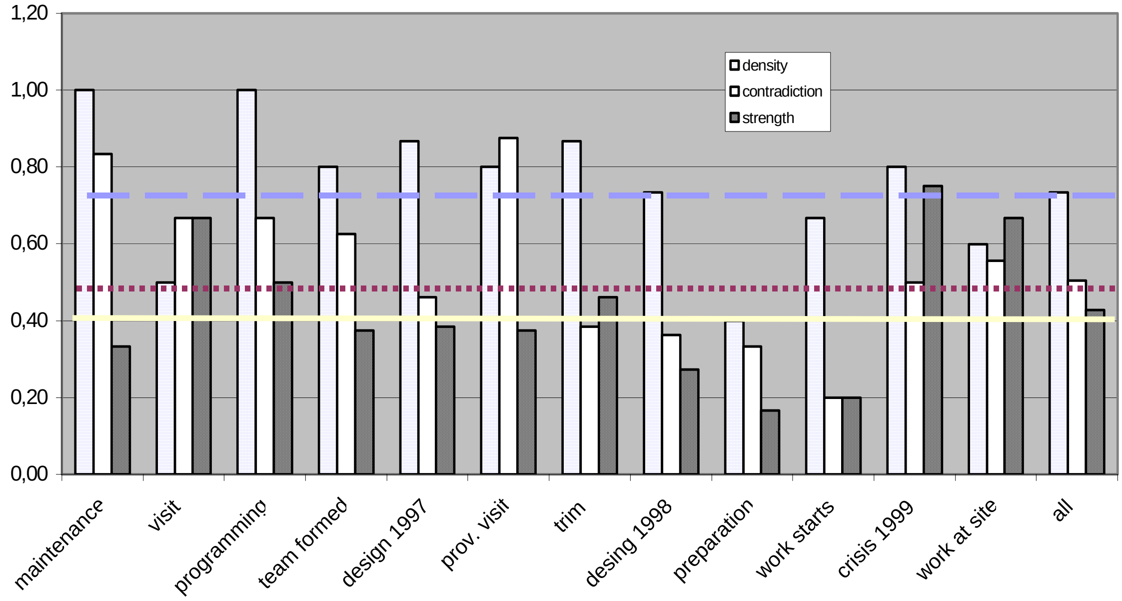


Figure 4.14: Density, strength, and contradiction of the links in Hakala

As we can see, the strength of the ties was above average in five phases: “the visit”, “programming”, “the trim”, “the crisis of 1999”, and “work at the site”. These were the most important periods with regard to the fundamental decisions of the project content and success. The strength of the ties seemed to increase towards the end of the project. Of course, one has to keep in mind that the number of links was smaller in the beginning. When missing ties were not included, only two strong ties among the six possible ties were needed to make “the visit” a network of strong ties. This was not the case in the later phases when the maximum number of possible links was fifteen.

The contradiction of the ties seemed to decrease towards the end of the project. In six phases the amount of problematic ties was higher than average. Five of these were among the first six phases and only one - “work at the site” - belonged to the latter half of the project.

The density decreased towards the end of the project. It was at its lowest during “preparation” and “the work starts” and increased again in the crisis of 1999.

The first half of the project was characterized by the high density of the network and the ties which were problematic and weak. In the middle there was a period when the density of the network was low and so was the strength and the contradiction of the ties as well. The last two phases and the one before the low-density period – “the trim” – were full of strong and non-problematic ties. This was a clear message from the informants: according to them the atmosphere got much better at the end of the project, whereas the beginning of the project was difficult for everybody.

Were there participants who had more weak ties or more problematic ties? All the ties of each actor are collected in the following table (Table 4.1):

Table 4.1: The quality of links of each participant in Case 1 (Hakala)

	strong	weak	***strong problematic***	*weak problematic*	missing	**all links**
School	18	10	8	9	7	52
City architect's office	1	3	16	20	12	52
School office	5	11	9	7	14	46
Architect	8	12	5	4	14	43
Construction management	9	12	3	6	9	39
Assistant designers	3	11	3	8	14	39
Maintenance	0	2	1	3	4	10
Province	0	0	1	2	1	4
	44	61	46	59	75	285

The city architect's office and the school had more links than the others, because they were present in more phases than the others. The maintenance department and the provincial official did not have many links, because they were present only in phases 1 and 3. What was remarkable was that both the school and the city architect's office had fewer missing links than the others. This was in accordance with the theory of scale-free networks: the older nodes have a preferential advantage (Barabasí 2002). We could say that the school and the city architects office had higher *centrality* than the others (Palonen 2003). They had 87% and 77% of the possible links, respectively.

However, there was a difference in terms of the strength of the links. The school had 26 strong ties when the city architect's office had only 16 strong ties. Of the school's non-missing ties, 58% were strong. The average was 39% and the city architect's office, school office, architect, and the construction management were slightly over-represented.

The biggest variation was in the contradiction of the links. If the provincial official was excluded again (all of his three existing links are somehow problematic) the city architect's office had created more problematic links than the others. Of all of its links, 90% were problematic. The average was 56% and the maintenance department was also above that (67%). The school (38%), the architect (31%) and the construction management (30%) were well below the average.

We can now make a 2x2 matrix of the participants and their network ties in all phases:

Table 4.2: The quality and strength of network ties in Case 1 (Hakala)

	contradiction	less contradiction
strong	**City architect's office**	**School** Architect
weak	Assistant designers Maintenance **Province**	**Construction management** School office

bold = centrality (proportion of existing links of all possible links)

Table 4.2 illustrates that the most effective network actors of the Hakala School renovation project (Case 1) were in the upper right corner of the matrix. They had lots of strong, non-problematic ties to other actors. The actors placed in the lower left corner of the matrix were less competent actors. They had lots of weak and problematic links to the others. As we can see, the school was the most dominant player of this network. Between the school and the other actors there were strong, non-problematic links and the school was more active than the others. The architect office was another strong player which formed a team with the school. The construction management and the school office were tied with weak links to these two. The city architect's office was a strong and central actor, but its action was characterized by its contradictory links with the other players. The assistant designers and the maintenance department were outsiders in the network. The majority of the participants had mainly weak links to the other actors.

The school and the city architect's office were the two poles of the network. The school could have been called the "hub" (Barabasí 2002) and the city architect's office the "anti-hub" of the network. There was always at least one strong, non-problematic link connected to the school (one exception: "the maintenance") and at least one strong, problematic link connected to the city architect’s office (two exceptions: “preparation” and “work at the site”). There seemed to be a pattern: if the school had more than one strong, non-problematic link, it always meant that the city architect’s office had more than one strong, problematic link (one exception: “work at the site”).

The school made its position better by investing extra resources to the project. The others did not have that advantage. The school took the initiative in many phases, or it could organize opposition to somebody else’s initiative (as in “the design trim”, when there was a threat that the city architect’s office would destroy the whole plan).

An interesting question is why were there problematic links around the city architect’s office when there were non-problematic links on the school’s side? First, the whole idea about the renovation arose in a meeting between the school and the school office (fig. 4.3), and it took a long time before the city architect’s office realized what was going on. During the programming the school worked independently with the architect and the city architect’s office felt that it was an outsider. When there was criticism about the project definition plan in the fall of 1997, the city architect’s office realized that the criticism was pointed at it. The whole network was divided into two: a circle of strong ties around the school and a circle of problematic ties around the city architect’s office (fig. 4.6). When the city architect’s office became active by protecting the budget and trimmed the plans, it created a circle of strong problematic ties around itself. At the same time, the school became a centre of the strong ties. The whole network was polarized (fig. 4.8, phase 7).

The network was divided into two sides again in the crisis of the fall of 1999. This time there were two centers on the strong side: the school and the construction management. The city architect’s office was surrounded again by strong, contradictionary links when it tried to protect itself against the accusations.

Judging by the strong, unproblematic links, the architect was always on the school’s side. The worse the situation between the school and the city architect’s office, so the stronger were the ties between the school and the architect. The same seemed to apply to the school office and the construction management, to a lesser extent though. The designers were in problematic ties to all the others, and the only one able to create strong, non-problematic links to them was the school (figs 4.8 and 4.9; phases 7 and 8) and the construction management in one phase (fig. 4.13, phase 12).

If one looks at this process from the school’s point-of-view, there was first the maintenance period, through which the school learned how to deal with the technical sector. Then a new situation emerged when renovation became a possibility during the visit of the school office. The school had to learn a new role as participant in a renovation project. It had no knowledge of such projects beforehand. It started collaboration with an architect it knew well and who it trusted. It had several preconceptions about the action and about the different roles. It believed that the experts would do their due share of work and study things like moisture problems carefully. It was soon disappointed in these expectations when the budget was exceeded and mold and moisture detected. It learned its lesson and adopted a more active role. It became a true leader of its own future and it sought alliances with the other participants. Finally, those who had objected to its new role surrendered and the situation normalized.

In the upper left corner of Table 4.2 there was the city architect's office. It was very sensitive about its role as a designer of all city premises. It was first difficult for the office to realize that Hakala was a major project. It had difficulties to accept the school's role as an active participant. It was involved in too many projects at the same time, and it could not invest enough time or energy in Hakala. Things happened, and the office had no influence on them. Finally it was alerted when the third parties – the province and the construction management – pointed out weaknesses in the work done so far. The office felt that it had to protect its field of expertise and carry its responsibility. It became active and tried to correct the mistakes made so far. It did not succeed very well in doing so. All ended up in a disaster when the mold and moisture damage was found. At that point the city architect's office admitted its mistakes and retreated into the background. The project was in the hands of others and the office was not active in the matter.

The school office drifted between the school and the city architect's office. It was a representative of the schools inside the city organization. This was not an easy position. Before the comprehensive school system was established, the secondary schools used to be private and independent. The city school office was often seen as a pure replacement of the state organization. However, this was not the case with Hakala. The school seemed to trust the school office to a certain degree. The school office, on the other hand, cooperated a lot with the city architect's office and the facilities department. In many cases it had to execute city policies together with the other central organizations and this made it a peer to the city architect's office. During the process the school office first cooperated with the city architect's office to obtain the subsidies from the state, but when things got worse it had to change sides. It supported the school in its fight against the budget cuts and the moisture problems.

The construction management was a newcomer in this process. Its appearance had an effect on the whole network. The school found an ally in the construction management, whereas the construction management's relationship with the city architect's office was an ambivalent one. They were partners in the sense that they shared the project management responsibilities, but the shared responsibilities were the very reason for the disagreements as well. Who decided what should be done when one commands the design and the other the construction site? By making the school its ally the construction management gained an advantage in this game.

The architect was in a tricky position. The city architect's office paid his salary, but otherwise he was on his own. The architect never called his loyalty to the city architect's office into question. However, when the power shifted into the hands of the school, he had to follow. The problems with the office were referred to when the architect talked about his fee. He felt that he was not paid for the extra work caused by the project management.

The relationships described have definitely triangle-like characteristics. The appearance of the school and construction management destroyed the earlier balance between the different actors. These balances (school office - city architect's office, city architect's office – architect) were based on dyadic relationships and when they became triads a new balance had to be created.

4.1.3 Lessons learned from Case 1 (Hakala)

The first research question asked about the quality of the documents and their relation to the action which produced them. The second research question focused on the dynamism of the network action. Research question 3 was about the factors behind projects' success. In this chapter the Hakala project phenomena are discussed in the light of the research questions.

The project definition plan did not mention moisture (RQ 1, RQ3)

One factor behind the project failure was the negligence of the mold and moisture problems during the programming and design phases.

The project definition plan said very little about moisture problems. Mold was not mentioned at all. There was only something about the poor general condition and leaks on the roof. There were some hints that this kind of problem might exist, but they were all neglected. Problems with the exterior walls were not mentioned, even though the team members knew about them. The general idea was that the school and its structures would be completely renovated anyway and all the moisture problems would be taken care of at the same time. However, no money for larger work was budgeted. There were also serious defects in the flow of information. People who knew that problems existed could not convey this information to those who were in charge of the project.

Everybody seemed to think that the problems were so small that they could be handled during the construction work.

> *"The mold has to be taken care of anyway."*
>
> *– the city school planner*

It was also considered impossible to study things more carefully.

> *"The idea was that once the work starts all the walls will be opened and checked…In an existing building there are always activities going on and it is impossible to study it thoroughly. There is no clear picture of the matters. It is not before the construction period that the truth is revealed. That is the problem with renovations. All the bearing structures should be revealed before the design starts."*
>
> *– the architect*

The representatives of the school did not share this opinion. They had the feeling that they had trusted professionals who failed to do what was promised.

> *“Always when there is a construction project going on they should be studied. Construction and design suffers if there is no research done beforehand. We would have got better design solutions if we had known that the walls would be removed anyhow. Would we have torn the whole building down if we knew its true condition?”*
>
> *– the art teacher*

One reason why mold was not studied was the timetable. As the city school planner expressed it: “If it had been delayed then, we would have had to start it over again”. Again, we see *confirmation bias* working (Busby 1999; Hakkarainen, Lonka & Lipponen 2004: 38-40; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 23; Saariluoma 1990; Tversky & Kahneman 1974; Wason 1968). Even the scientist often forget the principle of falsifying. According to this, hypotheses should be proven false, and if this is not possible, it can be interpreted as confirming evidence.

The scientific principle of falsifying can be applied to the mold problem of Hakala. If the team had the hypothesis that there was no mold or moisture, they should have done their all to prove that there *was* mold, and if they did not succeed in doing so, they could have been quite sure that the hypothesis was confirmed.

However, this is not the way humans work. If the information about mold would have disrupted the timetable, people did not want to hear about it. Some of the participants seemed to have decided that there was no mold and that was why they were not looking for it. These very same participants were those who were considered experts by the other participants. These other participants knew there were problems which should have been studied more carefully. There was a great resemblance with the situation during the maintenance period: power was shifted to people who were under-resourced or not motivated to study things further.

There was a failure on the level of primary artifacts (section 2.3.3): the molds were not found. This failure had its origin at the level of secondary artifacts: the project definition plan did not concentrate on the issue properly. The defects of the project definition plan were caused by the misunderstandings and conflicts on the level of the tertiary artifacts. Different parties had conflicting goals and interpretations over the matter.

Mold and moisture problems are very common in Finland, and by the turn of the millennium they had reached the level of an epidemic. The city had invested a lot in their prevention, and special mold and moisture were groups formed. It is difficult to understand that these problems were neglected by the people who were themselves members of these special groups.

The system was not designed for strategic purposes (RQ 2, RQ3)

There was a contradiction in the way different parties saw the content and aim of the activity during the maintenance period. There was no shared *theory of action* (Argyris & Schön 1978). This caused lots of problems on the operational level. However, its consequences on the strategic level were even worse. There was no vital information collected, or if it was, it was misinterpreted. The system had no capacity for strategic decisions, it could only postpone unwanted investments. This created a vicious circle: the bigger the need was for a renovation, the more likely it was to be postponed.

Here we can see two different logics working. Inside the school there were functioning teams, a clear division of labor, and methods for processing new information. Outside the school there was more or less a mechanistic system which was hierarchically organized. There was no clear division of labor or responsibilities, and the system's capacity to process new information was minimal.

Most of the problems had their origins in a conflict between these two ways of apprehending the world. It was difficult for these two to understand each other.

The power shift had been from the school to the outside system. Critical decisions were made by people who had not even visited the school. The only reliable source of information was the school itself, but in many cases nobody listened to it. Confirmation bias was working: people were deaf to information they did not want to hear.

The school and the facilities sector stayed in their own separate worlds. If we think of these two together, we see a system which focused on solving small-scale operational problems. It did not do this well, but somehow it managed to "keep the patient alive". However, it was a poor system for strategic purposes. Nobody gathered critical information or "weak signals" (Ansoff 1975). On the contrary, the system tried to bury such information. Its aim seemed to be to avoid investments, not to prepare for investment decisions or to study the environment objectively for strategic purposes.

The system failed because fundamental cognitive functions (executive function, transactive memory) were not designed. There was no reflection-on-action nor double-loop learning. Nobody was responsible for the whole or responsible for either defining the goals or their fulfillment. Again, this can be traced back to lack of shared theory-of-action.

Automated functions and official meetings (RQ 2, RQ3)

If all the time wasted at the beginning of the project had been spent studying the building or interviewing the people in the maintenance department, much of the later damage could have been avoided. But this was not the way the system worked. The reason was that when the same people were taking care of dozens of projects, nothing was done before it was absolutely necessary. Something was done because a deadline was approaching or then one incident pushed another incident forward. The whole course of action was a series of automated functions working on their own.

When it was a case of creative activity, a process of designing and building, a logical presupposition would have been that first there should have been a period of unofficial meetings when ideas were produced, then official meetings where goals were set and all the design work and production of artifacts should have come after that. If we look at “the EEG” of the project in fig. 4.1, we see a very different picture. It looked like the design artifacts were the starting point for discussion and the sole purpose of the official and unofficial meetings was to refine them and give them official status.

When things went wrong people did not gather and share information unofficially, but did it in official meetings. First the claims were produced and the processing of information came after that. This confirms the findings of Loosemore (1998 a-c) and Fink, Beak & Kenneth (1971): in the middle of a crisis information sharing decreases and becomes ritualized.

This project failed because the network action was not designed properly.

The nature of crisis (RQ2)

We can definitely conclude that the project had reached the level of crisis in the fall of 1999 when the moisture and mold damage was found. The project team’s “repertoire of coping responses was not adequate to bring about the resolution of a problem which posed a threat to the system” (Fink et al. 1971: 16). According to Hermann (1963: 64), “an organizational crisis (1) threatens high-priority values of the organization, (2) presents a restricted amount of time in which a response can be made, and (3) is unexpected or unanticipated by the organization.” There were no contingency plans in place and that caused stress symptoms in the participants (Loosemore 1998b). Several of the informants described stress symptoms and were worried about each other’s health as well. Many of these problems were related to mold. When the worst crisis was over and the school was cleaned up after the Christmas holiday, people were feeling much better.

The division into two groups of actors seemed to influence the nature of the crisis. Crisis means change which may threaten established positions. This was why the city architect’s office was protecting its position against the others.

Loosemore (1998a) talks about pressure and stress in these kinds of situations. Pressure makes people work for better end results and it can be exciting and challenging. Stress makes people feel unable to cope with the situation and it may lead to defensive behavior. This may explain why the relationship between the school and the architect could tolerate quarrels about architecture, whereas simple matters like the contract payments became very problematic between the architect and the city architect’s office.

Loosemore (1998a) suggested that in a construction crisis the positive phases are easily destroyed and the negative phases are self-perpetuating. He found one exception: if people were sensitive to each others' needs, open in their communication, and had a collective sense of responsibility, stability was maintained. This kind of an atmosphere was prevailing in the part of the project connected by strong, non-problematic links. These links were developed under a longer period of time, which made them long-lasting and capable of carrying over the crisis periods. In the crisis they grew even stronger. As Loosemore (1998b) puts it: a construction crisis can be seen as an opportunity as well as a threat.

Information was missed because of conflict between design and PM (RQ2)

All contradictionary relationships seemed to have their origin in the fundamental question of what is design and what is project management. It is obvious that this question will not be answered easily, if ever, but anyway it was something the actors should have discussed. The ambivalence between the design phase and the construction phase can be removed if these two phases are run by the same organization, but the ambivalence between the designer and the project manager remains still.

However, there was one important piece of information the system could not process properly: namely, the voice from the school declaring that there were serious problems with moisture was not heard. The centralized mindset caused everybody to rely on the project management to take care of the analysis of the information. There was no clear project management and there was no open discussion on a metacognitive level either (who *should* be responsible for what) because of institutional courtesy and assumed *theory in action* (Argyris & Schön 1978). The system possessed neither executive function nor perception.

There was not enough time for programming (RQ1, RQ2, RQ3)

One basic reason behind all the problems was the lack of time. People did not have enough time to gather and discuss the problems. The people who were in charge did not have time to concentrate on the project. The people who had time could not communicate with those who were in charge because they were not given a chance to do so.

The lack of time was caused by systemic structures. The state was strict about the deadlines for applications. The city architect's office was under-resourced and it could only produce what was necessary for the application: there were no resources for more surveys or for more precise programming. The city architect´s office and the school office saw the whole process as a technical one because they did not have time for anything else. The school would have expected more precise work and more time spent on the project.

The lack of time was a result of a systemic failure. There were two different processes which were not balanced. One was the state and province process of applications for subsidies, and the other one was the city budgeting and design process. These two processes did not work together because nobody had designed them to work together.

We have here two systemic archetypes described by Senge (1994). First there was the state application process affected by "*eroding goals*". It is a structure in which a short–term solution involves letting a long-term fundamental goal decline.

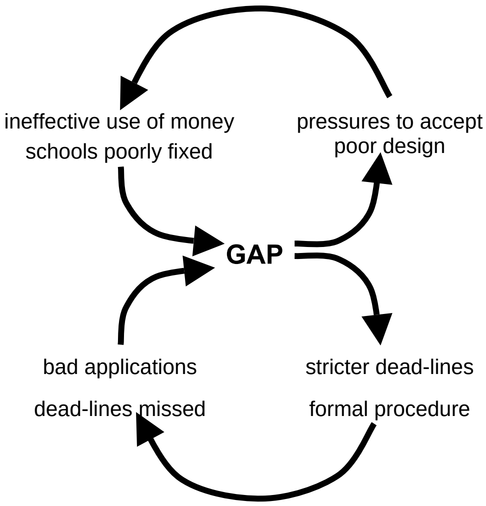


Figure 4.15: Eroding goals of state application

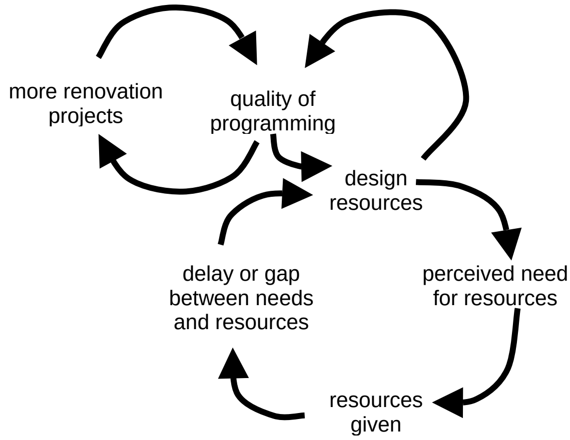


Figure 4.16: Growth and under-investment in

The state goal was the effective use of public resources and to get the schools fixed. It had a problem with the application procedure. Many municipalities were late with their applications or the applications were not complete. This was why the state was very strict with the application procedure. The stricter it was with the deadlines, the less time it gave to municipalities to prepare for their applications, and the poorer they were. Finally, the municipalities could produce applications which merely fulfilled the formal qualifications but were inadequate in terms of content and depth of study. The state was not interested in depth of study as long as the dead-lines and the formal qualifications were met. The state tried to work on the problem by publishing an instruction booklet, but the booklet concentrated on the process, not the content. In the end the fundamental goal of the effective use of money and properly fixed schools eroded away.

Of course, the state expected the municipalities to invest enough in the design process and to do design in advance. However, here we have another systemic problem called "*growth and under-investment*" working in the opposite direction.

In this structure growth approaches a limit which can be eliminated if the organization invests in additional capacity, otherwise performance standards have to be lowered. If this happens, it leads to lowered expectations which are borne out by the poor performance caused by the under-investment. This had happened to the city: during the great economic recession of the early 90's, when no schools were repaired and no designers were hired. Towards the end of the decade there was more state support available for school repairs, but the resources were still the same. This led to a culture of poor design and programming. This was not at all eased by state pressure to produce certain papers within a given timetable.

What would have been the solution? The state should have concentrated on the fundamental issue of good planning and should have been less interested in deadlines. If there had been no fixed deadlines and applications could have been sent at any time of the year, there would have been no problem of coordination between the municipal and the state processes. By telling municipalities that no money would be given to poor projects, the state would have forced the municipalities to invest in their design processes.

The failure of the project was a direct consequence of the poor quality of project programming. Programming was done in haste, because the programming work was not designed properly and it was not given the time nor resources needed. Project failure (RQ 3) was a direct consequence of the poor quality of design documents (RQ1). The design documents (artifacts) were of low quality because the network action which produced them was not planned well (RQ2).

Executive function transferred to an outside party (RQ2)

Executive function is the part of the cognitive system deciding what matters should be dealt with and when (e.g. central processor in a computer: Perkins 1993). In matters concerning mold and moisture executive function was transferred to an outside organization when a consultant was hired to make a survey of the general condition. What made this transfer problematic was that the outside organization was not told about this transfer. The transfer of executive function to the outside is very typical of human cognitive activity (Perkins 1993). We rely on text books, manuals, and experts instead of making decisions ourselves.

Two ways to approach team forming (RQ2)

People from the school and from the school office considered the art teacher’s nomination as the school’s representative crucial to the whole project. Her election showed that the school wanted to take the renovation process seriously and invest resources in it. The art teacher had been a mediator between the school and the core team. Another important person from the school’s point-of-view was the janitor. When the informants talked about the art teacher’s nomination they talked about team values and exchange of information. The art teacher was seen to have the role of a knowledge broker (Burt 1992) between different groups. When talking about the art teacher the informants were not talking as much about her personal qualities as about team values and the importance of shared processes. The art teacher was not seen as “a goddess” who was able to produce miracles alone. On the contrary, she was supposed to work as a mediator helped by the others.

However, the informants representing the technical professions seemed to blame the selection of the designers and the architect for the later mistakes. These informants laid more emphasis on personal skills and training. If the right people had been chosen, no mistakes would have happened. This way of thinking is one example of the centralized mindset (Resnick 1994): problems are caused by individuals, not the system. This kind of thinking leads to poor management: not enough emphasis is put on systemic problems and their solving. The architect and other designers were supposed to make the project a successful one on their own. This presupposition lead to a situation where the designers did not get the help they needed, and this was why they failed.

Project-based learning in mold and moisture matters (RQ2)

The crisis changed the way project was organized and the way knowledge was managed. The underlying assumption about the project environment was that it was bureaucratic (Jaafari 2003a: see section 2.1.4), peaceful and routine environment, where environmental complexity was low (Vartiainen, Ruuska, & Kasvi 2003: 40: see section 2.1.4). All of a sudden, the environment appeared to be a very turbulent and highly complex environment, where creative-reflective learning strategies and knowledge sharing between team members was needed.

The school, the construction management, architect, and school office were tied to each other by many strong links during the crisis. At the core of this network were the school and the construction management. This group, linked with strong ties, started to apply project-based learning practices with regard to the mold and moisture matters (Wenger 1998).

Mold and moisture problems were a new phenomenon to everybody and definitely in everybody’s interest to address. Knowledge about mold and bacteria was collected in an informal manner. There was no hierarchical organization, and the activity of the art teacher was not based on any agreement or rule. Members were in direct contact with each other on a daily basis and they had manifold reciprocal relationships. A shared language was developed around the bacteria and other phenomena, even narratives. The transactive memory worked and members knew who was good at what. There were many informal ties as well.

However, there were many factors preventing learning. Matters other than mold were not dealt with in the same manner. The line of order was followed instead. Everybody was an official member of a project team, and thus their status was not purely informal. The goal was not to acquire knowledge but to serve the instrumental purposes of the project. There was a time frame for the cooperation, it ended when the project was over. Here we encounter the problem described by Huysman (2004): knowledge vanishes when a project is over and it is hardly available for other projects.

It even looked like in this learning community people were aware of who was a member and who was not. The representatives of the city architect’s office were considered outsiders (Garrety, Robertson & Badham 2003; Hakkarainen, Lonka & Lipponen 2004). They approached the project from a specialist sub-culture point-of-view (Berger & Luckmann 1966). They tried to protect their own field of expertise and the interest of their own specialist professions. They saw things from the organization's point-of-view, but they did not have the informal approach of a member of community of practice. They even admitted this problem themselves:

> *"There was a feeling that the experts were not able to give as unambiguous answers as (the representatives of the school) would have wanted. The teacher learned things by herself. They were worried and uncertain. These mold and moisture problems are unclear to many, to me as well… One has to draw a line somewhere. One can't tear the whole building down."*
>
> *An expert from the city architect's office*

There seemed to be remains of the learning project community left after the crisis, but once the problems were solved and the mold and moisture matters were no longer on the agenda, project-based learning stopped.

This sudden enhancement in project learning raises the question as to whether there is a temporary, informal version of project-based learning inside projects. These *temporary learning networks* are born from action and for action purposes, and when they are not needed anymore, they disappear. Of course, some of the members may continue studying the subject and become a member of a more permanent community, but the community needed for the achievement of a certain goal dies when the goal is achieved.

The way the core team was organized around these matters resembles a community of practice or creative knowledge community (see Table 2.3 in section 2.3.5).

Finally the project became a vessel of distributed cognition (RQ2)

Even though the *temporary learning network* lasted for a short period of time, it had a serious impact on the project. It was a pity that such an activity was not present in the beginning of the project, when the acquisition of such knowledge would have been most needed.

The reason for this seemed to be the fact that it took several years before the project started to function as a vessel of distributed cognition. The first half of the project was wasted in the battlefield of weak and contradictionary ties and the false assumptions about the other parties involved. The strong, non-contradictionary ties and the learning network did not appear until the last possible moment, in the middle of the crisis. Is it so that we need a crisis to get our act together? Cannot socially distributed cognition be put to work on a voluntary basis? A lot of work and 75.000 euros were completely wasted because of the problems of the shared cognitive action. Even if we are not talking about money, it was obvious that the work conditions and general atmosphere were much better under the circumstances described in the latter half of the project.

If links are missing, that is not necessarily a problem. There are quiet periods when the routine work is done. If the passive actors trust those who are active at such moments, it only serves the purpose of division of labor. Others can use their cognitive capacity elsewhere. If there is a *structural hole* (Burt 1992) behind the missing link, it is a different case. An example of this are the same surveys the maintenance department did at the same time as the city architect's office without these two knowing about each other. Due to the missing link and the fact that the maintenance department was not interviewed, lots of important information was lost.

4.2 Description of the Kangas project (Case 2) as a dynamic network

The Kangas Service Center renovation (Case 2) differs from the Hakala School renovation (Case 2) in many ways. Kangas was part of the social sector, a former retirement home which was transformed into a modern service center for the elderly. The Kangas project was organized in a different way and it can be considered a successful project, unlike Hakala. There were some similarities as well. Both were renovations, both were public sector projects, where project management was taken care of by the town or city people. There were problems in both projects, as will be shown later.

The goal of the Kangas project was to renovate the old-fashioned retirement home to better meet the demands of the new millennium. There was a profound change in the way care for the elderly was organized in the town of Varkaus. The new residents needed care 24 hours a day, seven days a week, and most of them were incapable of moving. Kangas would take care of residents who were considered hospital patients before.

The dynamic network of the Kangas renovation project (Case 2) will be described here using the same system as was used in the description of the Hakala renovation project (Case 1). The system is outlined in Chapter 3.3. The network link analysis is in Appendix 8

4.2.1 A steady flow of documents is typical of the Kangas project (Case 2; RQ1)

The first research question asked about the quality of the documents and their relation to the action which produced them. The flow of documents in the Kangas project (fig. 4.17) was steady and there seemed to be logical explanations as to the variation in amount of documents and incidents.

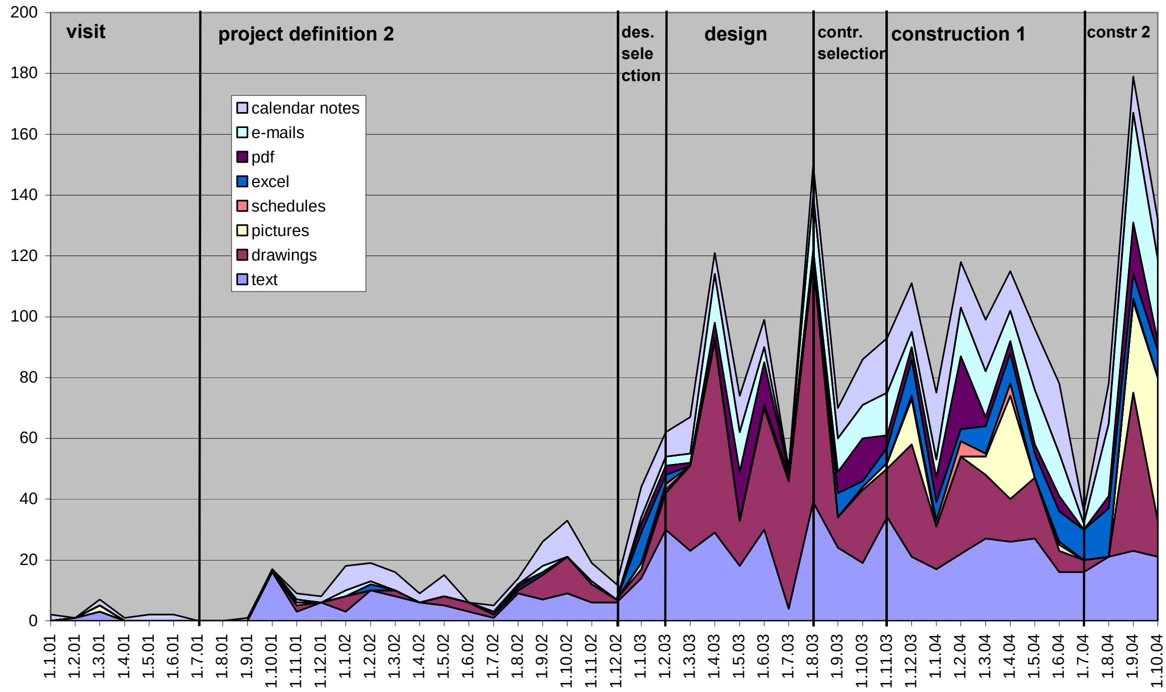


Figure 4.17. The production of documents over phases in Case 2 (Kangas)

First there was a very tiny stream of incidents in the period after a visit by the Ministry. During this visit the project objectives were outlined together with the Ministry's experts. Things started to happen after the new project manager was nominated and the second project definition period began. In the end of this period there was a minor peak, because there was a separate project where the saunas were renovated before the major project begun. The level of activity raised to a higher level all of a sudden when the consultants were finally hired and the design phase started. After that the production of documents never returned back to the lower level. Quite the contrary, there were first sharp peaks during the design phase when the different deadlines were met. After that there was a period of steadier production when the preparation for the construction site and the selection of the contractors took place.

During the first construction phase peaks reoccurred. The explanation was the same as during the design phase: different deadlines. The production of documents and the amount of incidents reached its highest peak in the fall of 2004 when the construction work went on together with the design of the next phase.

There was a drop every twelve months due to the summer holiday period. These two factors, the time of the year and the logical phases of a building project, explained all the changes in the level of activity. There seemed to be no crisis or other unexpected incidents.

The same applied to the quality of the documents. There were texts and meetings in the beginning, which should be the case when the project definition plan was written. During the design phase mainly drawings were produced. Excel charts and schedules belonged to the construction period. Pictures were not taken before there was something to photograph.

The Kangas "neural system" seems to have worked the way an ordinary building project's system should work.

4.2.2 The network links in the Kangas renovation project (Case 2; RQ2)

Link symbols used in the network illustrations are explained in the Table 3.3 in the end of the section 3.4.2.

Phase 1: The work done by the renovation group

A renovation group was founded and it had its first meeting on the 6th of October 1998. In the group all the departments were represented and the representatives had the duty of informing the staff about the matters. A physiotherapist was nominated as secretary of the group. She was not working in shifts and this might have been one reason why she was selected.

The renovation group continued its work even after the official project definition committee was nominated. It served as a means of co-determination between the staff and the management. The group made several benchmarking trips. The staff were asked about their opinions and ideas in several meetings. The facilities department did not attend the renovation group meetings before the project definition group was nominated, but it was informed about the group's work and it attended some of the trips. The facilities department was in charge of the town investment budgeting process and it reserved some money for the renovation somewhere in the future.

The renovation group served as an important forum of cooperation throughout the project. Its early work was important, because the project goal was defined even before the other parties had joined the project. In its early meetings the renovation group insisted on having a model room[8]. The most important act was probably the nomination of the physiotherapist to be secretary of the group. Later she carried a great responsibility as the user's representative in the project and as one of the project managers.

However, there were problems with the staff. Not everybody believed in the importance of the group's work. The management was not active enough in creating an enthusiastic and active feeling among the staff towards matters related to the future renovation (link 1 in fig. 4.18; see Appendix 8, phase 1 for detailed analysis of this link).

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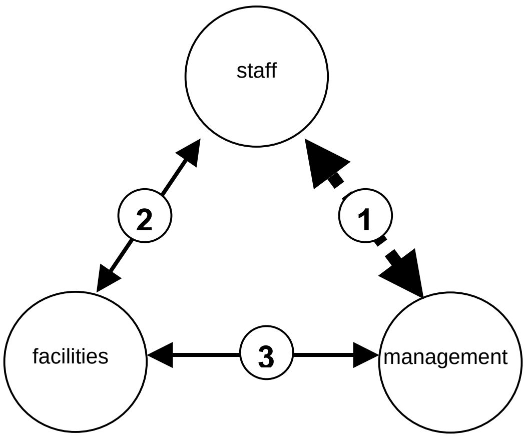
[8] A model room is a mock-up room build of gypsum board or other temporary material. It is a 1:1 scale model, where design solutions can be tested by users. It is usually built somewhere in the existing building, most often in the basement.

Network links

Link symbols explained in Table 3.3



1 Different parties saw this link in a different manner

2 Attendance, but no active participation on facilities side

3 Attendance, but no active participation on facilities side

Figure 4.18. Network links in phase 1.

Summary of phase 1

The Kangas Service Center did more than most of the users: it founded a group well before the actual project started and kept the idea of a renovation alive. The source of inspiration was the renovation of the town hospital. This activity played an important role later. The foundation of the user participation was laid and the infrastructure for it created. The idea of a model room and a part time user's representative emerged during this era.

Phase 2: The work done by the first project definition committee

The Chief of Social and Health Matters of the town of Varkaus nominated the official committee for the preparation of the project definition plan. Such a plan was needed for both state and town purposes. The town applied for a state subsidy for the renovation of Kangas, but later this application was turned down and the Kangas renovation became a town project. There were representatives from the service center, from the facilities department and from the Town Board for Social and Health Matters. The secretary was this time the Head of the Facilities Department, but the physiotherapist stayed as a member of the committee. At the same time there was another committee working on the general plan for the care of the elderly in the town of Varkaus. The work of the latter committee created a background and gave support to the project definition committee. The decisions made would be based on a larger view of the process as a whole.

The first project definition committee made several benchmarking trips. The staff made a two-day trip to a similar institution in Lohja. This trip was videotaped and presented to the committee. The Head of the Facilities Department – an architect by education – made sketches based on which a set of room cards[9] were written. On these cards the staff could write their wishes for furniture and other special needs. A first cost estimate was made. A decision was made that a survey of the general condition of structures would be made.

At the same time the renovation group continued its work. The staff needs were processed there, whereas the official committee concentrated on budgeting and on general matters. The head of facilities visited the renovation group and presented the drawings.

The staff was not all pleased with the way things were organized and decisions made. This was partly due to the work in shifts: the staff's representatives were changed all the time (link 1 in fig. 4.19; see Appendix 8, phase 2 for more detailed description). The project manager could not invest enough time in the project, and the head of the service center was about to retire. The link 2 (fig. 4.19) was problematic (see Appendix 8, phase 2 for more confirming evidence).

When it was found that no state money was available, a decision was made that the project would be divided into several phases and the service center would not be closed down during the construction work. The Town Chief of Social and Health Matters was not pleased with the committee´s work and asked experts from the Ministry to give a second opinion of the plans that had been made.

Network links

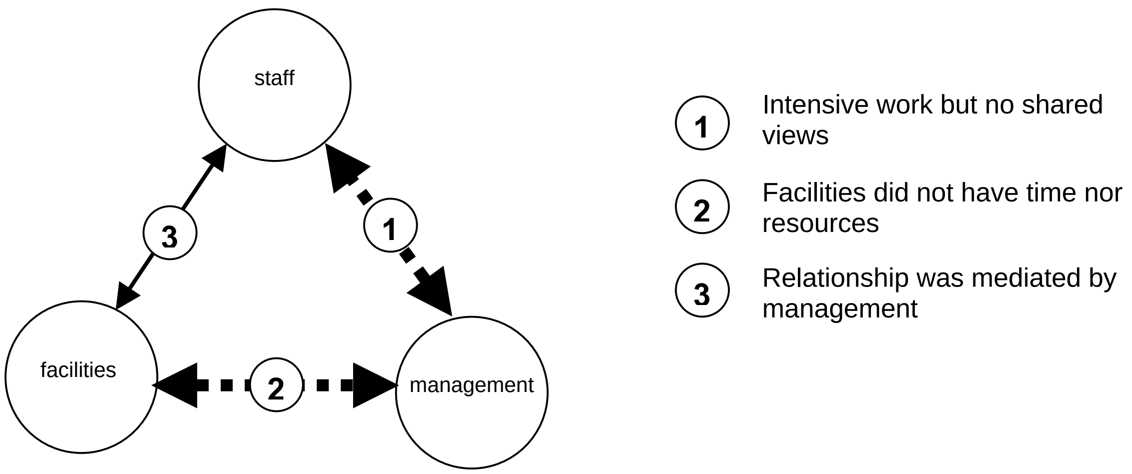


Figure 4.19. Network links in phase 2.

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[9] Room cards define the furniture and equipment needed in a room and it also describes the basic qualities (materials and so on) of the room. Usually room cards are made in the very end of the design process but in the Varkaus projects they were used as a method for communication between the users and designers in the conceptual stage of the design.

Summary of phase 2

The committee did what it was expected to do. It prepared plans and cost estimates. Users' needs were mapped and excursions made. However, the committee did everything in a very official manner. No true alternatives were studied and no great inventions made. Finally, the Town Chief of Social and Health Matters sought outside help. Behind this lack of enthusiasm was the fact that neither of the parties possessed the resources needed to do the job well.

Phase 3: Experts from the Ministry visit Kangas

The experts from the Ministry visited the Kangas Service Center on the 31st of January 2001. At the same time there was a staff training day. The experts attended it and made a tour in the building, discussing with the staff. They had lunch and tested the equipment in the health club. There was a meeting where the Head of the Facilities Department presented the plans. The visit lasted the whole day.

The experts sent a report after two months. The report was dated the 1st of March 2001. In the report the experts criticized the idea of sharing a bathroom between two residents. The idea does not work with demented people, they get confused if they have to use a bathroom with somebody else. The experts also recommended a solution where departments were divided into two sections: one for the demented and the other for those in need of constant care.

The ideas presented by the experts were seriously considered by the committee. Finally, the plans were altered according to the Ministry proposals. The Ministry visit and consultancy had a profound effect on the design work.

At the same time the Head of the Facilities Department decided to withdraw from the project. When his responsibilities had increased remarkably, it was impossible for him to run the project. A new person was nominated as project manager of the Kangas renovation project. He was a designer and a civil engineer, who had been working on the town hospital renovation and knew the methods used in the project. He was a proponent of user participation, interested in building a model room, and willing to write a detailed project definition plan. The Head of the Facilities Department was in charge of the town investment budget process and he had to be concerned about the town budget as a whole. There were often competing projects and there was no money available for every project. The new project manager did not have the conflict of interest the Head of the Facilities Department had and he could work more whole-heartedly for the good of the project and the service center.

It is questionable whether we can call the Head of the Facilities Department a project manager. He was an expert giving assistance to the users, but nobody called him a project manager in the interviews or in the documents. The new project manager was considered as one from the very beginning.

Many of the informants saw the visit, the change of plans followed by it, and the appointment of the new project manager as the point when the project really gained momentum. It was an event after which the work did not stop and it was still going on when the interviews took place. All links were described as strong ones. However, the most interesting are the non-existent links between the Ministry, the Facilities Department and the staff (fig. 4.20). This phase was in the hands of the management and the others were playing secondary roles.

Network links

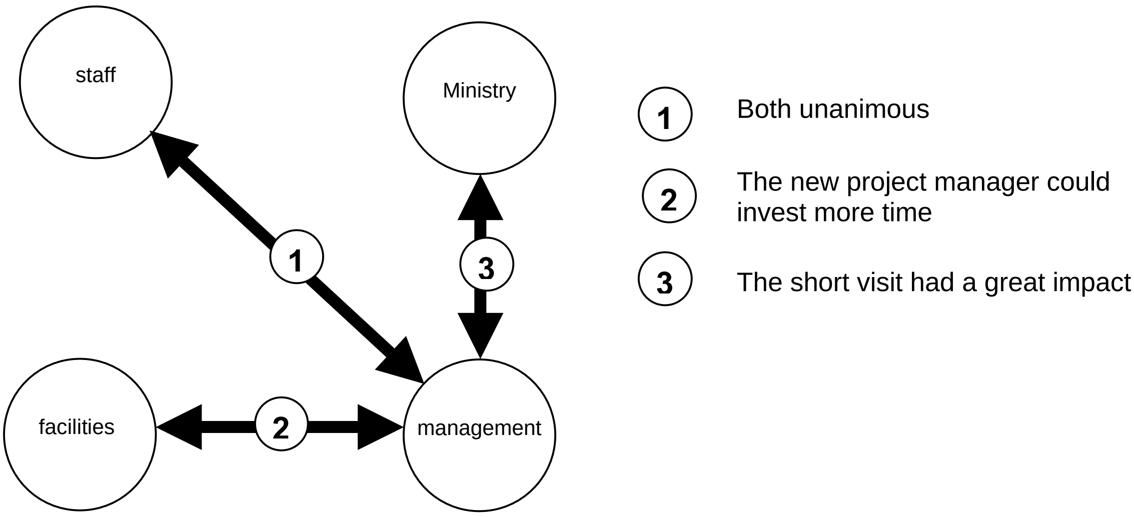

Figure 4.20. Network links in phase 3.

Summary of phase 3

Before the visit there was a cloud hanging over the project. There was a lack of insight and the worrying problem of money: if the state was not willing to help, was the town ready to make an investment on its own? Nobody was running the project, it was a motherless creature. All of a sudden, in half a year, all these clouds were driven away: the project had a devoted project manager and a new direction. Whether this would have happened without the visit by the Ministry experts is a good question. However, the informants experienced the visit as a culmination point in the project´s life.

Phase 4: The work done by the second project definition committee

The new project manager attended the committee meeting for the first time on the 25th of March 2001. Not much happened before the summer. The first thing done after the summer was to deliver space definition cards for the staff. Space definition cards[10] described activities taking place in the planned new rooms, and the furniture and equipment needed.

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[10] Space definition cards were cards where the user was asked about the activities taking place in a given room and the properties a room should have from the user point-of-view. Unlike room cards, space definition cards contain no technical information. They are filled in by the users.

The survey of the general condition was worked for the whole of 2001 and it is dated the 10th of April 2002. The security and nurse call systems were designed as a separate project. There was a discussion between the facilities and the management on whether this side-project should be part of a larger renovation, what kind of expert to use, and about many other things related to the systems.

The model room was built in March 2002. It was actively tested by the staff together with the customers (link 6 in fig. 4.21). There was a table on which staff could write their opinions about the model room solutions (link 5 in fig. 4.21). Two different kinds of rooms were tested. There was also an info corner in the lobby for customers and their next of kin. People could write their opinions at the info corner tables as well, but most of the remarks were made by staff.

The project definition plan was dated the 5th of August 2002. It was handled by the Town Board for Social and Health Matters only, it did not go to any other town body. In the fall of 2002 a separate sauna building project started. The saunas were ready by the end of 2002.

The staff was actively involved in the design process together with the management. They filled in space definition cards, made experiments in the model room with customers, got information from the info corner, and they were interviewed for the survey of the general condition by the Facilities Department (link 7 in fig. 4.21). A trip was made to Espoo. However, there were problems in the way the cooperation was organized. People were working in shifts and departments could not name a single person who could participate every time. Participation became fragmented (see link 1 in fig. 4.21). The staff still had problems in getting motivated in terms of the renovation. Was the renovation coming or not?

The project definition plan was well written and the benefits and weaknesses of both a renovation and a new building were compared in it (see links 2 and 7 in fig. 4.21). However, it was not introduced to the Town Board, the Town Council, or the Mayor (link 3 in fig. 4.21). At the same time with the project committee there was the other committee working on the general plan of the town care of the elderly. The fact that Kangas would be renovated was mentioned in the report of the other committee, and the management thought that it was enough. The latter report was handled by the Town Council.

Network links

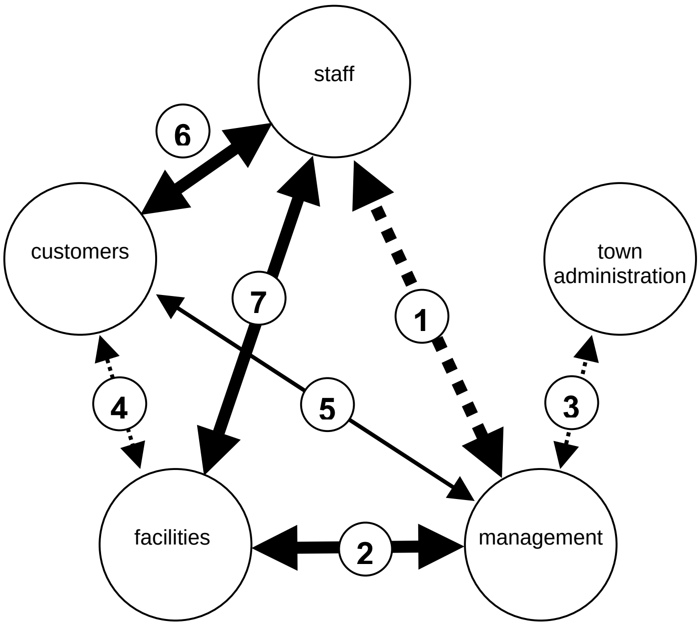


Figure 4.21. Network links in phase 4.

1. Working in shifts and poor motivation affected cooperation
2. The new project manager prepared an excellent project definition plan
3. The project definition plan was not introduced to the town administration
4. Facilities Dept informed by the staff about customers' needs. The model room helped.
5. Model room, info corners and other methods served as a channel
6. The model room provided a channel for exchange of knowledge
7. Model room provided a channel for exchange of knowledge

Summary of phase 4

The good start was followed by an active period of planning. The project produced artifacts as a steady flow during the one and a half year period before the designers were hired. This is not common. Usually the projects go into hibernation after their kick-off. An important innovation was the model room. It helped communication and made many links stronger than they would have been without it. There were many problems still, and the fact that the staff was not motivated and felt alienated was not the least of them. Another problem which popped up more strongly later was that the town administration was not informed well enough about the decisions that were made (link 3 in fig. 4.21).

However, the goal of this period was to produce a project definition plan where all participants were listened to. An excellent project definition plan was made. It was later gratefully accepted by the designers. It included all the information needed for a design process.

Even more important was that the relationships between the key participants grew stronger during this period. The project had two good and cooperating project managers, one from the facilities and one from the service center (the physiotherapist; see link 2 in fig. 4.21, and more confirming evidence in the description of link 2 in Appendix 8, phase 4). These two project managers, and the fact that project definition plan was excellent, made this project somehow extraordinary among the Finnish public sector projects that the author has seen before.

Phase 5: Selection of the designers

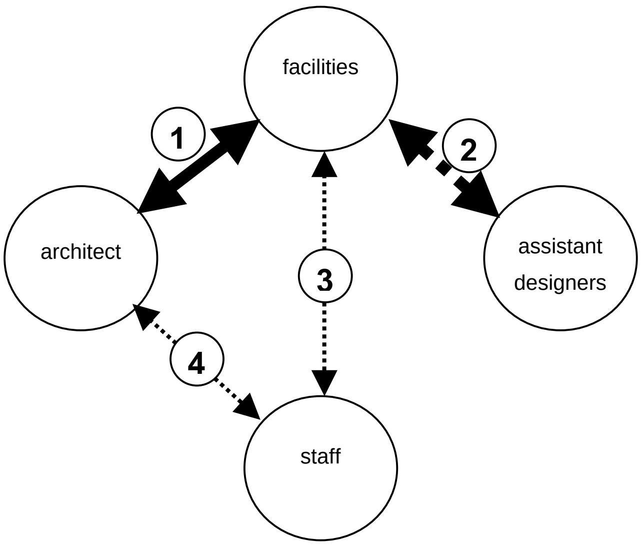
The project manager was both the head designer and the construction manager, so he needed help in the architectural design work. The town had a contract with a large architectural firm. The contract dealt with town-planning, but it could be extended to include design work as well. An architect working for the firm was a former employee of the facilities department and was a natural choice as a consultant. She became a collaborator for the project manager in the interior design and in other architectural design (link 1 in fig. 4.22; a closer description of the link in Appendix 8, phase 5).

The first plans were made by the project manager in 2002. There was money for the renovation in the budget of 2003. If any larger work were started in 2003, the assistant designers should be hired immediately. The designer procurement process started in the beginning of 2003 and the first meeting with the newly hired designers was on the 12th of February 2003.

There was a problem with the schedule. The bidding packages should have been ready for the contract procurement process before the summer. Only three months was reserved for the design work. The fact that the time given to the design work was too short may have been one reason why there were not many bidders for the design work.

The Facilities Department used a designer procurement method where the price was not a dominant factor. There was later discussion about the method, because even though the town paid more it got just as poor value for its money as usual. The designers had other projects going on and they could not concentrate on the Kangas project only (link 2 in fig. 4.22). There was lots of discussion about the selection of the architect and the quality of her work among the staff during “the color war” during phase 7 (to be described later). These disappointments may have affected the informants when they talked about this phase.

Network links



1 A former facilities’ employee was hired to assist the project manager

2 Mutual distrust and suspicions due to industry-related problems

3 Staff not pleased with the selection of the architect

4 Staff not pleased with the selection of the architect

Figure 4.22. Network links in phase 5.

Summary of phase 5

What was remarkable in this phase was that even when the client wanted to do it right this time, it failed again. Systemic problems could be one explanation: there was not enough time for the designer selection process and there was not enough time reserved for the actual design work. The designers wanted the job and they promised to do more than they were capable of doing.

Later there was discussion about the designers´ negligence of the users' needs and the project definition plan. It looks like they never read the plan. The users were by no means involved in the designer selection process. Should they have been? Would the end result been better if the client had spent more time and effort, arranged, e.g. a meeting for all the bidders where the fundamentals and specialties of the project would have been explained to the bidders and where the bidders could have met the users' representatives? Now it looked like the users and assistant designers never learned to know each other well (this link is missing in fig. 4.22).

It was not the things done, but the things undone, which made the links problematic in this phase. It had to be admitted that it was difficult to make a separation between cause and effect here. How people sensed these relationships was irreversibly affected by the later history.

Phase 6: The design

The first design meeting was on the 12th of February 2003. In the first meeting it was decided that the designs would be finished by the end of May 2003. There were five official design meetings altogether, plus one design review. There were other meetings as well between the users, designers, project manager, architect, and others in various constellations. There were 58 different calendar notes, most of which referred to a meeting.

The design team could not keep to the original schedule. At the design meeting on the 29th of April it was clear to everybody that the original schedule would not hold and the lag was at least 3 weeks. In the design review on the 15th of May the new deadline was announced: the drawings should be ready by the 20th of June so that the facilities experts had time to go through them before Midsummer. At that point it was clear to everybody that the construction work would not start in August.

At the last design meeting on the 12th of June no plans were ready. The electrical engineering drawings were far from being finished, but so were many others as well (link 9 in fig. 4.23). The final bidding package was put together somewhere near mid-August.

There were other related projects going on. The facilities had decided to integrate the building automation systems of the town. A separate automation system designer was hired. Changes in the automation system affected the engineering design and there was some dispute about it. A sprinkler system was needed in Kangas and a designer was hired for that. Finally, there was the security and nurse call systems project beginning as a separate entity. There were problems in the integration of all these separate projects.

The idea of nominating one of the users as a representative was an effective way to organize the design process. It had some negative effects as well. The rest of the staff felt alienated from the design process (links 1, 5, 6, and 7 in fig. 4.23; see Appendix 8, phase 6 for a detailed description). Everything going from the design team or from the management to the staff went through the physiotherapist. Matters were handled through a system of meetings in the departments. The way to organize user participation actually separated some of the users from the designers. There were even cases when somebody tried to contact the project manager directly. He refused to answer and referred to the line of order, according to which all the information should go through the physiotherapist.

Network links

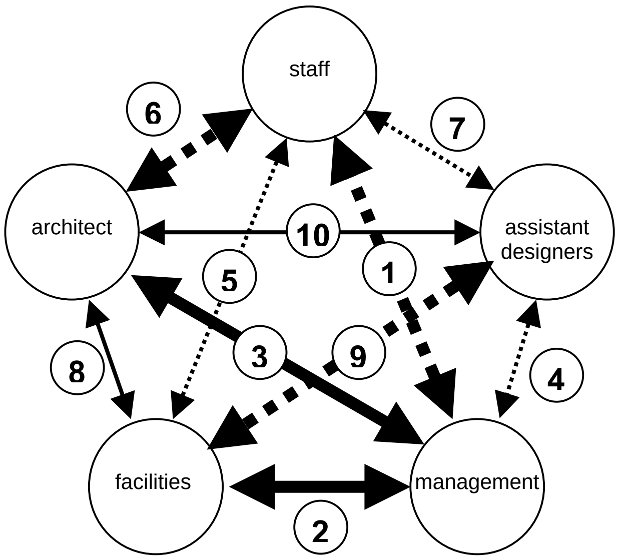


Figure 4.23. Network links in phase 6.

1. Staff felt alienated ftom the design process due to the way it was organized
2. The cooperation between the project manager and the physiotherapist worked out fine
3. The physiotherapist was the architect’s ally in disputes with the staff
4. No shared language was found
5. No direct contacts were allowed
6. The architect worked with the physiotherapist only
7. No shared language was found
8. The cooperation was so good that no stronger link was needed
9. Schedule slippages and doubts about each other’s motives
10. The cooperation was so good that no stronger link was needed

Summary of phase 6

After a good start the project faced troubles. The town budgeting system forced the facilities to tighten the schedule and this was fatal. No time was spent explaining to the newly hired consultants what the project was about. The excellent project definition plan was overvalued as means of carrying the intentions of the former team to the newcomers. The consultants seemed to have a very opposite attitude to user participation compared with the rest of the team (link 7 in fig. 4.23). The good work with the model room and the working arrangement between project manager and the physiotherapist blinded the management to the fact that the staff felt bypassed. Here again, too much emphasis was laid on the project definition plan.

These fundamental flaws, together with the failure to keep to the design schedule, got the project off track for a while. There was nobody to be blamed. It is very difficult to bring new ideas to the rigid and ritualized culture of the building industry. The facilities tried its best by listening to the users, making the project definition plan, applying new methods like the model room, using better systems in hiring consultants, and so on. It had a completely new attitude to design and construction processes, and that was the problem. Others could not understand what the facilities was doing, because its behavior differed so much from the usual procedures and thinking of the building industry.

Phase 7: Selection of the contractors

The procurement process was as fast as it could be. It had to be fast, because so much time had been spent in the design phase. The bids were sent on the 25th of August 2003, and the dead-line was the 29th of September 2003. The contract negotiations took place in the first half of October and the Town Technical Board chose the contractors at its meeting on the 21st of October. The contracts were signed on the 12th of November 2003 and the work started on the 17th.

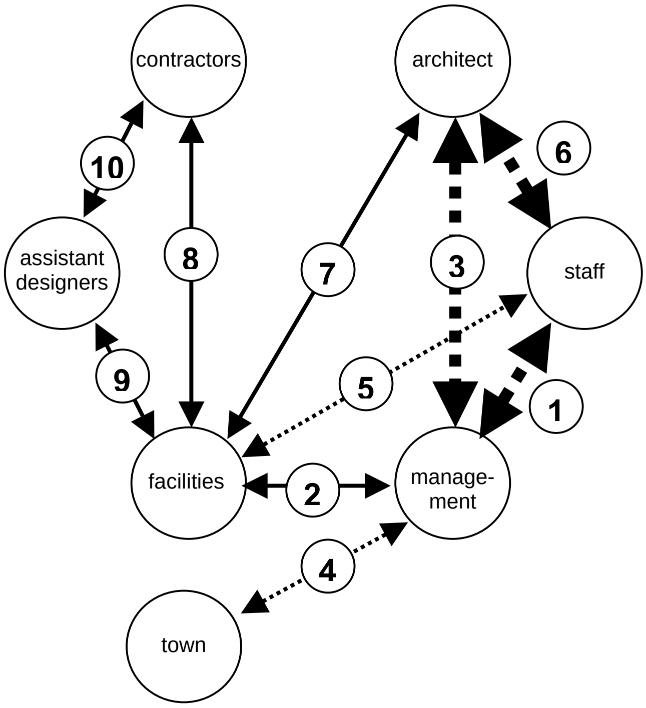
At the same time there were other processes going on. The colors were chosen and the other decisions about details were made during the bidding. The departments in the construction area had to be emptied and the customers had to be moved from them to other locations.

The “color war” broke out (links 1, 3, and 6 in fig. 4.24; see Appendix 8, phase 7 for a more detailed description of links). The staff were furious about the way the decisions were made. Demented people react to colors very strongly, and this fact was neglected in the design of the colors and so was the staff´s position as professionals in their own field. It looked like the staff realized for the first time that there would be a renovation coming. They had to plan their everyday life in the midst of a building site. This made all things more real. This may have affected their reactions about the colors.

The town administration woke up to the fact that there was a major renovation beginning in Kangas (link 4 in fig. 4.24). The Mayor was worried about the expenses and questioned the reasons for spending so much money on an old building instead of building a new one somewhere else. The procurement process had gone so far that it could not be stopped without serious consequences. Besides, the project definition plan had been approved a year earlier and all the measures to be taken were described there. The Mayor understood that he was too late in his reaction and the whole incident was soon forgotten.

The first interviews were made around this time.

Network links



1. "The color war": staff felt bypassed in design
2. The facilities concentratred on the procurement process
3. The management had to take staff's side in "the color war"
4. Everybody was amazed at the mayor's reaction
5. The project manager acted as a mediator in "the color war"
6. "The color war" reached almost a personal level
7. "The color wars" did not affect this link
8. The first meetings
9. The assistant designers attended the meetings
10. The first meetings with the contractors

Figure 4.24. Network links in phase 7.

Summary of phase 7

Without "the color war" and the mayor's intervention, this would have been an intermission in the project life. Everybody was preparing for the building site. The stage was ready, and these little incidents worked as some kind of a prolog to the drama that was about to begin.

It is interesting to notice that there were two separated clusters during this period. There was a triangle of weak links between the facilities, designers, and contractors (links 8, 9, and 10 in fig. 4.24). The other one was a strong, problematic triangle between the architect, staff, and management (links 1,3, and 6 in fig. 4.24). These separate triangles described this phase well: there were two separate processes going on: the selection of the contractors and "the color war". The bridge builder here was the facilities (links 2,5, and 7 in fig. 4.24). It was the only one somehow involved in both processes.

Phase 8: The first phase of construction

The first site meeting took place on November 20th,2003. The first milestone in the contracts was the site model room, where all the design solutions should be tested before permission was given from the client's side to go on building the rest of the rooms. The acceptance inspection was held in the site model room on the 6th of February 2004. Only minor changes were made to the plans. The problem with the site model room was that the contractor had built the rest of the rooms well before the acceptance inspection and it would have been a major operation to make any bigger changes to already built rooms. The site model room had lost its purpose.

The construction work was divided into stages. The acceptance inspection of the first part of the first stage, the ground floor, the kitchen, and the basement was held on the 24th of May 2004. The contractor had divided the site into stages in a slightly different way compared to the division mentioned in the contract, but this was accepted by the client. The rest of the first construction stage was accepted in an inspection on the 16th of July 2004.

The contract included only part of the building. The rest of the renovation was not designed before 2004. The first meeting for the 2005 renovation was held on the 1st of April 2004.

In the spring of 2004 the new furniture had to be ordered. The architect helped the user with the design and bidding process (link 7 in fig. 4.25).

The facilities were not pleased with the designs and the way the designers participated (link 12 in fig. 4.25). There were lots of extra orders in the electrical and mechanical works (links 11 and 15 in fig. 4.25). In the electrical works these extra orders exceeded 20%. One reason for the extra orders was the poor quality of the survey of the general condition. The designers had trusted it and not studied things on site.

The staff had to work a lot in moving things from one department to another. The staff was helped by a town workshop for the unemployed. After "the color war" was over, the relationship between the staff and the management became much better (link 1 in fig. 4.25). The staff finally understood the size and the content of the project. It realized that by suffering some inconveniences now it would get a high quality work environment in the long run.

The appearance of the builders to the middle of a working institution for the elderly and demented was a shock for everybody: for both builders and the staff (link 4 and 8 in fig. 4.25). On neither side had anyone really understood all the consequences. It was like a temporary fusion of two organizations. The representatives of the staff described it the way it was: there was a terrible tension between the two parties. Everybody protected his or her own territory. The procedures and borders were described in the contracts, but everybody seemed to be testing their limits. There were many occasions when problems were solved between the employees without informing the management on either side.

Network links

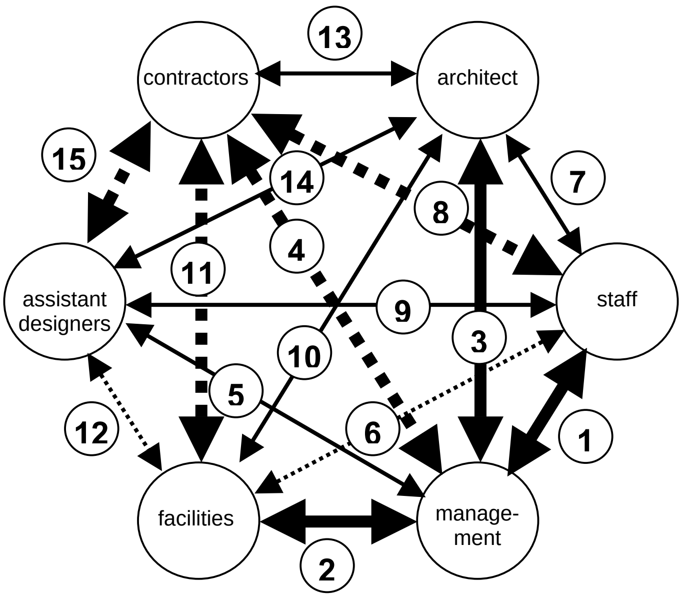


Figure 4.25. Network links in phase 8.

1. The staff realized its position and was pleased with the situation
2. The beginning of works put this relation to the test, but it lasted
3. The relationship grew stronger in “the color wars”
4. The appearance of the builders in a working institution was a shock for everybody
5. Both attended the site meetings
6. Feeling of abandonment on the staff’s side
7. The architect met the staff in meetings.
8. Tension between the two parties: everybody protected their own territory
9. All the information went through third parties
10. A clear division of labor
11. Problems with side-contractors due to poor quality of design
12. The poor plans caused accusations and lack of trust
13. The architect contacted the master builder if necessary
14. The architect contacted the assistant designers if necessary
15. The contractors complained about the quality of the design, and the absence of the designers

Summary of phase 8

It looked like the whole project had been preparation for this point: the beginning of the works. This moment was the test of everything done so far: the design, organization, user participation, new methods, and vision. Did they pass the test? It looks like the weaknesses in the user participation came up in the previous phase and the problems were already solved when the work started on site. This was essential, because the conflict in the building site would have been even stronger if the staff had still felt alienated.

However well the facilities had tried to prepare for the work, it had failed on many occasions. There were problems with the designers, the design, the site model room, and so on. However, it had done the most important thing right: it had organized the cooperation with the service centre well and its management had become an important ally with the facilities (link 2 in fig. 4.25). Even more important was that by starting the work with the user early on and keeping the communication alive the whole time, it had prepared the system for the job. If there were problems, misunderstandings, or weaknesses in the organization, they appeared early. The longer the time span, the better the links became.

What the facilities could not do - which may be an impossible task for anybody - was to change the culture of the building industry. The designers and the contractors did not understand that this was a different building site, where extraordinary methods were supposed to be applied. But soon they learned it.

The contractors were newcomers in this scene. They collected lots of strong, problematic links in the beginning (links 4, 8, 11, and 15 in fig. 4.25). Later these links became non-problematic, but they stayed strong. It was sometimes good to have strong links, even when they were problematic. It appeared to be much more difficult to make a weak link strong.

Phase 9: The second phase of construction

The construction work went on after the acceptance inspection of the first stage. Everything was much easier now. People were familiar with the problems and could more easily approach them and solve them together. The staff realized how lucky they were to get a newly renovated facility. Keeping this in mind, one should not complain about details. There were signs of excitement. “The color war” was over, and the architect had learned her lesson. The decisions about the color were made by the staff with the assistance of the architect (link 7 in fig. 4.26; see Appendix 8, phase 9). Everybody was choosing colors and taking part in the design work. The staff felt that the whole process had strengthened their community. They had decided about something and it had happened. They could see the results of their action before their own eyes. This project had increased their feeling of empowerment.

The design work went on. The first official design meeting for the 2005 renovation was held on the 22nd of September 2004. The idea was to have all the drawings ready by the 30th of October. In the next meeting on the 19th of October it was concluded that the schedule was too optimistic. There were many lessons learned from the renovation of 2003 and 2004. To obtain a learning curve was the very reason why the renovation was divided into two parts. One example was the electrical taps. They were too modern for the elderly clients to use and they were also too expensive. The radar switches in the bathroom lamps was another mistake: they went too easily on, and scared the customers. The old people were used to old-fashioned equipment.

The construction work was proceeding so well that the main contractor suggested that the delivery could be three months earlier. The other contractors and the client approved this. It led to some problems later in 2004, when things were proceeding at an accelerated pace.

The first mistakes made during the first stage were found by the fall of 2004. The kitchen was too hot in the summer and too cold in the winter. There was a long debate going on between the contractor, the designer, and the client over this matter (links 12 and 15 in fig. 4.26). Finally, the facilities ordered a data-simulation of the kitchen ventilation from the automation design office.

When the last interviews were made and data gathered in the fall of 2004, the final acceptance inspection had not yet taken place.

Everybody was very pleased with the end result when the findings of this research were described to the informants in a meeting May 3rd, 2005. After the meeting the newly renovated areas were proudly presented. The budget has not been exceeded.

Network links

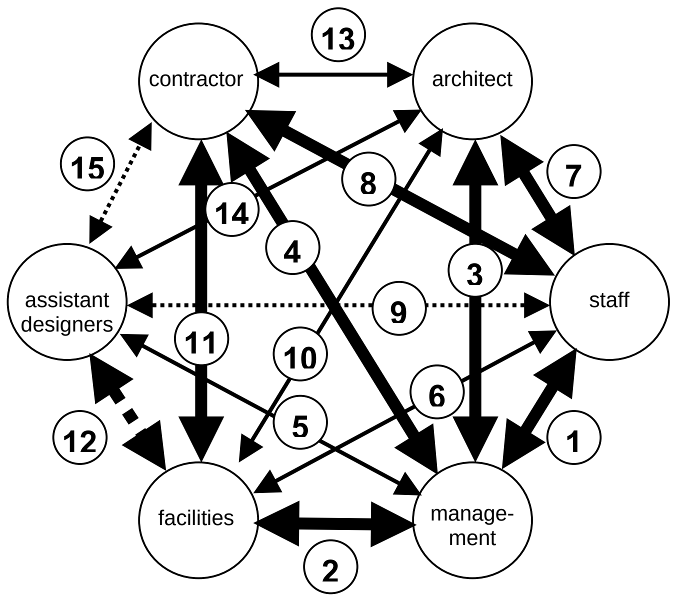


Figure 4.26. Network links in phase 9.

1 The project increased the feeling of empowerment.

2 Feeling of gratitude on both sides

3 The management was pleased because there was no tension left between the architect and the staff

4 Both parties understood how dependent they were on each other

5 The management demanded detailed explanations of designs

6 No problems: all contacts through the physiotherapist

7 Both parties had learned their roles

8 The staff and the construction workers had learned to live with each other in peace

9 The distant relationship caused problems

10 All connections through the physiotherapist

11 A feeling of mutual trust and interdependence

12 A feeling of distrust and mutual accusations due to kitchen ventilation problems

13 The architect visited the building site occasionally

14 The architect coordinated the designers' works

15 The contractors felt abandoned

Summary of phase 9

Many building sites become better when people have learned to know each other. However, the Kangas project appeared to be even better than many building projects I know. One factor was missing: the problems with the users and their demands. The problems caused by lousy design work are common in many building projects. Here they have risen above other problems because there were not that many other problems. Construction work today is so complicated that no extra load is needed. If a problem like the user participation is solved, a lot of energy is released and can be used elsewhere.

There seemed to be three centers of strong links: the staff, the contractor, and the management. The only party collecting lots of problematic links were the assistant designers (links 9. 12, and 15 in fig. 4.26). It appeared that the links became stronger and better as a function of time. Those who were around longest had the best links. There was an exception: participants who tried to minimize their effort and did not respond in a constructive manner to the actions of the other participants. Their links became even worse when time passed.

Comparative analysis of the network links in Kangas (Case 2; RQ2)

In Appendix 9 there is a table of Case 2 (Kangas), where all the links described in the previous chapters are collected. Again the strong links increased towards the end of the project. There were links which were strong and non-problematic from the beginning to the very end (management-facilities, management-architect), and there were links which were mainly strong and problematic (management-staff). There were also links which stayed weak and non-problematic through the whole process (facilities-architect). The relationships were not going through lots of changes in terms of the quality of the links.

Depending on the phase, there were three to six nodes in the network, so the number of possible links varied between three and fifteen. If all the links in different phases were counted, there were 73 possible links in the project during its life-span. There were only 9 missing links, so the density of the network was high compared to Case 1. “Unexpected visitors” like the Ministry and town administration, who appeared only once or twice, were not included in these calculations.

The strength of links in a given phase is the ratio between the strong and the weak links. The contradiction of links in a given phase is the ratio between the problematic and the non-problematic links. The density of the network in a given phase is the amount of existing links compared to the amount of possible links. The result is shown in the following chart (fig. 4.27). The missing links were excluded when calculating the strength of the links and the contradiction of the links.

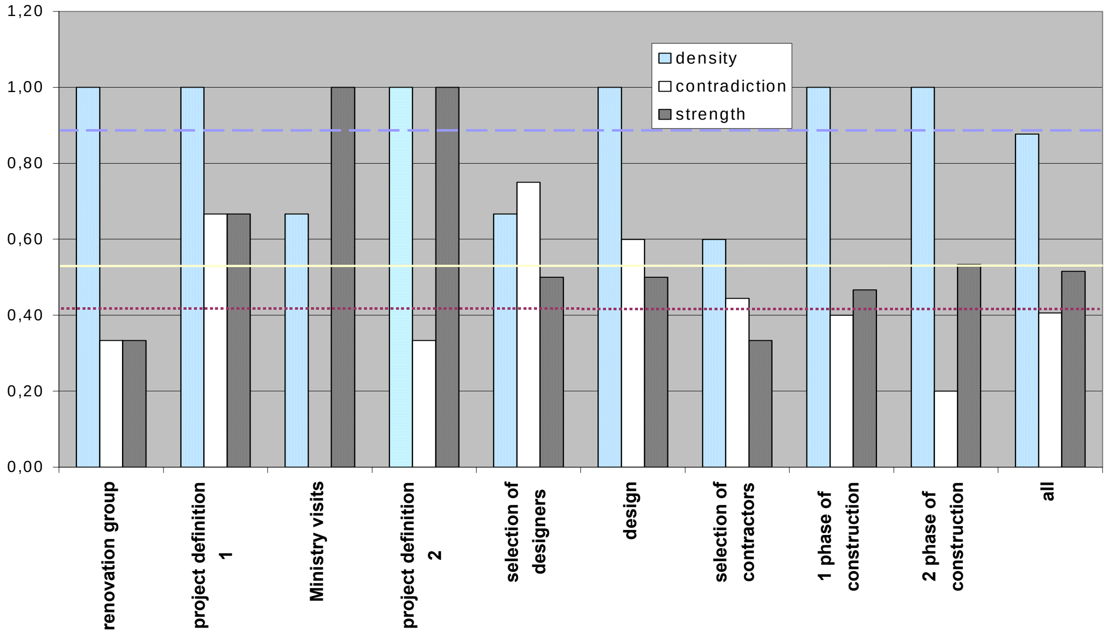


Figure 4.27: Density, strength, and contradiction of links in Kangas

The density was 1,0 (no missing links) in six phases. There were missing links in "visit", "selection of designers", and "selection of contractors". The lower density in the selection phases was understandable: the selection process was delegated to the facilities department, and others were not needed.

The strength of the ties was below average in the very beginning, during the selection of the contractors and at the beginning of the building site. The strength was highest during the visit by the Ministry and during the second project definition phase. The strength was lowest in the beginning and during the selection of the contractors. The latter was explained by the fact that the selection process was a very routine-like procedure under the EU procurement system. The strength of the ties did not vary much in Case 2 (Kangas).

Contradiction was missing completely during "the visit". It was at its highest during the selection of the designers and after that it steadily decreased. In the end only 20% of the ties were problematic.

In Case 2 (Kangas) the network dynamism worked in a very predictable manner. The ties were strongest during the project definition process, when the goals were set, and decreased when the more routine-like execution took place. Contradiction was at its highest in the beginning when the ties were new, and it decreased when the ties matured. The variation in the density was explained by the nature of the work in different phases.

All the ties of each actor are collected in the following table (Table 4.3):

Table 4.3: The quality of links of each participant in Case 2 (Kangas)

	strong	weak	***strong problematic***	*weak problematic*	missing	**all links**
Management	12	4	8	1	2	27
Staff	6	5	8	7	4	30
Facilities	8	11	5	5	1	30
Architect	5	10	3	1	3	22
Assistant designers	0	8	4	5	5	22
Contractors	3	4	4	1	3	15
All	34	42	32	20	18	146

The management, the staff and the facilities had more links than the others, because they were present in more phases than the others. The contractors did not have many links, because they appeared only in the end. The centrality did not vary much. The amount of missing links changed between one and five. The facilities had only one missing link, which gave it the highest centrality. Assistant designers had the lowest centrality. This seemed to be their strategy: they tried to avoid contacts with others and thus minimized the time and effort spent in communication. They saw design work as a separate action taking place in their own offices; time spent in cooperation with the users was wasted time for them.

There was a difference in the strength of the links. The management had 20 strong ties, whereas the assistant designers had only 4 strong ties. The assistant designers had no strong, non-problematic links at all, whilst almost half of the management's ties were strong and non-problematic (12 out of 25 existing ties). Of the management's non-missing ties, 80% were strong. The average was 50%. The staff and the contractors were slightly over the figure.

The architect seemed to operate through weak, non-problematic links. 10 of her 19 existing links were weak links. The Facilities Department also built weak links (11 out of 29 existing links).

There was no big variation in the contradiction of the links either. The architect had very few contradictionary links, only 20% of her links were somehow problematic. The management and the facilities had the second lowest figures, 36% and 34% respectively. The staff and the assistant designers hadthe highest figures with respect to contradiction. The average was 41%.

We can now make a 2x2 matrix of the participants and their network ties in all phases:

Table 4.4: The quality and strength of network ties in Case 2 (Kangas)

	contradiction	less contradiction
strong	**Staff**	**Management** **Facilities** Contractors
weak	Assistant designers	**Architect**

bold = centrality (amount of existing links of all possible links)

As we can see, the management was at the centre of this network. It had strong, non-problematic links and it had a high centrality (i.e. it was more active than the others). The Facilities Department was another strong player and these two formed a team. The third part of this central formation were the contractors, but they entered the picture later and they were not as central as the other two. The staff was active and had many strong links, but they were often problematic. The architect worked in a routine-like manner, mainly through weak, non-problematic links. The exception was “the color war”. This incident forced her to choose a different strategy with the users. When the war was over, she could go back to her previous role. As a matter of fact, “the color war” made her links better when she learned to know the users better. The assistant designers seemed to have a problem: by trying to avoid extra effort they stuck to weak links, but the strategy was not working and they ended up having lots of problematic links. It is an interesting question why the assistant designers failed and architect succeeded in using the weak links.

The tie between the management and the facilities was the backbone of the whole project. This was much due to the persons, the project manager and the physiotherapist, and their good working relationship. The delegation on both sides worked out fine and the link was strong through the whole project. It seemed that most of the other relationships were somehow related to this central tie.

The dark side of this relationship was the influence it had on staff. Relationships between the management and staff stayed strong and problematic throughout the project, whereas the relationship between the facilities and the staff was mainly weak and problematic. The fact that all the information from the users´ side was channeled through the physiotherapist left the staff as outsiders in the process and they criticized this in the interviews.

The triangle of management-architect-facilities was a very different story. The relationship between the architect and the management was strong from the beginning. The only exception was “the color war”. The tie between the architect and the facilities was weak, but not problematic. It looked like the project manager used the link to the architect as a means of taking care of the users’ needs, and this strategy worked out so well that the project manager did not need to invest more in this relationship. The same seemed to apply to the relationships between the project manager and the contractors. The problems with the contractors had nothing to do with the architect, they were related to the poor quality of the assistant designers’ work. The project manager successfully used the links both to the physiotherapist and to the architect as a means of taking care of the problems in the building site.

There seemed to be a pattern. The ties formed triangles, where somebody was using a link to somebody else as a means of taking care of a relationship to a third party. Sometimes these triangles did not work. Such a case was the relationship between the contractors and the project management. The facilities´ intention was to hire good consultants and pay them well to handle the relationships to technical contractors, but this strategy failed. The consultants did not invest enough resources, the plans were not good enough, and this caused lots of disputes during the construction phase.

The same seemed to apply to the relationships between the facilities and the users. The facilities´ idea was to use the link to the assistant designers as a way to make the link between the users and the project management better. The Facilities Department used model rooms and made a good project definition plan, but these methods were neglected and not understood properly by the assistant designers. Many of the problems between the project management and the staff were related to this malfunctioning link, the kitchen ventilation problems being one example.

However, the problematic relationship between the Facilities Department was somewhat eased by the work of the architect. She was a knowledge broker and a mediator between the other designers and the project management. This was partly due to the fact that she worked in the same city with the other designers, but her personal qualities were an important factor as well.

To enter a network seems to be a difficult task. The appearance of both the architect and the contractors to the picture caused a crisis. The management tried to use the link to the architect as a means of handling its own relationship with the staff, but the staff objected to this strongly. It had difficulties to accept the role of the architect. The dispute reached a crisis level during “the color war”. For a brief moment all the links in the triangle architect-management-staff were strong and problematic. When the crisis was over, the links soon returned to normal, even strong.

The same applied to the contractors. They had difficulties in understanding that the Kangas project was not on ordinary project and what it meant to work in the middle of a functioning service centre. In the beginning of the construction work all their links were strong and problematic. When the first crisis was over and everybody adjusted to the new situation, the links became strong.

In summary, one could say that the Case 2 (Kangas) network was a well functioning one. It was active when activity was needed, and it went to a lower activity level if action was not needed. It was not a perfectly functioning network. There were nodes which could not work well in their relationships to others, but the network seemed to have a system with which it could stabilize these malfunctioning ties or at least minimize their negative consequences. Many of the problems were related to the new methods used and organizational experiments. The culture of the construction industry is so strong that different parties feel uneasy if the action does not follow the predicted order and presumptions of the industry.

4.2.3 Lessons learned from Case 2 (Kangas)

An excellent project definition plan was the cornerstone of the project success (RQ1, RQ3)

All the informants agreed that the project definition plan was excellent. One has to admit that. compared with other public sector project definition plans. it was a positive exception. Usually the plans are done only for the purpose of applying for state subsidies and they merely fulfill the criteria set by the state authorities.

A lot of effort was put into the preparation of the plan together with the users. Special space definition cards were used and a lot of work was done in the model room. The report of the general condition of the structures was an appendix of the project definition plan and the staff were interviewed when the report was made. The whole process of writing the report started after the project manager was nominated in the spring of 2001 and it was delivered by August of 2002. As could be seen from the amount of documents produced, all the time was spent actively preparing for the project definition plan. Of course, all the work done from the very first meetings of the renovation group in 1998 was actually preparation for the project definition plan.

However, there was a problem with the staff involvement. Because of working in shifts the representatives changed and the staff had difficulties in understanding that all the work would one day lead to a real-life building project. The staff was not motivated at first when the construction began.

Was there a common goal and top management support? The answer is both yes and no. The Town Chief for Social and Health Matters and the Town Board for Social and Health Matters were actively involved and they were committed, but the Mayor somehow missed the whole process. This lack of commitment had some consequences later. There was a moment of hesitation when he was supposed to sign the construction contracts.

The project definition plan was well written, but not everybody was committed to it. The project manager doubted whether the assistant designers ever read the plan, even though it was an appendix to their bidding letters. The designs were often in a contradiction with the plan. The assistant designers themselves said in the interviews that the project definition plan was a good one and helped them in their design work.

Project plan not made: problems with resources (RQ1, RQ3)

There was no project plan, where all the resources (time, budget, personnel) were described. In the projection definition plan there was a sentence which stated that a project quality plan would be prepared later, but no such plan can be found.

The project definition plan included a budget, but it was a budget for the construction work only. The definition of project resources was missing. The lack of resource planning had serious consequences later. The designers were hired too late and the design schedules did not hold. The division of phases was changed during the construction phase. Finally, the construction work was finished three months ahead of time. The main contractor did not understand the meaning of the site model room and it was not built in time. There were problems with the side projects, nurse call systems, and so on.

The amount of work needed from the users' side exceeded all their expectations. With better planning there would have been fewer problems with the users' participation. The shifts could have been changed and more resources given to the participation. There were more problems in the very beginning of the project, but when the project manager was hired, the situation was eased.

The Kangas project was not an exception in terms of the missing project plan. Project plans are very seldom used in public building projects in Finland.

Client participation well organized (RQ2, RQ3)

Even though there were problems with the actual resources, the user participation was exceptionally well organized in the Kangas project. Early on a person was nominated as a users' representative, a committee was nominated, a system of participation in the different departments was organized.

This initial work in the service center was followed by techniques introduced by the project manager: the model room, the room cards, interviews, and the project definition plan. One of the motivations for hiring the architect was to better serve the users. The project management seemed to be most concerned about the users' participation. The management was investing resources to the participation for obvious reasons: if something went wrong with the participation, it would lead to serious consequences during the construction period. The project management saw participation as a risk management strategy.

There were problems with the participation, and nobody denied it. There were not enough resources, and it was difficult to motivate the staff. Most of the difficulties were related to the third parties: the contractors, architect, and assistant designers. It was not easy to make them understand the exceptional characteristics of the Kangas project and make them committed to the participation.

However, all these efforts were paid back during the later construction period, when the cooperation worked, and no risks materialized. The staff experienced the whole process as a learning experience which strengthened their community. They had worked hard together and their work had an influence on their own environment.

Systems thinking helped (RQ2)

One reason why the project network was so well functioning was the fact that it was deliberately designed to do so. The project manager spent a lot of time beforehand contemplating how things should be arranged from the information flow point-of-view.

The actual nomination of the project manager and the way his tasks were organized was one example. He was both the main designer and the construction manager at the same time. This is not common in Finland, where the main designers are usually architects. Architects try to avoid the position of construction manager, because there is no project management, cost estimation, or contract jurisdiction in architects' training. The project manager was an engineer by education, but he had worked as a designer.

The idea of writing a thorough project definition plan and of using participative methods in the process was based on systemic thinking, as was stated earlier. The same applied to the method of designer selection, the aim of which was to secure enough resources for the design work. A new method of design reviews was tested.

Even the network connections were consciously designed to work in a certain manner. The users were not supposed to contact the project manager directly, all the information went through the physiotherapist. The physiotherapist was seen as a some kind of knowledge broker. The architect was hired and her work arranged so that she could take care of the contacts with the users and the other designers. Her role was essential, once the main designer was a project manager at the same time.

Things did not go according to plan. The problems with resources and timetables caused unwanted systemic effects. The user participation did not work as expected. The designers failed to do their job. There were occasional information overflows and crisis. However, all these risks and deviations were handled, because they could be approached from the systemic level. There was a monitoring system and rescue plans. Part of the network action was self-organized. There were network connections (architect-physiotherapist-staff-project manager) which could react and handle any problem or unexpected deviation. A centrally organized system could not have operated and reacted as fast.

In the interviews, the informants constantly weighted different alternatives and were creating new solutions to occurring problems (see Appendix 8). There seemed to be a double-loop learning system in place. The organization had the capacity to learn and to improve its performance.

4.3 Cross-case analysis: description of the two projects as dynamic networks

4.3.1 Similarities and differences in the level of activity in both projects (RQ1)

The graphs showing the amount of incidents taking place or documents produced in a given time-period during the two projects are shown in figs. 4.1, 4.27, and 4.28. If we look at these two graphs, we discover similarities and differences. The biggest difference is, of course, the scale. The method used in gathering material was different in the two projects and this led to a difference in the amount of documents collected. In Case 1 the highest figure was around 20 incidents a month, whereas in Case 2 there may have been over 150 incidents a month. The other striking difference is the variation. Case 2 (Kangas) seemed to produce a steadier flow of documents, whereas the Case 1 (Hakala) graph is characterized by many peaks, often followed by a complete halt in the activity. This phenomenon could be partially explained by the method of collection: the Kangas material included all the computer files, whereas in Hakala this material was omitted or did not exist.

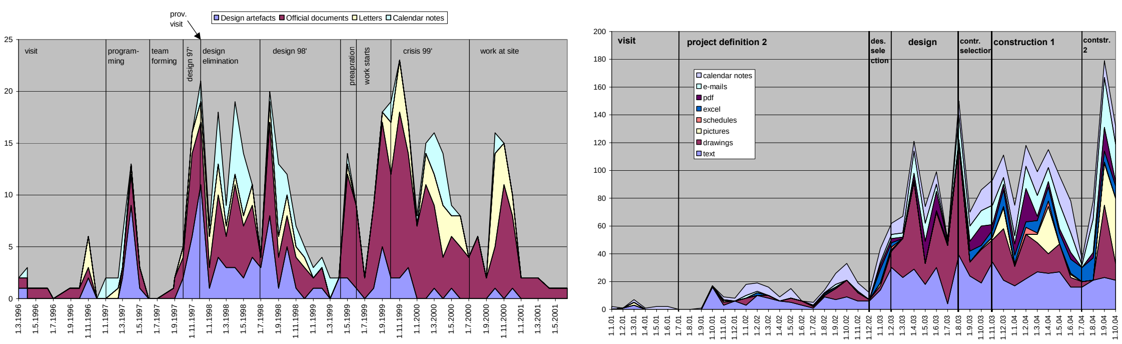


Figure 4.28. The production of documents over phases in Case 1 (Hakala) and Case 2 (Kangas)

However, there seemed to be an explanation for the steadier production of documents in Case 2. The Kangas renovation (Case 2) was consciously kept alive by the users and by the project management before the design phase. There were questionnaires sent to staff and experiments made with the model room. The programming was not a single incident as it was in Case 1, but a longer effort. In Case 1 there was a period of low activity after the design phase when the project moved from the city architect office to the construction management department. This did not happen in Case 2, where the same person was in charge of the project all the time. There was no crisis during the construction period in Case 2 (Kangas) and the sharp peaks in the level of activity took place during the design phase. The construction phase produced a steady flow of incidents, whereas in Case 1 (Hakala) the crisis during the construction caused the highest peaks of activity.

In Table 4.5 all the document types in a given phase in Case 1 are analyzed. The design process was divided into three phases: “design ’97”, “trimming”, and “design ´98”. Of these, “trimming” produced more design artifacts than the other two phases. There were also more calendar notes from this phase than from any other phase. During the crisis of ’99 more official documents or letters were produced than during any other phase.

Table 4.5: Types of documents found in each phase (*) in Case 1 (Hakala).

	Design artifacts	**Official documents**	**Letters**	**Calendar notes**	**Σ**	**%**
2: visit	4	9	3	1	**17**	**4 %**
3: programming	11	4	2	6	**23**	**5 %**
4: team forming	1	5	0	0	**6**	**1 %**
5: design 97	8	10	3	0	**21**	**4 %**
7: trimming	***31***	36	13	***23***	**103**	**21 %**
8: design 98	19	24	8	17	**68**	**14 %**
9: preparation	3	18	1	1	**23**	**5 %**
10: work starts	1	10	0	0	**11**	**2 %**
11: crisis 99	14	***93***	***30***	14	**151**	**31 %**
12: work at site	2	39	15	2	**58**	**12 %**
all	**94**	**248**	**75**	**64**	**481**	**100 %**

*) The first phase (maintenance period) is not included, because it would have been impossible to gather material from a 30 year period. The sixth phase (the provincial visit) is not included, because there were no documents produced.

The production of different types of documents in the phases of the Kangas project (Case 2) is described in Table 4.6. In Case 2 there was one intensive design phase and almost half of the drawings were produced then. The first construction phase was also an active period with respect to the production of drawings. There were more text files, pdf-files, schedules, excel-files, or calendar notes from the first phase of the construction work than from any other period. It was a period when lots of action took place simultaneously. There was no crisis, but there was a clash between different cultures when the contractors entered the scene. There was the argument about colors, site meetings, model rooms, design alterations, and many other reasons for the production of official documents.

Almost half of the pictures were from the second construction phase. This is understandable: when the construction work proceeded there were more things to photograph. 40% of the e-mails were from this period. There was a building site going on and at the same time the design of the future works had started. The low amount of e-mails in previous phases might be explained by the problem with the collection of the material: people do not preserve their e-mails for a long time and the e-mails from the previous phases may have been destroyed.

Table 4.6: Types of documents found in each phase (*) in Case 2 (Kangas)

	text	**drawings**	**pictures, presentations**	**e-mails**	**pdf**	**schedules**	**excel**	**calendar notes**	**unknown**	**all**	**%**
2: project plan 1	37	8	1	0	0	0	0	18	0	**64**	**3 %**
3: Ministry visits	4	0	2	0	0	0	0	7	0	**13**	**1 %**
4: project plan 2	92	43	1	7	1	0	6	67	1	**218**	**9 %**
5:selection of des.	20	4	2	2	3	0	10	15	6	**62**	**3 %**
6: design	173	***279***	2	59	41	2	9	58	12	**635**	**27 %**
7: sel. of contr.	43	34	1	22	21	0	10	25	0	**156**	**7 %**
8: phase 1	***174***	154	57	84	***50***	***13***	***54***	***121***	6	**713**	**30 %**
9: phase 2	97	75	***79***	***103***	29	2	53	65	3	**506**	**21 %**
all	**640**	**597**	**145**	**277**	**145**	**17**	**142**	**376**	**28**	**2367**	**100 %**

*) The first phase (renovation group) is not included, because there was such a small amount of documents

Case 1 and Case 2 were two completely different building projects. Case 1 (Hakala) was a failure in terms of knowledge management and project management. The mold problems were not detected early enough and programming was done hastily. All this led to lots of extra work on the building site. In Case 2 (Kangas) everything was done as well as possible and by following the best procedures. The programming was done properly and everything studied carefully in a model room before and during the design process. There were no big surprises when the building site was opened.

However, if we compare the amount of incidents and documents produced in each phase, there is very little difference between the two projects. In Case 1 (Hakala) 9% of the documents were produced before the design phase, in Case 2 the figure was 16%. The design phase in Case 1 (“design ’97”, “trimming”, and “design ‘98”) amounted to 39% of the documents, in Case 2 (“design”) 27%. The selection of contractors produced 7% (“preparation” and “work starts” in Case 1, “selection of contractors” in Case 2) of documents in both projects. The amount of documents produced during the building site was 43% in Case 1 and 51% in Case 2.

The result could be explained by the different method of collection: the material from the building site was more easily available in Case 2 (Kangas) when the communication was handled via e-mail. In Case 1 (Hakala) most of the material was in paper form. During the design phase there was no big difference between the two, because the design phase was better documented, for obvious reasons (the end products of design are the documents) in both cases. The second phase of the construction work in Case 2 was a design phase for further work as well and this explains the higher activity compared with the later construction phase of Case 1.

It is difficult to call the other project a complete failure and the other one an unquestionable success. The design team of Case 1 was working hard during the design phase because of the trimming of the design. It did not detect the mold, but otherwise it did good work. In Case 2 the design team did good work early on, but still it faced lots of difficulties at the very beginning of building site. Because of the strong culture of the construction industry, it had problems conveying its ideas to other designers and to the site crew.

By using two different methods and by studying two different projects we have produced two similar pictures. The similarities of these two pictures could be explained by the same factors behind them. The culture was the same, the construction industry was the same, the overall structure of the organization was similar. It can be assumed that the habit of producing less material in the beginning of the project and spending more time solving problems later was not caused by some factors typical of these two projects alone, but was caused by the very nature of the construction and design work in the public sector of Finland.

4.3.2 Comparative analysis of the network links in Cases 1 and 2 (RQ2)

The essential properties of the two networks are compared in Table 4.7.

First of all there was a difference in the size of the networks. In Case 1 there were 12 phases and 143 possible links. In Case 2 there were only 9 phases and 73 possible links. The number of links per phase was 11,9 in Case 1 and 8,1 in Case 2. This was understandable, because there were 7 key participating organizations in Case 1 and only 6 in Case 2.

However, the Case 2 (Kangas) network was more dense. In Case 2 the number of missing links was 12%, whereas in Case 1 (Hakala) it was 27%. The difference in density could be explained by the number of phases. The more phases there were, the higher was the probability that not all the informants remembered all the phases, and thus the picture of the network was not as dense.

Table 4.7: Comparison of two networks

factor	**Case 1 (Hakala)**	**Case 2 (Kangas)**
number of phases	12	9
number of possible links	143	73
density	73%	88%
strength of existing ties • variation	43% 17% - 58%	52% 24% - 80%
contradiction of existing ties • variation	50% 31%% - 100%	41% 21% - 58%

The links in Case 2 were stronger than in Case 1. In the Case 1 network the contradiction of the links was higher. The difference in both factors was higher, if we look at variation. The lowest number of contradictionary links in Case 2 was 21% and the highest in Case 1 was 100%. The highest strength of ties in Case 2 was 80% and the lowest in Case 1 was 17%.

The difference of the two networks could be summarized by stating that the Case 1 (Hakala) network was bigger, less dense, more contradictionary, and weaker than the Case 2 (Kangas) network. If we assume that the better functioning network was less contradictionary, stronger, and denser, we could say that there seemed to be a relation between the overall qualities of the two networks and the project success. In Case 1 there were some participants who had very problematic network relationships, whereas in Case 2 these kinds of participants were missing. The best network actors could be found in Case 2.

If we look at the dynamic picture of the two networks, we get more convincing evidence. In Case 1 the contradiction of the network increased towards the end, whereas in Case 2 it decreased. This was explained by the crisis in the Hakala building site (Case 1).

However, there were some similarities as well. The strength of the ties and the density of networks was high in the beginning and in the end of both projects. This was explained by the routine-like character of the design and contractor selection processes. The team formation was a contradictionary phase in both projects. This contradiction had its origin in the retrospective approach the informants had in the interviews: they were reflecting the selection on to the further problems. There were contradictionary phases in both projects during the early programming phases. It is understandable that there will be arguments when decisions about the project goals have to be made.

There was also a difference in the fundamental dynamism of the two networks. The Case 1 network was characterized by the polarization of the ties between the city architect's office and the school. This was the source of constant tension and most of the contradictionary links in the Case 1 network had origins in this polarized structure. In Case 2 the tension was always around the newcomer of the network and the situation was eased after a while. Case 2 was more organized around triads, Case 1 around dyads.

There was a similarity, though. Both networks had a key tie around which the strong ties were concentrated. In Case 1 (Hakala) it was the school and the architect, in Case 2 (Kangas) it was the Facilities Department and the management of the service centre.

4.3.3 Were the two projects successful? (RQ3)

Success criteria

In section 2.1.2 I described the four categories of project success depending either on the project management (i.e. execution) success or the overall success of the project based on the usefulness of the project deliverable. The *project management success* is traditionally described as the fulfillment of the triple constraint (Table 4.8) of time, money, and meeting the specifications. The two projects can be compared in the following manner:

Table 4.8: The two networks and the triple constraint

Constraint	Case 1 (Hakala School renovation)	Case 2 (Kangas Service Center renovation)
Time	Was delivered on time, but a great effort in overcoming the difficulties was needed.	Was delivered before the due date
Money	Exceeded its budget by 20%	Was delivered within the budget
Specifications	A lot of trimming was needed to get the project done. Did not meet its specifications.	Was delivered according to the project definition plan.

Case 1 (Hakala) did not satisfy the triple constraint, whereas Case 2 (Kangas) did. Case 2 can be called a project management success and Case 1 a project management failure.

As a whole, the Kangas Service Center renovation (Case 2) can be called a successful project. It was finished three months ahead of time, it did not exceed its budget, and the users are pleased with the end result. By increasing the efficiency of the care of the elderly in Varkaus, it most probably has a positive effect on the clients´ economy and future. For the clients, the senior citizens of Varkaus, it provides a better quality of life.

In terms of the project management, there is very little doubt about the matter: Hakala School renovation (Case 1) was a failure. This is the general opinion of the informants and there are concrete facts supporting it. But whether Case 1 was a failure as a *project* is a more interesting question. In the validation meeting in December 2004 everybody seemed to be happy with the end result. This would imply that Case 1 belongs to type 2 in the taxonomy presented in section 2.1.2 (Table 2.1): it is *a potentially successful project*.

However, there are some strong arguments against this interpretation. Due to the changes in the plans the clients did not get the kind of spaces they would have needed. Because of the immigrant pupils, smaller classrooms would have been needed, but they were removed from the plans due to the budget cuts of 1998. Some informants said that if they had known the total price beforehand, they would have recommended the demolition of the building instead of its renovation. A brand new building would have been a less expensive alternative. During the construction work the staff and the pupils already infected by the mold were exposed to heavy doses of mold. Nobody has calculated the costs or the effect on the quality of life caused by this extra exposure.

It can be argued that Case 1 belongs to type 4: it is a failure beyond doubt. This failure is related to the very concept of success *criteria*. In Case 1 not enough effort was put into the definition of the project goal. The sponsors (the state and the city) were not interested in the proper definition of the project goal and not enough resources were given in the definition phase of the project. The sponsors should have been interested in the very essential question of whether the building should have been renovated at all. When this question was not properly asked and answered, the whole project was based on sand and nothing but failure could be expected.

5 Discussion

In this chapter final conclusions are drawn based on the evidence analyzed in previous chapter. First the three research questions will be answered. After that there is a description of the two projects as distributed cognitive actions and a model for better projects knowledge management. The last section includes an evaluation of the research work and suggestions for further research.

5.1 The findings of the research

The objective of this research was to study factors related to project success and failure. A question was asked how project success factors can be understood and described better by studying projects as distributed cognitive actions. As a method for building such understanding a social network analysis based on qualitative material, made retrospectively, and covering the whole life-span of the two projects was used. It was assumed that methods of better project knowledge management could also be created if projects were studied as distributed cognitive actions.

There were three research questions:

RQ1:	What do the documents and other artifacts produced tell about the collective activity which produced them?
RQ2:	How can the *changes* during the two projects be described as *dynamism of the social network*?
RQ3:	What were the factors behind the projects' success or failure?

This study shows that:

1. <u>**There was a direct relation between the quality of distributed cognitive actions and project success or failure.**</u> Case 1 (Hakala School renovation) did not satisfy the triple constraint of time, money, and meeting the specifications, whereas Case 2 (Kangas Service Center renovation) did. Case 2 can be called a project management success and Case 1 a project management failure. In Case 1 not enough effort was put into the definition of the project goal. The sponsors were not interested in the proper definition of the project goal and not enough resources were given at the definition phase of the project. (section 4.3.3)
2. <u>**The quality of the artifacts and the way they were used was essential to project success.**</u> The documents produced and their amount in the different phases described the action well. There was no big difference between the two projects with respect to the amount of documents in different phases, even though the other project had knowledge management failures and the other did not.

However, the quality of documents was better in Case 2 (Kangas) and there was more work done defining project objectives and client's needs than in Case 1 (Hakala). The similarity in the document flow charts is explained by the culture of the Finnish construction industry. (section 4.3.1)

3. **The quality of network action was an essential prerequisite for project success.** There was a big difference in the dynamism of the two networks. Case 1 (Hakala) network was bigger, less dense, more contradictionary, and weaker than the Case 2 (Kangas) network. In Case 1 the contradiction of the network increased towards the end, whereas in Case 2 it decreased. However, there were some similarities as well. The strength of the ties and the density of the networks was high in the beginning and in the end of both projects. If we assume that a better functioning network is less contradictionary, stronger, and denser, we could say that there seemed to be a connection between the overall qualities of the two networks and the projects' success. (section 4.3.2)

4. **For the first time projects were described as distributed cognitive actions in a way which explained the project success and failure.** The research focused on matters most essential to project success or failure. It was shown that the new method that was created was fit and proper for studying small-scale network phenomena. An analysis based on qualitative material gave a lively picture of the network dynamism. It would have been impossible to build such a picture based on quantitative material and by using statistical analysis. The qualitative material could be summarized quantitatively in a manner which enriched the picture and made the findings more reliable and more understandable. The analysis gave enough knowledge for the betterment of project work . In the following section there is a model for better project knowledge management based on the findings of the research.

There were many sub-questions which were not answered yet. In the following sections the findings are analyzed in detail and answers will be given to most of the research questions.

5.2 Two building projects as distributed cognitive actions

5.2.1 The role of artifacts (RQ 1)

The amount and the quality of documents produced is described in sections 4.1.1, 4.2.1, and 4.3.1. The conceptual nature of the artifacts produced and used will be analyzed in this chapter.

What are the primary artifacts (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 132; Wartofsky 1979) in a building project? If we are talking about material artifacts as objects of human action, the answer is easy. The goal of a building project is to create a building or renovate an existing one, so the project is aimed at producing primary artifacts. But primary artifacts are more than this. They are tools and practices used in human activities. Thus a meeting or a computer are primary artifacts. The existing buildings of Hakala (Case 1) and Kangas (Case 2) are primary artifacts.

A design is a representation of a primary artifact. But is it a secondary artifact? It is usually a one to one representation of what the designed object will look like. Ordinary designs can hardly be considered as secondary artifacts, unless they have a conceptual characteristic and/or they are used for the purpose of building theories or alternative solutions to the problems.

Secondary artifacts are symbolic externalizations of primary artifacts. They are theories and social representations. When the mechanical engineer and the outside consultant in Case 2 (Kangas) had their dispute over the heating system in the kitchen, they were working on a theory of how the ventilation system functions. An expensive expert system was used in its simulation. The theory and the simulation model are examples of secondary artifacts or “knowledge objects”. They were used to make a representation of the material object and then used as an object of knowledge building.

The same applies to the model room. It was used to create theories and representations of the actual work of taking care of the demented. The space definition cards were knowledge objects as well. They were means of finding out what the activity is like, a means of creating a picture of everyday work. The model created by using the model room and the cards was all described in the project definition plan. It could be considered a secondary artifact, because it only described the design problem. Its aim was to serve as a framework for further theory building.

The question of tertiary artifacts is even more interesting. They are derived and abstracted from secondary artifacts and they mediate relationships between the primary and secondary artifacts. Scientific theories are one example. Do such things exist in the two projects?

There was theory building in both projects. In Hakala (Case 1) the principal was not familiar with construction work. Because he knew nothing about the work, in his interviews he was all the time creating theories of how the project was managed and why things were done in a certain manner. One of my colleagues once said that there should be a five-year old boy in every building site asking why things are done the way they are. He said that there would be very few answers to such questions. The principal was such a five-year-old boy in the Hakala project in a positive way. He asked the right questions and thus helped the experts to see beyond their routines.

In Case 2 (Kangas) there were theories created about the user participation, of what its real purpose and content was. How could user participation be carried through in such a manner that it would fit to the overall process of design and building? Why was user participation important? The same kinds of theories were built around the true essence of the care of the demented, about the way relationships between clients, designers, and contractors should be arranged. In his interviews the mechanical inspector of the Kangas project spent hours talking about such matters.

The people in Case 2 were constantly building a theory of why the world around them was arranged in a certain way and how it could be changed. They experimented with it, and the results of their experiments affected their interpretations of the world. It was clearly a process of semiosis.

The color war could be seen as a conflict between two conceptual artifacts, two theories of how colors affect people. The architect's theory was that colors have universal qualities and that they have a similar effect on every person. To choose a right color is only a matter of education. The staff believed that colors have different effects on different people, depending on their personal history and background and even medical condition. If somebody has been witnessing traumatic events, she does not want to see red. To choose a color is a matter of situational knowledge, a relative thing.

In Case 1 (Hakala) there was the working theory of the renovation project as a new beginning to the building. It could be compared to building new facilities: the school would finally get the classrooms it needed in the new situation. The conflicting theory was the one by the city architect's office. According to the latter, it was a matter of renovating the existing building the way it was and adding little extra.

Behind the crisis of Case 1 was the fact that these two theories were never openly discussed. The problem should have been solved and the solution written into the project definition plan. When this was not done, neither of the theories was proven right. The school did not get the premises it wanted, but the renovation can hardly be called a minor fixing of the existing building.

The problems in Case 2 (Kangas) were smaller, because the main theories were discussed openly and early enough. The colors were a minor matter, and the problems with the assistant designers were later solved or at least their effects neutralized.

It looks like the production of the right kind of artifacts at the right time is essential for the project success. If big issues are not discussed early enough and on a theoretical level, the cognitive system cannot work properly. The problem with the construction industry is its very rigid tradition and avoidance of theoretical discussions. Because of the low profit margins the whole activity is aimed at the production of primary artifacts: designs and buildings.

What we need are new kinds of artifacts. We need theories and social representations. We should arrange model rooms, vision meetings, workshops. We should ask the fundamental questions first and look for the answers after that, not vice versa. The designers in the Kangas project (Case 2) had many tested solutions, and they were looking for the questions. They did not understand that the question had changed.

The following picture (fig. 5.1) shows how much more time should be given to theory building and definition of problems instead of answering the questions. The dialog between the artifacts is one form of semiosis described in section 2.2.2. To define what the exact methods are is not part of this dissertation.

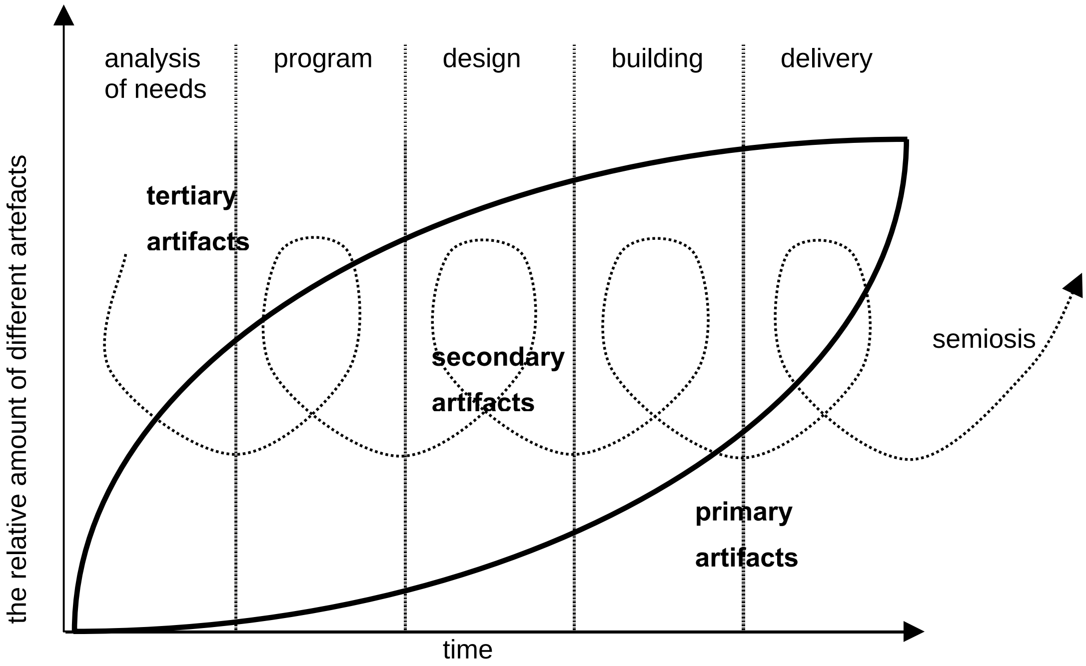


Figure 5.1. Different kinds of artifacts needed in different phases and the process of semiosis between them

5.2.2 The dynamism of network action (RQ 2)

One of the main contributions of this thesis is a methodological one. In order to understand the factors behind project success or failure, a method was created which would better serve the purpose of describing social networks in projects. The results are described in Chapter 4 (sections 4.1.2, 4.2.2 and 4.3.2). Projects as networks have not been studied this way before. More has been learned about them for two reasons:

1) **A picture of dynamic action evolving over time has been created.** Hakkarainen, Palonen, Paavola and Lehtinen (2004: 76) propose that the evolution and dynamic development of the links over time would be a very useful object of investigation.

2) **There is qualitative analysis of the links.** Palonen (2003: 33) says that richer and more detailed databases combined with qualitative methods should be collected.

Based on these approaches information typical to social network analysis has been produced: the degree and centrality of actors, the density of the network, the strength of the ties. The method used has been fairly simple and easy to use.

However, there have been some aspects of networks which have not been revealed by previous statistical methods. In this chapter some of them will be described.

Triads and semiosis

The triads and dyads found are described in Chapter 4 (4.2.2 and 4.3.2). Triads and dyads are not unknown to the previous research applying statistical methods (Krackhardt 1999). However, their true nature is seldom revealed through mere statistical analysis.

Krackhardt (1999) makes an interesting comparison to Burt's (1992) theory of structural holes (see section 2.3.5). According to Burt (1992), the strength of the ties does not matter, but the bridging does. If one is a holder of a bridging tie (i.e. if one is a knowledge broker), one has superior bargaining power and fewer constraints. Krackhardt's criticism is aimed at the concept of constraint. If one is a member of a clique, one has to accept the constraints this has over one's actions. Cliques often represent social roles. If one is a member of several cliques, there will be more constraints on individual actions. However, the less public the ties are, the less constraining power they have.

If we follow Krackhardt's (1999) thinking, the role of a network broker is not a pleasant one at all. This may be one reason why people in such position show lots of humbleness (section 5.2.5).

The physiotherapist in Case 2 (Kangas) was a network broker. She was a member of the project team, but at the same time a representative of the user's community. This situation was not easy. When "the color war" broke out, she was accused of betraying her community. This led to a retreat from her side: she took the staff's side even though she was able to maintain good working relationships with the architect. However, this all had a positive effect on the architect's behavior: without the physiotherapist's support she could not keep her position. Finally, the staff were allowed to make the decision about the wall colors. The architect's and physiotherapist's role became only a consultative one (See Appendix 8, phase 9).

It looked like everybody was trying to use the Divide et Impera –method in gaining power (section 2.3.4). The staff tried to separate the physiotherapist and the architect by appealing to the physiotherapist as a member of their working community; the architect was trying to create a cleavage between the physiotherapist and the staff by appealing to the physiotherapist as a member of the design team, and the physiotherapist was trying to create distance between the staff and the architect by saying that all connections between the design team and the staff should go through her. Finally, the war ended when a balance was found between the different parties. The end result was very much in line with the wishes of the service center staff.

We are talking about power games here and thus approaching the field of sociology. But was it a question of pure power games? The knowledge played an important role. Who was allowed to form the final interpretation about the role of colors? In other words, who was giving the meaning (the role of colors) based on the information (the possible choice of colors)? The staff saw colors as a means to treat demented people, the architect saw them as a means to create the aesthetical quality accepted by her profession. It was the interpretation that counted.

Meaning making and power struggles were intertwined and inseparable activities in this particular case.

Peirce’s pragmatism includes the idea that the interpretation leads to action. What follows is that if power is described as the ability to guide the action, there is no way to separate the interpretation and the use of power from each other. Power plays are part of the process of interpretation.

Why is this? Why are power plays needed instead of peaceful negotiation? One reason may be the pressures of a tight timetable. Because there is no time for the long processes of meaning making, each party wants to push its ideas through. The other reason may be in the institutionalized nature of action (Berger & Luckmann 1966). The distributed cognitive systems consist of humans and institutionalized groups. Negotiations between groups have different kinds of dynamics compared with ones between individuals. A system of making a decision as to which interpretation is right is needed.

Hutchins (1997) faced the same problem. If the system of “society of societies of mind” is based on distributed cognition and independent actions of partially specialized agencies, who decides which procedures to use? If there is a managerial agent (either inside an individual´s head or in a society of individuals) how can the relations among agencies be organized to perform new functional skills (Hutchins 1997: 12)? What makes this issue problematic is the presupposition that if such a manager intervenes too soon, the agencies will not develop properly, and if she does it too late the agencies are too rigid to be brought into coordination. What Hutchins (1997, quoting Minsky and Papert 1988) suggests is an analogical to biological maturation: where some kind of a “maturational program would introduce the right kind of managerial agencies at the right time” (Hutchins 1997: 13).

What is the maturational program of a community or a project? It looks like power plays and social life in general are the means of deciding about the right procedures. There seems to be a gap between sociologists, who seem to interpret all phenomena as social ones, and psychologists, who are accused of seeing all phenomena as individual ones. But what if they are both right at the same time? Sometimes the nature of a problem is such that the best way to solve it is at the individual level. Sometimes the individual is put aside and the cognitive system functions at a level of the whole community or network. This fits well with the findings of Hutchins’s (1991) simulations: it is both-and, not either-or. It depends on the situation as to which approach is better, the sociological or the psychological one.

Triads and dyads are the ways whereby this maturational program is organized on a community level. At first there is a dyad, then a third party appears, and it becomes a triad. Finally, there is a network of interrelated triads. At the beginning the dyads and triads are formed by individuals, later they can be formed by organizations as well.

We could take a public building project as an example. First there is the dyad of the project manager and the user. They may have a hectic period together when the project definition plan is written, even arguments. Typical of dyads is that more individualism is allowed (see above) and it may take a long time before an agreement is reached. In Case 2 (Kangas) the interference of the Ministry was needed before the final decisions were made. It looks like a third party was sought for decision maturation purposes. Later a designer was used as a means of producing the designs. This led to a difficult situation, because a triad was formed. The designers had a different view of problems and they tried to persuade each party to share their opinion of how problems should be solved. In Case 2 their intention was to avoid user participation and apply the routine methods applied in previous projects. In Case 1 (Hakala) the triad was unbalanced when construction management appeared between the city architect's office and the school and criticized the work done so far.

In all these situations it is not only a question of who rules, but also a question of different interpretations of information as well. “What is participation?”, “how should mold and moisture be taken care of?”, and other questions were issues the teams were trying to solve. A new actor introduced a new, alternative interpretation to the existing facts or criticized the stabilized, previous interpretations. Another circle of interpretations followed, when the dyad of project management and design was enlarged into a triad due to the appearance of the contractors. They had a different, construction-oriented point-of-view on the interpretation of the facts and this led to a power games in a triad of project management – designers – contractors. These big triangles are escorted by minor ones, including representatives of staff or city technical experts. The powerful triangles seemed to be formed by strong links, problematic or non-problematic, depending on power-shifts.

Many of the problematic ties seemed to be related to these kinds of situations. They often appeared right after a new party had entered the stage. They could be directly connected to the new actor or they could have been seen as consequences of his actions, like the appearance of the construction management in Case 1 (Hakala) which made almost all the links of the city architect's office problematic. Problematic links are ways through which important new interpretations are possible. Without them the system would get stuck in its previous interpretations and the cycle of interpretations would stop.

This cycle of interpretations can be found in Peirce´s philosophy. In section 2.2.2 his concept of *semiosis*, a continuous cycle of interpretations, is described. According to Peirce, the interpretant, or the effect a sign has on somebody, can cause another interpretant or an effect on a third party (Veivo 2000: 134). This somebody can be a human or a thing. The process will stop when the interpretation stabilizes, but it can start again if new information appears and challenges the interpretation. Human culture is a system of continuous chains of interpretation of previous knowledge, and so is a project.

Figure 5.2 shows how the project network evolves through a continuous circle of homeostasis – unbalance – new homeostasis.

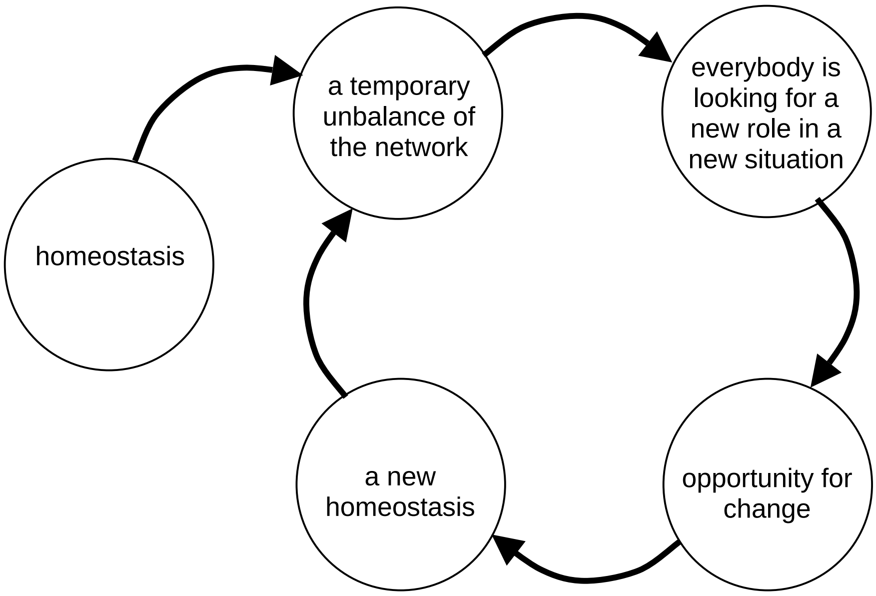


Figure 5.2. The process of project network reorganization

Self-organized systems and the executive function

A picture is now drawn of a project as a complicated system of individuals, dyads, triads, and networks in a constant process of endless semiosis, dynamically changing all the time due to the dynamism caused by inner tensions and power-plays. Is this monster running free or can it be managed somehow? Are we talking about self-organized or centrally controlled activity?

Self-organized processes are not random processes. Instead of a central controlling agent, there is a rule of ordering, which internally organizes the action to follow a certain pattern (e.g. a flight of cranes, ant-paths, a traffic jam). Lots of such rules can be found in projects: the triad-dyad patterns, institutional presuppositions, shared cultural artifacts, and so on. The fact that these two projects followed the same patterns in many ways (section 4.3) is one example. Based on common experience, these patterns are not unique in the construction industry.

They are not intentionally created rules for the two projects alone, they are culturally given forms of action. Is there any space left for the management of a single project? It looks like the actors themselves are not so interested in holding the executive function. There were disputes over official status (between the construction management and the city architect's office in Case 1, and who was the users' representative in Case 2), but when the actors were asked about it, they very often underrated their own position. The executive function is very willingly given to an outside party (e.g. the consultant studying the structures in Case 1), or to a booklet or other cultural object (Perkins 1993). Humans have limited processing capacity, and it would be much easier if we did not have to worry about anything extra than our daily practice. The fact that no project plans were made in either of the projects show the minimal interest actors have in these matters.

However, if something is not done, it does not mean that it could not be done. The self-organized processes can be ordered through changing the rules (Resnick 1994). The system can always become aware of itself in the meta-level and discuss the rules and their consequences. In fact, there were many signs of this kind of discussion in both cases. In Case 1 (Hakala) they were more or less retrospective considerations of how things should be done next time, whereas in Case 2 (Kangas) the people from the facilities tried to consciously change the rules of action. Sometimes they succeeded (the model room during the design phase), sometimes they failed (the designer selection process). These discussions followed the same pattern of semiosis and they were constantly carried on. There was something deliberate going on in the world of thirdness. There were special tertiary artifacts (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 132; Wartofsky 1979) created for these purposes: the model room, the space definition cards, and so on.

There were also occasions when the executive function was taken into the hands of the actors themselves and action became centrally organized. The trimming process in Case 1 (Hakala) was very clearly run by the city architect himself. In Case 2 (Kangas) the project manager had to take charge of the relationships between the designers, contractors, and town experts when things were not going well on the building site.

If the two projects are compared, it appears that Case 2 was more clearly centrally organized (the project manager and head designer were the same person), whereas Case 1 was less centrally organized (the system of two project managers). However, in Case 2 the action itself was more self-organized and people were given more independent status than in Case 1. The better the atmosphere, the less control was needed. In this case the good atmosphere was partly created by clear organization and division of power. The leader could delegate power, because he trusted other people.

The level of control seemed to depend on the situation. The ideal state of the project would be a routine, self-organized state in general. If things go wrong, another approach is adopted and more centrally organized means of control are applied. The situation resembles a lot the one in an airplane cockpit. The pilot aims to fly by using the autopilot, and in a state of emergency he switches to manual. These situations are high risk situations, because a failure can be caused by one individual alone. Moreover, they consume lots of processing capacity, and create a cognitive load. That is why single-controlling-unit strategies are not preferred.

A shared goal is the most important prerequisite for self-organization. The project definition plan of Kangas project (Case 2) was well written, whereas the programming of the Hakala project (Case 1) was done in a very hasty manner. Kangas team spend a lot of time contemplating on the very prerequisites of the project before any designing was done. They had a clear vision of what the care of the elderly is like and what the renovated service center will look like. It seemed that there was no such mutual understanding of project goals in Case 1.

The goal is more important for the self-organized systems than it is for centrally organized systems. A dictatorship lacks a common goal, everybody is under the mercy of mere whims of a single individual. He may or he may not formulate his whims into some guiding sentences, but he has the right to change his mind whenever he feels like doing so. Nobody is committed to anything and that is why there is a constant demand for suppression and control systems. Otherwise nobody would do anything.

Any self-organized formations, like flock of birds, market economy or democratic organizations are highly depended on shared goals. For birds the goal is their destination, for market economy the goal is the prosperity of the community, for democracy the goal is the well-being of every member. Without the shared goal organizing process would not take place. By very definition, self-organizing processes are about organizing something. The word organization means a tool for achieving something. Self-organization means achieving a shared goal without a central controlling unit.

A project is a temporary organization created for achievement of a certain goal. Without the goal a project does not make sense. If the goal is clearly understood and accepted by all participants, everybody is committed to it and no strict control is necessary. If the goal is not so clear, the only way to keep the team together is to exercise some kind of discipline through control systems.

However, there is a difference between “control” and “communication”. Control means, that all action is forbidden without the permission of the central unit. Communication means that participants are knowledgeable about each others actions. Communication between participants is necessary in a changing situation, where negotiation is needed for the coordination of action. Sometimes the goal itself has to be refined or renegotiated. Project network is the most important means of communication. The goal has to be expressed in a very unambiguous manner, as a vision statement supported by shared values and strategies.

If we want to enhance the self-organizing capabilities of the actors and teams, we have to make sure that

- there is a common goal
- the goal is written as a vision statement supported by shared values and strategies
- the goal is clearly understood and everybody is committed to it
- there is a system of open communication
- there is a functioning project network

The most important task of the project manager is to make sure that all above is taken care of and happens. If there is no shared goal, she has to stop the project until an agreement has been reached. She is responsible for the openness of the communication and for the quality of the network action. She is responsible for the commitment of every single team member. Commitment can only be achieved through communication. If things go wrong and e.g. the project goal has to be redefined, a centralized control has to be applied but only on a temporary basis. Dictatorship exercised by a project manager is always a sign of weakness *and* of unclear goal.

Transactive memory and structural holes

The executive function is not the only problem which needs to be solved if we want the cognitive system to run smoothly. There are other forms of metacognitive functions needed as well. One of them is the transactive memory (Hakkarainen, Lonka & Lipponen 2004; Hakkarainen, Palonen, Paavola & Lehtinen 2004; Moreland, Argote & Krishnan 1996; Moreland 1999; Palonen 2003; Wenger 1983) of the project. For the team to be effective it is essential to know who knows what. A team has to be able to recruit the best forces for the tasks at hand. Transactive memory is not only needed for the knowledge of who knows what but also for the purpose of figuring out who does what and who *might learn* to know what. We are talking about the *zone of proximal development* (ZPD; Vygotsky 1978) here. ZPD refers to abilities not yet possessed by individuals but which can be activated in interaction between an individual and her environment. This is essential if the project team wants to exceed its capacity. A good example of this was the Case 1 (Hakala) team's action when mold was found. The art teacher acquired the knowledge needed and she was *encouraged* to do so.

Even an ordinary building project like Case 2 (Kangas) contains a huge amount of information. As was shown in section 3.4.1, there were 2400 files containing 1240 Mb of data. There is no way one person alone could handle such an amount of information. Some kind of cognitive delegation is needed. This is a challenge to the team's expertise and to the distribution of expertise inside the team. The idea of *shared (or homogeneously distributed) expertise* (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 82; Johnson, Heimann & O'Neill 2000) has to be rejected. Shared expertise would mean that every team member would share the same expertise and they could be replaced by each other like the members of a rowing team. The system has to be based on heterogeneously distributed expertise, otherwise all fields would not be covered.

This conclusion leads to the problems of proper cognitive organization. In Case 1 not much effort was put into considering these issues, but according to the interviews of Case 2, the team spent a lot of time thinking about this problem.

The design teams in the construction industry seem to be perfect examples of transactive memory functions. Everybody is representing a very narrow field of expertise and all the design teams have the same collection of expertise represented. There is a lot of knowledge about which profession knows what, and which profession has responsibility for doing certain tasks. There are very low profit margins, especially in design, and this means that nobody is willing to do extra work. This leads to situations where tasks are not performed because somebody else was supposed to do it. A good example were the mold and moisture problems in Case 1 (Hakala): the designers supposed that the builders would check matters and the builders considered such inquiries to be the responsibility of the designers. Many of the problematic links in the both projects had their origin in this very rigid and institutionalized structure of transactive memory.

Hakkarainen, Palonen, Paavola & Lehtinen (2004) warn about the same rigidity in relation to others´ expertise. People want to decrease their intellectual efforts and they trust the person considered the most experienced in the matter. Instead of having many brains working on a complex matter, there is only one, which may be subject to many biases, “starting from overestimating his own competency” (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 83). This may lead to accidents, of which the way the mold and moisture problems were handled in Case 1 (Hakala) was a good example.

Whenever this system is changed, it causes problems to actors who are used to the rigid, traditional way of organizing cognitive activity. If the head designer is a project manager at the same time, as he was in Case 2 (Kangas), many of the traditional role expectations are changed. The project manager was aware of that and hired an architect to assist him. This led to a situation where there were two brains instead of one, and both described the cooperation as being very fluent and mutually beneficial. However, there were bitter remarks from the assistant designer´s side, who saw one of the designers as having too much power. From their point-of-view the traditional triads were not working the way they should.

The architect of Case 2 was a good example of another metacognitive function. She worked as a knowledge broker between many sub-networks of the project. She was the messenger between the facilities and the assistant designers in the neighboring city, the mediator between the project manager and the users, and was sometimes even a mediator between the staff and the management. When people talked about her role, they talked more about her role as a knowledge broker or mediator than as a designer.

There are lots of similar examples: the physiotherapist in Case 2 (Kangas), the art teacher in Case 1 (Hakala). All these examples share one feature: the people in knowledge-broking roles were not representing any of the traditional roles in a design team[11]. It looks like a person in traditional role is bound to the role; it is very difficult to do anything which is in contradiction to the role or does not meet the role expectations. This was well demonstrated in the mold crisis in Case 1: the art teacher was the one who became the mold expert. The matter was openly

[11] In addition, they were all women!

discussed and accepted (not easily though!) by the other team members. This was one of the few cases when transactive memory system did not follow the traditional design team roles, and the reason for this is self-evident: there was no such role, because the mold problems were such a new issue.

Structural holes can be deliberately created as well. The design work in Case 1 was arranged so that the designers had to communicate through the city architect's office. Nobody seemed to be pleased with the arrangement, not even the experts in the city architect's office. The reason for this arrangement was the consequence of the power-plays between different departments. The end-result was most interesting: the experts of the city architect's office became involuntary knowledge-brokers. This led to many contradictionary ties, when the experts carried messages between the designers and the construction management and the messages were often misinterpreted or delayed.

Problematic ties

In the original taxonomy of ties by Palonen, Hakkarainen & Lehtinen (2003; section 2.3.5, Table 2.2) there were two kinds of ties: strong ones between team members and weak ones outside the team. Weak ties were more individual ones by nature. They were means of getting new information and ideas.

Two more links are added to that taxonomy: the *weak problematic link* and the *strong problematic* link. The definition of a problematic link is very simple: it is a link which does not fulfill its function or the expectations different parties have concerning it. This is often related to institutional role expectations (Berger & Luckmann 1966). People have very strong opinions about the way things should be (Bruner 1990), and the way different professionals should behave (Berger & Luckmann 1966), and if these expectations are not fulfilled, we spend a lots of energy in bringing back the balance.

There are plenty of examples. The assistant designers in both projects were supposed to make better designs. Mold and moisture problems should have been taken care of, but they were not. The users believed that they would be listened to. Often this phenomenon worked another way round as well: the construction management people knew that the assistant designers would not invest enough resources in their design work, and they tried to change the situation. When this did not happen, they felt that their expectations were proven right. What they did not see was that there was a possibility that their expectations would become a self-fulfilling prophecy: they unconsciously send a message that they did not trust the designers and the designers behaved accordingly.

However, the picture is much more colorful than that. The problematic links can serve important purposes. They are a means of negotiation and conveyors of necessary power plays. Through them, new interpretations are created. They are the dynamic engines which keep the system moving. There is a similarity to the role of weak links as described by Hakkarainen, Palonen, Paavola & Lehtinen (2004): weak links are important for the creation of new knowledge. Without them, the flow of new ideas would come to a halt.

5.2.3 Contradicting and ill-defined goals (RQ 3)

The goals of a building project are usually defined in two different documents. The one defining the project activities and resources needed is called a *project plan*. The other document describing the properties of the designed building is called a *project definition plan* or a client's brief. The definition of client's needs is one of the most fundamental risk management strategies of any project (section 2.1.3).

It is surprising that there were no project plans made in either of the projects. However, this is very typical of public sector building projects. The construction management is taken care of by the officials and they do not see their labor as a separate resource, they assume that they will get paid anyhow. There is no price for their work and no planning of resources is needed. A systemic archetype called "Tragedy of the Commons" (Senge 1994: 387) is an inevitable consequence of such thinking. In this archetype individuals (cattle owners) use a commonly available resource (shared pastures or "the Commons") to their own benefit without having to pay for it. In the end, the resource is entirely used up. This was the case in Case 1 (Hakala), where 80 project definition plans were made by one person within a year. (The cattle owners were the inner clients of the construction management department and "the Commons" were the construction management services.) This is also one reason why project plans are not made: there are no resources available.

It is rather surprising that there was no project plan in Case 2 (Kangas). After all, the project team and the project manager thought very carefully about matters related to project resources and project activities beforehand. For some reason, nothing was written on paper.

There was a project definition plan made in both projects. There was a big difference in their quality. The Case 2 project definition plan contained everything one would assume a project definition plan should contain. It was praised by the designers and the management of the service centre. One proof of its quality is the budget, which was not overrun.

In Case 1 (Hakala) everybody seemed to agree that the project definition plan was good for nothing. It was sketchy and made mainly for state subsidy application purposes, not in order to guide the action. This led to under-budgeting and many other ills later. The project definition plan was practically torn to pieces during the design trimming phase. There were parts of the project definition plan which were too precise. The drawings attached to it were on a detailed level and the most important design decisions were described in it. This is in contradiction with the general idea of a project definition plan or client's brief: it should describe the user's needs and frame the problems, not give answers or solutions to problems on a design level.

However, in Case 2 (Kangas) there were also problems with the use of the project definition plan as a guiding document. The project manager doubted whether the assistant designers ever read the book. The staff were asking for more than was written in the project definition plan. People were not committed to the plan, not even those who participated in its creation through a very thorough process with the aid of model rooms, space definition cards, and other assisting artifacts.

There were plenty of examples in both projects of conflicts or tensions caused by contradicting goals. In both projects there was a dispute over money and how resources should be allocated. In Case 2 these disputes focused on minor matters, in Case 1 they were a continuous source of fierce fighting, even on very fundamental issues. In Case 1 the overall extent of the renovation work was not decided before the construction work started. This led to conflicts between the client and the designers, the architect included, who had not reserved resources to carry out the larger work needed.

There were similar kinds of issues in Case 2 (Kangas) as well. Poor understanding of the project goals by the assistant designers led to design solutions which were not in accordance with the project goals. The contractors missed the point of the construction site model room, because they were not committed to or understood the meaning of the model room and the user participation as a whole. The mayor was not committed to the project definition plan, and his intervention took place too late.

There were also problems which were not related to the level of commitment. The dispute over colors showed a fundamental disagreement between the two professions involved. It was a question of work goals. The aim of care of the demented is to ease the pressure caused by dementia. The colors of the wall served as one means of treatment. The choice of colors was a decision related to the care of the elderly. From the architect's point-of-view it was an aesthetic decision. The aim of her profession is to create an aesthetic whole which fulfils the general criteria of good quality as defined by her profession. The solution to the disagreement was that these two goals were integrated. The architect offered a selection of colors approved by her criteria and the staff chose from them the ones that fulfilled their criteria. It would have helped if the two different goals were coordinated and brought into balance already in the project definition plan. But such matters are very seldom mentioned in the project definition plans.

There was a conflict between the two conceptual artifacts (see section 2.3.3). The two parties were able to solve the conflict in a process of semiosis, where the two conceptual artifacts were integrated and new material artifact – color – was created. Such semiosis should take place before the work and be written in a smart tool called project definition plan.

When we talk about organizations and goals, we are talking about very fundamental issues. Organizations are created for the achievement of certain goals (section 2.1.1). If there is a contradiction between different interpretations of project goals and thus no shared goal, a question can be raised as to whether we are talking about an organization at all. Projects are temporary organizations created for the achievement of very specific goals. The commitment to shared goal is fundamental to their very existence.

5.2.4 Quality management systems and experts: rule-based or knowledge-based activities?

To have an expert team is a necessary condition for project success. Another prerequisite for success are the quality systems applied. It could be assumed that a project with a good quality management system would be a successful one. As was stated earlier (section 2.1.5) the very essence of the expertise is the ability to apply automated, routine skills and procedures.

Why did the experts fail in many occasions? As was described in section 2.1.5 an important part of expertise was the ability to choose between rule-based activities and knowledge-based activities depending on the situation. An expert should be able to analyze the environment and decide whether automatic skills will do or is knowledge creation needed. Otherwise her performance will not match her competencies.

There were no standardized quality systems in either of the parent organizations nor there were any quality plans made in either of the projects. According to my own experience this was typical to public building projects in Finland in the 1990´s. The basic assumption was, that the bureaucratic procedures of the cities and of the state were enough and no extra systems were needed.

The construction industry in Finland is organized in a manner which supports the quality management processes. There are general conditions for building contracts (YSE 1998) which are almost exclusively used in all construction contracts. There are also general procurement and delivery terms for construction products (RYHT 2000). Public sector procurement methods are standardized due to the EU requirements.

There is a non-profit Building Information Foundation RTS (www.rakennustietosaatio.fi), which publishes RT (Building Information) Files including regulations, standards, contract documents and forms, the RYL Handbooks (General Specifications for Construction Work) as well as product files. RT Files have practically become the quality documents of Finnish construction industry. Certified ISO 9000 quality systems are very few in Finland, but 715 construction companies have became registered members of the Construction Quality Association (www.rala.fi).

There are very seldom any disputes or claims in construction industry due to the small size of the market. The construction industry in Finland is based on mutual trust between the clients and suppliers.

Even though there were no standardized systems, a lot of effort was invested in these issues in both projects. The processes were described in the project definition plans and dealt with in numerous meetings and their minutes. The process descriptions were important parts of both design and construction contracts. If one compares the two projects with the requirements of the ISO 9001:2000 standard, one can find many features typical to quality systems.

Table 5.1: Two projects compared by using ISO 9001:2000 standard

ISO 9001:2000	Case 1 (Hakala)	Case 2 (Kangas)
Section 4: General requirements	Construction management department had a document management software which was used for quality management purposes	There was no official system of software, but there were lots of different quality management documents created, i.e. for design audits.
Section 5: Management responsibility	The city technical sector had started to implement a quality management system. There was a quality manager nominated, quality policy was worked on, and all the key processes were described. The top management was committed to quality. There were no agreement on customers' role in processes.	There had been a quality management system project in the town technical sector in the 1990´s, but it was later abandoned. However, many quality procedures were adopted and the top management considered quality as an important issue. A lot of work had been done to identify, meet and enhance the customer satisfaction.
Section 6: Resource management	There was not enough quality resources. All the staff was highly competent and it had been trained for quality management. Both the physical work environment and the IT-systems were of high quality.	There was not enough quality resources. All the staff was highly competent and it had been trained for quality management. Both the physical work environment and the IT-systems were of high quality. Special methods were developed to support design processes.
Section 7: Product realization	The customer product requirements were poorly identified and communicated. There was a system for design input and output definition and review as well as management of design changes. Production process was well managed due to the national standardization of procurement procedures. There was continuous validation and improvement of processes and methods.	A lot of effort was invested in customer product refinement identification, review and communication. There was a system for design input and output definition and review as well as management of design changes. Production process was well managed due to the national standardization of procurement procedures. Lots of innovations and experiments in this field.
Section 8: Measurement, analysis and improvement	No remedial processes. Internal audits.	Remedial processes planned and implemented. Internal audits on regular basis.

The conclusion is that both projects had some kind of a quality management system covering most parts of the ISO 9001:2000 standard.

It looks like the quality management of Case 2 (Kangas) was better taken care of, but the difference is not big enough to solely explain the successes or failures of the two projects. It was not the matter of having a quality management system, it was more question about how they were used in both projects. There was nothing wrong with the procedures as such, even though they were not described according to a standardized system. It is very possible, that the failures could have happened independent of the methods used.

In the interviews the members of the Hakala (Case 1) project team talked about the process as something given, as something they could not control themselves. There were some experiments with procurement methods during the construction, though. Construction management was based on client project management. There was no general contractor, the client was in charge of the building site and there were lots of small contractors. However, the fact that the project process was divided into two and there was a different project manager for design and construction periods alienated the parties from the process. Nobody was in charge of the whole process.

The members of the Kangas team (Case 2) were talking about the process as a tool, as something they could and should improve. They experienced with different procurement methods and many intelligent tools were created to ease the customer participation. These experiments often failed but still there was an atmosphere of empowerment. Process participants could reflect on the process and on their own actions.

There is a difference between merely following quality management standards and total quality management (TQM; Oakland 1995). Quality management systems, like ISO 9000, are often criticized (Wikipedia “ISO 9000”), because they

- make processes more consistent but at the same time they make them harder to improve
- are not adaptable to fields requiring creativity
- are really documentation standards, not quality standards

The proponents of TQM want to proceed from the mere application of controls and systems to total commitment to quality by all participants. There are several intelligent tools created for the purpose of quality improvement (“The seven basic tools of quality” by Ishikawa, Oatley 1995:197). They are used as means of collecting, presenting, and analyzing data. Everybody should be able to evaluate the situations and plan for improvements. The management can make this happen by (Oakland 1995: 30):

- identifying customer-supplier relationships
- managing processes
- changing the culture
- improving the communication
- showing commitment

The Kangas team (Case 2) was customer-oriented (model rooms, high quality of project definition plan), tried to manage and improve processes (new procurement methods), struggled to change the culture (space definition cards, a designer as a chief designer) and by doing this all it showed commitment to quality. What made the quality management of Case 2 better than it was in Case 1 was not the quality management system as such, but the commitment to quality. Case 2 (Kangas) had total quality management approach and this made the project more successful.

Failures took place in both projects, because the experts relied on the routines and official procedures. In Case 1 (Hakala) the programming phase was not given enough time and the same took place in the first design phase of Case 2 (Kangas). These problems could have been avoided, if the experts had been more critical to routines and procedures and taken corrective measures in situations where it was obvious that things were not proceeding in an orderly fashion. This is the very essence of any quality system. The systems are not good for anything without continuous reflection and conscious betterment of procedures (The circle of improvement: Evaluate-Plan-Do-Check-Amend; Oatley 1995: 26). If the procedures are too precise or they are uncritically relied on, they may make people mentally lazy and open the back door for the disasters to take place. It looks like this was exactly what happened in the cases studied.

The fundamental cause behind both failures mentioned above was the changes in the environment. There were government processes in Case 1 (see section 4.1.3 subsection “There was not enough time for programming”) and the city budgeting system in Case 2 (see section 4.2.2 subsection “Phase 6: The design”).

The failures in both cases had positive consequences: they led to reflection and corrective actions. In both cases the problems were soon understood and the projects reorganized accordingly. In Case 1 (Hakala) the project was practically reprogrammed during the trimming process and in Case 2 (Kangas) the second design phase was given more time. The rule-based activities could not handle the problems, so the knowledge-based activities had to be executed instead.

The informants talked a lot about these periods of knowledge-based activities and hardly mentioned the periods of rule-based activities. The project manager of the Case 1 (Hakala) could not remember even taking part in the programming whereas he had much to say about the trimming period. During the programming everybody was working independently and relying on her/his own routine skills. During the later periods, when there were lots of problems to be solved, informants described joint efforts and shared processes. The periods of rule-based activities seemed to include lots of individual efforts, whereas the knowledge-based periods were dominated by the group work. The finding of mold and the knowledge creation needed to handle the problem was a typical example of such period. The trimming and the crisis at the building site produced more documents than the other periods, which was also a sign of shared knowledge creation.

There is a connection between the rule-based activities and standardized quality systems. They both make routines easier and thus relieve resources needed for higher order activities. They are necessary conditions for success, but will not guarantee success. The sufficient condition for success is the ability to adapt to the changes in the environment through learning. This is why knowledge-based activities are essential to success. The seven basic tools of quality are typical intelligent tools used in knowledge-based activities. Total quality management approach includes both rule-based activities and knowledge based activities. Properly used TQM is necessary and sufficient condition for success.

5.2.5 Success factors (RQ3)

Both projects are good examples of how the success *criteria* are related to success *factors*. If we apply the Project Implementation Profile (PIP) model by Pinto and Slevin (Pinto & Mantel 1990) to the two projects, we could draw the following conclusions:

Table 5.2: Two projects compared by using the PIP model by Pinto and Slevin (Pinto & Mantel 1990)

Factor	Case 1 (Hakala)	Case 2 (Kangas)
1. Project Mission	Was not clearly defined.	Was well defined
2. Top Management Support	Missing. Not enough resources given to the programming.	There was top management support and enough resources were given to the project. However, the support was not from the very highest level, because the town administration was not committed.
3. Project Schedule Plan	Was not made. There was not enough time for programming.	Was not made. However, the time used for programming was long enough.
4. Client Consultation	Worked out well, because the client's representative practically ran the project and organized the consultation of other users.	Worked out well. The participation was well organized and the division of labor between the client and the project management worked out well.
5. Personnel	There were contractual and other problems during the selection process and these problems had influence on all the future actions. Project management and design management were separated.	There were contractual and other problems during the selection process and these problems had influence on all the future actions. Project management and design management were not separated and this helped in solving the problems.
6. Technical Tasks	The methods used for the study of structures and the preparation of the cost estimate were improper.	Cost estimates were based on proper investigations of structures. The were problems with the quality of technical design, but the project management could handle these problems.
7. Client Acceptance	The actual end product differed a lot from the initial one. However, the client was so involved in the process that it is difficult to tell who sold what to whom.	The project deliverable exceeded expectations, due to well organized user participation.
8. Monitoring and feedback	There was no feedback or monitoring before the end of the project. There were many systemic problems.	There was a well organized monitoring and feedback system. The overall organization was deliberately designed to support monitoring and feedback.
9. Communi-cation	Many examples of failures in communication.	The problems with communications were mostly on the conceptual level, even though there were some technical problems.
10. Trouble-shooting	The size of the crisis exceeded the capacity to handle unexpected crises.	The project network was deliberately organized to detect and handle unexpected crises.

Many of the fundamental problems in Case 1 and the successes in Case 2 can be related to the dynamic action of the project network. In the PIP model network problems are seen purely as part of communication. By the time the PIP model was made, networks were not an issue. If we look at the ten success factors of the PIP model and compare them with my network analysis, we could say that factors 4, 7, 8, 9, and 10 can be directly related to network action. Factors 1, 2, 3, 5, and 6 could be indirectly related to network action: problems in these fields caused serious damage to the network action.

The PIP model is just one of the many other sets of project success factors (Belout & Gavreau 2004; Tan 1996). Later studies of success factors lay even more emphasis on communication than the PIP model (Clarke 1999). Network analysis is one way of arranging and looking at success factors. It cannot introduce any new success factors or solutions to the problems in projects, but it gives us a better picture of how different factors influence each other and how the system functions as a whole.

What is a successful public building project like? (RQ3)

After the analysis of Case 1 (Hakala) and Case 2 (Kangas) it is possible to describe a recipe for a successful public building project. In order to succeed, it must be made sure that the project network works well.

Table 5.3: Actions needed to make a project successful

Success factor	Action needed
1) A well defined project goal accepted by the top management	Make a good project definition plan and get it approved by the top management
2) Enough resources: time, money, personnel	Make a good project plan and get it approved by the top management. A good method of recruiting consultants is needed.
3) Client participation	User participation needs to be well planned and the user has to invest enough resources in the participation. Special methods and techniques need to be applied to ease the communication with the users. Everything has to be agreed on together with the users' representatives.
4) A well functioning network	An environment has to be created where the network dynamics work in a positive manner and where there is a good mixture of weak and strong links.
5) Metalevel monitoring is needed	Planning of planning and metalevel control of cognitive functions has to be applied. Feedback and monitoring systems need to be planned beforehand.

5.2.6 An individual as the unit of analysis

What is the role of an individual?

When we talk about individuals and their roles, we are dealing with the most fundamental question of distributed cognition. This is the demarcation line dividing the scholars of the field. What is a unit of analysis: is it an individual, the team, or the community they belong to? The organizations first studied were navigation, surgery, or aviation teams working as one functional unit. Concepts like “distributed mind” or “collective mind” were created (Hakkarainen. Palonen, Paavola & Lehtinen 2004: 65). Can the team of a construction project be seen as such a tight organization? What is the role of an individual? How do the actors themselves see the situation?

There is the metaphor of “society of societies of mind” (Hutchins 1997). A network can also be seen as a metaphor explaining the role of an individual and the larger organization. According to the latter, the connections of an individual node and the history of the connections are more important than the other qualities of an individual node. (section 2.3.5)

Individuals and distributed cognitive action

The only way to answer the question about the role of an individual actor is to choose an individual as a unit of analysis and see how many things can be explained that way. In the analysis made so far the sub-organizations are chosen as the units of analysis, but there is a plenty of material about the individuals as well. As a matter of fact, the informants talked more about other individuals than organizations in the interviews. This information was clustered into organizations for research ethic purposes.

The most important individuals were the project managers. In Case 2 (Kangas) the project manager’s role was crucial. He was the one who introduced new methods like the space definition cards, and the information corner. He wanted the project definition plan to be as thorough as possible and he invested a lot in the user participation. He understood well the meaning of the model room as a shared knowledge object (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 123). There was also something extraordinary in the way his tasks were organized: he was head designer and construction manager at the same time. An interesting question is, of course, whether these were his own ideas, or did he get them from somewhere else.

Space definition cards, in which users write down the activities they perform in certain space - instead of describing the detailed qualities of the spaces - are very seldom used in design. It is possible that they were genuinely developed by the project manager or that they were developed in the Varkaus Facilities Department. However, most interesting was the project manager’s description of why cards are needed:

"…I have tested them in some previous, smaller projects. The users wrote the kind of cards where they describe what the spaces should be like from their point-of-view and what kind of needs they should fulfill. Here and in general I see a problem concerning the project definition plan and programming of a project. The users mirror the needs based on existing premises and based on existing practices, which means that it is difficult to get information about the needs, information not related to present spaces. When the activity has been going on in the same spaces for ten years or more the action becomes so bound to existing spaces that it becomes impossible to objectively evaluate what the needs really are."

– the project manager (Kangas)

The project manager felt that he needed a conceptual artifact (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 123; Bereiter 2000a) which would guide the activity away from the world of real objects to the realm where alternative decisions could be made. The problem is very similar to the one of computer programming described by Hakkarainen et al. (2004: p. 126). Problems cannot be solved in Popper's World 1 (Popper 1972), one has to move to World 3 of conceptual artifacts and knowledge building.

As was said previously about project risks (section 2.1.3), the poor definition of project goal and poor definition of client's needs are the biggest risk factors. There has been constant propagation inside the building industry that one should concentrate more on project definition phase and listen to users more. Work place management is one of the fads today. Project definition cards are a very obvious solution to the problem. One should first listen to the users´ needs, formulate problems based on them, and the design should come after that.

A conclusion can be made that previous experiences and the discussion inside the community changed the thinking of the project manager, and this new structure influenced his actions. More than knowledge creator, we could call him a knowledge broker (Burt 1999; Moreland 1999). He was brokering organizational novelties in the form of the cards, but we could call this knowledge-oriented brokering as well (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 77). He was trying to conceptualize things.

However, he faced difficulties. Not everybody understood the meaning of conceptual artifacts or the existence of other worlds:

"We have internal problems in this matter. Sometimes when there have been more people from our department in the same meeting – I am talking about the programming phase - and I have suggested that we should take away these drawings representing the existing spaces and concentrate on thinking activities from activities point-of-view, a colleague has said that we cannot do so. We have to take the existing building into consideration. We have different views inside our organization as well."

– the project manager (Kangas)

His colleagues wanted to stick to World 1, which is typical of humans (Feltovich, Spiro & Coulson 1997; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 24). As we found earlier, there were the same kinds of problems with other actors in other areas, too. The info corner did not work out as was planned, the user participation was not organized as well as was planned, the model room idea was not understood during the construction phase, and so on. Even his role as a project manager and as an architect at the same time was a source of contradiction and tension. Other parties had difficulties in accepting the new activity system (Cole & Engeström 1993).

According to Salomon (1993b), there is no distribution without individuals' cognition. When the individual is part of distributed activity, this leaves a cognitive residue (Salomon 1993b: p.125), which affects his later actions. The new action of one individual has an effect on distributed action and they both change in interaction. Hutchin´s theory of societies of societies of mind (Hutchins 1997; section 2.3.3) has a similar kind of action - distributed action -structure.

There is a network approach to the same phenomena. Network nodes are not similar, they are affected by their previous network contacts. The longer a node has been in the network, the more and better connections it gathers. The importance of the node is based on its previous network connections. They make the node what it is. (Barabási 2002)

The project manager in Case 2 (Kangas) is one example of a node with lots of connections, the art teacher in Case 1 (Hakala) is another one. Her importance was partly due to the fact that she had been a member of the original design team and she knew the architect and other members of the original team. The architect in Case 2 had a good start because she had been working in the Facilities Department before and her office was in the same city as the offices of the other designers. There is an opposite example: the city architect's office in Case 1 had been collecting negative ties for a long time and this affected the way others approached it.

Of course, all these phenomena could be explained from the mentalistic or cognitivist point-of-view. The explanation would be that the art teacher of Case 1 (Hakala) and the project manager of Case 2 (Kangas) had contemplated these problems themselves and created solutions to them alone. Why others had not done so before could be explained by their personal qualities. However, there were factors which make such explanations difficult. The two did not see their roles as important ones. They just did things they had heard about from somewhere or which were obvious things to do in their situation. It would be very difficult to imagine that the project manager had invented the space definition cards alone or that the art teacher would have coordinated the action the way she did without the support of her community. After all, we are talking about conceptual artifacts produced for cooperation purposes.

The same applies to the difficulties the two faced when they tried to apply the methods invented. If it was all a matter of decisions made by individuals, excellent methods would have been applied immediately. The very difficulty of their application shows that they needed to be culturally accepted before they could be used. It took time before the sub-system could change the way the larger system functioned.

The ability to act as a knowledge broker seems to be of vital importance, as well as generic skills – the ability to cooperate, engage in social action, for example – are important if one wants to have plenty of network connections (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 32). There is another important talent: *humbleness*. There was a striking contradiction in the way certain central actors (the project manager, physiotherapist, and architect in Kangas, and the architect and art teacher in Hakala) talked about themselves and how others described their behavior. They undervalued their achievements, while others praised them. Humbleness is a sign of willingness and the ability to work as a part of a team and readiness to admit that one does not master all the knowledge needed (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 34). It is a prerequisite to learning. The actors who had problems with their network ties, e.g. some of the assistant designers in Case 2 (Kangas), showed very little humbleness. In both examples, the positive and the negative, this attribute can be seen as a direct consequence of the previous network action. The humble ones had learned that this attitude brings them the best results and fosters learning, whereas the not so humble actors (e.g. the designers in Case 2) had learned their behavior in instances when they have had to protect themselves against law-suites or other claims. The very strict competition - and low fees as a consequence of it - meant that they did not have resources for an alternative strategy of behaving so well that there would be no claims or disputes afterwards.

Individual competencies: experts or skilled non-experts?

The domain-specific skills of an architect or an engineer are, of course, essential. They are the prerequisite for joining the project team. The user representatives are experts of their own field and most knowledgeable about the project environment. The members of the both teams were well qualified for their tasks[12]. In the interviews some of the informants expressed doubts about the others' competence, but these remarks focused more on the insufficient time and resources invested in the project, not on the competencies as such[13]. However, it looks like the expertise was not a sufficient condition for success.

The social role as an expert very seldom helped any of the actors. The worst example was the architect in Case 2 (Kangas) and her "color war" with the staff. As socialized in the architect's profession (Berger & Luckmann 1966), she saw colors as a purely aesthetic and design quality matter, and failed to see the importance colors have in the treatment and care of the demented.

[12] However, there was a difference between two projects. Paradoxically, the members of the Case 1 team had university degrees and the Case 2 team members did not. Still the Case 2 could be seen as more successful.

[13] On the other hand, an expert should be able to plan her workload properly and not to promise something she is not able to deliver

The staff, on the other hand, associated her behavior with the well-known arrogant manners of architects.

This is a good example of how expertise is socially negotiated and cannot be explicitly defined. "Experts often form professional groups that defend their status and privilege to define the problem space and determine the validity of knowledge required for acceptable solutions in the domain" (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 20; see also Berger & Luckmann 1966). Experts make mistakes, they do not agree with each other and they challenge the legitimacy, validity, and credibility of each other's expertise (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 20).

The dispute about the ventilation and heating of the Case 2 (Kangas) kitchen is a typical case of a struggle over the legitimacy and validity of expertise. The client hired another consultant to check the calculations of the original designer. The designer saw this purely as the other consultant's attempt to put him out of the market. In Case 1 (Hakala) there was a situation where the provincial officer and the construction management criticized the city architect office for the poor quality of the project definition plan.

Functional fixation (section 2.1.5) explains why the assistant designers in Case 2 did not read the project definition plan or did not understand the need for user participation. This was against their previous experience and expectations. They had not invested any time or resources for such things, even though a lot of emphasis and effort were put into these matters from the client's side. The following quotes reveal this tension:

> *"What is extremely important in this facility and important in all non-normal/non-standard facilities from the mechanical design point-of-view is to understand what goes on in those spaces."*
>
> *– the project manager (Kangas)*
>
> *"What is the problem with these matters is that when the users are all the time allowed to express their wishes, they want everything possible and everything impossible so that all these expectations are in contradiction with each other."*
>
> *– the mechanical engineer (Kangas)*
>
> *"There should be two kinds of meetings: those between the architect and the users and those where only the architect and the assistant designers are present. The designers use the same language and it is unnecessary to have those users there anymore."*
>
> *– the structural engineer (Kangas)*

The remark of the structural engineer revealed that he would rather not see the users at all. It seemed obvious that the designers had not understood even the basics of user participation or communicative design processes. User participation is a new problem solving domain, and the designers have a feeling of uneasiness with it. They prefer sticking to their old routines. There were plenty of other examples in the material: the contractors had the same problem as the designers and did not understand the meaning of the site model room in Case 2 (Kangas), and the role of project definition plan was not understood in Case 1 (Hakala).

Human beings are *cognitive or methodological conservatives* (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 38; Harman 1986; Argyris 1992): we try to avoid problem solving and cognitive effort and rely on existing knowledge and skills as far as possible. Experts rely on their automated skills (see section 2.1.5). In the assistant designers' case there were economic limitations as well: the fees did not allow extra work needed for meetings, and user participation. This led to a situation, where the experts did not develop their skills according to the new needs of the trade. Their output competencies did not match their input competencies (Crawford 1997:25).

Bereiter and Scardamalia (1993; Hakkarainen, Palonen, Paavola & Lehtinen 2004: 37) talk about *crystallized* and *fluid* competence. The former present automated or partially automated skills and the latter refers to the process of deriving new knowledge and skills from the experts´ knowledge base. If this does not happen, an expert becomes a “routine” expert or an *experienced non-expert*.

If the tradition and practice of the building trade lead to a situation where the experts have no means or social support for the development of their expertise, can we talk about the building industry as a field of expertise anymore? It looks more like a domain of *skilled non-experts* (Hakkarainen, Palonen, Paavola & Lehtinen 2004).

Shared and divided mode of action

How did actors themselves see their position, was their thinking based on *weak* or *strong distributed cognition* (Hakkarainen, Lonka & Lipponen 2004)? Part of the actors approached the projects from the weak distributed cognition point-of-view. Their world was *socially constructed* (Berger & Luckmann 1966). In this world every individual is a representative of her parent *institution* and acts accordingly. People are good or bad in relation to their capacity to fulfill the role expectations attached to the institution they represent. People have *personalities* and they matter. If the personality is wrong and/or personal resources are not adequate, they are not capable of carrying out their tasks. If this happens, problems arise and they are to be blamed. This is the acquisition metaphor/lay-psychology approach to everyday intelligent phenomena.

The strong distributed cognition approach is completely different. People's personalities do not matter if they are willing to join intelligent cooperation and share their capacities with others. The distributed action is the most important. There is no feeling of guilt, because there is no individual to be blamed. Institutions are seen as man's creations and nothing more. What matters are the networks and the communities of practice, where knowledge is created and shared. The junior construction manager in Case 1 (Hakala) was more attached to the team than to his parent organization. He talked very enthusiastically about team work. His socialization was stronger to the project (Lave & Wenger 1991) than to professions or organizations.

"Divide et impera" – thus the Romans described their way of ruling their subordinates. The idea was to support nations in their fights against each other. Lay psychology leads to the same end-result. Big projects deal with such big financial sums that no person alone dares to take the responsibility. Different individuals, organizations, and professional institutions each carry only a share. Once their job is done, they move the responsibility to the next desk. Nobody has to carry the horrible responsibility of the whole. From the actors' point-of-view, this is centrally organized action because their limited perspective is centrally organized. From the general point-of-view, it is self-organized action because there is no way to organize the whole. What looks centrally organized from the inside is not centrally organized from the outside.

The lay-psychology way of approaching distributed action could be called a *divided model*. It can well be applied to routine, non-intelligent work. Amazingly, many human processes are routine and non-intelligent. One does not need an intelligent system or shared consciousness to produce hamburgers or open the door. However, if we are talking about intelligent or non-routine action, the divided model is not the way to go. It lacks a sensory system, it is difficult to know what is going on in the system as a whole, and there is no space for shared consciousness to study all the different directions of future actions. In Case 1 (Hakala) the divided model made it impossible to notice the mold and moisture problems.

Intelligent action needs a *shared model* to function. Intelligent action is typically self-organized. The idea of controlling it or limiting it somehow is self-contradictory and ridiculous. There is no way to control what people think, alone or together. The only way to somehow manage complicated systems is by means of intelligent, shared action. The more you try to control things, the less control you get.

Intelligent action can only be guided through means of values, shared vision, team learning, and other means of shared action (Senge 1994 gives good examples of how intelligent action can be guided). Machine organizations do not understand values or visions. "Divide et impera" was a method of suppression, not of creation.

Why is the divided model needed at all? The problem with the shared model is that it is very time and energy consuming. Strong ties need lots of effort from both parties. The divided model is needed just as weak ties are: they are excellent for routine work or knowledge. People in projects are usually members of several teams and they cannot afford to invest time and energy in all the projects all the time. This is why it is important to change the model if necessary

These two models or modes, the divided and the shared, can be found in both of the cases. In the beginning of the Case 1 (Hakala) project the divided model was applied, when the shared model would in fact have been needed. In the period before the crisis the divided model was applied, and it fitted the routine work well. The shared model was adopted as a result of the crisis. The problem was that the modes could not be employed in a flexible manner. In Case 2 (Kangas) the modes were used in a more flexible way and this led to better results.

5.2.7 Projects as environments of intelligent action

There seem to be many different environments and semi-formal organizations for intelligent action of distributed cognition. According to contingency theory (Morgan 1996: 44-50) the environment of an action is one of its most fundamental prerequisites. What is a project like as an environment for intelligent action?

Are projects communities of practice? There seem to be similarities: the structure of weak and strong ties, common interest, shared tools, and knowledge brokers can be related to both (Ruuska 2005). There are differences as well. Projects are limited in relation to the time and number of people involved, whereas communities of practice are open both ways. Projects are legitimized when communities of practice are uncanonical. Projects have some kind of an organization, whereas communities of practice are not hierarchically organized.

The latter point is interesting. Communities of practice are self-organized and thus not ravaged by the centralized mindset, whereas projects have a project manager and the general conception is that they are strictly ruled operations. However, we all know that modern projects operate on a wide field of specialties and the amount of information included is so huge and varied by content that it is impossible to control them with one central actor. In fact, projects could be described as self-organized entities as well.

If projects are communities of practice, are they aimed at maintaining practices or are they innovative knowledge communities aiming at progressive creation of new knowledge? Are there creation of shared knowledge objects?

Another interesting question is whether projects are networks and/or what is their relationship to networks. It should be taken for granted that there is some kind of network action around projects. All projects take place in a certain organisational background and are thus parts of a larger network. Projects form their own, temporary networks as well (Loosemore 1998 a-c; Mead 2001). However, by definition, projects are closed entities. There are people who work in the project on a full-time or part-time basis and there are people who are outside the project organization. Projects are part time, small-scale organizations. Of course, it is much better for the project, especially in its early stages, if members of the project team belong to the same networks.

If projects are networks, are they random networks or deliberately built intentional networks? Nardi, Whittaker & Schwarz (2000) did not address the issue, but even intentional networks have random characteristics. What we are interested in is to find out whether projects include deliberate work on network building and maintenance.

The following analysis is based on Table 2.3 in section 2.3.5. If we look at the definitions of different organizations, there is no doubt about the special characteristics of the two projects. The projects are not traditional organizations because of their limited life-span. They are not networks, because they have definite goals. They are not communities of practice, because the purpose is not to deepen knowledge in a special area. They are not innovative knowledge communities, because the focus is not on creation of new knowledge but the application of existing knowledge to the achievement of the project goals.

However, most members of both the projects belonged to parent organizations and their interests were partly those of their parent organizations. We could well talk about matrix organizations more than of pure project organizations. Projects are not permanent, but they are relatively long lasting. From start to finish the projects studied lasted from five to six years. There are many communities of practice (Brown & Duguid 1991; Wenger 1998) which do not last as long.

In order to achieve their goals, both projects needed larger networks to gather the intelligence needed. There were 185 different participants, 100 of which were institutions mentioned in the interviews of Case 1 (Hakala). The interaction with the people from the Ministry played a crucial role in Case 2 (Kangas). In order to win the battle against molds a large pool of collaborators had to be activated in Case 1.

It was not enough to gather information, it had to be processed together. In Case 1 there was clearly a small scale *temporary community of practice* working on mold issues. In Case 2 the issues related to dementia created many circles of innovation and learning aiming clearly at a deeper understanding of the world of the demented. The ultimate aim of these learning experiences was not to understand the world of demented people, but to create new means for helping them. The same applies to the user participation. There were lots of deliberate efforts to create better methods for user participation and many took part in them. Even special knowledge objects (model room, space definition cards, info corners) were created together for those purposes. So Case 2 could well be seen as an innovative knowledge community.

Both projects were officially nominated, deliberately designed, formal organizations run by a project manager. However, both projects lacked a project plan and thus the official organizational support from above. There was no decision made on their founding. The role of project managers and their authority varied. It looked like the leadership was taken over by different people on different occasions depending on the matter. We could well talk about semi-formal organizations.

In terms of the ties there was a constant process of reordering and change going on all the time. New actors came in and all the old ties were rearranged. Sometimes all the ties were weak, a good example was the contractor selection phases in both projects. Sometimes all the links are strong and contradictionary, as in the crisis in Case 1 (Hakala) or in the beginning of the construction work in Case 2 (Kangas). In the very end they became strong in both projects.

Sometimes the work is done by the core team alone, like during the programming in both projects, at other times a huge number of people was needed. The most surprising result of this research was the ever changing picture it gave of the project network dynamism.

Where did this dynamism came from? One explanation could be the changing project environments. According to the principle of *requisite variety*, “the internal diversity of any self-regulating system must match the variety and complexity of its environment if it is to deal with the challenges posed by that environment” (Morgan 1996: 112; see sections 2.1.3 and 2.1.4). Is the environment of the two projects a stable *first order* environment or *second order* environment (Hakkarainen, Palonen, Paavola & Lehtinen 2004: 47; Bereiter & Scardamalia 1993), where the requirements are constantly changing?

In both projects there were very stable phases, like the programming phase in Case 2 (Kangas) or preparation for the building site in both projects. There were very turbulent phases as well, during the construction work in both projects, or when greater changes were needed in the plans in Case 1 (Hakala). However, it is very difficult to see any correlation between the turbulence of the environment and the changes in the form of intelligent action. The programming phase in Case 2 (Kangas) was a stable one and still there was knowledge creation going on around user participation. The temporary community of practice in Case 1 arose in the middle of the crisis.

The network ties seemed to rearrange themselves according to changes in the environment. Routine periods were characterized by weak ties, sometimes the projects declined to the level of an open, unintentional network, sometimes they were very strongly organized around the core, typically in a crisis situation. The same seemed to apply to the level of authority, it varied according to the situation.

Are these changes deliberately planned and controlled? Typical of intentional networks is the way they are consciously built and maintained. In the interviews many of the informants spent a lot of time contemplating these matters. The project manager in Case 2 (Kangas) was very worried about the flow of information and everybody’s role in it. The architect in Case 2 was interested in organizing her work so that she could handle the cognitive pressure created by many projects:

> *“I have got the drawings easily, I get them well from (the project manager), I just send him a mail that I need a certain plan. We agreed in the beginning that I will not make any changes to the plans. Every time there was a change, they updated it and I just used it as a background image, so I did not make any changes. And then I have sent my designs back to (the project manager). We have not printed anything on paper or sent through mail. And then electrical and mechanical, mechanical sent good paper copies, I have then asked that they send certain pictures via e-mail, like I need that and that picture for the ceiling drawing. …I have had plenty of other things to do, there have not been any idle moments. When I have got those other pictures I have tried to circulate them as soon*

> *as possible. There was a moment, though, when I had the feeling that I could not keep to the schedule, and some of my pictures were late as well. I have gathered too many jobs to myself!"*
>
> *– the architect (Kangas)*

There were similar kinds of contemplation on the ways of organizing the network connections as effectively as possible. It was decided inside the service centre that all the information to the project manager would go through the physiotherapist, otherwise contradictionary messages would block the project manager's information channels. The same accuracy was used in planning the participation inside the centre. There was a meeting system of nominated contact people in each department.

There is an opposite example. The mechanical engineer in Case 2 was frustrated by the amount of e-mails he got. He had the feeling that all his time was consumed by the correspondence via e-mail, and there was no time to do the actual design work. He tried to minimize all his network activities. He was a member of an *un*intentional network. This avoidance of contacts led also to a negative attitude towards user participation matters. They were also consuming his precious time.

It could be argued that there was a deliberate building and maintenance of the network system in Case 2. This is not an intentional network (Nardi, Whittaker & Schwarz 2000), but still it has some intentional characteristics.

With respect to the question about the projects as an environment of intelligent action, there is an unanticipated answer. Projects are communities of practice, innovative knowledge communities, intentional and other networks or traditional organizations, but not at the same time. Their character varies depending on the situation and changes in the project environment. The system of human intelligence is created for the purpose of adaptation. This quality of ours has brought us all the way from the deserts of Africa to the Arctic Circle. Today it will take us through the fearsome world of projects.

5.2.8 Two building projects as distributed cognitive actions

The central research question was whether project success factors could be understood and described better by studying projects as distributed cognitive actions. What we have found out so far is the following:

1) The creation of artifacts is strongly related to the project success. The better quality of conceptual artifacts made Case 2 (Kangas) a better project. One should look for the problems first and then look for solutions, not vice versa. Processing at the level of theories is a necessary condition for project success.

2) The network action can be seen from two different perspectives: psychological and sociological. Which to choose depends on situation. The cognitive processes and

sociological power-plays are intertwined. The power plays of triads and dyads have an important role in the cognitive system. The contradictionary relationships are important, because they keep the cycle of interpretations or semiosis moving. Process can be centrally organized or self-organized, depending on the situation and the task. Other metacognitive functions are transactive memory and knowledge brokering.

3) The goals of the projects studied were ill-defined. This had many negative consequences. The Case 2 (Kangas) goals were better defined, and the project had fewer problems.

4) There was an action-distributed action -structure, similar to the society of societies of mind -metaphor. The action evolved through interaction between the individuals' actions and the distributed action. The interaction with the distributed action left cognitive residues to the individuals, which affected their later actions. Human beings try to minimize the cognitive load due to their limited processing capacities and that is why humans are cognitive conservatives. There were two modes of action, shared and divided action.

5) Projects are constantly changing environments of intelligent action. They can be communities of practice, innovative knowledge communities, intentional or other networks, project organizations, all depending on the situation. The driving force for change is the project environment. The intelligent environment of the project adapts to the larger environment.

These two projects can be interpreted and described as distributed cognitive actions. There were similarities in spite of their different characteristics. Both projects seemed to be mainly self-organized, complex activity systems. The driving force was the adaptation to the project environment. The cognitive systems reacted in many ways, depending on the nature of the change in the project environment. The projects could change the control system from a self-organized to centralized system, they could rearrange internally, they could change the form of intelligent action from hierarchical to network-like action. There were metacognitive functions, but they were not controlled by any individual directly. The metacognitive functions reacted to the changes in the environment or then they were affected by the internal dynamics of the project.

Even though the metacognitive functions were not directly controlled by any individual, they were influenced by the project team. In Case 2 (Kangas) there was more emphasis on goal definition, on creation of secondary and tertiary artifacts, better organization of network activities and more refined methods of quality management. This was not the work of a single individual, even though the project manager was very interested and active in these matters. It was more a question of better organizational culture.

In fact, it is amazing how little central control there was in either of the projects. There were project managers, at whom others were aiming when the question of leadership was raised, but the project managers themselves saw their role as not so important. They felt that everything was run by the culture of the building industry or the town organization. All efforts to change things were in vain, either due to the strength of the culture or limited resources. It is questionable whether this is typical of public sector projects only. One could assume that there are the same problems in private projects as well, but probably not to the same extent. This is a question, the answer to which is beyond the scope of this research and a matter for future research.

5.3 Managerial implications

As a result of this research we have a framework for making the cognitive system of projects work better. It is the organizational culture which matters. The success factors described in section 2.1.2 can all be related to organizational culture. It is a question of the overall culture of the organizational environment of the project – the parent organizations - and the culture of a single project at the same time. There is the interesting question of the culture of the construction industry or public sector in Finland, but I will leave this issue out of my study for further consideration. The findings of this study would suggest that the Project Implementation Profile (PIP) model by Pinto and Slevin (Pinto & Mantel 1990) and the five elements derived from them in section 5.2.5 include the most important factors affecting the distributed cognitive system of a project.

5.3.1 Cultural change and the new process for public building

To change an organizational culture is not an easy thing to do (Kotter 1996, Schein 1985). I see two important prerequisites for such an effort to succeed:

1) We have to understand the nature of the culture and the distributed cognitive action behind it.
2) We have to know which parts of the culture and the distributed cognitive action are the easiest to change and would give the best leverage.

I presume that the most important contribution of this research is to an give answer to the two key challenges described above in the case of public sector building projects. In Table 5.4 the five success factors are analyzed in the light of this research and the changes in culture needed to make projects successful are described.

The change in activities is essential, but it has to be accompanied by new structures. In the case of a project it means a new process of design and construction. A new public building process is sketched in fig. 5.3 and explained in detail in Table 5.5. This is just a proposal based on the findings of this research. To be developed to a full extent it would demand an action research project, which would be the most beneficial to all parties concerned.

The new process for public building projects described in Table 5.5 and in fig. 5.3 focuses on the conceptual phase of the project. The evidence of this research showed, that the early stages of the project are the most important. There are lots of methods for enhancement of the later stages of the project - design, construction, and delivery – because the training of the technical and design professionals concentrates on technical issues. The later stages do not differ that much from the general construction process and that is why there is lots of practical tools and research findings available. What makes public building projects different are the early stages of the project. The two cases studied in this thesis showed that a lot should be done for the enhancement of the public building process.

Table 5.4: Success factors and cultural change

Success factor	Considerations
1) A well defined project goal	Before writing the project definition plan a process of semiosis has to take place. Several cycles of creation of primary, secondary and tertiary artifacts are needed. Different conceptual artifacts have to be brought into conflict with each other and negotiation about their value and meaning has to take place before a definitive plan is written. All stakeholders including clients/users have to take part in this process and enough resources – time, people, and money – have to be invested in it.
2) Agreement on action written in the form of a project plan	What is said above about the project definition plan applies to the project plan as well. Before the project is started, there have to be answers to how-questions. The project plan should also describe the environment of the intelligent action in different phases of the process. Metacognitive functions (network structure, executive function, transactive memory etc.) should be considered carefully before the project starts.
3) Knowledge creation together with the user.	It has to be understood that the users are the most important stakeholders of any public project. They have to be part of every cycle of artifact creation or semiosis. The focus of the design process has to be in the distributed cognitive action of the user, not in the building *per se*. Material, smart artifacts (e.g. model rooms or space cards, ICT-systems) and other representations have to be created to ease the process of semiosis.
4) A well functioning network	There has to be a thorough understanding of how meanings are negotiated in the project network. There have to be fluent information channels and weak links, there have to be strong links as well as problematic links for the negotiation to take place. Power plays should not be avoided, they should be managed instead. The management and the technical instruments have to understand this kind of action.
5) Metalevel monitoring is needed	The whole project team, not only the project manager, has to be aware of the metacognitive functions. There has to be understanding about the distribution of expertise and the roles of the knowledge brokers. The team has to be able to change the environment of the intelligent action if necessary, e.g. to consciously create a network of formal and informal expertise.

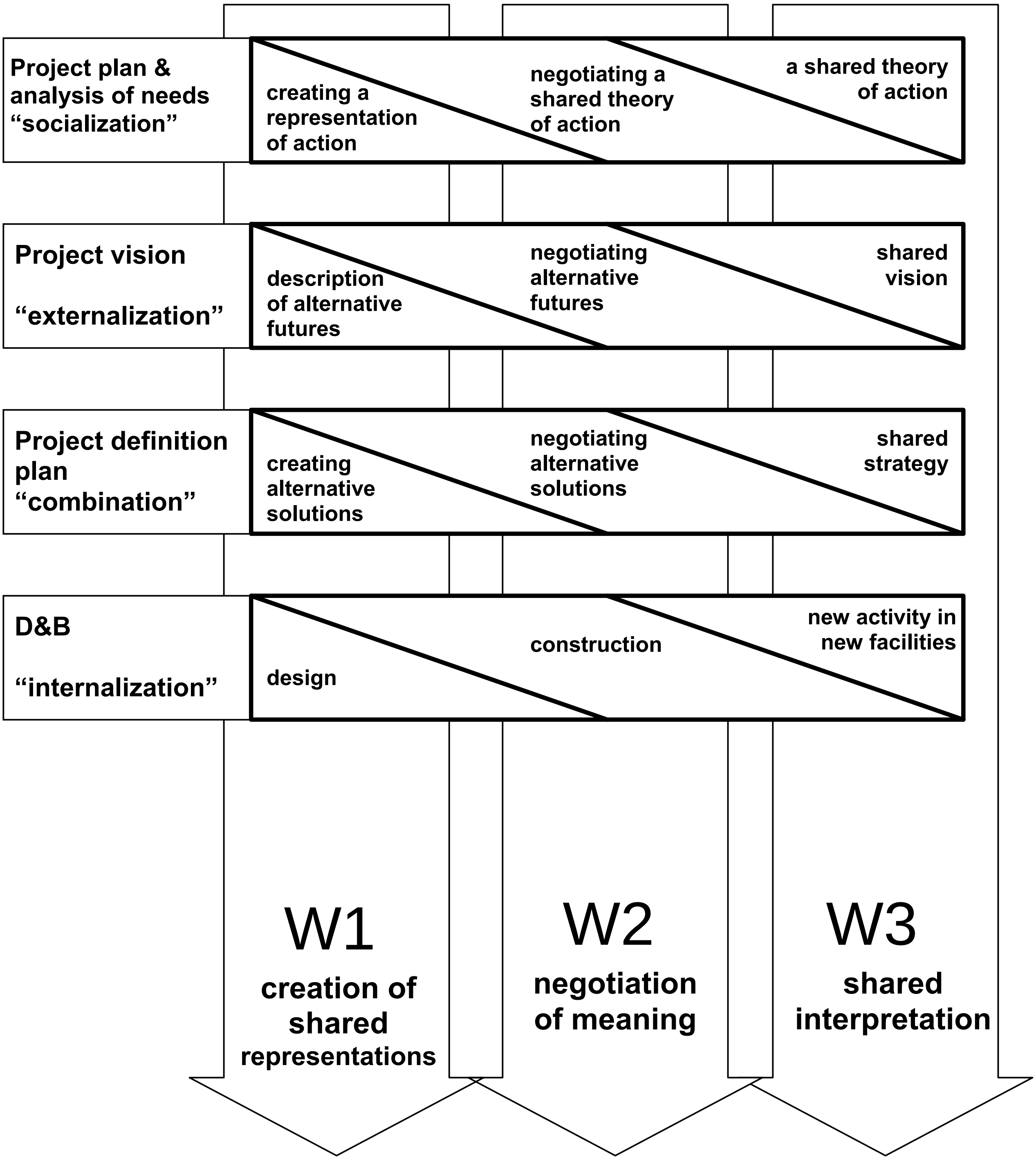


Figure 5.3 The new process for public building projects

Table 5.5. The new process for public building projects

creation of shared representations	**negotiation of meaning**	**shared interpretation**
Creating a representation of action There are several activity systems in a public building: the facilities', the users', the users' clients', and so on. They all have to be analyzed and represented in a form which is understandable for everybody	**Negotiating a shared theory of action** The representations of action include different theories and conceptual artifacts which are in contradiction with each other. The contradictions and conflicts have to be analyzed and interpreted in a shared process (semiosis). A creation of shared language and concepts is essential.	**A shared theory of action** When the process of interpretations has reached its end, its results can be described in written form. Those concerning the users' activity will be collected in *the analysis of the needs*, those concerning project activities will be collected in *the project plan*.
Description of alternative futures Based on the shared theory of action, alternative future actions have to be planned in an abductive process of hypotheses building. In the case of renovation the existing building has to be studied and alternative futures for it be described as well.	**Negotiating alternative futures** Different hypotheses have to be tested in a shared process, where their consequences are negotiated and interpreted. In case of a renovation the hypotheses have to be tested together with the alternative futures of the building.	**Shared vision** When the process of interpretations has reached its end, its results can be described in a shared *vision statement*.
Creating alternative solutions All possible ways to produce the chosen future are described. Limiting conditions (time, money, existing building, lot etc.) are studied and described.	**Negotiating alternative solutions** Different strategies have to be tested in a shared process, where their consequences are negotiated and interpreted.	**Shared strategy** When the process of interpretations has reached its end, its results can be described in *the project definition plan*.
Design All possible design strategies are studied and described. Design strategy which produces a future of the highest quality is chosen.	**Construction** A design strategy is implemented in the construction of a building. All actions are checked by using a vision statement and project definition plan.	**New activity in new facilities** A finished building is accepted for use. Users´ actions in a new building are compared to the vision statement and deviations are studied. Feedback is collected from the users and this is utilized in future use.

The culture of the public building projects has to be changed. Municipalities own 15 billion worth of facilities. They invest 1 billion every year in construction and renovation of facilities. Public building projects affect the lives of hundreds of thousands of civil servants and their customers over decades.

Tax-payers money should never be wasted in careless undertakings. The quality of public investments is not a local issue, it is an issue of highest national concern. One generation of actors should not be allowed to destroy the future of the coming generations. However, we cannot and we should not go back to the centralized control systems abandoned a decade ago. In Chapter 4.1.3 (“There was not enough time for programming”) there is a description of what happened when direct state control was applied on a project programming. Project work has a self-organized character and the empowerment should be supported by any means.

To prevent public project failures and to support the quality of public building project work I make following proposals for new national legislation:

Licensed project managers

There should always be one project manager through the whole project, and she should be nominated before any project planning work has started. She should be accompanied by the user representative also nominated in the very beginning of the project. These two should be given enough time and resources. They should have right to stop the project if the project goals are not defined well enough. Both of them should have training and qualifications in project management. The project team members should have training and/or they should have qualifications in project work. The project manager should be personally responsible for the project success and if the failure is imminent, she should lose her license.

The research shows, that project management of Hakala project (Case 1) was divided between two departments and caused many information breaks. The project management in Case 2 (Kangas) was more centralized and this arrangement was one factor behind the project success.

Participation as a civil right

Citizens and public employees should have right to participate in the project processes the way they have a right to participate in the town planning processes. The employee participation should be well organized and everybody who is working in the renovated or new institution should be given preliminary training in project work and in special project issues.

Client participation was an important success factor in the projects studied and it should be encouraged.

Quality systems should be compulsory

Project definition plan and project plan (including project quality plan) should be compulsory. If the size of the project exceeds a certain limit, there should be an audited quality system applied and a panel of independent experts nominated. The project should not be allowed to proceed from one stage to another unless the expert panel has approved the quality of the project work so far. Quality systems for public building processes should be developed based on Table 5.5 and fig. 5.3.

National training and research center

A new national research and training center for public project management should be founded. The research and training center would be responsible for the training of the project managers and the development of the public project processes and quality systems. It would be the licensing authority and responsible for the register of qualified professionals.

New actors needed

Finnish municipalities are small and they have limited resources. There is a market for private consultancy in the field of public project management. Another alternative are the joined project offices of several municipalities. I am sure that the proposals made above make it much easier for the new actors to enter the market.

5.3.2 The role of the project manager

The role of project managers in public building projects should be reconsidered. I will make a proposal, which may sound paradoxical. I suggest that the position of project managers should be made stronger, but at the same time they should apply less direct control in matters. They should be educated to understand the meaning of distributed cognitive action and self-organized processes. I do not mean that every project manager should become a Zen Buddhist (Watts 1957), but those who overemphasize only the interests of narrow professions, easily blaming other people for failures, or who believe in a very authoritarian model of management, should either be kept outside projects or should be trained.

Project managers should understand the way knowledge is created in networks of formal and informal expertise and they should be able to foster them if necessary. They should constantly analyze each phase of the project: is this a routine phase or is a higher level of activity needed? The latter is most important at the very beginning of the project. Too often we just start doing projects without really concentrating on the problems first. This is typical of novices. Experts spend a lot of time contemplating the problem and once they find the problem, the solutions are there (Hakkarainen, Palonen, Paavola & Lehtinen 2004). That is why they are called experts: they have solutions to problems. Routine periods are those when solutions are applied.

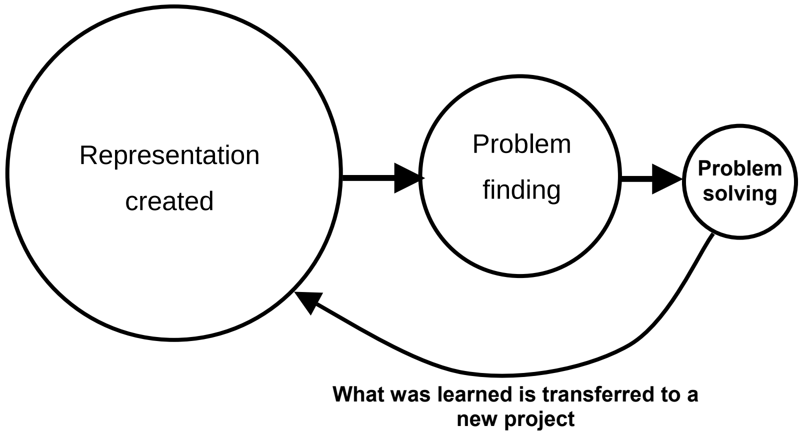


Figure 5.4 A “good” project. The size of the circle symbolizes the time and effort spent.

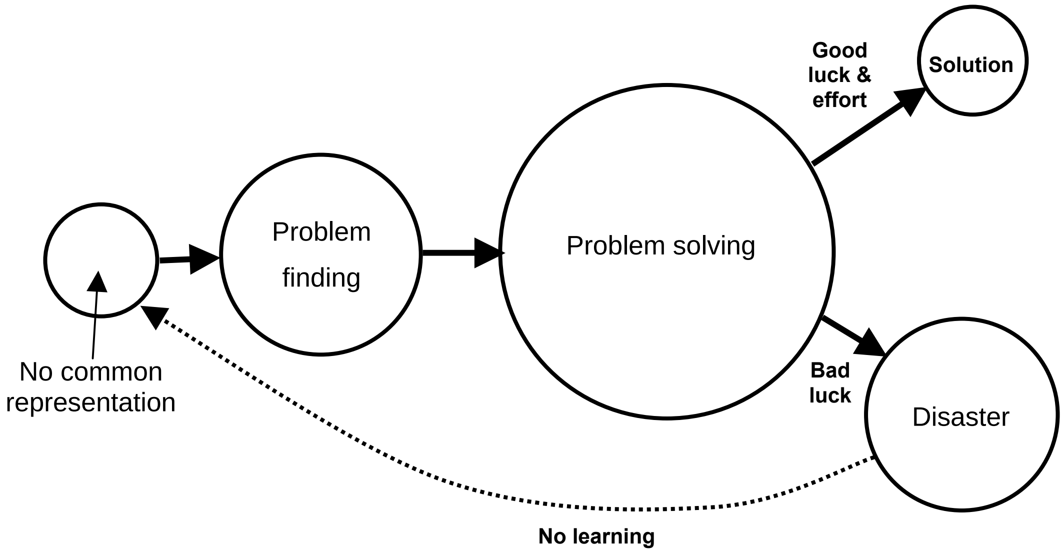


Figure 5.5 A “poor” project. The size of the circle symbolizes the time and effort spent.

A project manager should by any means support self-organized processes. If she shows too strong a centralized mindset, she easily destroys the project cooperation. It is a disease which spreads easily and makes people mentally lazy. Why bother when somebody else is responsible for everything? A project manager should activate others instead of telling them what to do and support self-directed learning.

A team should be able to discuss about matters on a metacognitive level. This includes discussion about the executive function (who should take care of coordination and how decisions are made in each phase of action), about transactive memory (who knows what and who is good at something), about network structure (are there any structural holes, does the network action rely too much on either weak links or strong links, which are problematic links, and so on) and about many other things above the level of everyday activities. To foster these discussions and make sure they take place if necessary is the key responsibility of the project manager.

A project manager should know the basic rules of network dynamism. She should create a good mix of links inside and outside the team. A team needs a “hub”, a person or two with many contacts, but as well it needs persons who only concentrate on work and do not need more than a few strong links. A project manager should pay attention to the dynamic action of links inside the team. Not all links should be strong or non-problematic. There should be room for criticism and small talk. Otherwise there is a danger of group think or confirmation bias. It is not possible to avoid missing links, in routine phases they are useful, but structural holes in vital areas of knowledge should be avoided by any means. This problem is best taken care of by means of weak links.

It is not enough that the project manager knows who knows what, she must be sure that everybody else knows that as well. And most important of all, if something is missing from the cognitive arsenal of the team, the project manager has to create it. It does not mean that the project manager herself should be or should become a jack of all trades. However, she must be able to make other people acquire those skills, to reach their zone of proximal development. A good project manager is a good teacher: she does not teach, but makes people learn and love learning.

It is not a question of hiring a team of 130% capacity compared to other teams. It is a question of making *our* team exceed its capacity by 30%. And more.

5.4 Evaluation of the research

In this section the methodological issues are analyzed and the research process evaluated.

5.4.1 Qualitative inquiry

The research was a comparative case study of two cases. The evidence was qualitative, but quantitative kind of methods were also used in analysis.

The problem of *validity* is different in qualitative inquiry compared to quantitative inquiry. In fact, authors like Creswell (1998) would like to use word “*verification*” instead of “validation” in qualitative inquiry. The term validity is deeply rooted in quantitative research, and it is questionable whether it can be applied to qualitative studies. A qualitative approach is not parallel to a quantitative one, it is “a legitimate mode of inquiry in its own right” (Creswell 1998: 201).

The aim of qualitative research is to *understand*, not to prove something. The credibility of a study is important, and that is why terms like *trustworthiness* and *authenticity* should be applied (Creswell 1998: 201). To establish trustworthiness, one should replace words in the manner described in Table 5.6.

Table 5.6: Comparison of quantitative and qualitative terms for trustworthiness or validity

Quantitative term	**Qualitative counterpart**	**A way to operationalize the qualitative term**
Internal validity	Credibility	Prolonged engagement in the field, triangulation of data methods, and investigators
External validity	Transferability	Thick description makes sure that the results are transferable between the researcher and those being studied
Reliability	Dependability	Auditing of the research process
Objectivity	Confirmability	Auditing of the research process

(Creswell 1998: 197-198)

Creswell (1998: 193-194) sees verification as a *process* going on through the data collection, analysis, and report writing. According to him, it is difficult to tell where the discussion about verification ends and that of *standards* begins. Standards are criteria imposed after the study is completed.

The method used in this thesis fulfills these criteria. The systematic arrangement of the material into phases, its careful analysis tie by tie, phase by phase was a way to create standards and to verify the conclusions. The credibility of the study was based on extensive interview material, large collection of document material, and triangulation.

The mode of inquiry chosen for this thesis, *abductive reasoning*, fits very well with the special frame of qualitative studies. Like a detective, the qualitative researcher compiles pieces of evidence to formulate a compelling whole. The confluence of evidence breeds credibility and leads to a feeling of confidence about the observations, interpretations, and conclusions (Creswell 1998: 198). The network system analysis created in this thesis added to the feeling of confidence. The whole is more important than the details. Even if some of the ties we ill-defined, that does not change the whole picture.

Creswell (1998: 201-203) describes eight verification procedures and in the following their application to this study are analyzed.

Prolonged engagement and persistent observation in the field

I had been working in both organizations before and after the research. I knew the culture well and people trusted me. There were 56 interviews of 36 informants and several group meetings. A lot of time was spend on the two building sites and there were numerous informal discussions. Improvements to existing methods were tested and there were some features of action study. However, this is not an action research, because the improvements were not made as a part of the research.

I can be accused of studying my own backyard, but on the other hand a deep involvement was a consequence of that. After all, by the time of analysis I had not been part of the working communities for several years.

Triangulation

There was corroborating evidence from different sources. There was *data triangulation*: the analysis was based on both interviews and on documents. There was triangulation among different *evaluators* due to the PROLAB research project, and there was *methodological triangulation* when different methods were used on the same phenomenon (network analysis and document analysis). However, there was no *theory triangulation*, because different theories were not used on *same* data set (Yin 1994).

Peer review or briefing

There were several “devil´s advocates”. This is a doctoral thesis and the supervisor and instructor all the time critically looked at the material and the analysis. There were several meetings of a research group (PROLAB) where results and methods were discussed and analyzed. However, there are no written accounts of these peer debriefing sessions.

Negative case analysis

There were several initial theories, and many working hypotheses were rejected. The unit of analysis was initially an individual, but this led to the problem of too many links. Finally, the organizations were chosen. Only the weak links and the strong links were counted in the beginning. First the contradictory links were introduced, but the analysis did not work before the contradictory links were divided into weak and strong ones. There was the theory that the successful project produces more material in the early phases, but this was proven wrong. The whole analytical framework was a true heir of the analysis process.

Clarifying researcher bias

In sections 3.3.1 and 3.3.2 I have explained my own involvement in both cases and its impact on research is analyzed. It is more difficult to analyze other, theoretical or methodical prejudices or biases. The point of departure of this thesis is distributed cognition. The basic assumption has been that intellectual activity is distributed. There is a danger of “decentralized bias”, i.e. the centralized phenomena or individuals´ impact on activity is overlooked in analysis and data collection. However, this is one of the main contributions of this study: what do phenomena look like if we abandon the centralized and individual perspective. The risk of going too far in that direction had to be taken. There is a lot of contemplation on the matter and the reader can draw her own conclusions.

Member checks

In section 3.4.2 the review meetings with the informants are described. All the links and the whole history was described to the participants and they confirmed the findings. There was hardly any criticism of the analysis, conclusions, or interpretations. This can be seen as a weakness as well: did the participants concentrate on the matter deeply enough? The research subject was seen as an important one and it dealt with a process everybody had been involved in for several years. It is hard to believe that the informants would not have taken the results seriously or underrated their importance.

Rich, thick description

This can be seen as the strongest part of this study. The descriptions of the two building projects are thorough, detailed, and go through all the phases. The two descriptions make it easy to believe that the findings could be transferred to other settings. A third case would most probably look very much like the two presented. Is this a weakness? Has the network method dominated the description to the degree where all the other features disappear? This can hardly be seen as a major problem. In the beginning of each phase description there is a short history based on documents and interviews. There is a thorough analysis of the document material and in the “lessons learned” (sections 4.1.3 and 4.2.3) more traditional methods of qualitative analysis are used. There is always a trade-off between the depth and the extent of description. One of the main contributions of this study is the network method and it has to be given enough space in the description of the cases.

External audits

There have been audits by fellow researchers and outside experts all through the writing process. The findings have already been presented in several seminars and articles and there has been plenty of critical advice and remarks.

5.4.2 Case studies

This is a comparative case study of two cases. Most of the analysis is qualitative, but some has quantitative characteristics. Verification of qualitative research is not enough, validity is an issue as well. For case studies Yin (1994) suggests four commonly used tests: those of construct validity, internal validity, external validity, and reliability.

Construct validity

Case 1 (Hakala) documents were not available as computer files whereas in Case 2 there was an access to digital material. A problem of comparison arises, because the two materials are asymmetrical. However, the problem was eased by the analysis of the material as was described in the end of the section 3.4.1 (Comparison of Cases 1 and 2).

The analysis of the network links was reliable, but laborious. Of course, a relationship between two people depends on interpretation and the two have the final word when the quality of the tie is defined. However, the quality of relationships between organizations is more easily justified from the material. There are always several points-of-view inside organizations and outside them. Very few of the links were weighted against one comment only.

The distribution of the links into four categories (or five, if a missing link is included) is a very rough way to describe the quality of links. However, four is more than the two used in previous studies. Scoring of the links (e.g. from scale of 1 to 5 or 10) would have been an alternative. This would have raised the question of validity. The division into four categories was difficult enough. The material (retrospective interviews) did not give enough basis for more precise analysis. It would have been a very demanding task for the informants to confirm such scaling.

To distribute the links into four classes is a way to quantify them. It can well be asked whether the method used is qualitative analysis or not. It is typical of qualitative analysis that some kind of quantitative representations are used, tables or other (Creswell 1998). The method can still be called a qualitative one.

What is a problematic link is a question not answered well. This study is only an observation or an attempt to suggest that such links exist. The links need to be operationalized better in further studies. The concept is interesting and it describes real life phenomena well.

The biggest problem with the method was that the idea of the dynamic network arose after the material of Case 1 was collected. The informants should have been asked more directly about their relationships with the others in the interviews. However, in the material there are lots of references to the links and to other actors. They seem to be matters people are naturally interested in. There were similar problems in Case 2 where the first interviews were made for slightly different purposes. They were more aimed at the physically distributed cognition.

All the interviews were retrospective, we were studying past activity. However, in both cases the building work was still going on during the time of the interviews. In Case 2 there were two interview periods during different phases of the project, so there are two cross-sections of the activity. It is possible that the activities at hand have biased the informants´ memories. However, a lot of time was spent in recollecting past action and remembering the order of occurrence of each incident. In Case 1 there was even some kind of a stimulus used in the form of a process chart drawn together. The timing of the incidents was checked from the documents during the interviews and this often helped the informants to better remember the right order.

The construct validity of the study is firmly established. There is a specific kind of change tested (the dynamic network action), and the selected measures (informants´ concepts of the quality of ties) reflect the change well (Yin 1994: 34)

Internal validity

According to Yin (1994: 35) internal validity is an issue only if there is causal reasoning. The study has some causal or explanatory characteristics. One of its aims is to show that the better network action is related to project success. The concept of network dynamism includes the idea that there is a web of causal relationships between the actors and the ties connecting them.

It was shown that one of the projects was successful and the other one was not. There was a set of success factors related to the success of Case 2 (Kangas) and to the failure of Case 1 (Hakala). However, both the failure and the factors affecting it are fuzzy concepts as was shown in sections 2.1.2 and 4.3.3. All building projects are successful to some degree in retrospective consideration and the amount of factors, data, and actions in even a simple building project is so huge that any clear causal effects are almost impossible to establish. However, what is shown in this thesis is that the team's ability to establish goals and monitor them is of vital importance. Without this capacity it is impossible to succeed, because there is no clear definition of success.

The chains of cause and effect are much more strongly established in the descriptions of the two networks' dynamism. There is the historical evidence from documents and the participants' opinions about their own action and that of others. Some details may be wrong or interpretations fuzzy, but the general picture can hardly be anything else than what is described.

External validity

Are the findings generalizable to larger populations? Critics of case studies typically state that a few cases offer a poor basis for generalizing (Dyer & Wilkins 1991; Eisenhardt 1991; Yin 1994: 36). A survey constructed in the right manner readily generalizes to a larger universe. However, this analogy is incorrect if applied to case studies. Surveys rely on *statistical generalization*, whereas case studies rely on *analytical generalization*. The idea of this study is to generalize to a broader theory of network action and factors affecting project success.

There is a replication logic. One case is not enough and that is why two different cases were compared. This raises two questions:

1. Were the two cases similar enough to be compared?
2. Were the two cases different enough to generalize a theory?

As can be seen, these two questions are in contradiction. It is impossible to answer "yes" to both questions at the same time. It is obvious that we are talking about an optimalization problem here. The stress in both questions is on the word "enough".

There is a strong similarity. Both projects are public building projects in Finland. The Finnish building industry represents a small market area, where the culture of the trade is strongly shared. There were some similar characteristics in the way projects were organized. The user participation was a key feature in both projects. Both projects were renovations executed in phases in operating institutions.

There were enough differences as well. The way the goal was defined, and the way the design work and the construction management was organized in each project was all different. The one was a success and the other one a failure. Case 1 (Hakala) was a school and Case 2 (Kangas) a service center for the elderly, so there was a big difference in the client culture. Case 1 took place in the metropolitian area, Case 2 was a town project in the eastern part of the country.

The replication logic of the research design was proper. It is hard to imagine a third project which would have added to the understanding of phenomena or better generalized the theory.

Reliability

The idea of the reliability test is to make sure that if another investigator studied the same cases with the same methods and same procedures she would end up with same conclusions (Yin 1994: 36).

The most important part of the material are the interviews. It would be impossible to repeat the interviews, because so much time has passed. However, all the interviews are on tape and they are transcribed. All the documents have been collected and even more of them could be (theoretically) found from the cities' archives. The technique of analyzing the material is described in detail in the methods section of the thesis. In the appendices there are examples of how the analysis was made. There is no extra data needed to weight the quality of each tie. I was helped by the background information from previous involvement, but the same information would be available to anyone. Some extra interviews would be needed, though. However, this kind of information about general conditions does not age as fast as the knowledge of separate incidents.

5.5 Some ideas for future research

One of the main contributions of this research was the method of mapping small-scale cognitive networks. It was applied in a case study of two building projects. It would be interesting to test the method in different environments.

Another unit of analysis could be chosen. Instead of studying projects, one could study communities of practice. It would be interesting to know how a community of practice evolves over time. Do people really learn in communities of practice? Is the criticism of Huysman correct: do the parent organizations learn through communities of practice or not? Is there a big difference between communities of practice and innovative knowledge communities (Hakkarainen, Palonen, Paavola & Lehtinen 2004), does new knowledge get created in communities of practice or not?

There could be other units of analysis as well. What is the relationship between different communities, networks, and projects? All human cognitive action is placed in networks, so the network analysis could be applied to any case study.

The analysis of documents revealed interesting information about the amount and quality of information processed. The method was very simple and could easily be developed further. It would be easy to collect databases from different activities, communities, and networks and check the information flows as a function of time. These studies could be combined with the studies suggested above.

The managerial methods introduced in the previous chapter are only a sketch of what project knowledge management and production and application of different artifacts could be. An action research would reveal more about the actual benefits of better methods of project management. There was an action research (PROLAB) going on during the research, but the ideas were developed so late that they never really got tested.

The influence of different professions and their role-expectations was remarkable in both cases. How do the representatives of different professions themselves see their situation and the network action? Is there a difference between different professional communities, is the socialization stronger among some professions? Do professional communities possess metacognitive knowledge about other professions or situations? What is the relationship between fluid and crystallized knowledge? Is all action completely institutionalized, or does the level of institutionalization vary? These questions could easily be answered in qualitative interviews or case studies.

The construction industry was the setting of this study, not its subject matter. However, many industry-related problems appeared in its cases. The low profit margins, strong industry culture, fragmented production, and many other factors make the construction industry a unique setting for distributed cognitive activity. If the methods of this thesis were applied in a wider research program, its findings about the nature of construction industry could be more firmly established.

5.6 End of this journey and the beginning of a new one

Qualitative research is sometimes compared to a journey (Ylijoki 1998). At this moment I feel like finishing a long journey. It started from the principal’s office over eight years ago, and it ended here. Was it worth it?

The methodological question was much easier to answer than the other questions: what did I learn? I am an architect by education and I see this journey as a journey away from that profession. Through this study I have learned how blinding secondary socialization to an expert culture can be. The word “architect” comes from Greek and it means “the first builder”. We architects believe that projects can and should be controlled by a single mind only. This research has taught me how ridiculous such a belief is.

This study has taken me far, far away from the world where heroic individuals fight alone for their destiny. I have come to the edge of a devastating question: do single minds matter at all? To think about it is like standing on the edge of a deep cliff in a dream: do you dare to throw yourself over and trust your wings? I started by using a metaphor of flying and finish this thesis in the same way.

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Appendices

Appendix 1: Cost analysis of the Hakala project (Case 1)

Usually contingencies in a renovation project are 4% of the total cost. In the Hakala project they were 20%. These costs can be divided into three categories:

normal contingencies	Unavoidable extra costs in any renovation project.
unexpected costs	Costs that would have been paid anyway, but with good project management they should have been predictable.
extra costs	Costs that could have been avoided altogether with better project management.

Part of the extra costs are a side effect of the unexpected costs. If certain structures or operations are designed and ordered after the bidding and contracts, they cost more. In this study it is estimated that proper competition would give 20% lower prices. This is a very modest estimate; double prices are not unheard of in these cases. So 20% of the unexpected costs are added to extra costs.

A following analysis can be made of the contingencies:

Vat 22% incl.	**%**	**€**
normal contingencies	**2,7%**	**58.453**
unexpected costs	**14,0%**	**305.800**
extra costs	**3,4%**	**74.691**
total	**20%**	**438.944**

The total of original contracts was 2.191.677 euros. In construction management projects the contingencies are higher than in the general contract projects, but 20% exceeds all the limits. Normal contingencies were what they were supposed to be (2,7%), but the amount of unexpected costs tells that there has been a free fall in terms of cost management.

The project team named the reasons for extra contingencies. According to the project team, they were caused by:

extra costs

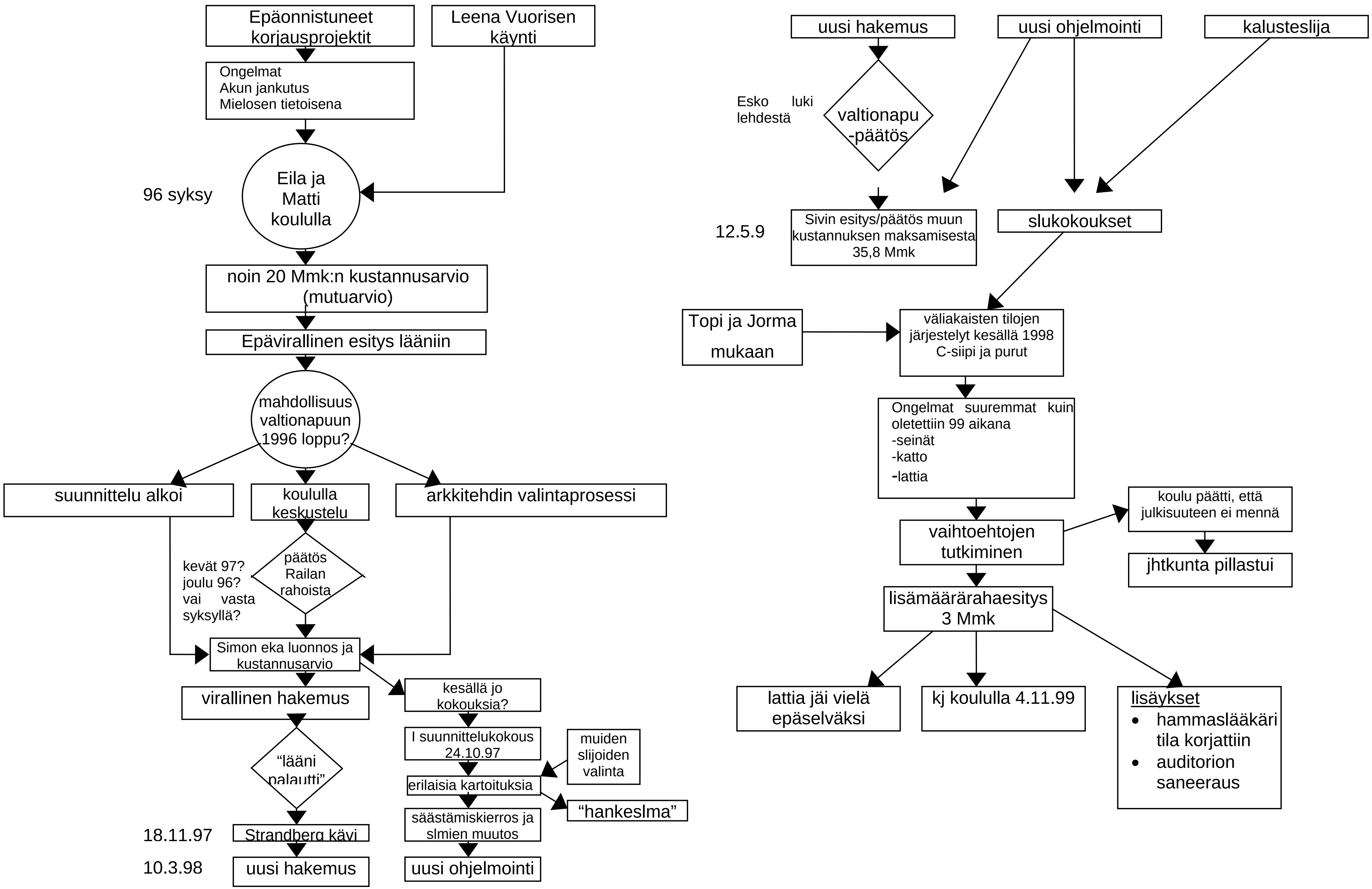
cause	%	costs (VAT 22%)
inadequate research of existing structures	32%	23800
failed cost elimination efforts	25%	18753
the work of the design team	11%	8348
changes in standards	11%	8317
the design of phases	7%	5202
users were not interviewed properly	5%	3398
programming	4%	2895
coordination of works	3%	2369
lack of resources	2%	1607

unexpected costs

cause	%	costs (VAT 22%)
inadequate research of existing structures	41%	124976
failed cost elimination efforts	21%	65455
changes in standards	11%	33270
the work of the design team	8%	25428
programming	8%	23627
users were not interviewed properly	5%	13686
coordination of works	3%	2369
lack of resources	2%	6430
the design of phases	1%	3454

Here we can see a typical Pareto-distribution, where 80% of the incidents are caused by 20% of the factors. The *inadequate research of existing structures, failed cost elimination efforts and unexpected changes in standards* caused over 70% of the contingencies. These can all be related to problems in the flow of information. *Failed cost elimination efforts* describe costs caused by efforts to correct problems created by bad budget management.

Appendix 2: A chart drawn together with informants in Case 1(Hakala)



Appendix 3: Part of document list of Case 1(Hakala)

1.	24.10.1997	oppilasmäärät	lähete	Liisa Aaltosen lähete Simo Rautamäelle. ”Tässä ovat nämä oppilas- ja tuntimäärät Peltolan yläasteelle. 17% pienempi.” Mukana hankesuunnitelman liitteenä olleet tilamitoituksen pohjana olevat oppilamäärät ja Esko Leinon selvitys viikkotunneista 24.4.97 (yht. 1000 tuntia)
2.	24.10.1997	yhteystietoluettelo	luettelo	Suunnitteluryhmän yhteystiedot
3.	24.10.1997	I. suunnittelukokous	pöytäkirja	Todettiin kustannustavoite mahdottomaksi. Viemärilinjojen kuvaus. pyrkimys säilyttää mahdollisimman paljon linjoja. Kaikki kiintokalusteet uusitaan. Yhteenveto jo tehdyistä töistä. Jako korkeintaan kolmeen vaiheeseen. Urakkasarjat oltava valmiit 1.4.1998. Radonmittaus, asbestikartoitus, kosteusmittaukset ja putkistojen kuvaus tilataan.
4.	31.10.1997	ruokapalvelun lausunto keittiöstä	lausunto	Mervi Aleniuksen allekirjoittama lausunto, lähetetty Jarmo Fäldtille. Peltolaan tarvitaan valmistuskeittiö, koska oppilasmäärä on niin iso, ettei kuljetus kannata. Keittiöstä suunniteltu Tikkurilan alueen keskuskeittiötä. Kuvattu laitteisto, mukana isot padat. Arkkitehdin kappaleessa käsin tehty merkintä vieressä: ”padat pois”.
5.	3.11.1997	rakennesuunnittelijan valinta	teknisen toimen johtajan viranhaltijapäätös	Vantaan Runkosuunnittelu Oy:n valitseminen rakennesuunnittelijaksi 90.000 markan kokonaishintaan
6.	4.11.1997	valmistuskeittiön tila- ja laite-ehdotus	fax	Jarmo Fäldtin lähettämä telekopiosaate, ei liitettynä varsinaista asiakirjaa. Ilmeisesti mukaan kuulunut vuoden 1987 taulukko: ”Peruskoulun ja lukion keittiö-, ruokailu- ja henkilöstötilojen mitoitus. Arkkitehti lisännyt tekstin: ”lisäksi keskuskeittiön suurempi eteistila” ja ympyröinyt kohdan 673-768 opp., 24 por, valmistuskeittiö 155-165 m2.
7.	6.11.1997	tutustuminen koulun tiloihin	muistio? **ETSI**	suunnittelijat, käyttäjät?
8.	6.11.1997	palohälytysjärjestelmän tarve	muistio	Arkkitehdin käsin kirjoittamat muistiinpanot (puhelinkeskustelut?): ”Sähkösuunnittelija Sahlman kyseli vanhan palohälytysjärjestelmän tarpeellisuutta. Kallis saneerata, onko luvan ehtona. Kaupunki haluaisi purkaa vanhat järjestelmät. Rak. tark. Puustienn: jos halutaan, vanha järjestelmä voidaan purkaa. Anssi Parviainen (palolaitos, palonehk. os.): antaa ehdot uudelle järjestelmälle, joiden mukaan me määritellään lupahakemukseen.
9.	6.11.1997	ohjeita koulujen suunnitelijoille	ohje	Matti Vertolan tekemä luettelo suunnittelijoille eri tilojen kalusteista, varusteista ja ominaisuuksista.
10.	10.11.1997	taloussuunnitelma 1998 ja talousarvio 1998	kaupunginvaltuuston päätös	Opetuslautakunnan alaisia perusparannuskohteita 1999 39,2 Mmk, 2000 34,1 Mmk ja 2001 42,3 Mmk. Summia ei eritelty.
11.	14.11.1997	kokous koululla	muistio? **ETSI**	Arkkitehtisuunnitelmien jatkotyöstäminen

Appendix 4: Part of document list of the Kangas project (Case 2)

25.11.2004	15:48	H S„hk”j„rjestelm„t_kunnossapitojaksot	dwg
12.2.2004	13:00	HA4230_1_04022004	pdf
12.12.2003	11:51	HA4230_1_12122003	pdf
30.12.2003	11:17	HA4230_1_17122003	pdf
18.12.2001	14:27	Hankekok 10	rtf
3.6.2002	10:46	hankesuunnitelman lviosa	doc
30.5.2002	22:27	Hankesuunnitelman s„hk”osa	doc
25.11.2004	15:49	harjalaite k„pykankaalle	txt
21.8.2003	8:01	Heloitusluettelo K„pykangas 2003-2004	doc
28.10.2004	13:36	Heloitusluettelo K„pykangas 2005	doc
20.8.2003	12:48	Heloitusluettelo	doc
15.10.2003	9:16	Hoitajakutsu	pdf
26.9.2003	8:59	Honeywell_toimittajakeskustelun yhteenv	pdf
17.11.2004	8:27	huoltokirja RAK_j„rjestelm„t	xls
24.11.2004	15:33	huoltokirjakommentit	eml
15.10.2003	9:16	Huone	pdf
13.8.2003	16:45	HUONEIDEN 1015 JA 1016 PERUSTUS	bak
29.1.2004	8:50	HUONEIDEN 1015 JA 1016 PERUSTUS	dwg
14.6.2004	6:41	Huonekaluhankinnat	doc
17.7.2003	10:18	hydro 2000 2xcre5-10 pmu	pdf
17.7.2003	10:18	Hydro_2000_ME_liite	doc
7.6.2004	7:25	H_matros_small	jpg
17.11.2003	9:41	ikkuna	dwg
25.11.2004	15:49	ilma-1kerros	bak
10.11.2004	11:53	ilma-1kerros	dwg
25.11.2004	15:49	ilma-2 kerros Model (1)	pdf
25.11.2004	15:49	ilma-2 kerros	bak

Appendix 5: An example of the analysis of the links in Case 1 (Hakala): The design trim

lihavoitu = vahva sidos; normaali = heikko sidos; *kursiivi* = jännitteitä, ongelmia

ulkopuolinen näkökulma	näkökulma 1	näkökulma 2	analyysi
koulu-sivi	**koulu sivistä**	**sivi koulusta**	**Vahva sidos**
	Meihin on tehnyt vaikutuksen SIVI:n tahto tehdä laadukas lopputulos ja antaa kunnon varustelu. Me syötetään oppilaita viestintälukioon. Ratkaisu ei ole halpa.(A) Työsuojelu kävi. Matti Vertola, Leena Vuorinen oli mukana katsomassa.(B)	Suunnittelun alussa rakennuttajapäällikkö ja Hasanen alkoivat kysellä iltakäytöstä ja kartoittaa käyttäjiä uutta hankesuunnitelmaa varten. Silloin ajattelin: voi ei, mitähän tästäkin tulee! (C) **Pidin silloin luentoja yhdessä Leinon kanssa.(C)** Koulu joutui tosiasian eteen. (C)	Karsimisessa sivi ja koulu ovat pitäneet yhtä. Tätä on auttanut muu kuin remonttiin liittyvä yhteistyö.
koulu-talonsuunnittelu	**koulu talonsuunnittelusta**	**talonsuunnittelu koulusta**	**Vahva ongelmallinen sidos**
	Säästämiskierros 1997-98 vei rahat auditoriolta, pihasuunnitelmaa karsittiin, pienet luokat poistettiin, samoin kattoikkunat. Myös peltiset julkisivut päätettiin jättää uusimatta. Oli valtionapu ja sen taustalla oleva todellinen kustannusarvio, joka piti saada näyttämään oikealta karsimalla auditorio. *Sadekatos kytkettiin jotenkin. 250.000 leijuu edelleenkin, ei ole kytketty. Oliko vai ei?* Auditorion irroittaminen oli tosiasia, se tehdään kaupungin omana työnä ja omalla budjetilla. Kotitalousluokkien mukaanottaminen kevennyksenä laskelmassa. Rakennus oli analysoitu pitkälle. Auditorion irroittaminen oli tietoinen ratkaisu. (A) Silloin Jarmo Fäldt oli keskeinen henkilö, hänen kanssaan suunnitelmia katsottiin.(B) *Samaan aikaan tuli vesi- ja viemäriputket ja sähkö. Tuli päätös siitä, että infotekniikka vaatii toisenlaiset sähkölinjat. Pekka Halonen esitti, että linjat uusitaan. Valaisimet säilytetään, vaikka olikin huonot kiinnikkeet.(B) Arto Alanko käynyt toukokuussa. Kattoikkunoita tekstiilityön luokassa katsottiin silloin*	*Raimon kanssa paljon mietittiin ja käytiin läpi. Koulu oli mukana. Oli ristiriitoja teidän ja Railan kanssa siitä, mitä kaikki maksaa. Raimo ei voinut hyväksyä että maksaa mitä tulee maksamaan. (E) Arto ei kaikkea hyväksynyt. Erikoisesti ei kattoikkunoita työpajasiipeen. Sain ohjeet, että ne jää pois, ilmoitin siitä suunnittelukokouksessa. Käytävien kolmiomaiset ikkunat oli toinen sellainen asia. Ne sai jäädä, eivät olleet sellainen kustannustekijä, joka olisi pelastanut siitä konkurssista.(E) Homeasiat ei olleet esillä. Ei ne näkyneet ennenkuin päällimmäinen levy oli purettu.* ***Koulu kai painosti asiassa?*** *Ei ne ainakaan suunnitteluvaiheessa reagoineet. Lähinnä auditorion alapuolisesta tilasta oli juttua, kanaaleista samoin, mutta ei luokkien homeen hajusta. Oli kai yllätys koulullekin, kun paikat revittiin auki ja ne paljastui. (E)*	Karsintavaihe aiheutti suuria ristiriitoja koulun ja talonsuunnittelun välille. Erimielisyyttä näyttää olevan kaikesta: kuka johti suunnittelua, tutkittiinko asioita vai ei, mitä karsittiin ja mitä olisi/ei olisi pitänyt karsia. Talonsuunnittelun sisäinen tilanne ei varmastikaan helpottanut tilannetta. Koulun puolelta näyttää siltä, että karsintaa johti Jarmo Fäldt, Jarmo pitää taas Raimoa ja kaupunginarkkitehti Arto Alankoa karsimisen päätoteuttajina. Raimo Haltusen mielestä ajatus lähti kaupungin ja toimitilojen johdosta. Yksimielisyyttä näyttää olevan vain siitä, että kaiken takana oli läänin ilmoitus siitä, että rahaa ei tule lisää. Taustalla on myös yleinen näkemys, että käyttäjähallintokunnat lähtevät liikkeelle liian vähäisin eväin ja paisuttelevat hankkeita matkan varrella. Talonsuunnittelun asiantuntijoiden ja koulun välit tulehtuivat myös karsintavaiheessa. Karsinnan kohdentamisesta vallitsi erimielisyys.
	Arto Alanko oli karsinut tekstiilityön ikkunat. Kävi paikan päällä ja katsoi, että kattoikkunoita	*Oli kyllä tietoa julkisivuvuodoista ja puhuttiin sen korjaamisesta. Vesikaton ongelmat tiedettiin ja ne*	

	tarvitaan. Karsi silloin myös sisääntulokatokset. Oli karsinut jossain vaiheessa lasiseinät, joiden kautta valo tulee käytäville. Käytyään koululla ja nähtyään tilanteen nekin palautettiin. Ainoa, joka lopulta jäi karsinnoista jäljelle oli katoksen pienennys. … Arto Alanko oli mukana, koska hänen kauttaan menee lupakuvat. Karsintaa ja palautusta. Arto Alangon kanssa käydyt asiat oli arkkitehtikuvia, tiloihin liittyvää, valaistusta ym (B *Koulun taholla tapahtui paljon LVI-asioissa, mutta paljon myös virastolla. Periaatepäätöksistä ei tullut tänne aina tieto, olisiin kyllä olettanut.* ***Kun suunnittelijat olivat täällä, oliko täällä silloin myös viraston väkeä?*** *Ei, oltiin keskenämme) (B)* *Suunnitteluaikana oli paljon tekemistä Pekka Halosen kanssa. Oli periaateristiriitoja, suuriakin, niitä selvitettiin keskustelemalla. Walleniuksen Pekan kanssa olisin toivonut enemmän yhteistyötä.(B)* *Tuli myös pihasuunnitelmakarsinnat. Pyrittiin karsinnassa perustoimintojen, lvi ja sähkö, säilymiseen. Karsinta meni seiniin ja tiloihin, ajatus oli, että puretaan mahdollisimman vähän ja käytetään olemassa olevaa. Opettajainhuone oli ainoa suuri järjestely, joka jäi. Olemme vieläkin pahoillamme sadekatoksesta, että se poistettiin. Toivotaan että kaupunki lahjoittaa sen koululle 30-vuotisjuhlissa. Meille sanottiin: jos kosteusvaurioita ilmenee, niin sitten niitä korjataan. Kattoja ei avattu, eikä näytteitä otettu. Rauhoiteltiin, että jos tulee jotain esiin, niin korjataan. Ei budjetoitu, kun ei tiedetty, mutta ei tarkistettukaan. Päätöstä, että kattorakenteita ei korjata ei varsinaisesti tehty, toivottiin vain hiljaisesti, että mitään ei oo. (194). Jatkossa teidän on kyllä tutkittava, että ei käy näin. (B)* *Jännä juttu kaupungin puolelta, sanotaan nyt nimi suoraan, Halosen Pekka. Auditoriosta sanoin, että pitää valot uusia, kannat hajoo. Ensin ei meinattu uusia mitään….Sitten uusittiin…(M)*	*oli tarkoitus purkaa. Jos jotain ilmenee työvaiheessa niin ne korjataan. Väliseinät oli sellainen, kukaan ei tiennyt tai osannut epäillä, että ne on lahot. Oli suunnitteluratkaisu, jossa pyrittiin säilyttämään seiniä mahdollisimman paljon. Kun ne menikin uusiksi, niin olikin typerä homma tai turha.(E)* *Takana oli Helena Arema ja Juha Berg, jos en väärin muista. Jos tästä mennään yli, tekninen toimi menettää kasvonsa. Ei täältä talonsuunnittelun puolelta, suuri ääni ei tullut täältä… Olin kurkkua myöten täynnä Peltolaa. (J)* *Opetus on, että en hyväksy eteenpäin menoa tolla tavalla. jos haluatte kevyen remontin, niin pankaa nimi paperiin ja ottakaa vastuu. …80-luvun kokemus oli, että mentiin aina hankesuunnitelmavaiheesta ylöspäin. Oli tasainen nousujohtoinen tilanne. Löytyy 80-luvulta aina kiva ylämäki. En ole sitä koskaan hyväksynyt. Mieluummin mennään hankesuunnitelmatasolta alas kuin ylös. (J)* Rakenteiden puolelta ei karsittu mitään. Ei koskenut rakenneasioita. Pihan osalta. Pihan muutokset eli, kuivatussuunnitelmia ei saatu. Että pihaa on veivattu, niin sit on vaikuttanu. Kustannuspuoli vaikuttanut, ettei oo saatu pihasuunnitelmia. (N)	
koulu-arkkitehti	**koulu arkkitehdista**	**arkkitehti koulusta**	**vahva sidos**
	Me katsottiin Simon kanssa koulun edustajina mitkä seinät voidaan sittenkin säilyttää. Muutokset vedettiin silloin takaisin. (B)		Koulu kokee, että arkkitehti tuki koulua ja arkkitehdin kanssa tehdyt päätökset karsinnoista oli yhdessä tehty.

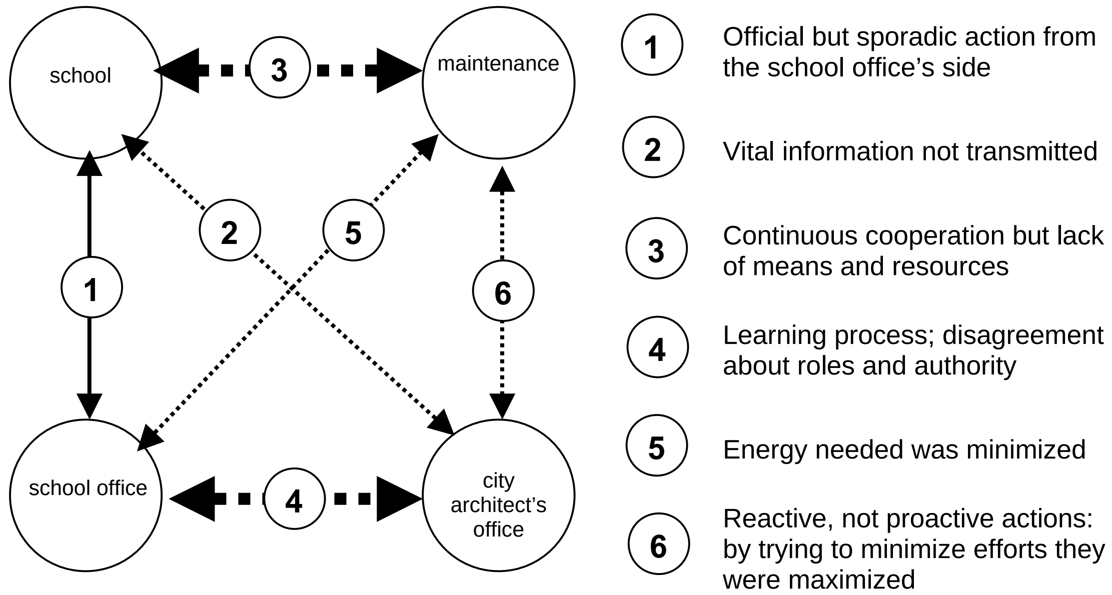
	Arkkitehtisuunnittelu ja kalustesuunnittelu eteni hyvin (B)		
koulu-rakennuttaminen	**koulu rakennuttamisesta**	**rakennuttaminen koulusta**	**heikko sidos**
		Sitten oli hankkeen eteenpäin työstämistä, hankesuunnitelman työstämistä ja vaiheistusta. Suunnittelukokouksista ei ole jäänyt paljoakaan mieleen. Hankesuunnitelmasta ja vaiheistuksesta enemmänkin. Suunnittelijoiden kanssa pähkäiltiin hankkeen pilkkomista.(F)	Rakennuttaminen tuli mukaan laajemmalla rintamalla, mutta ei syvällisemmin ollut vielä kuvassa mukana
koulu-apusuunnittelijat	**koulu apusuunnittelijoista**		**vahva sidos**
	Kevään aikana suunniteltu tiiviisti koulun ja sisustussuunnittelijan kanssa kalusteita. (B) Arkkitehtisuunnittelu ja kalustesuunnittelu eteni hyvin (B) **LVI-suunnittelijan kanssa tehtiin paljon työtä, käytiin jopa kaikki lvi-kalusteet läpi. Mitä pesualtaita voi jättää, näin yksityiskohtaisesti. Paljon palavereita täällä ja hänen virastossaan. Erittäin hyvää oli vesi- ja viemärisuunnitelmien teko, ilmanvaihto ja lämpö-suunnitelmat enemmänkin tuli tänne ja niitä katsottiin. Mutta että tehot riittää, oletin että ne menee normien mukaan. Tiettyjä tarkennuksia tehtiin kyllä ongelmatilojen suhteen. Aku oli mukana tiiviisti. Ongelmana oli, että vanhat lvi-kuvat ja todellisuus eivät kohdanneet. (B)** **Sähkösuunnittelu oli myös hyvää. Kun rakennusvaiheessa oli päätösten ja suunnittelun takia ongelmia, niin itse suunnitteluvaihe meni kyllä hyvin.(B)** Vielä keväällä oli eri suunnittelijoiden kesken kokouksia. Siellä tapahtui varmasti hiljaista toimintaa. Sieltä otettiin yhteyttä, jos koulun mielipiteitä tarvittiin. Se toimi hyvin. Koulun edustaja ei ollut aina mukana. (B)		Talonsuunnittelun keskittyessä karsintaa tuntuu kuin sivusuunnittelua olisi vedetty koululta. Yhteistyöstä on paljon mainintoja, se näyttää olleen tiivistä ja koulu on siihen tyytyväinen.
sivi-talonsuunnittelu	**sivi talonsuunnittelusta**	**talonsuunnittelu sivistä**	**heikko ongelmallinen suhde**
	Jarmo Fäldt varmaan ajatteli, että täytyy järjestää asia, että saadaan homma tehtyä. Mä olin syrjässä: ei tunnetiloja. Liisalla on varmaan paremmat muistikuvat. En tiedostanut, että silloin karsittiin. Muistaako ihminen paremmin positiiviset asiat? Tiesinkö vai en? Jäin mielikuvaan, että raami on mikä on, loput tehdään itse…. Esityksessä ei ollut karsintoja. Toiset vie. (C)	Lääni ei nostanut hintaa, sitä me Raimon ja SIVI:n kanssa mietittiin (E) *Opetus on, että en hyväksy eteenpäin menoa tolla tavalla. jos haluatte kevyen remontin, niin pankaa nimi paperiin ja ottakaa vastuu. …80-luvun kokemus oli, että mentiin aina hankesuunnitelmavaiheesta ylöspäin. Oli tasainen nousujohtoinen tilanne. Löytyy 80-luvulta aina kiva ylämäki. En ole sitä koskaan hyväksynyt.*	Tässä vaiheessa SIVI näyttää loistavan poissaolollaan, ainakin mitä haastattelumainintoihin tulee. Joka tapauksessa sivi on ollut mukana ja hyväksynyt tehdyt päätökset. Jälkeenpäin se ei sitä näyttäisi suostuvan myöntämään.

		Mieluummin mennään hankesuunnitelmatasolta alas kuin ylös. (J)	
sivi-arkkitehti	**sivi arkkitehdista**	**arkkitehti sivistä**	**ei linkkiä**
	Simosta en muista mitään. (c)		
sivi-rakennuttaminen	**sivi rakennuttamisesta**	**rakennuttaminen sivistä**	**heikko sidos**
	Suunnittelun alussa rakennuttajapäällikkö ja Hasanen alkoivat kysellä iltakäytöstä ja kartoittaa käyttäjiä uutta hankesuunnitelmaa varten. Silloin ajattelin: voi ei, mitähän tästäkin tulee! (C)		Yksi maininta muussa yhteydessä.
sivi-apusuunnittelijat	**sivi apusuunnittelijoista**		**ei linkkiä**
talonsuunnittelu-arkkitehti	**talonsuunnittelu arkkitehdista**	**arkkitehti talonsuunnittelusta**	**vahva ongelmallinen suhde**
	Arto oli mukana kun karsintaa tehtiin. Se oli hässäkkäaikaa, jäi huonosti mieleen. Kun Arto hyväksyi pääpiirustukset, Simo esitteli ne yksin, en ollut paikalla. Arto poisti silloin kattoikkunat. Silloin tarkoituksena oli määritellä mikä jää valtionapuun ja minkä kaupunki tekee itse.(E)	*Talohan osoittautui täydeksi pärekoriksi. Seinät piti ensin säästää ja ne kuitenkin jouduttiin purkamaan. Uudet seinät rakennettiin sitten entisten paikalle, kun suunnitelmia ei ehditty muuttaa. Joka paikassa oli hometta. Rakenteet oli järkyttäviä.(H)*	Se että kaupunginarkkitehti astuu kuvaan mukaan vasta tässä vaiheessa ja ilmeisesti ohi suunnittelua vetäneiden alaistensa saa arkkitehdin ja talonsuunnittelun suhteen kummalliseen valoon. Arkkitehti ei anna suurta arvoa tehdyille ratkaisuille eikä tunnu olevan niissä mukana. Talonsuunnittelun toimintaa voi pitää puhtaana vallan käyttönä.
talonsuunnittelu-rakennuttaminen	**talonsuunnittelu rakennuttamisesta**	**rakennuttaminen talonsuunnittelusta**	**heikko ongelmallinen suhde**
	Raimon kanssa paljon mietittiin ja käytiin läpi. Koulu oli mukana. Oli ristiriitoja teidän ja Railan kanssa siitä, mitä kaikki maksaa. Raimo ei voinut hyväksyä että maksaa mitä tulee maksamaan. (E) Korjausrakentamisen kanssa tulee usein vastaan, että ei voi tehdä jos ei ole suunnitelmaa, mutta jos suunnitelma on, ne sanookin, että se on huono ja tekee toisella tavalla. Olisiko suunnitelmaa silloin tarvittukaan? …suunnittelija on tehnyt useita päiviä töitä ja sitten toiset sanoo, että ei tehdä. Usein voisi ensin mennä työmaalle ja kysyä kuinka tehdään ja sitten tehdä siitä kuvan.(E)	*Yksi säästötaho Pekka sanoi, että pakotettiin vanhat valaisimet säästämään. Ne on muovia, ihan turha säästää, ei ne kestä. Jouduttiin uusimaan kaikki. Tarpeet laajeni heikkovirtatekniikassa. Pekka sanoi, että kun tekivät retken Raumalle se tuli ilmi. Pekka sanoi, että pakotettiin säästämään. Kuka pakotti? Oli uusi insinööri silloin. Kun seinät purettiin, jouduttiin kaikki uudestaan tekemään. Eihän sellaista voi uudestaan kiinnittää, joka hajoaa käsiin.(L)*	Projektin johtamisen jakaminen kahteen osaan poikii välittömästi ongelmia eri vaiheiden välillä. Suunnittelun vetäjä katsoo, että asia ratkaistaan toteutusvaiheessa kun taas toteuttajan näkökulma on täysin päinvastainen. Rakennuttaminen ei ollut tyytyväinen suunnitteluvaiheessa tehtyihin päätöksiin. Tässä vaiheessa ei rakennuttaminen vielä mukana, joten sidos on heikko.
talonsuunnittelu-apusuunnittelijat	**talonsuunnittelu apusuunnittelijoista**		**vahva ongelmallinen linkki**
Koulun taholla tapahtui paljon LVI-asioissa, mutta paljon myös virastolla. Periaatepäätöksistä ei tullut tänne aina tieto, olisiin kyllä olettanut. **Kun suunnittelijat olivat täällä, oliko täällä silloin myös viraston väkeä?** Ei, oltiin keskenämme. Kouluisäntä oli paikalla. Sähkösuunnittelu oli myös hyvää. Kun rakennusvaiheessa oli päätösten ja suunnittelun takia ongelmia, niin itse suunnitteluvaihe meni kyllä hyvin. (*tarkista*	Rakenteiden puolelta ei karsittu mitään. Ei koskenut rakenneasioita. Pihan osalta. Pihan muutokset eli, kuivatussuunnitelmia ei saatu. Että pihaa on veivattu, niin sit on vaikuttanu. Kustannuspuoli vaikuttanut, ettei oo saatu pihasuunnitelmia.(N)		Apusuunnittelijoiden suhde kouluun tuntuu olleen merkittävämpi kuin muihin osapuoliin. Suhteessa talonsuunnitteluun apusuunnittelijat tuntuvat olevan statistin roolissa. Tämä voi johtua myös siitä, että apusuunnittelijoita ei ole haastateltu. Talonsuunnittelu kuitenkin johti suunnittelua ja vaikutti ratkaisevasti päätöksiin. Tosiasia, että se teki sen toimivan tiimin ulkopuolelta tekee tästä linkistä ongelmallisen.

nauhalta) Se, joka valvoo suunnittelusektoria...(B) Tuli myös pihasuunnitelmakarsinnat. Pyrittiin karsinnassa perustoimintojen, lvi ja sähkö, säilymiseen.(B) Yksi säästötaho Pekka sanoi, että pakotettiin vanhat valaisimet säästämään. Ne on muovia, ihan turha säästää, ei ne kestä. Jouduttiin uusimaan kaikki. Tarpeet laajeni heikkovirtatekniikassa. Pekka sanoi, että kun tekivät retken Raumalle se tuli ilmi. Pekka sanoi, että pakotettiin säästämään. Kuka pakotti? Oli uusi insinööri silloin.(L) Jännä juttu kaupungin puolelta, sanotaan nyt nimi suoraan, Halosen Pekka. Auditoriosta sanoin, että pitää valot uusia, kannat hajoo. Ensin ei meinattu uusia mitään….Sitten uusittiin…(M)			
arkkitehti-rakennuttaminen	**arkkitehti rakennuttamisesta**	**rakennuttaminen arkkitehdista**	**heikko linkki**
		Sitten oli hankkeen eteenpäin työstämistä, hankesuunnitelman työstämistä ja vaiheistusta. Suunnittelukokouksista ei ole jäänyt paljoakaan mieleen. Hankesuunnitelmasta ja vaiheistuksesta enemmänkin. Suunnittelijoiden kanssa pähkäiltiin hankkeen pilkkomista.(F)	kts koulu-rakennuttaminen
arkkitehti-apusuunnittelijat	**arkkitehti apusuunnittelijoista**		**heikko linkki**
Vielä keväällä oli eri suunnittelijoiden kesken kokouksia. Siellä tapahtui varmasti hiljaista toimintaa. (B)			Arkkitehdin roolista pääsuunnittelijana ei ole mainintoja yhtä lukuun ottamatta. Karsintaan liittyvät ratkaisut tehtiin koulun ja talonsuunnittelun välillä.
rakennuttaminen-apusuunnittelijat	**rakennuttaminen apusuunnittelijoista**		**heikko linkki**
	Sitten oli hankkeen eteenpäin työstämistä, hankesuunnitelman työstämistä ja vaiheistusta. Suunnittelukokouksista ei ole jäänyt paljoakaan mieleen. Hankesuunnitelmasta ja vaiheistuksesta enemmänkin. Suunnittelijoiden kanssa pähkäiltiin hankkeen pilkkomista.(F)		katso koulu-rakennuttaminen

Appendix 6: Description of network links in Case 1(Hakala)

Phase 1: Maintenance period



1 ***School - school office:*** a weak link

The communication between the school and the school office was based on official correspondence and sporadic inspections. The school office considered the school to be an active one and the school considered cooperation with the school office non-problematic.

2 ***School - city architects office****: a weak problematic link*

The city architect's office could not find any problems with the school. It was a school among many others and there were no exceptional problems. According to the office problems were not discovered before the renovation project. The school, on the other hand, had always been aware of the fact that problems existed, but it had no means to convey this message to the office through the weak link between these two. This is why it could be called a problematic or contradictionary link: it could not serve its purpose of transmitting information. By definition a difference between a weak link and a strong link is the nature of the information transmitted. If no information is transmitted, the link can be called a problematic one.

3 ***School – maintenance: a strong problematic link***

The school's only physical contact with the facilities section had been the maintenance department. The school office and the city architect's office had tried to stay further away and most of the people from both offices had not even visited the school.

The school felt that it did its best to make the relationship with the maintenance department work, but it did not succeed. It did not blame the maintenance department for this, but insufficient resources were given to maintenance. The school was not pleased with the services it was given. The school experienced that the symptoms were dealt with, but not the cause.

The maintenance department was disappointed, too. Without resources it could not serve the school. On the other hand, it blamed the school for being hysterical about the mold and moisture.

This was an important tie and there was something happening on a monthly or yearly basis. Both parties would have liked to invest more in this link, but the school lacked the means and the maintenance department the time and the resources.

4 ***School office - city architect's office: a strong problematic link***

There was a shared learning and developing project on mold and moisture problems. However, there seemed to be a disagreement about authority and each other's roles and even distrust. Because of the joint learning process this could be called a strong link, but it was definitely a contradictory one as well.

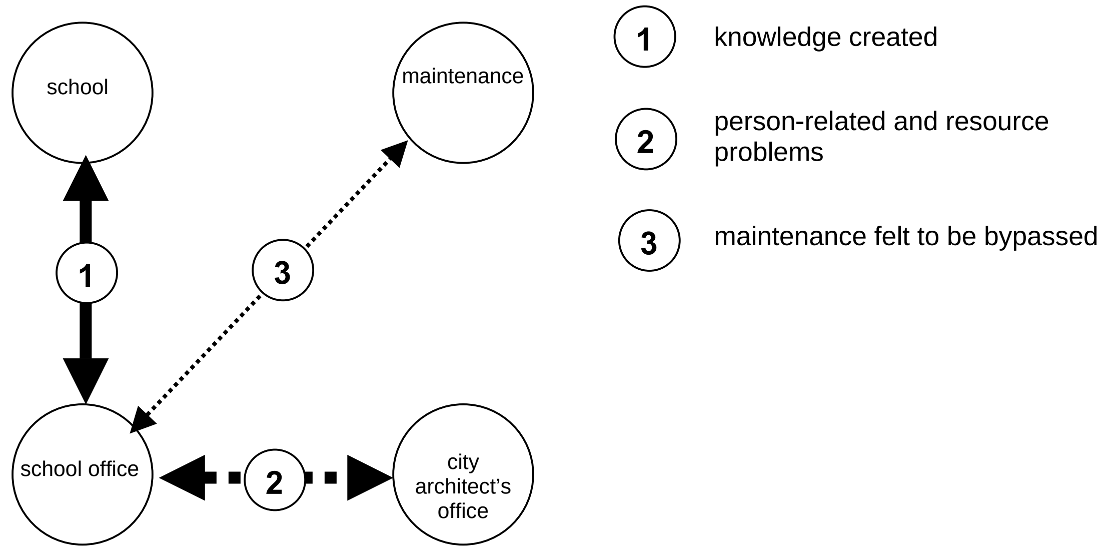
5 ***School office – maintenance****: a weak problematic link*

There was a clear and codified procedure between the school office and maintenance on how to deal with matters related to facilities. However, this relationship was not working. Things were not taken care of and the school office got messages that things were not well in the Hakala project.

6 ***City architect's office – maintenance***: *a weak problematic link*

Both parties tried to keep these relationship on the lowest possible level. However, there was a demand for cooperation. The conflict between the demand and the actual cooperation made this link problematic.

Phase 2: The school office visits the school



1 ***School - school office:*** **a strong link**

In spite of its short endurance – one day – this link could have been considered a strong one. There was new knowledge created, not only explicit, but tacit as well. The reality of the people present was changed. Their approach to the school and to its renovation changed in such a way that in their minds there was no alternative to a complete renovation. This link and that moment can be called the birth of the project.

School, maintenance - city architects office: *a missing link*

The city architect's office did not interview the maintenance department, because it had hired a consultant to do the survey of the general condition of the school. The fact that these links were missing shows how the system worked. Measures to save energy going into social ties had gone to their extreme. The whole relationship was outsourced and later all the actions were based on information from this outside source, with devastating consequences. We could call this a structural hole (Burt 1992), if it was not created on purpose.

School - maintenance: *a missing link*

The link was missing. The maintenance department was not present when the decisions were made about the renovation. However, the maintenance department was actively working inside the school and it even hired its own consultants. There was no flow of information concerning a renovation project, though.

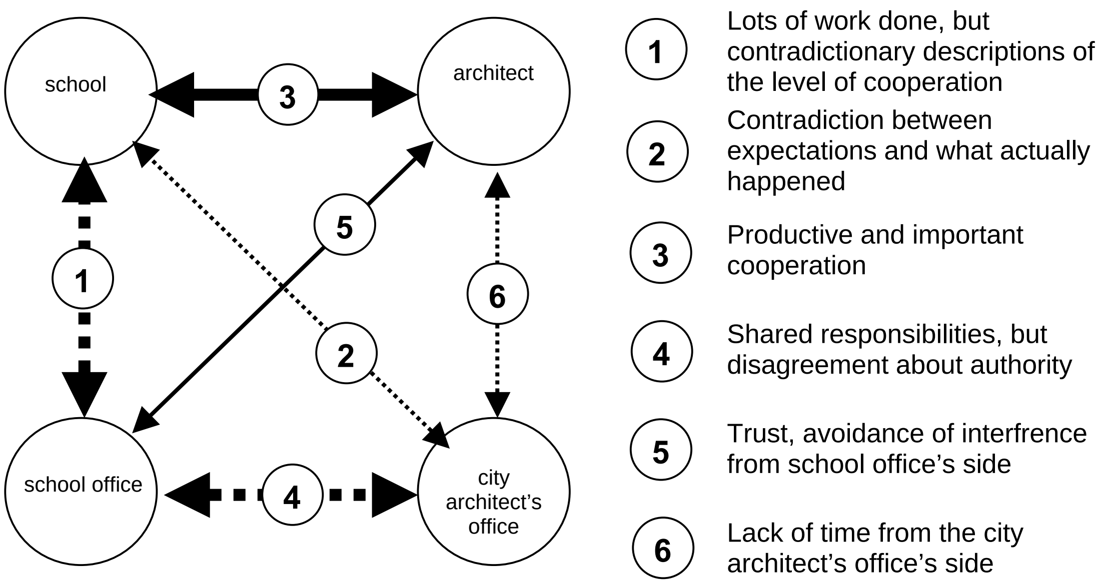
2 ***School office - city architect's office: a strong problematic link***

Both parties took care of important matters together and they even attended training in project programming together. There were official channels and procedures to handle information. The channels were not functioning well due to person-related and resource problems. The link was strong but problematic.

3 ***School office - maintenance:*** *a weak problematic link*

The maintenance department had the feeling that matters important to it were handled somewhere else without its presence. It had difficulties to understand why the school office was needed between it and the school.

Phase 3: The programming



1 ***School - school office: a strong problematic link***

A long time had passed between the programming and the time of the interviews. The contradictionary descriptions informants gave about the cooperation between the school and the school office were puzzling. Some said a lot of work was done in a good atmosphere, some accused the other party of being greedy. Those who did most of the work did not refer to this tie at all. It was a strong link, because a lot of work was done together, but it was a problematic one because of these contradictionary recollections of it.

2 ***School - city architects office:*** *a weak problematic link*

This was an important relationship. The city architect's office was responsible for the technical aspects of design. However, none of the key actors referred to the existence of this tie. The informants talked more about things that did not happen than those that happened. There was a link, but it was a weak and a problematic one, because of the contradiction between the expectations and what actually happened.

3 ***School - architect:*** **a strong link**

This was definitely a strong link. Both parties were precise and unanimous in their memories, a lot of work had been done and it was important for the project's future. One can say that the essential content of all design work was produced during two months in the spring of 1997 as a result of this cooperation. The school was worried about the short time frame given to the architect.

4 ***School office - city architect's office: a strong problematic link***

Officially the two were responsible for the project definition plan. In spite of this both referred to this link as a weak link. When any deeper cooperation was referred to, it was marked by quarrels and contradictionary goals. There seemed to be confusion among the informants about the leadership at this point. The link between the two offices could well be called an unclear one. However, due to the shared responsibilities it can be called a strong one.

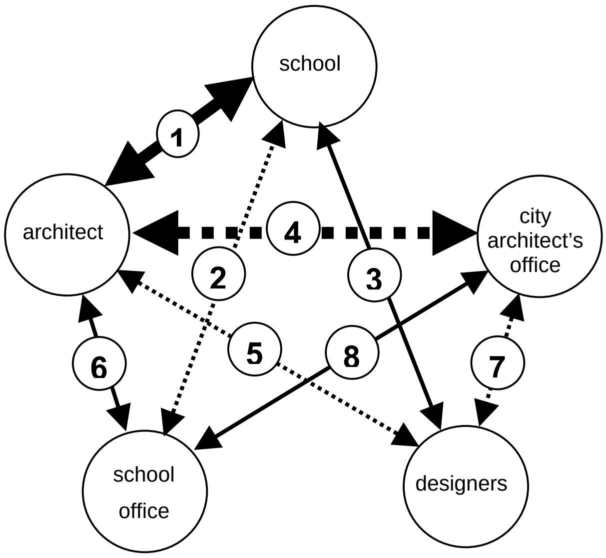
5 ***School office - architect:*** a weak link

The school office wanted to have an architect who knew the building and who had a lot of experience in school design. After the architect was hired, the school office trusted him and did not interfere. There was a tie, but it was not a strong one.

6 ***City architect's office - architect:*** *a weak problematic link*

The link between the city architect's office and the architect could be called a problematic one, because in retrospect the office was not pleased with what happened. The office felt that by investing more time in the tie it might have prevented the future problems caused by the poor programming.

Phase 4: The team is formed



1 Good working relationship
2 Tension, problems with the division of labor
3 Meetings
4 Contractual problems
5 Problems with coordination
6 Past history is a burden
7 Contractual problems
8 No problems mentioned

1 ***School - architect:*** **a strong link**

The art teacher, architect, and city school planner all talked about the good working relationship between the art teacher and the architect. There seemed to be a strong link and no contradiction between the school and the architect.

2 ***School - school office:*** *a weak problematic link*

There was tension between the school and the school office. One of the informants from the school office spent a long time talking about how difficult it was to deal with schools and with certain groups inside them. According to him Hakala was not the most problematic of schools. There had been a problem related to the division of labor between the office and the school.

3 ***School - assistant designers:*** a weak link

There was a connection to the assistant designers through the art teacher. Representatives of the school met the designers in the meetings. The interior designer was important for the school, because the client organization was responsible for furniture and equipment.

4 ***Architect - city architect's office: a strong problematic link***

The architect's office carried the burden of its past as the original designer of the school. There was opposition to the architect's selection and the past casts a shadow over all the architect's later actions. From the architect's side there were contractual problems. However, from the city architect's office's point-of-view, the architect was their key collaborator. This made the link a strong one, even though it was a problematic one as well.

5 ***Architect - assistant designers:*** *a weak problematic link*

The problems with the design contracts were the reason for the problems between the architect and the assistant designers. Those who looked at the situation from a distance blamed the architect for the poor coordination of the design team. The link between the architect and the assistant designers could definitely be called a contradictionary one and the contradiction had its origin in the team formation process.

6 ***Architect - school office:*** a weak link

There was resistance to the architect's selection in the school office as well. However, everyday relationships were not affected by past problems.

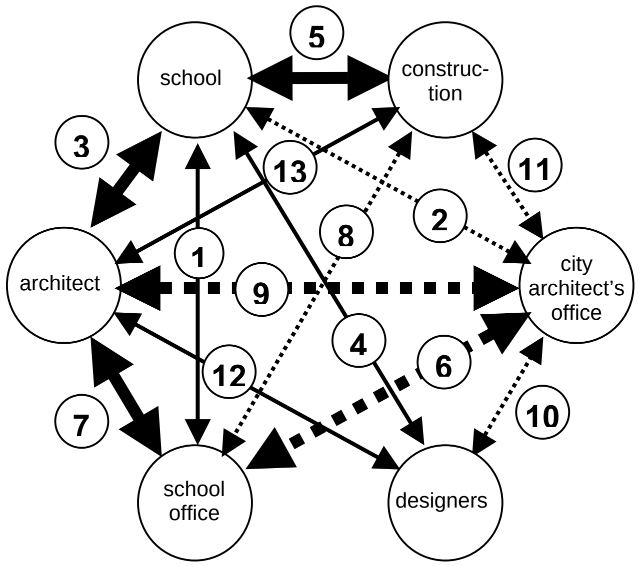
7 ***City architect's office - assistant designers:*** *a weak problematic link*

The problems with coordination and schedule cast a shadow over the relationships between the assistant designers and the city architect's office as well. However, people in the city architect's office shared the designers' opinion that part of the problems could have been traced back to contracts made with too little knowledge about the amount of actual work needed. There was a contradiction and everybody admitted it.

8 ***City architect's office - school office:*** a weak link

Only one of the informants talked about these relationships, but in a manner that left no doubt about the good connections between the two offices.

Phase 5: The design meetings of fall 1997



1 Normal, routine relationship

2 Rivalry over the position as a clients representative, distrust

3 Reciprocal and active cooperation

4 Good collaboration

5 Shared interests

6 Shared history, but emotionally loaded discussions

7 Trust and openness

8 Questions in the air

9 Conflict between reality and expectations

10 Conflict between reality and expectations

11 Tension prevented open discussion

12 Meetings

13 Routine relationship

1 ***School - school office:*** a weak link

It looked like in the beginning that this was just a routine task for the school office and its relationship with the school was good but did not go beyond the normal in terms of depth.

2 ***School - city architect's office:*** *a weak problematic link*

We can call the relationship between the school and the city architect's office a problematic one. It was manifested in the school's inability to communicate its knowledge of the moisture problems to the city architect's office.

3 ***School - architect*: a strong link**

The cooperation between the art teacher and the architect was reciprocal and active. The art teacher was the sole representative of the school and this helped the architect considerably. Even informants other than the architect and the art teacher recognized this. We could call the link a strong one.

4 ***School - assistant designers:*** a weak link

Even though the relationship between the school and the specialists in the city architect's office was a contradictory one, these relationships had no effect on the relationships between the school and the designers. The school and the assistant designers worked together and some of them are even mentioned as good collaborators from the school's side. We can call this link a weak one.

5 ***School - construction management.* a strong link**

A new actor introduced in this phase was the construction management. We were responsible for the construction phase of the project and our representatives attended the design meetings to check whether everything was all right from the construction point-of-view.

I was a new construction management chief and I attended some of the meetings. However, these few appearances raised strong but somewhat mixed feelings in some the of participants. In the first meeting I expressed my doubts about the budget. I said it would not hold. I also wished that a lot of energy should be invested in user participation in the project.

It looks like all this appealed to the school. They had unofficial meetings with the construction management where budgeting techniques and other problems were talked about. We can call the link between the school and the construction management a strong one.

6 ***School office - city architect's office: a strong problematic link***

The fact that these two could approach even difficult and emotional issues showed that the link was a strong one. Strong links may have their downsides, too (Janis 1982; Palonen 2003). In this case emotions and tensions were too strong and led to the wrong kind of institutional courtesy. The issues about mold and moisture were by-passed, because there were enough problems and load in the relationships already. There was no demand for new complicated issues. Because the link did not serve its purpose, it could be called a problematic one.

7 ***School office – architect:* a strong link**

In spite of the keen cooperation between the two parties, the school office was a little concerned about the architect's role as a designer of the original building and as a designer of its renovation. Would somebody else have had a different and more critical approach to the existing building?

This link should be analyzed as a contradictory one because of the concern. It is typical of strong links and deeper cooperation that actors are aware of other parties' strengths and weaknesses. This is one form of transactive memory (Moreland, Argote & Krishnan 1996): we are aware of when and in what matters others are good and when they are not. It is not self-evident and this is why we need reflection. The link between the school office and the architect could well be described as a strong one.

8 ***School office - construction management:*** *a weak problematic link*

My remark in the design meeting caught the school office’s attention. Had the programming of the project been done as well as possible? There was only one occasion and the information flow was not reciprocal even though it was a question of a serious matter to the school office.

9 ***Architect - city architect’s office: a strong problematic link***

There were differing interpretations about the relationship. The architect and the client saw the city architect’s office as the project manager in the design phase, whereas the city architect’s office said it was the architect. The city architect’s office claimed that once consultants were hired, why should the city architect’s office do their job?

The contradiction in the link between the architect and the city architect’s office lay in the fact that the reality of this link differed from its expected role. At this stage it was still a strong link, because the architect discussed all important matters with the office first.

10 ***City architect’s office - assistant designers:*** *a weak problematic link*

The conclusion made about the architect and the city architect’s office can be applied to cooperation between the assistant designers and the architect as well. The city architect’s office saw the architect as the leader of the whole design team, whereas the architect saw the client as the most important actor. This link remained weak.

11 ***City architect’s office - construction management:*** *a weak problematic link*

It may be that the tension in this relationship prevented an open discussion in other relationships. Other parties did not want to increase the burden on the city architect’s office any more. This was definitely a problematic link.

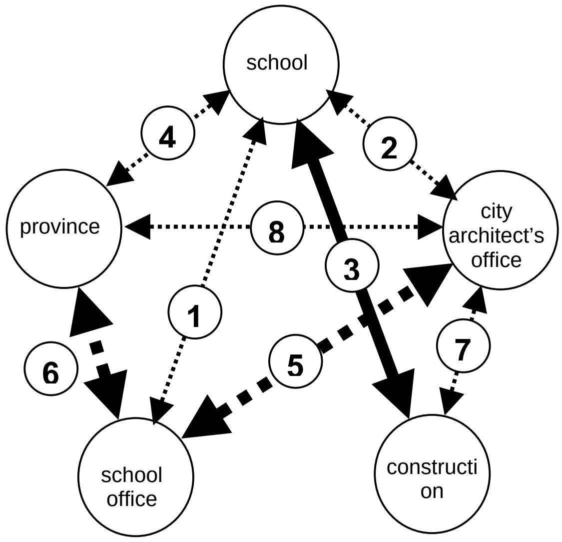
12 ***Architect - assistant designers:*** a weak link

Nobody mentioned this relationship, which was a confusing fact. There was a lot of discussion going on in Finland about the architect’s role as the head of the design team. However, all attended the same meetings and thus there was at least a weak link between them.

13 ***Architect - construction management:*** a weak link

The architect was also affected by the criticism from the construction management. However, the architect did not feel that his expertise was questioned. He was more surprised about the fact that there was not enough money. This was a weak link.

Phase 6: The provincial visit



1 Disagreement about responsibilities

2 Disagreement about roles

3 Two challengers of the old regime

4 Contradictionary interpretations about the nature of the tie

5 Disagreement about moisture problems

6 Suspicion of foul play on province's side

7 Tension because of accusations

8 The city has to obey and trim the plans

1 ***School - school office:*** *a weak problematic link*

The school office knew that the school was worried about the moisture conditions in the building, but they considered it the school's responsibility to react. This was a weak, problematic link.

2 ***School - city architects office:*** *a weak problematic link*

The school did not feel that they were responsible for the project. They saw it as a technical project carried out by the city architect's office or the facilities department. The school saw itself as an object of action, not as an actor. The other participants saw the school's role as more important as it did itself.

3 ***School - construction management:*** **a strong link**

The school felt that things were not going well, but it did not know how they should be run. The fact that the construction management department "shook the structures", structures which did not seem to serve the school well, pleased them. This was a strong link between two challengers of the old regime.

4 ***School – province:*** *a weak problematic link*

This could not be called more than a weak link, because there was no real exchange of knowledge. Again there was a contradictory interpretation of the tie.

5 ***School office - city architect's office: a strong problematic link***

In the maintenance period interviews the city school planner referred to how difficult it was to convince the city architect's office that moisture was a problem. The city architect's office reacted as it had reacted many times to other claims from the users' side: they saw it as a way to get more city resources than schools were rightfully entitled to. Technical matters were the city architect's office's responsibility and there was nothing the school office could do. So the relationship between the school office and the city architect's office "fluctuated", and at this moment they were in a state of contradiction.

6 ***School office – province: a strong problematic link***

What we are talking about here was a classic case of lack of trust, even though the link was strong and important information was exchanged.

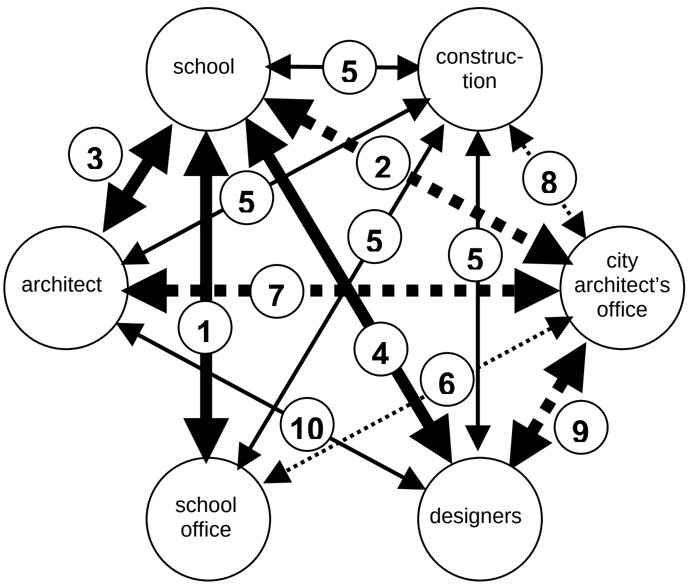
7 ***City architect's office - construction management:*** *a weak problematic link*

In the last phase, the construction management pointed to problems in the programming. When the province repeated the same story it did not make the relationship between the city architect's office and the construction management any better, for obvious reasons. The relationship remained tense.

8 ***City architect's office and province:*** *a weak problematic link*

There was no open discussion about the problems between the province and the city architect's office at this moment. The province had declared its will and the city had to obey. This relationship was a weak and problematic one.

Phase 7: The trimming of the design



1. The school office supports the school
2. The school is in opposition to the office's actions. Disagreements about the project management
3. The architect is on the school's side
4. The school became the client's representative in design matters
5. Routine action
6. Avoidance of responsibilities on school office's side
7. The architect had to submit to the trimming decisions
8. Disagreements about the project management
9. Disagreements about the project management
10. Routine action

1 ***School - school office:*** **a strong link**

A strong link was built between the school and the school office during the design trim rounds. The school office supported the school in the difficult decisions and the school accepted the school office's decisions. There were informal relationships as well.

2 ***School - city architects office: a strong problematic link***

There was the old suspicion that the users might take advantage of the situation and try to get more than their fair share for themselves. To prevent this from happening in the future the city architect's office decided to be very harsh on all who demanded extra money.

There was also lots of tension between the school and the office's experts who were in charge of the assistant design. The school worked independently with the designers, but at the same time there was pressure from the office's side to cut the plans and do less than suggested. Because of the need to change the plans the city architect's office tried to raise its profile as a project manager. This inevitably led to conflict between the school and the office in terms of the management of design work.

3 ***School - architect:*** **a strong link**

The more there was pressure from the city architect's office, the deeper the cooperation seemed to be between the school and the architect. The school interpreted that the architect was on their side against the city architect's office's efforts to change the plans.

4 ***School - assistant designers:*** **a strong link**

The school became the project manager in design matters.

5 ***Construction management – school/school office, construction management - assistant designers/architect:*** weak links

The construction management started to figure out how to cut the project into phases. It concentrated on these matters (there were several documents), but otherwise it had a much lower profile than in the previous phases. After all, it had got its wish: something was done for the budgetary problems. The construction management had weak links to the school and to the designers. It also planned the removals and arrangements together with the school office.

6 ***School office - city architect's office:*** *a weak problematic link*

It looked like the school office had disappeared from the project after the previous phase. However, this was not the case. It had to approve all the decisions made, and there are several documents produced by it related to budgetary and occupational safety matters. The school office tried to avoid its responsibility in this phase and handed it over to the city architect's office. This link could be called a problematic one.

7 ***City architect's office – architect: a strong problematic link***

The architect worked a lot with the office when the designs were trimmed. The way the city architect's office used its power over the design team made the relationship between the architect and the office a tensioned one. He and the school submitted to the decisions made.

8 ***City architect's office - construction management:*** *a weak problematic link*

The division of the project management into two phases (design and construction) was definitely a source of problems between the two. The party running the design phase saw that problems could be solved later during the construction phase, and the other party vice versa. Later the construction management was not pleased with the decisions made and the informants expressed it in the interviews of this phase.

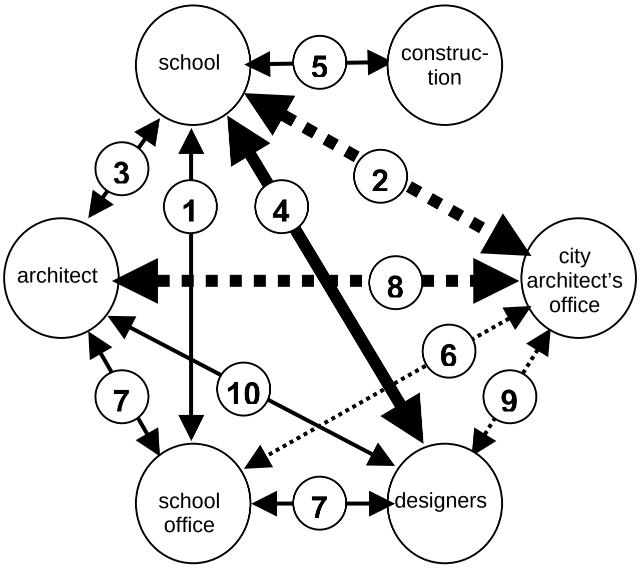
9 ***City architect's office - assistant designers: a strong problematic link***

Lots of work was done between the office and the designers. There were differing views on the client's side as to who was running the design process. This caused problems to the relationships between the assistant designers and the city architect's office. Who to obey?

10 ***Architect - assistant designers:*** a weak link

There was only one quotation concerning this link indicating that the architect had meetings with other designers. The cooperation between the architect and the assistant designers was on a purely technical level. All the important issues were dealt with in the meetings with the school.

Phase 8: The design period of winter 1998-1999



1 Participation through statements

2 Mutual suspicion after trimming process

3 Routine action on a weekly basis

4 Routine action on a weekly or monthly basis

5 Planning of phases together

6 School office was worried about moisture

7 Participation through statements

8 Different interpretations about the office's role as a supervisor

9 Different interpretations about the office's role as a supervisor

10 The school carried responsibility for this tie

1 ***School - school office**: a weak link*

The school office took part in the project from a distance. They handed in a statement of their opinion (doc 201), which was a one-sided act and fulfilled the criteria for a weak link. The school office saw to it, together with the city architect's office, that nobody exceeded the limits of the budget or the city standards of design. However, it was not very active in the latter role and that was why this was called a weak link.

2 ***School - city architects office: a strong, problematic link***

The relations of the school and the city architect's office had not changed. There was an argument about the moisture problems and trimming of the budget, but somehow the school seemed to accept the office's role as the nominal project manager. However, all the strings were still in the school's hands in terms of the management of the design process. The office was still suspicious about the school's motives and it had a keen eye on the project budget. Even if the link was a very active and close one, it was still problematic.

3 ***School - architect:*** a weak link

Only a few remarks referred to the relation between the school and the architect. There was no reason to doubt that the cooperation went in the way it had started. The art teacher talked a lot about her role as a coordinator and seldom mentioned the architect.

4 ***School - assistant designers:*** **a strong link**

It looked like there was lots of interaction between the school and the assistant designers. In many meetings they went through all the details. A lot had to be done with the phasing and temporary facilities and this gave the school the status of a central actor. The official supervisors were only interested in the end-result, the finished project, not in how the actual work was done.

5 ***School - construction management.*** a weak link

The phases were the only issue handled between the school and the construction management by this time.

6 ***School office - city architect's office:*** *a weak problematic link*

The school office was very worried about moisture, but did not express it strongly.

7 ***School office - architect/assistant designers:*** weak links

The informants representing the school office talked a lot about their statement of opinion, but not about other things. This was their only way to communicate with the designers.

8 ***City architect's office - architect: strong problematic link***

The art teacher talked like a project manager about her actions. Was the city architect's office supervisor of design or not? In the case of the architect this lead to strong tensions with the city architect's office.

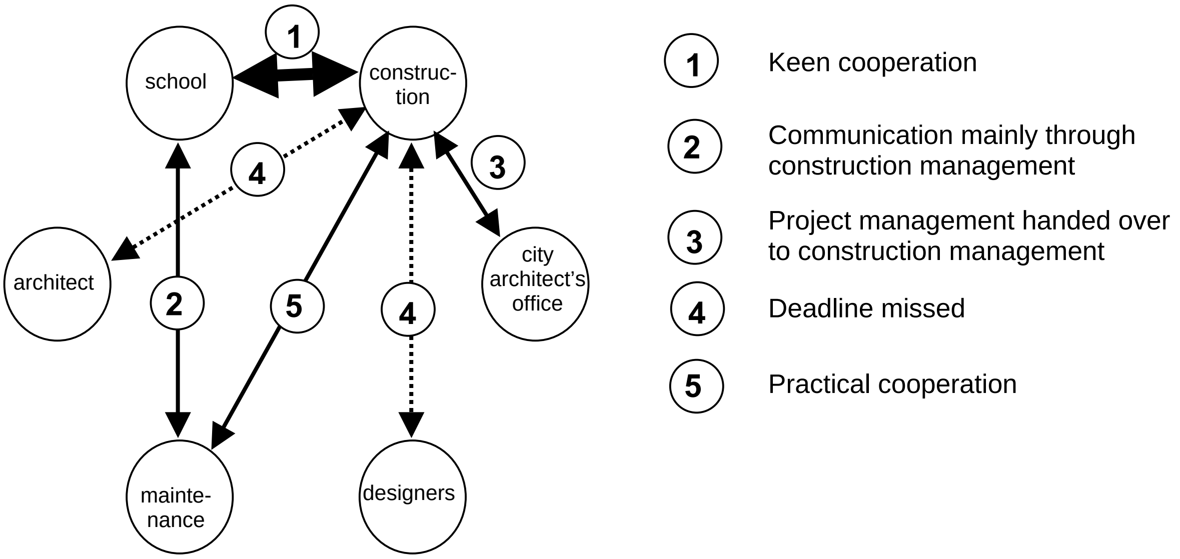
9 ***City architect's office - assistant designers:*** *weak problematic link*

The problem with the other designers were not as bad as they were with the architect.

10 ***Architect and assistant designers:*** a weak link

This was a weak link. There seemed to be no direct contact between the architect and the assistant designers without the art teacher's presence.

Phase 9: Preparation for the construction work



1 ***School - construction management:*** **a strong link**

From the very beginning, the relation between the school and the construction management was good. This was natural, because, unlike the city architect's office, the construction management spent lots of time at the site.

2 ***School – maintenance:*** a weak link

The school was very pleased with the efficiency of the maintenance department. The schedule was of vital importance to them and they were not disappointed. However, all the communication with the maintenance department went through the construction management, and the link between the school and the maintenance department stayed weak.

3 ***City architect's office - construction management:*** a weak link

It was amazing that there were no ceremonies or interaction between the two project managers when the project changed hands.

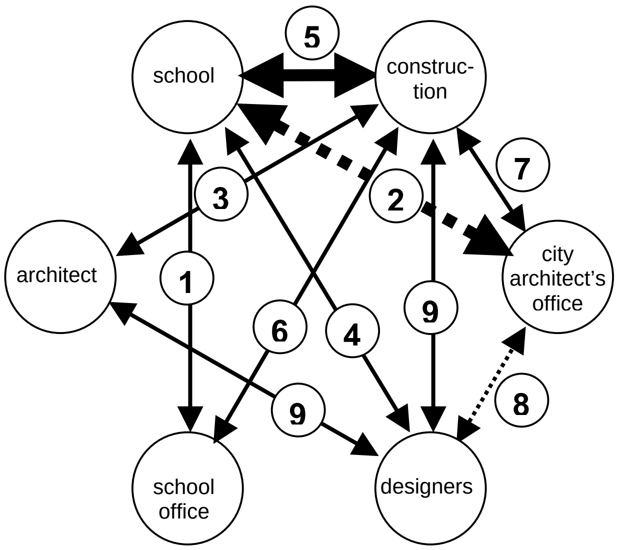
4 ***Architect/assistant designers - construction management*:** *weak problematic links*

The construction management was not pleased with the fact that the designs were late. They did not have enough time to study the drawings and this caused them lots of problems later.

5 ***Construction management - maintenance:*** a weak link

The cooperation between the construction management and the maintenance department was good and clear but stayed on a very practical level.

Phase 10: The work starts at the site



1 Formal relationship

2 The finding of mold traumatized the relationship

3 Visits at site, meetings

4 The art teacher contacted the designers if necessary

5 Many problems solved together, investigation of mold and moisture

6 The office accepted and was pleased with the cooperation between the school and the construction manager.

7 The office kept at distance

8 The distance caused problems for this tie

9 Meetings

1 ***School - school office:*** a weak link

This was a very formal relationship between the central office and its subordinate.

2 ***School - city architects office: a strong problematic link***

The tie was strong because of the mutual attempts to get information (about mold), but it was problematic one, because no information (laboratory results) was given.

3 ***Construction management – architect:*** a weak link

The architect visited the site and attended meetings.

4 ***School - assistant designers:*** a weak link

The designers were not active. The art teacher contacted some of them.

5 ***School - construction management:*** **a strong link**

After problems with mold were detected, the cooperation between the school and the construction management became even closer than before. Together these two started to investigate the extent of the moisture and mold problem. There were many other problems solved together. Small victories were celebrated together when the school started and temporary spaces were ready for pupils and staff to move into. It was not only the art teacher and the senior construction manager who did well together, other people from their organizations shared the good feeling.

6 ***School office - construction management:*** a weak link

The school office was pleased and saw no reason to interfere. Temporary spaces were checked and accepted.

7 ***City architect's office - construction management:*** a weak link

The city architect's office had transferred the project to the construction management and therefore it kept at a distance.

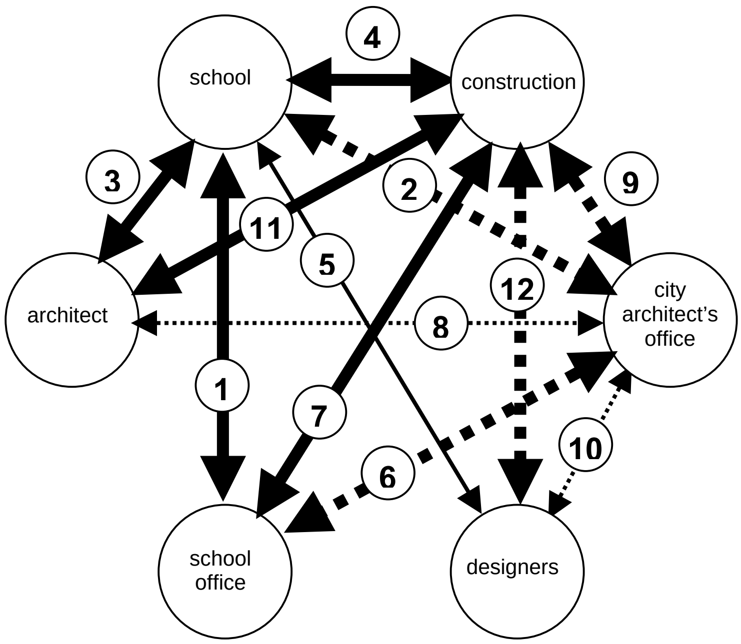
8 ***City architect's office - assistant designers:*** *a weak problematic link*

Because of the distance there seemed to be problems arising. Specialists in the office were not pleased with the designers and suspected that they were not spending enough time on the building site.

9 ***Architect – assistant designers:*** a weak link

The architect arranged a meeting where the plans were checked.

Phase 11: The crisis of fall 1999 and its resolution



1 The office helped and school was grateful
2 There was exchange of information, but the mold problem cast a shadow over the tie
3 Mutual feeling of trust could last even through disputes
4 An alliance born in the middle of crisis
5 Cooperation on routine basis
6 Cooperation, but fundamental disagreement about the approach to project management
7 Joint efforts to raise more money
8 Disagreement about extra work
9 Division between design and construction problematic
10 Disagreement about extra work
11 Difficult problems solved together on daily basis
12 Poor quality of design work

1 ***School - school office:*** **a strong link**

The school was in crisis and the school office supported it as its parent organization. In every site meeting representatives of the school office asked for structural details and were worried about the insufficient investigation of mold and moisture. When more money was needed the office did its utmost to help the school. The school recognized this and was very grateful. When the school decided not to raise a public outcry, the school office felt relieved.

2 ***School - city architects office: a strong problematic link***

This was definitely a strong link, because so much information, both explicit and tacit, was exchanged. The new educational equipment was designed together. The mold and moisture problems were discussed thoroughly and the city architect's office accepted the art teacher's role as a person who knew a lot about the subject. However, the link was contradictionary as well. The school was not sure whether the city architect's office was aware of all the consequences of the mold problem and it gathered information on its own. The art teacher became famous for knowing all the germs and bacteria by name. By doing this she crossed an institutional border and became a rival of the experts. The experts sensed that their expertise was being questioned and they felt hurt. So, even though a common language was created, a language containing a specific vocabulary, the relationships were characterized by distrust and tension. There was a negative dialectic process going on: the more each party worked on the problem, the worse it got (Morgan 1996; Senge (1994) describes a systemic archetype of *escalation*).

3 *School – architect:* a strong link

There was one incident which was illustrative of the relationship between the architect and the art teacher. There was a dispute about the color of the exterior cladding. To find out the alternatives a trip was made to the factory producing the panels. The architect preferred silver grey but the school - not only the art teacher, but the others as well - disagreed. A test was made and different panels were hung on the school wall. There were several meetings and plans (docs 351, 358, 359, 365, 368). Finally the school won this debate. The architect accepted defeat and this caused no harm to their relationship.

It looked like the school and the architect had gone through so many battles together that they could disagree without losing the feeling of mutual trust. The quarrel about the color was remarkable in the sense that aesthetics is the core field of an architect's expertise. Of course, the art teacher was an expert in aesthetics as well, but still there was a fundamental difference compared with the link to the city architect's office with reference to mold matters. A dispute is not a dispute if both parties can handle it in an adult manner.

4 *School - construction management:* a strong link

The relationship between the two parties was as intense as it can be. The two organizations were almost united as one. However, there was not only sunshine. The construction management had the money and the school was painfully aware of its own position as an underdog. However, it was easier to deal with the construction management than with the city architect's office. The discussion was about matters and money, not about institutional borders. The parties were not suspicious about each other's motives. The aspirations of the other were clear and understandable to both, the problem was that these aspirations were not easy to achieve.

5 *School – assistant designers:* a weak link

The school cooperated with the assistant designers and they saw each other in the meetings, but there were no special remarks about the relationship.

6 *School office - city architect's office: a strong problematic link*

After the mold was detected, the school office became active. It raised the mold question in every site meeting in the fall (docs 347, 366, 381) and insisted that the necessary measures be taken. It was difficult to say from the documents whether these demands were aimed at the city architect's office or the construction management, but it was clear that there was a lot of pressure on the city architect's office because of its role in the design process.

However, there was lots of cooperation and exchange of knowledge on many levels between the city architect’s office and the school office in this phase and thus the link can be called a strong one. The fundamental disagreement about the approach to project management made this link a problematic one as well.

7 ***School office - construction management:*** **a strong link**

The school office and the construction management had to join their efforts if they wanted to get more money for the project. There was a demand for cooperation on many levels.

8 ***City architect’s office – architect:*** *a weak problematic link*

There was a disagreement about the extra work needed due to poor project management. The city architect’s office approved the designs on an official level and in the form of statements. With respect to the essence of the design work, the city architect’s office let the architect do what he wanted. The city architect’s office tried to minimize its effort.

9 ***City architect’s office - construction management: a strong problematic link***

All the decisions related to the design were the city architect’s office’s responsibility. The office was needed in all important decisions on the building site. However, it was not responsible for the decisions it made and it executed its authority through statements and official minutes. Even some representatives of the office itself criticized this state of matters. A project - and a renovation project especially - cannot be divided into design and construction.

It could be deduced from some comments that the good atmosphere on the site had spread to this link as well. However, it could be called a strong but problematic link.

10 ***City architect’s office - assistant designers:*** *a weak problematic link*

The link was similar to the one between the office and the architect. The city architect’s office was not willing to pay for the extra work. According to the office the designers were responsible for insufficient research of the structures and they should not have been paid more for correcting their own mistakes. The designers were not motivated to do underpaid work and this was noticed by the third parties. The office tried to avoid doing things themselves and guided design through statements. This did not work out and the office experts had to do some design themselves. It was a problematic link and a weak link.

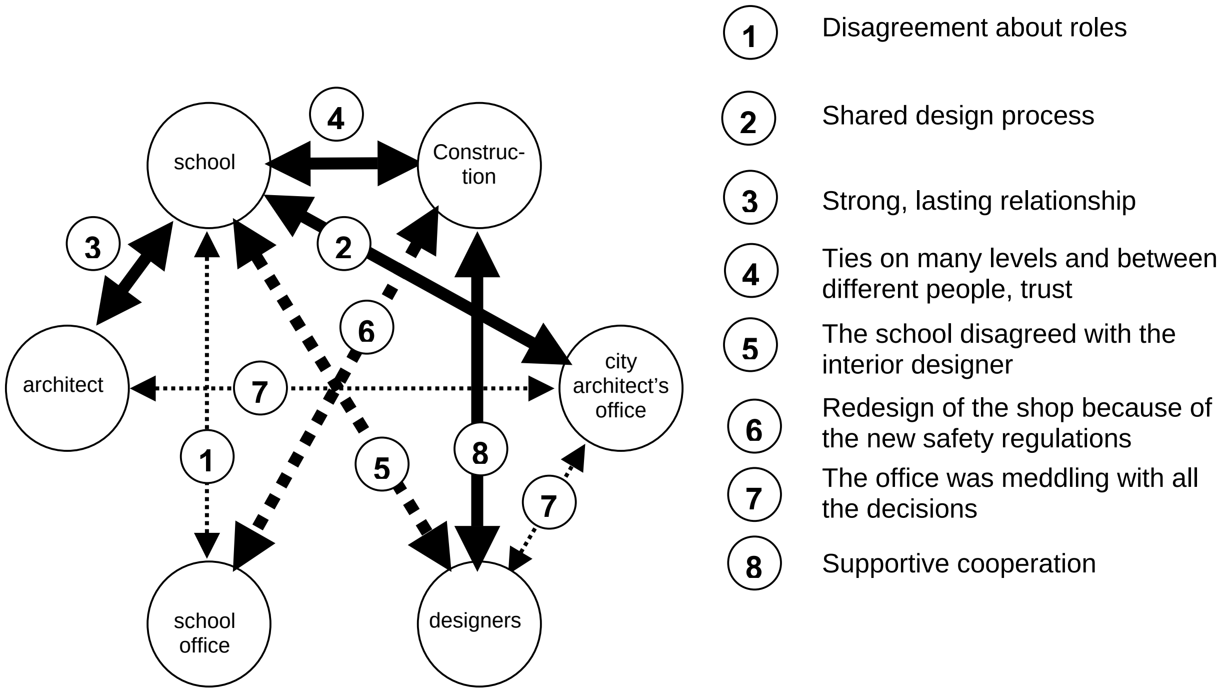
11 ***Architect - construction management:*** **a strong link**

The junior construction manager’s statement about problems which unite people applied to the relationship. The work was done together and lots of energy was invested in figuring out better ways of doing things. The site crew contacted the architect on a daily basis. There were plenty of documents related to this link.

12 ***Construction management - assistant designers: a strong problematic link***

The construction management was dependent on the assistant designers as well. However, it looked like the construction management blamed the assistant designers for the poor design and insufficient research. The poor research caused lots of problems on site and part of them were difficult to solve. The city architect’s office’s role as a mediator between the construction management and the assistant designers did not ease the situation. There were lots of documents related to this link, which was a strong but problematic one.

Phase 12: The work at site



1 ***School - school office:*** *a weak problematic link*

After the crisis was over and no mutual support was needed, the underlying problems in the relationship between the school and the school office reappeared. There seemed to be a disagreement about who was the client’s representative. This was a weak link, because the school office stayed in the background, but it was a problematic one because of the conflict.

2 ***School - city architects office:*** **a strong link**

There was only one reference to this relation and it was a positive remark about the electrical engineer’s role as a mediator. He cooperated with the school when the new integrated classroom system was designed. There was a shared design process and this made the link strong.

3 ***School – architect:*** **a strong link**

This relationship was a lasting one. On a public occasion the representatives of the school said something negative about the architects’ competence in choosing colors, but the architect chose not to comment on it.

4 ***School - construction management:*** **a strong link**

This was the strongest link during this period, for obvious reasons. The school and the construction team were working together under the same roof. Classes went on at the other end of the building. The removal of classes was a big effort and the construction team helped the school. Pupils could visit the building site. There were ties on many levels and between different people. People were worried about each other's well-being and health. There were unsolved issues, but they were worked out in an atmosphere of trust and collective responsibility.

5 ***School - assistant designers: a strong problematic link***

The problems were focused on interior decoration. She was a key designer at this stage and there was lots of work to be done.

6 ***School office - construction management: a strong problematic link***

The redesign of the shop caused lots of problems for the construction team. The team had to believe the school office when the office declared that the redesign had to be done due to new safety regulations.

7 ***City architect's office and assistant designers/architect:*** *weak problematic links*

The office was still dubious about the designers' role in the design process. Did they suggest light renovation, because it was easier to design? The designers felt that the project management should have decided upon the level of the work before it commissioned the design work. After the crisis the office was not present at the building site and the designers were more or less on their own. However, the office was meddling with all the decisions. When the designers asked for advice, the office saw this as a sign of incompetence.

8 ***Construction management and assistant designers:*** **a strong link**

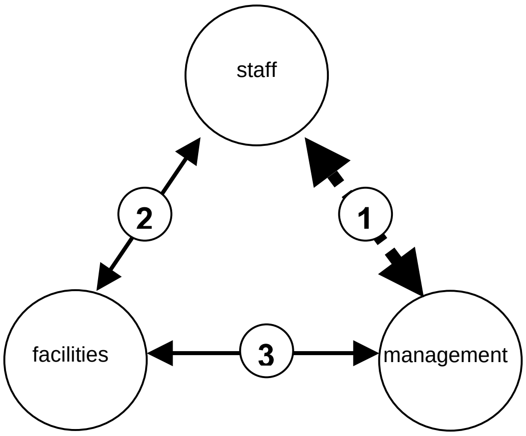
The only reference was the one where the construction management's sympathies were on the interior decorator's side in a conflict with the school. A strong link, because the construction management had to prepare many procurements with the decorator.

Appendix 7: Network links in Case 1(Hakala)

Case 1 (Hakala) links	**maintenance**	**visit**	**programming**	**team formed**	**design 1997**	**prov. visit**	**trim**	**design 1998**	**preparation**	**work starts**	**crisis 1999**	**work at site**
school-school office	───	━━━	■ ■ ■ ■ ■	■ ■ ■ ■ ■	───	···········	━━━	───		───	━━━	···········
school-city architect's office	···········	missing	···········	missing	···········	···········	■ ■ ■ ■ ■	■ ■ ■ ■ ■	missing	■ ■ ■ ■ ■	■ ■ ■ ■ ■	━━━
school-architect			━━━	━━━	━━━		━━━	───	missing	missing	━━━	━━━
school-CM					━━━	━━━	───	───	━━━	━━━	━━━	━━━
school-designers				···········	───		━━━	━━━	missing	───	───	■ ■ ■ ■ ■
school office- city arch. off	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	───	■ ■ ■ ■		···········	···········		missing	■ ■ ■ ■ ■	missing
school office-architect			───	───	━━━		missing	───		missing	missing	missing
school office-CM					···········	missing	───	missing		───	━━━	■ ■ ■ ■ ■
school office-designers				missing	missing		missing	───		missing	missing	missing
city architect's office-architect			···········	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	missing	missing	···········	···········
city architect's office-CM					···········	···········	···········	missing	───	───	■ ■ ■ ■ ■	missing
city architect's office-designers				···········	···········		■ ■ ■ ■ ■	···········	missing	···········	···········	···········
architect-CM					───		───	missing	···········	───	━━━	missing
architect-designers				···········	───		───	───	missing	───	missing	missing
CM-designers					missing		───	missing	···········	───	■ ■ ■ ■ ■	━━━
school-maintenance	■ ■ ■ ■ ■	missing							───			
school office-maintenance	···········	···········										
city architect's office-maint.	···········	missing							missing			
CM-maintenance									───			
maintenance-designers/arch									missing			
province-school						···········						
province-school off.						■ ■ ■ ■ ■						
province-city arch. o.						···········						
province-CM						missing						

Appendix 8: Description of network links in Case 2 (Kangas)

Phase 1: The renovation group



1 Different parties saw this link in a different manner

2 Attendance, but no active participation on facilities side

3 Attendance, but no active participation on facilities side

1 ***Management-staff:*** **strong problematic link**

Staff attended the work through its representatives. There were trips and brainstorming sessions. All departments processed the results in their own meetings. Important issues were dealt with in a very thorough manner. However, there were severe flaws in the cooperation. The staff was working in shifts, which meant that the representatives were changing from meeting to meeting. The staff was not actively participating in the work. The renovation was not seen as a realistic alternative in the foreseeable future. Nobody talked about great inventions made in the group or true enthusiasm. Thr link was problematic, because it did not serve its purpose and different parties saw it in a different manner.

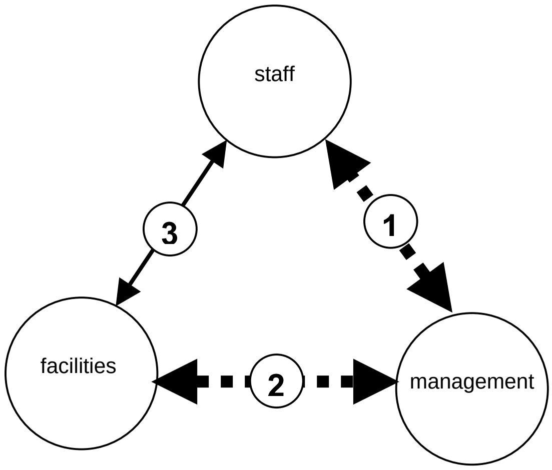
2 ***Management-facilities:*** weak link

There was a link, because the facilities took care of the budgeting, attended some of the trips, and even attended some of the meetings later. The facilities were by no means active participants at this stage.

3 ***Staff-facilities:*** weak link

The facilities attended the trips and some of the meetings together with the staff.

Phase 2: The project definition committee 1



1 Intensive work but no shared views

2 Facilities did not have time or resources

3 Relationship was mediated by management

1 ***Management-staff: strong problematic link***

There were many disputes both in the committee and in the renovation group. These disputes dealt with the organization of the daily work in the renovated center: whether there should be a central kitchen or whether the food should be cooked in the departments. There was a similar kind of discussion about the medicine storage. Members in both groups changed and when matters were taken to the departments they were not agreed on. The work was intensive and dealt with important matters but there were no shared views.

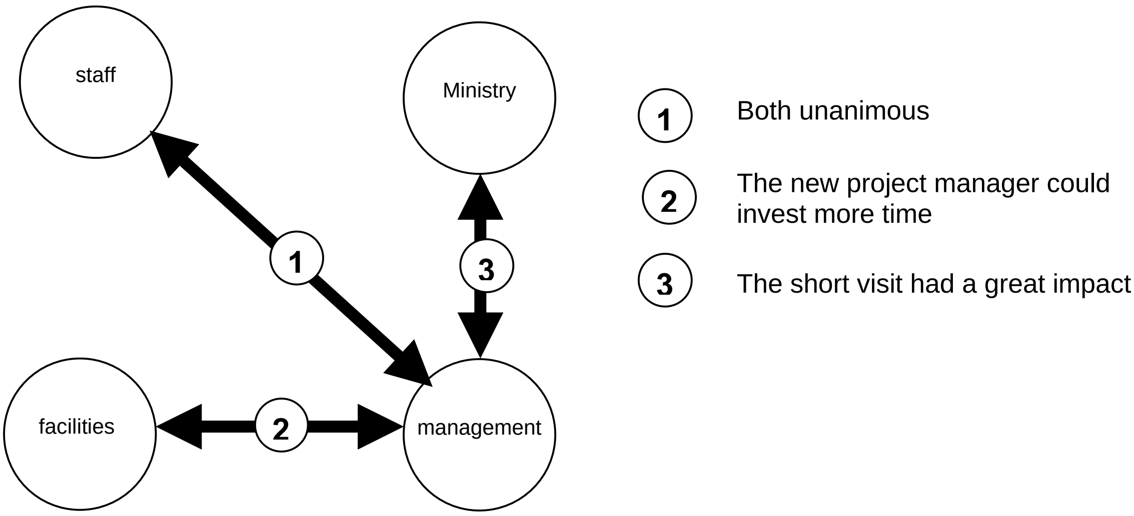
2 ***Management-facilities: strong problematic link***

Facilities were an important partner for the service center. The service center was very active and demanding in its collaboration. However, there had been reorganizations in the Facilities Department and the former head of the Architect´s Department was made the head of the Facilities Department. He did not have enough time and resources to concentrate on the committee's work. He was also worried about the budget and this cast a shadow on the cooperation. The facilities took part in trips and it produced the minutes and other material, but still there were growing problems in the relationship. The head of the service center was about to retire and this may have affected her motivation to really invest in the project.

3 ***Staff-facilities:*** weak link

Both attended trips and exchanged materials. The head of facilities attended the renovation group meetings. However, the important issues were discussed in the committee. The facilities did not cooperate directly with the staff, there was the management as a messenger between the two.

Phase 3: The experts from the Ministry visit Kangas



1 ***Management-staff:*** **strong link**

During the big decision staff and management seemed to be unanimous. There were training days and the Ministry report was analyzed together. There was no reason to doubt that the link is strong.

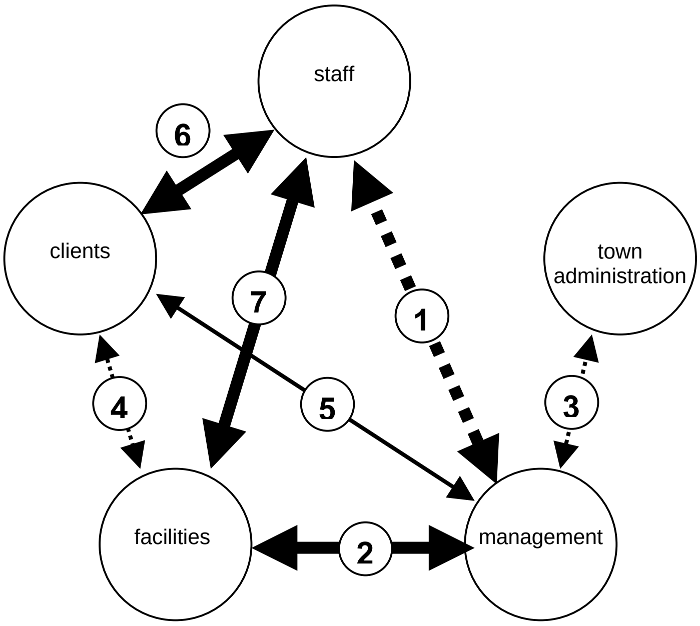
2 ***Management-facilities:*** **strong link**

The change of project manager improved the relationships. From the very beginning cooperation was deep and based on mutual trust and understanding. What was most important was that the new project manager could invest more of his time in the project than the previous one.

3 ***Management-Ministry:*** **strong link**

It is amazing how great an impact a short visit and a report can have on a project. It looked like the ideas introduced were not all new to the Kangas people. Better room arrangements were discussed , but they were rejected because of the loss of beds and cost increases that would have followed. However, everybody seemed to agree that the new direction and the momentum given to the project was a direct consequence of this intervention. The link is strong even if it lasted for a limited time.

Phase 4: The project definition committee 2



1 Working in shifts and poor motivation affected cooperation

2 The new project manager prepared an excellent project definition plan

3 The project definition plan was not introduced to the town administration

4 Facilities was informed by the staff about clients' needs. The model room helped.

5 Model room, info corners and other methods served as a channel

6 Model room provided a channel for exchange of knowledge

7 Model room provided a channel for exchange of knowledge

1 ***Management-staff: strong problematic link***

The staff felt that it was not listened to and that participation was not organized in the way it should have been. The only thing everybody was pleased with was the model room and the way it was used.

2 ***Management-facilities:*** **strong link**

The appointment of the new project manager had a positive effect on the cooperation between management of the service center and the facilities. Finally the physiotherapist had an ally and a partner from the technical side. All the new methods, the model room, the cards, and the info-corner were eagerly accepted and applied by the management. The project manager had an active and positive attitude and this pleased the staff. As a result an excellent project definition plan was produced and it was later appraised by the other parties. There were problems, though. The info corner and the cards did not work as well as planned and the security and nurse calling systems caused lots of problems and tension. However, these were minor incidents compared with the overall level of interaction between the two.

3 ***Management-town:*** *weak problematic link*

So the town administration was informed about the renovation. Should it have been better informed? The later incidents showed that the problem with this link was that it was not strong.

4 ***Facilities-clients:*** *weak problematic link*

Facilities tried to reach the end-users in several ways: through the info corner and through the model room. It only succeeded in the model room. Otherwise the information came filtered through the staff.

5 ***Management-clients:*** weak link

There was no direct connection between the management and the clients. All the information came through the model room, the info corner, and from the physiotherapist. Even though the link was weak, important information was delivered.

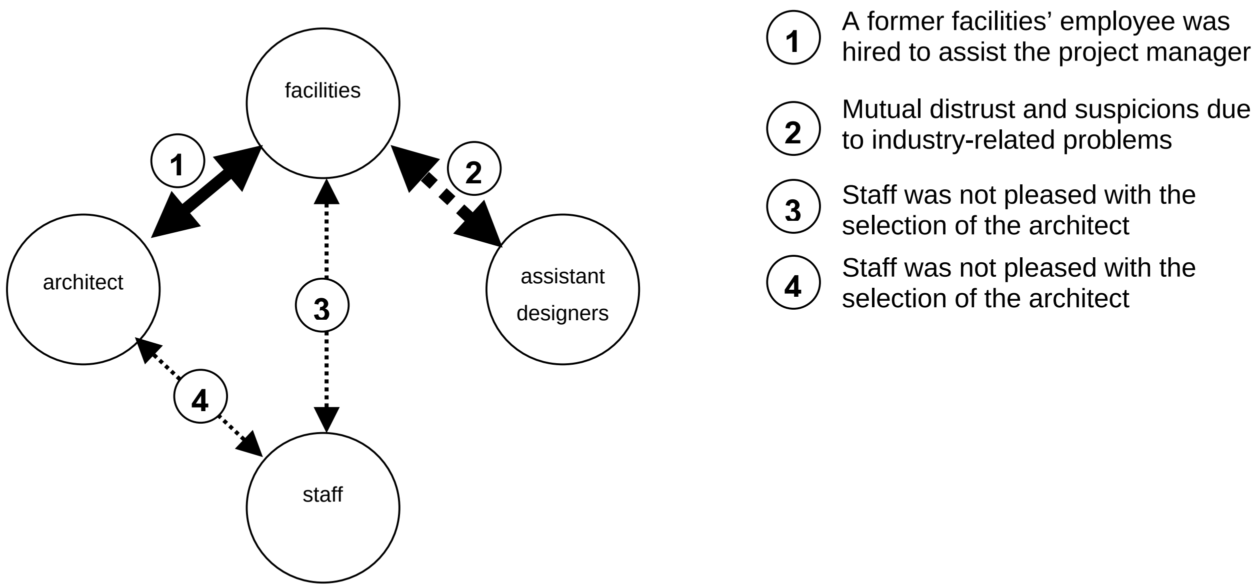
6 ***Staff-clients:*** **strong link**

The work done in the model room was a good example of a strong link. Even when part of the clients were severely demented, they could communicate with the staff about important matters through means of the model room. Important alterations were made. One example was the white railing by the bath-tub. It was made red, because the clients could not see the white railing against the white bath-tub. The next of kin contacted the staff about the matters concerning the renovation directly, they did not use the info corner.

7 ***Staff-facilities*****: strong link**

The model room helped a lot in making this link strong. Through the experiments and reports written the facilities got a good conception of what the staff thought about the design. The info corner was used by the staff. It was remarkable that the facilities was even more worried about the user participation than the management. The facilities were genuinely interested in making the situation better for the lay participants and understood their problems. It looked like the staff sensed this and appreciated the attitude that facilities had adopted in matters concerning their democratic rights.

Phase 5: The selection of the designers



1 ***Facilities-architect:* strong link**

The facilities did not have enough resources for the project. The project manager was the designer and the construction manager at the same time. User participation consumed his time. He needed somebody to assist him in the design work. Under new EU-laws the designer procurement process took a long time. It was a lucky coincidence that the town had a contract with the architectural firm and that the firm had a former facilities worker as its employee. The architect was an old friend, everybody liked her, and she was known as an effective and talented professional. Her presence was considered a necessity.

The architect started to work on the project immediately. At this time she was learning the fundamentals of the project and working on the general plans with the project manager. So in the very beginning the link was strong.

2 ***Facilities- assistant designers: strong problematic link***

This link was a problematic one, but it is questionable whether it was problematic from the very beginning. After all, this was just a procurement process, firms sent their bids, and one was chosen. The link was seen as a problematic one, but the informants' considerations were colored by later incidents. However, there was mutual suspicion hanging in the air even during the selection process. The design firms felt that they were exploited by the clients, the fees were poor, and the schedules too tight. The facilities felt that consultants were after money and they were not interested in serving the client well. When referring to the link, the informants talked a lot about how things usually were, not about the actual case at hand. The designers admitted that this time there was a proper project definition plan and they appreciated the way the selection was arranged. The client assumed that finally they had bought quality instead of pure efficiency. But it looked like the past experiencesof both sides had been so bad that there was a mutual feeling of distrust from the very beginning.

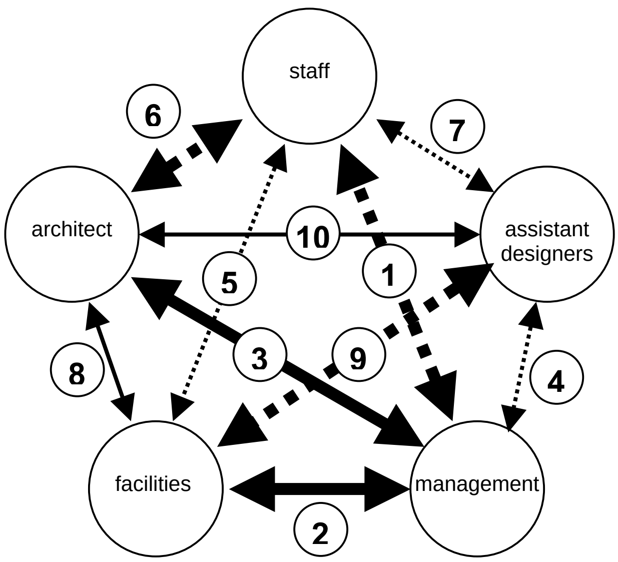
3 ***Staff-facilities:*** *weak problematic link*

One of the informants said that the staff had its own candidate for an interior designer, but they were not listened to. If this was the case, we can call this a problematic link.

4 ***Staff-architect:*** *weak problematic link*

If the staff had wanted another designer, it would explain why the cooperation was so difficult from the very beginning.

Phase 6: The design



1 Staff felt alienated from the design process due to the way it was organized

2 The cooperation between the project manager and the physiotherapist worked out fine

3 The physiotherapist was the architect’s ally in disputes with the staff

4 No shared language was found

5 No direct contacts were allowed

6 The architect worked with the physiotherapist only

7 No shared language was found

8 The cooperation was so good that no stronger link was needed

9 Schedule slippages and doubts about each other’s motives

10 The cooperation was so good that no stronger link was needed

1 ***Management-staff: strong problematic link***

There were occasions when the management chose the designers’ side in the disputes between users and designers. The staff felt abandoned. They had to work hard on design work when questions poured in from the design team. This extra time was taken from their daily responsibilities. The staff felt that they were made to do the designers’ work.

2 ***Management-facilities:*** **strong link**

The whole idea of the way in which user participation in Kangas was organized was to make this link strong. Both parties had defined representatives and the communication between the two was thorough and took place on a weekly, if not daily basis. The project manager's work and manners were appreciated by the management. The project manager was pleased with the assistance he got from the physiotherapist.

The way decisions were made inside the service center was complicated, but the physiotherapist could interpret the situations to the project manager. The project manager was sometimes very strict when it came to the money and changes to things already agreed on in the project definition plan, but the other party understood his position as the one responsible for the project. A strong link does not mean that sun is shining all the time. The stronger the link, the more it can take.

3 ***Management-architect:*** **strong link**

The architect worked a lot with the physiotherapist. The architect often contacted her directly without consulting the project manager first. The physiotherapist was the only contact the architect had inside the service center. This led to situations where the physiotherapist was defending the architect's designs against the opinion of the staff. There were lots of e-mails and pdf-files send, because the architect was working in a city 80 km away. The link could be considered a weak one, if there had not been situations when the physiotherapist and the architect had to take a lot of pressure from the staff's side. And, of course, the matters dealt with were of a very profound nature.

4 ***Management-assistant designers:*** *weak problematic link*

The management and the assistant designers hardly ever met. The designers thought that the users would not understand the technical drawings anyway, and saw them more as a nuisance than as a customer. The only time these two met were in the official design meetings, where all off a sudden a pile of drawings were spread on the table. Later the management understood that they should have spend much more time studying the technical drawings. What made this link problematic was the fact that it was weak.

5 ***Staff-facilities:*** *weak problematic link*

Because the link between the management and facilities was strong the link between facilities and staff was weak. Whether the two-step-arrangement made the link problematic or not is an interesting question. The staff felt that it was too far away from the point where decisions were made and they were not listened to. The facilities felt the situation problematic as well. It had to rely too much on the information which was not coming directly from the users. At this time the model room was used for only some details. Everybody agreed later that the technical solutions should have been tested in the model room as well.

6 ***Staff-architect: strong problematic link***

The architect worked with the physiotherapist only. She was far away and it would have consumed too much energy to keep in contact with the rest of the staff. This strategy backfired. The architect became a scapegoat in a dispute between the staff and the management. She was considered the source of all ills when the staff felt that they were bypassed. “Where did you find this lady”, somebody said. It may be that architectural design, colors and materials were more tangible and that was why the architect had to carry the burden of the staff's hatred instead of the other designers. She was also present more often than the other designers, who were hardly ever seen by the staff.

7 ***Staff-assistant designers:*** *weak problematic link*

The staff never saw the assistant designers and did not know who they were. The janitor felt that he was neglected as a source of information. One has to be amazed about the manner in which some of the assistant designers described this relationship. The users were seen only as a nuisance, demanding impossible things, and making the design process more complicated, without offering anything to it.

8 ***Facilities-architect:*** weak link

There was a good working relationship between the project manager and the architect. The architect was working in another city, but the two communicated via e-mail. The architect worked independently with the user but kept the project manager aware of what was going on. The division of labor was self-evident and they hardly had to discuss about it. This smoothness and the light way the relationship was described in interviews gave the impression that this relationship was so automated that it had become weak. This weakness of the link had no effect on the quality of work. Is it so that when cooperation reaches the highest level, it can be and is best handled through a weak link?

9 ***Facilities- assistant designers: strong problematic link***

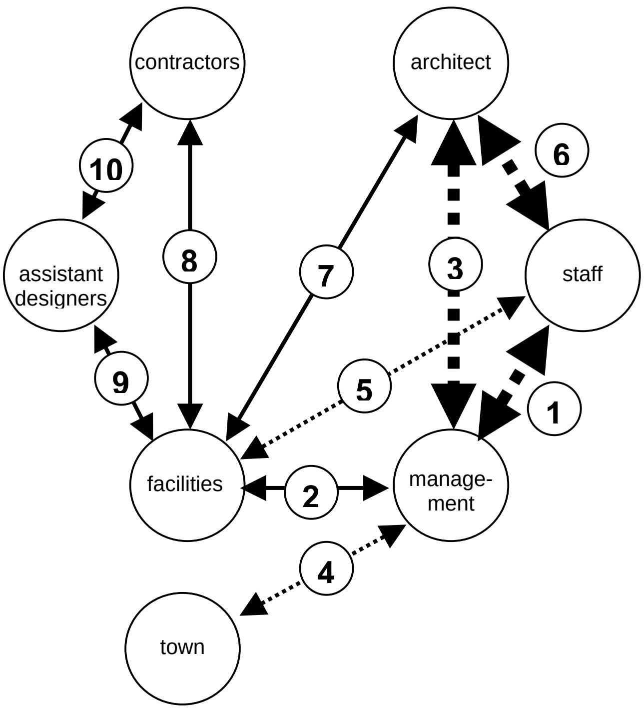
It is difficult to find a better example of a strong problematic link than the relationship between the facilities and the assistant designers. It was a strong link, because extremely complicated matters were dealt with, the time spent on matters was long, a special vocabulary was used, and deep understanding of each other´s field of expertise was needed. However, almost everything failed from the very beginning. The schedule did not hold and this affected all relationships, not only the ones between the client and the designers but the ones between the designers as well. Everybody was accusing each other of delays. There were doubts about each other's motives. The town representatives thought that the designers were greedy and took too many commissions simultaneously. The designers thought that the town employees were lazy by nature.

It may have been that the too tight schedule caused a systemic problem. Once somebody slipped from this dead-line, it was impossible to correct it later. When more time was given, it was too late. Everybody was working on the next project already. The time slot reserved for the project had gone.

10 ***Architect-assistant designers:*** weak link

This link was similar to the one between the project manager and the architect. All the consultants worked in the same city. The architect worked as a link between the facilities and the designers. She even arranged a meeting between them. Otherwise everything was taken care of by e-mails. There was one occasion when a lighting fixture was chosen together with the electrical engineer and the architect, but otherwise this was typically a weak link.

Phase 7: The selection of the contractors



1 “The color war”: the staff feels bypassed in design

2 The facilities concentratred on the procurement process

3 The management had to take staff’s side in “the color war”

4 Everybody was amazed by the mayor’s reaction

5 The project manager acted as a mediator in “the color war”

6 “The color war” reached almost a personal level

7 “The color war” did not affect this link

8 The first meetings

9 The assistant designers attended the meetings

10 The first meetings with the contractgors

1 ***Management-staff: strong problematic link***

Gradually the management understood that it had to take the staff’s side in the dispute about the colors. This put the physiotherapist into a tricky position. She got blamed for overdoing her job as a secretary of the renovation committee. It was argued that as a physiotherapist she did not represent the staff as a whole. She had to retreat in the matter. However, during the fall of 2003 there was a continuous debate going on.

2 ***Management-facilities:*** weak link

The facilities were concentrating on the complicated negotiations of contracts. The management did not take part in them, even though the project manager later thought that it would have been a good idea to have the users’ representative present in the meetings. Issues like the arrangement of works in the functioning institution were dealt with in the contract negotiations and a users’ representative could have given good advice.

3 ***Management-architect: strong problematic link***

The link between the management and the architect stayed strong during the “color war”. There were important decisions to be made. It was natural that the situation between the management and the staff affected this link as well. The management had to take distance from the architect. However, all this made the link even stronger.

4 ***Management-town:*** *weak problematic link*

The dispute between the mayor and the management had a negative effect on this link. Everybody was amazed by the mayor´s reaction.

5 ***Staff-facilities:*** *weak problematic link*

Just by the time of the first interviews the project manager was asked to act as a mediator in the “color war”. He did it, but reluctantly.

6 ***Staff-architect: strong problematic link***

This relationship was intense and problematic during the rest of the year 2003. Both parties saw that they were bypassed as professionals. Some of the outsiders saw this plainly as a power game. The architect may have been an innocent scapegoat in the delicate relationship between the management and the staff, but she did not ease her situation by not retreating early. The matters reached almost a personal level.

7 ***Facilities-architect:*** weak link

Facilities was asked to be a mediator in the dispute. The staff reaction was an annoying matter to the facilities but on no occasion did it draw its support from the architect. It saw this more as a domestic matter, not as something the architect had brought about. The facilities had other things going on and it could not concentrate on this matter.

8 ***Facilities-contractors:*** weak link

There had been a bidding process and both parties had met in the meetings for the first time. Nothing extraordinary cropped up, the real problems started later when the flaws in the designs were found.

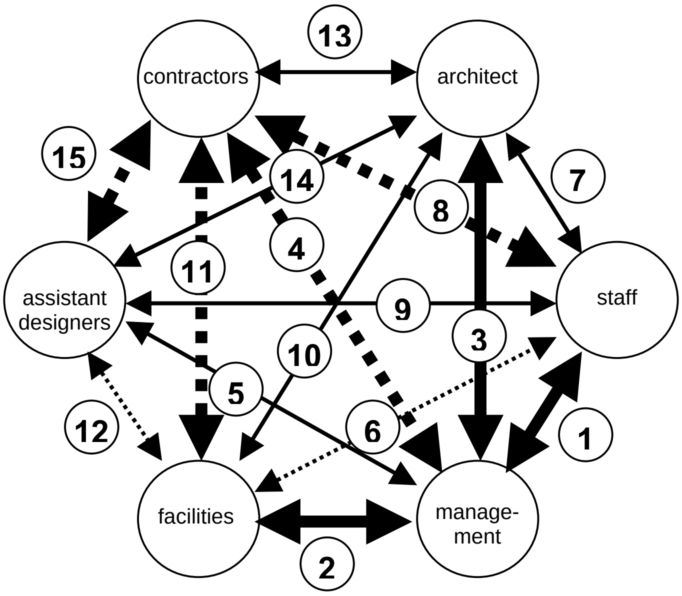
9 ***Facilities- assistant designers:*** weak link

The facilities were still feeling sorry about the way the design process was handled, but at that moment no new issues came up. The assistant designers took part in the contract meetings as the client’s experts.

10 ***Contractors-assistant designers:*** weak link

The assistant designers took part in the contract meetings as the client’s experts. They answered questions concerning the designs.

Phase 8: The first phase of construction



1 The staff realized its position and was pleased with the situation

2 The beginning of works put this relation to the test but it lasted

3 The relationship grew stronger in “the color war”

4 The appearance of the builders in a working institution was a shock for everybody

5 Both attended the site meetings

6 Feeling of abandonment on the staff’s side

7 The architect met the staff in meetings.

8 Tension between the two parties: everybody protected their own territory

9 All the information went through third parties

10 A clear division of labor

11 Problems with side-contractors due to poor quality of design

12 The poor plans caused accusations and lack of trust

13 The architect contacted the master builder if necessary

14 The architect contacted the assistant designers if necessary

15 The contractors complained about the quality of the design, and the absence of the designers

1 ***Management-staff:* strong link**

The system of having a mediator between the contractors and staff seemed to please everybody. If there were problems with the work arrangements, noise, dust, or if the model room did not serve its purpose, the management was not to be blamed but the contractors.

2 ***Management-facilities:* strong link**

The building site was the test for the division of labor between the management and the facilities. It seemed to work well from the very beginning of the construction work. The project manager was in charge of the building site and the physiotherapist of the staff. If there were any problems on either side, these two solved them in collaboration. They coordinated their work so that the physiotherapist was allowed to contact the master builder directly in minor cases. The physiotherapist herself understood that in matters of importance it was better to operate through the project manager. There were problems, though. The model room was a failure and the security and nurse call systems caused problems. The project manager was irritated by the exaggerated wishes of the users.

The link was working so well that it could be interpreted as a routine, weak link, but it was just these problems and the effort put in solving them which made it a strong link.

3 ***Management-architect:*** **strong link**

The architect worked directly with the physiotherapist and kept the project manager informed if necessary. She did not want to bother him with details and ongoing processes, she reported the results only. The architect did not visit the building site often, she came when the physiotherapist asked her to come.

"The color war" was over and the staff and the architect found a shared way to work on colors and on other matters. This eased the relationship between the architect and the management. Some of the informants mentioned that there was one member of staff who was more active than others in the matter of colors and without her the whole riot ??would not have occurred.

This link could be interpreted as a weak one, if one only listens to the informants. However, there was so much work done together in the meetings and with the model room that it was a strong link.

4 ***Management-contractors: strong problematic link***

Most of the problems were solved by the master builder, the physiotherapist, and the project manager. The contractor saw this relationship as a routine one, but at least in the beginning it was far from routine. The problems were solved quite quickly. It has to be remembered that by the time of the second round of interviews (spring 2004) a long time had passed. However, in the beginning there were lots of tensions. The model room and the way the contractor dealt with it described well how little the contractor understood about the very basic principles of the project.

5 ***Management-assistant designers:*** weak link

The assistant designers attended the same meetings with the management. There was not much interaction but there were no problems either.

6 ***Staff-facilities:*** *weak problematic link*

The facilities had delegated the responsibility of listening to the staff to the management. Especially with the janitor this did not work. The fact that the link was missing made it problematic. The staff had wishes and they were directed to the facilities, but there was no way of expressing them directly. In terms of the electrical work, the inspector was absent and he assumed that the contractors would be contacted directly. In his case there was a feeling of abandonment on the staff's side.

7 ***Staff-architect:*** weak link

After "the color war" was over, the link became a routine one and there were no major problems. The relationship between the architect and the staff was directed through the physiotherapist. The architect met the staff in meetings. There were essential matters dealt with in the model room, but even then the architect was listening to the conversation between the management and the staff as an outsider.

8 ***Staff-contractors: strong problematic link***

The third parties saw this relationship as a non-problematic one. However, the physiotherapist sensed that the beginning of coexistence in the same building was not a fairy tale, rather a nightmare. Finally everybody learned to see things from each other's perspective, but this process took time.

9 ***Staff-assistant designers:*** weak link

These two parties hardly ever met. All the information went through third parties. However, because both sides were aware of each other's existence and even some information was exchanged, it could be assumed that there was a link.

10 ***Facilities-architect:*** weak link

There was a clear division of labor between the architect and the project manager. The architect was allowed to work independently with the user and she kept the project manager aware of essential matters. Not all links need to be strong to function well.

11 ***Facilities-contractors: strong problematic link***

The relationship between the project manager and the master builder was intense and functioning. They met on a weekly or even a daily basis. All the problems were solved as they appeared. The project manager was the leading designer at the same time and this helped. He did not have to draw everything, things could be solved on site.

However, things did not work as well with respect to the side-contractors. There were lots of problems with the mechanical designs and the designers were not present when needed or did not do what they promised. The facilities electrical inspector was the head of the town electrical department and he did not have time to visit the building site often enough. The problems in the design work and contracts made this link a problematic one.

The fact that the main contractor did not understand the meaning of the model room and did the stages in a different order than expected shows that there were some problems with his links as well.

12 ***Facilities- assistant designers:*** *weak problematic link*

The plans were poor and there was no way to make the designers change them fast enough. Here the very weakness of the link made it problematic. The client would have liked to have had deeper cooperation but he did not get it. This lead to mutual accusations, lack of trust, and a bad atmosphere. If one looks at the effects, one could call this a strong link. The link was weak but its consequences were strong.

13 ***Architect-contractors:*** weak link

If asked or if it had been necessary, the architect would contact the master builder.

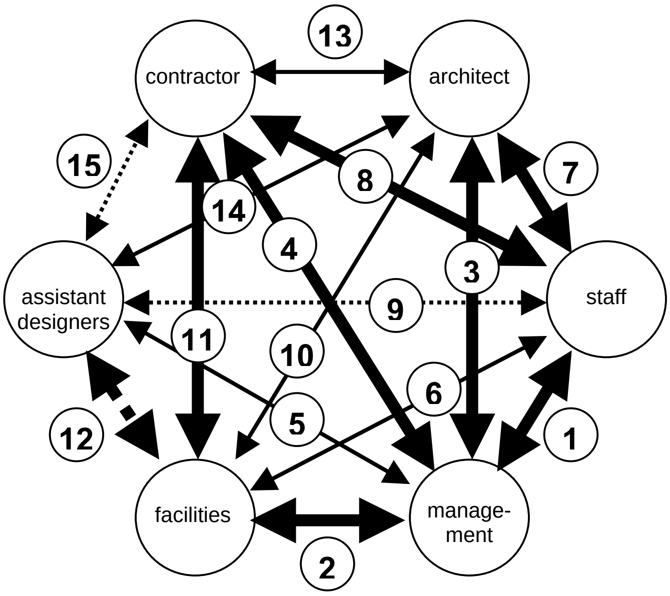
14 ***Architect-assistant designers:*** weak link

If asked or if it had been necessary, the architect would contact the other designers.

15 ***Contractors-assistant designers: strong problematic link***

There were contradictory descriptions of this link. The designers knew part of the contractors well from previous projects. There was even an employee from one of the engineering firms who was now a boss in one of the contracting companies. However, the contractors complained about the lack of designs, the quality of the designs, and the absence of the designers. This all would refer to a weak link. The absence of the electrical inspector increased the problem. The contractors needed the services of the designers desperately, otherwise they could not fulfill their obligations to the client. This was a strong link and it was definitely a problematic link.

Phase 9: The second phase of construction



1. The project had increased the feeling of empowerment.
2. Feeling of gratitude on both sides
3. The management was pleased because there was no tension between the architect and the staff
4. Both parties understood how dependent they were of each other
5. The management demanded detailed explanations of designs
6. No problems: all contacts through physiotherapist
7. Both parties had learned their roles
8. The staff and the construction workers had learned to live with each other in peace
9. The distant relationship caused problems
10. All connections through the physiotherapist
11. A feeling of mutual trust and interdependence
12. A feeling of distrust and mutual accusations due to kitchen ventilation problems
13. The architect visited the building site occasionally
14. The architect coordinated the designers' work
15. The contractors felt abandoned

1 ***Management-staff:*** **strong link**

The link was strong. The only exception was the janitor, but this may be due to his ambivalent position as the facilities' employee.

2 ***Management-facilities:*** **strong link**

At this stage it was becoming evident to everybody how important the users' involvement had been. There was a feeling of gratitude on both sides. There had been mistakes and failures, but everybody talks about things that might have happened without cooperation.

3 ***Management-architect:*** **strong link**

The architect had learned her lesson and was not as dominant as before. There was no tension between her and the staff, and the management was pleased. There was a new reason to be worried: the town planning department was about to hire the architect. Would she be allowed to help in the Kangas renovation? The people in Kangas had became dependent on her.

4 ***Management-contractors:*** **strong link**

After the first tension was over, both parties understood how dependent they were on each other. There was no alternative to good cooperation. There was some kind of a “Stockholm-syndrome” working: when people stay together long enough, they learn to understand each other. The phenomenon is common in many renovation projects.

5 ***Management-assistant designers:*** weak link

The management was more active in the technical design when the renovation of the 2005 was designed than they had been in the previous phases. They demanded detailed explanations of the drawings. The management had learned to be a better client for the assistant designers. The designers appreciated this. However, there were not many contacts. The link stayed weak.

6 ***Staff-facilities:*** weak link

There is not much said about this link in the interviews. It may be that the project manager stayed in the shadow of the physiotherapist in the eyes of the staff. There were no problems, though.

7 ***Staff-architect:*** **strong link**

The architect had learned her lesson. One of the meetings where colors were discussed was taped and in this taped meeting the architect let the staff make all the decisions. She only suggested things and analyzed whether certain colors fitted to the larger composition. The staff, on the other hand, accepted her role as the one who was responsible for the unity of the design. Both parties had learned their roles. The staff was finally heard and they were grateful for that.

8 ***Staff-contractors:*** **strong link**

There were two levels in this link: the one through the project manager and the physiotherapist, and the direct one. The direct one functioned on the employee-to-employee level. This latter level made the link strong. The staff and the construction workers had learned to live with each other in peace. Gradually they had learned to know each others problems and intentions. After all, they all had a shared goal: the finished renovation.

The janitor was left outside of this feeling. The poor integration of janitor to the design and the cooperation was one of the mistakes made in the project.

9 ***Staff-assistant designers:*** *weak problematic link*

When the consequences of the poor design of the first stage appeared, this link became problematic. It seemed to be difficult for the designers to understand what the staff wanted. The distance between the two parties made this link problematic.

10 ***Facilities-architect:*** weak link

This link worked but there was a strong sense of routine in the way the parties described it. The contact to the architect had been transferred to the physiotherapist. The connection between the architect and the project manager was purely on a technical level.

11 ***Facilities-contractors:*** **strong link**

Things were working out fine in this relationship. Both parties were in keen cooperation and all the problems were solved when they appeared. There was a feeling of mutual trust and interdependence. Even the problems with the electrical contract seemed to be fixed. All the inspectors were obliged to visit the building site once a week. All the problems in this relationship seemed to have their origin in the doings of third parties: the users, designers or others.

12 ***Facilities- assistant designers: strong problematic link***

This link became strong again when serious problems appeared and they had to be solved together. However, it became extremely problematic due to the kitchen ventilation problems and the use of a simulation consultant. The atmosphere was sometimes frosty. There was a feeling of distrust and mutual accusations.

13 ***Architect-contractors:*** weak link

The architect visited the building site occasionally. There seemed to be no problems.

14 ***Architect-assistant designers:*** weak link

The architect went on coordinating the designers' work with the same routine-like manner as before. Problems between the facilities and the designers had no effect on this link. The architect was seen as a trustworthy and effective professional.

15 ***Contractors-assistant designers:*** *weak problematic link*

The designers saw no problems, but the contractors felt abandoned. The weakest link was the one between the electrical engineer and the electrical contractor. The problems in this link affected the other links as well. The amount of extra work from the client was increasing and it was not good for anybody.

Appendix 9: Network links in Case 2 (Kangas)

tie	renovation group	project definition committee 1	Ministry visits	project definition committee 2	selection of designers	design	selection of contractors	first phase of construction	second phase of construction
management-staff	■ ■ ■ ■ ■	■ ■ ■ ■ ■	▬▬▬	■ ■ ■ ■ ■		■ ■ ■ ■ ■	■ ■ ■ ■ ■	▬▬▬	▬▬▬
management-facilities	———	■ ■ ■ ■ ■	▬▬▬	▬▬▬		▬▬▬	———	▬▬▬	▬▬▬
management-architect						▬▬▬	■ ■ ■ ■	▬▬▬	▬▬▬
management-contractors							missing	■ ■ ■ ■	▬▬▬
management-ass.designers						·········	missing	———	———
staff-facilities	———	———	missing	▬▬▬	·········	·········	·········	·········	———
staff-architect					·········	■ ■ ■ ■ ■	■ ■ ■ ■ ■	———	▬▬▬
staff-contractors							missing	■ ■ ■ ■	▬▬▬
staff-ass.designers					missing	·········	missing	———	·········
facilities-architect					▬▬▬	———	———	———	———
facilities-contractors							———	■ ■ ■ ■	▬▬▬
staff-ass.designers					■ ■ ■ ■ ■	■ ■ ■ ■ ■	———	·········	■ ■ ■ ■
architect-contractors							missing	———	———
architect-ass.designers					missing	———	missing	———	———
contractors-ass.designers							———	■ ■ ■ ■ ■	·········

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