The current situation on environmental management in construction raises a number of questions on how environmental issues are dealt with in practice. It can be asked why individuals in construction projects, despite academic and industrial efforts and raised awareness on environmental issues, still feel that they lack knowledge and control over how to handle environmental issues? Why have so many construction companies chosen to implement environmental management systems when it is known that practices within the industry previously have failed to support other control systems? More, if communication has been put forward as critical for efficiency in construction projects and at the same time as problematic, why has so little been done to understand the mechanisms underlying environmental communication? If project organising has been found to hinder innovations and changes, how does this affect environmental management in construction?

The purpose of this thesis is to find some answers to these questions by creating an understanding on how environmental issues are managed in the construction industry and especially in construction projects.

PERNILLA GLUCH Building Green - Perspectives on Environmental Management in Construction 2005

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THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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Building Green:
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ISBN 91-7291-729-6

Doktorsavhandlingar vid Chalmers tekniska högskola
Ny serie nr 2411
ISSN 0346-718X

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Cover: “Doing field studies in construction” (P. Gluch)

Chalmers Reproservice
Göteborg, Sweden 2005

Till Isak och Jacob

Abstract

Over the last two decades the construction industry has made efforts to develop green building practices. Researchers within the field have provided theoretical knowledge on how to design green buildings and analytical environmental management tools have been developed to guide the practitioners. Information campaigns have raised the general environmental awareness among building practitioners. In spite of these efforts, building practices do not seem to have undergone any marked changes. This raises the question of how environmental issues actually are dealt with in construction.

The aim of this thesis is to create an understanding of how environmental issues are managed in construction. The thesis consists of five papers exploring various aspects of the greening of construction. The research methods range from theoretical discussions of the usefulness of environmental management tools and a questionnaire study on environmental management in the construction industry, to text analytical studies of media's representation of green building and field studies on environmental management in construction projects.

Findings show that project practices conflicts with the long-term principles of sustainable development and that environmental concerns have been narrowed down to a few targeted issues. Moreover, organisational structures and project practices of construction were found to be mismatched with centrally controlled and generic environmental management practices. It was also found that the way environmental issues were dealt with in construction projects depended on their legitimization in the organisation and how well interpretive and socio-cultural communication processes has created meaning and understanding for practitioners in relation to their specific situation and context.

It is concluded that there is a need to go beyond the prevalent normative and rationalistic technological view by shifting to a perspective that integrates technical and social aspects of environmental management. To achieve green building it is necessary to take into account that individuals when acting take part in on-going processes of organising and social practice which influence the way they act. Such a change of perspective is metaphorically illustrated by shifting the product-centred *Green Building* to the process-centred *Building Green* and thereby emphasizing the importance of not neglecting the influence of on-going processes on the outcome of construction projects.

Key words: corporate environmental management, green building practice, construction projects, construction, social practices, organising processes, communication, decision-making, environmental information

Sammanfattning

Under de två senaste decennierna har svensk byggindustri satsat resurser på att utveckla ett miljöanpassat byggande. Forskning har bidragit med teoretisk kunskap kring olika miljötekniska lösningar samt utvecklat ett stort antal analytiska miljöverktyg såsom miljövärderingssystem, miljöledningssystem, och checklistor. Informationskampanjer har dessutom bidragit till en ökad medvetenhet hos praktiker om vikten av att ta hänsyn till miljöaspekter i byggandet. Trots dessa insatser har det inte skett någon direkt märkbar förändring av de byggtekniker som används eller de byggnader som byggs. Detta leder till frågan hur miljöaspekter egentligen hanteras i byggande.

Syftet med denna avhandling är att söka förståelse för hur miljöaspekter hanteras i byggande. Avhandlingen består av fem artiklar som var och en tar upp lite olika aspekter av hur miljöaspekter har införlivats i själva byggprocessen. De forskningsmetoder som använts spänner från teoretiska diskussioner kring tillämpligheten av miljöanalytiska verktyg samt dess roll i praktiken, enkätstudie som kartlägger attityder och barriärer för miljöanpassat byggande till textanalytiska studier av byggpressens bild av grönt byggande och fältstudier av miljöarbete i byggprojekt.

Resultaten visar att perspektivet på byggprojekt inte överensstämmer med den långsiktighet och helhetsperspektiv som krävs för att nå en hållbar utveckling. Resultaten visar också att synen på miljö har blivit avgränsat till att behandla ett fåtal öronmärkta aspekter. Resultaten visar också att sättet såsom byggprojekt organiseras och styrs inte överensstämmer med standardiserade och centralt styrda ledningssystem. Till vilken grad miljöaspekter fått utrymme i byggande beror också på hur de har legitimiserats i organisationen samt på de kontextberoende kommunikationsprocesser som skapar mening och tydlighet kring miljöaspekternas betydelse.

Den viktigaste slutsatsen i föreliggande avhandling är att det finns ett behov av att utvidga det normativa och rationalistiska synen på hur miljöaspekterna ska hanteras i byggande genom att växla till ett perspektiv som integrerar tekniska aspekter med sociala. För att åstadkomma miljöanpassat byggande är det därför viktigt att även ta hänsyn till de människor som är delaktiga i de pågående organiseringsprocesser som skapar sociala mönster, praxis och betydelse, vilket i sin tur påverkar deras agerande. Ett sådant perspektivskifte illustreras metaforiskt genom att skifta det produktinriktade *Green Building* till ett processinriktat *Building Green* och därmed betona vikten av att inte åsidosätta den påverkan som pågående processer har på slutresultatet från byggprojekt.

List of publication

This thesis is based on the work contained in the following papers, referred to by Roman numerals I to V in the text.

I. **Costs of Environmental Errors (CEE) – a managerial environmental accounting tool or a symptom of managerial frustration?**
Gluch, P. (2001) *Greener Management International,* **31**, pp. 87-99.

II. **The Life Cycle Costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making.**
Gluch, P. and Baumann, H. (2004) *Building and Environment* **39**, pp. 571-580.

III. **How do Trade Media Influence Green Building Practice?**
Gluch, P. and Stenberg, A.-C. (2006) *Building Research and Information* **34**(2), pp. 104-117.

IV. **Mediating Environmental Concerns in Construction Projects.**
Gluch, P. and Räisänen, C. (2005) Submitted to *Construction Management and Economics.*

V. **"It's about time" – for Environmental Management to team-up with Project Management.**
Gluch, P. (2005) Submitted to *Business Strategy and the Environment*

Acknowledgements

As a former 800 meter runner, I have throughout the doctoral project compared it with a race. Full of adrenalin you always take off too fast, at the 200m lap-time you realise that you have to slow down in order to be able to finish the whole race. After one lap (the time of a licentiate) you are full of self-reliance. It is also possible to quit here; 400m is after all an official race distance. Deciding to continue the race, the first sense of fatigue strikes you on the further long side (~550m). For some reason there is always a headwind on this side, which makes you consider stopping since you know it will be worse because once 600m are passed there is no return. You just do not quit on the finish straight. The last 200m are a struggle, both mentally and physically. When I am writing this I have reached the first of the finishing lines (10m left), I am physically and mentally exhausted, lactic acid is killing my legs, but I know that I am close to the feeling of having accomplished something arduous. Maybe I will even break my personal record!

Neither a fast race nor a thesis is accomplished without encouragement and support from others, and I would like to thank everyone that has made this “PhD-race” possible.

First of all, performing good results and breaking records require good coaching. My special thanks go to my main supervisor, and head coach, Associate Professor Henrikke Baumann, for taking me on when I was stuck in a project that was not proceeding as planned and for invaluable guidance and professionalism, for encouraging me to continue in my most doubtful moments, and for listening to all my whining (please forgive me for being a dalkulla). Thanks also to my supervisor, and mental coach, Associate Professor Christine Räisänen for guiding me through the hardship of writing and for introducing me to the area of socio-cultural communication, but especially for being such a friendly soul. Many thanks also to my training companions Lotta Stenberg and Dr. Paula Femenías, with whom I have had fruitful research co-operation.

I also thank the late Gösta Fredriksson for taking me on and signing me up for this race. I thank all my present and previous colleagues at Building Economics and Management with whom I have gone through numerous organizational and

structural changes, but foremost for pep-talking in tough times and for sharing discussions and some great laughs with me in the ‘locker room’. Thank you: Ingeborg Knauseder, Anneli Linde, Sven Gunnarsson, Per-Erik Josephson, Göran Lindahl, Ulrica Wallström, Lasse Saukkoriipi, Peter Samuelsson, Johan Björnström, Mikael Frödell, Bengt Larsson, Roger Flanagan and Angela Fjordsten. I also thank Dr. Inma Fortanet, our visiting researcher, for comments on language as well as all colleagues at Environmental Systems Analysis.

Last but not least, I thank the cheering crowd of: friends, my brother with family, and my parents-in-law. And which athlete can do without their biggest fans, mum and dad. Thank you for never having doubted my capacity for achieving whatever I set my mind on, and so giving me my motto:

“I can do anything, as long as I like doing it”

Most of all I would like to thank the three boys in my life. My partner Henrik for encouraging me to make this effort and for supporting me throughout, for commenting diverse manuscripts, but foremost for sharing every-day life with me and our sons Isak and Jacob. Isak and Jacob, you are the most precious treasures in my life.

This thesis has been possible thanks to financial support from MISTRA – Foundation for Strategic Environmental Research, CMB – Centre for Management of the Built Environment, SBUF – The Development Fund of the Swedish Construction Industry, Åke and Greta Lissheds stipendiefond and Adlerbertska Research Foundation.

Pernilla Gluch, December 2005

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1 Introduction

> *…we create power, we harness the Flood, the Earth is built upon, so we can inhabit it. We build a linking bridge between distant shores; we draw a road between foreign countries… (free translation from Swedish)*

The above verse is taken from a traditional song that students from civil engineering schools in Sweden sing at festive occasions. The essence of the song, I believe, illustrates the concept of construction. The construction industry has in all times harnessed natural forces in order to serve mankind. Buildings and facilities, such as power stations, tunnels, bridges, canals and skyscrapers have been constructed. Think the Pyramids, think the Chinese wall, the Suez Canal, the Eurotunnel. As such the construction industry has a long tradition of making irreversible tracks in nature.

With increasing awareness of the construction industry's influence on the natural environment, a shift in focus seems to have taken place during the 1990s (for historical reviews see Stenberg and Räisänen, 2006; Cole, 2004). From being an industry that, in terms of environmental pollution, mainly has regarded itself as a technical problem solver, the construction industry was in the 1990s put into the environmental spotlight as a major source of environmental impact. The construction industry was identified as a major consumer of natural resources as well as generator of tremendous amounts of waste (Ofori, 1992). In Sweden, the image of the industry as a major environmental polluter was brought to its head with the Halland's Ridge Case, an environmental accident where toxic substance leaked out to nearby watercourses killing fish and making cattle and human ill (see Danielsson *et al.* (1998) for a comprehensible account for the incident). The incident was heavily exposed in mass media and the construction industry was placed in the limelight.

The building sector, of which the construction industry is a large part, is in Sweden nick-named the '40% sector' since it is set responsible for approximately 40% of the total energy use, 40% of generated man-made waste, and 40% of the total material use (The Ecocycle Council of the Building Sector, 2003; CIB,

1999). Consequently, decisions made in the construction industry extensively affect the environment.

This increased awareness and insight called upon the recognition of a fourth objective in construction projects, that of ecological sustainability to be added to the traditionally three: time, cost and quality (Ofori, 1992). Recognizing this need for change also gave rise to a need to consider environmental issues within management routines in construction projects. For example, in 2002 over 90% of the Swedish construction companies with more than 50 employees had an official environmental policy and almost 80% had implemented or were in the process of implementing an environmental management system (Baumann *et al.*, 2003). Companies launched environmental training programs for their employees and greening was changed from being an issue that foremost involved initiated experts to an issue that was everyone's concern.

> *Suddenly I realized that 'this also involves me', that it is not only an issue for a few enthusiasts.* Interviewed Project Manager, Construction Company

In spite of this increased awareness among practitioners and that construction companies state that they have an ambition to build in an ecologically sustainable way (Björnberg, 2003), it seems as "every-day" building practices have not undergone any marked changes and thus remain the same as always, i.e. business-as-usual. Femenías makes the same reflection from her study on demonstration projects and states that green building has become "sidetracks from mainstream building practice" (Femenías, 2004: 247).

The project-based organising, the complexity, the distributed construction work and the fragmented dispersed organisations have been observed as obstacles for change in the construction industry (Bresnen *et al.*, 2005; Kadefors, 1995). In dealing with this complex and distributed work, especially good communication has been recognized as important (Kadefors, 2004). However, despite of widely implementation of environmental policies and environmental management systems, individuals in the construction industry still feel that they lack understanding of and the ability to control wider environmental problems caused by construction (Baumann *et al.*, 2003; Teo and Loosemore, 2001; Bordass, 2000). More, notwithstanding academic, industrial and societal efforts, and despite the availability of a multifaceted smorgasbord of systems, methods, and tools, there is a noticeable lack of enthusiasm among practitioners in project-based organisations to adapt, use or apply them in their day to day work (Trinius,

2002; Cole and Sterner, 2000; Gluch, 2000a). Practitioners have been found to rather base their decisions on previous experience and current practice than on information from environmental tools and systems (Larsson *et al.*, 2003). This low prioritization in practice, however, seems to be a tendency not only for environmental management but for management control systems in general (Samuelsson and Gräns, 2004; Styhre *et al.*, 2004; Shammas-Thoma *et al.*, 1998). There is also a common notion within the construction industry that environmental work has negative effect on short-termed profit, cost-savings and on productivity (Baumann *et al.*, 2003) and that environmental work a priori is expensive (Svane and Wijkmark, 2002).

Due to the project-based mode of organising, construction has been acknowledged to have problems to grasp the holistic perspective that is necessary if environmental aspects are to be managed properly (Labuschagne and Brent, 2005; Roodman and Lenssen, 1995). Organisational characteristics, such as, too much focus on avoiding failure at expense of innovation, and decision makers in projects being isolated from the environmental consequences of their decisions are factors that have been identified as hinders for proper environmental management. Some even go further by suggesting that environmental management in construction still remains at a level that basically serves as image creating lip service (Tam *et al.*, 2004).

Aim

The current situation on environmental management in the construction industry raises a number of questions on how the industry actually deals with environmental issues in practice. It can be asked why actors in construction projects, despite academic and industrial efforts and raised awareness on environmental issues, still feel that they lack knowledge and control over how to handle environmental issues? Why have so many construction companies chosen to implement environmental management systems when it is known that practices within the industry previously have failed to support other control systems? More, if communication has been put forward as critical for efficiency in construction projects and at the same time as problematic, why has so little been done to understand the mechanisms underlying environmental communication? If the project organising mode has been found to hinder innovations and changes, how does this affect environmental management in construction?

The purpose of this thesis is to find some answers to these questions by creating an understanding on how environmental issues are managed in the construction industry and especially in construction projects.

Structure of the thesis

The thesis is organised in nine chapters plus five included papers. In this introduction the research problem has been outlined and the aim of the thesis has been presented. Chapter two describes the research process and establishes the basic epistemological and methodological approaches that have been a point of departure in this thesis. Since the intended audience for this thesis is rather broad, ranging from practitioners within the construction industry to researchers within different scientific disciplines, chapter three to five serve as orientation for different readers. Chapter three provides a brief overview of main characteristics of the construction industry and provides a description on terminology related to environmental management in construction. Chapter four provides a overview of the body of knowledge concerning corporate environmental management in construction. The chapter ends with a reflection on the research field, and identifies a gap within this field of research. Chapter five provides the reader with the theoretical perspectives that has been used as exploratory and explanatory tools for understanding environmental management in construction. In chapter six main findings from Paper I-V are presented. Based on the empirical findings, the discussion in chapter seven develops the proposed need for a changed perspective on environmental management in construction and introduces the concept Building Green to signal this. Finally, chapter eight provides conclusions and raises questions about the direction that future research could take.

2 Research approach

To create a better understanding on how environmental issues are managed in the construction industry and in construction projects social practices and organisational features of construction projects and their relation to environmental management were explored. This chapter describes the research process as well as my research perspective in the doctoral project. More, the studies that have been carried out within the doctoral project are described briefly as well as the methods used in these studies. More detailed descriptions on methods used and on methodological considerations in the studies accomplished within the frame of the doctoral project can be found in Paper I to Paper V.

The research process

Although the objective in this thesis is to explore practices and organisational features it did not start in that end. The doctoral project was initiated within a nation wide research program called MISTRA Sustainable Building. The main purpose of MISTRA Sustainable Building was to meet a growing need of environmental knowledge within the Swedish construction industry (Edén and Jönsson, 2002). A majority of the research projects within the program had a technological or natural science perspective. They focused on developing technical solutions to what was perceived as the construction industry's environmental problems or developing methods to monitor those problems. Within this technological research community there was, however, a notion of an implementation deficiency. This notion gave rise to a handful projects, one of which was my project. The initial objective of my research project concerned implementation of sustainable construction in general, and implementation of financial environmental tools in particular. The project was defined prior to my engagement and departed from an assumption that the implementation difficulties were caused by a problem to mediate the benefits from applying or using the technical solutions, tools and means in practice. The suggested solution to this problem, which was also stressed by the industry, was to 'translate' environmental impact into for practitioners 'comprehensible' language. This comprehensive language had in turn been identified as monetary terms.

My background and profession as a civil engineer and my experience from the construction industry provide me with an understanding of the basic characteristics of the construction process, constructions and the construction industry that has been valuable for the doctoral project. However, my technological background and the employment at a technical university also set out a base where a natural scientific perspective on reality dominates, which influenced the way my research process has proceeded. The initial studies, on Costs of Environmental Errors (CEE) (see Paper I) and Life Cycle Costs (LCC) (see Paper II), departed with a positivistic approach. However, as the studies evolved it shed light on numerous phenomena related to the communication of environmental aspects in construction projects rather than ending up in a useful prescriptive tool for environmental decision-making. During these early accomplished studies I began to question the strength of the initially positivistic direction of the doctoral project. Applying a positivistic approach on the studies assumes that there is a true reality 'out there', a reality that, in turn, is objective and that is measurable and thus can be rationally determined. The researcher's task is therefore to generate facts through methods that model this reality as precisely and objectively as possible. However, through the initial field studies and conversations with practitioners within the industry I discerned wider communication problems that the positivistic causality perspective of methodologically aggregating milligrams and millilitres into monetary terms would not be enough to explain. Recognizing the importance of social and organising processes the doctoral project made a turnabout.

Being interested in understanding environmental management in construction, as well as trying to explain phenomenon related to this issue, it has been more fruitful to apply a social constructionist perspective to the studies. This means that to understand how individuals act, for example make decisions, it is necessary to understand also their social construction of the reality in which they take part (Arbnor and Bjerke, 1994). In so, issues of how things are constituted as environmental problems, how different environmental practices emerge as social practices, and how local perceptions of the natural environment create organisational effects that are incorporated with more familiar management and organisational behaviour are studied (Füssel, 2005). In this perspective, the researcher's contribution is to "aggregate" individuals' perceptions with previous experience and theories, and in so provides a comprehensive wording of the specific problem or phenomenon (Arbnor and Bjerke, 1994). Within this perspective the researcher examine phenomena, such as practices, roles, artefacts,

and other institutionalizations, and how these are constructed in an over-all process. Some of these phenomena are illustrated in Figure 1.

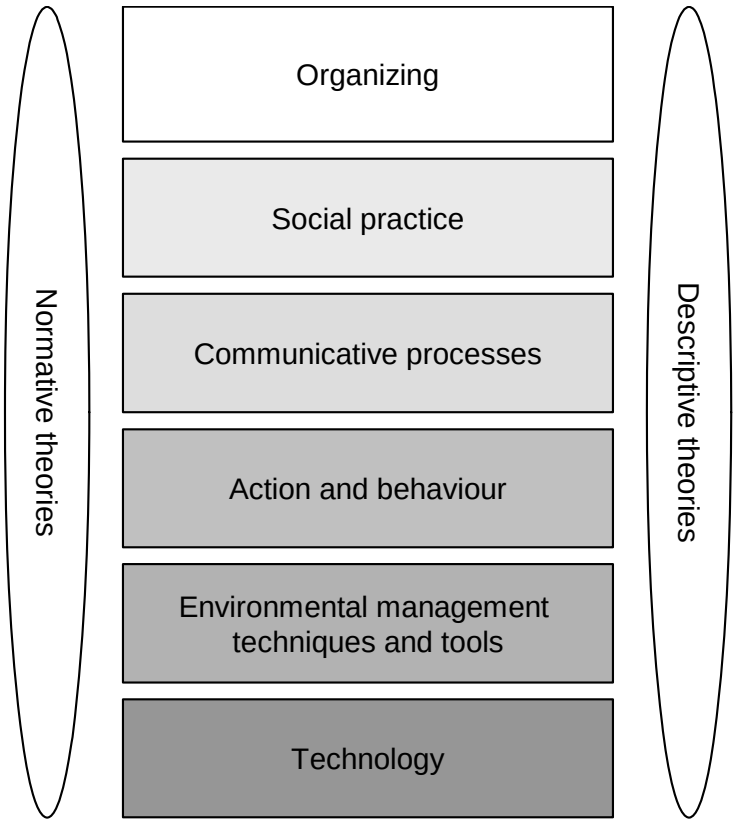

Figure 1: Illustration of issues that has been dealt with during the doctoral project.

The doctoral project has been explorative in the sense that the studies carried out within the doctoral project have during the research process continuously and through an iterative and dynamic process been influenced by empirical findings, existing theory, previous research and continuous dialogues with actors representing research as well as industrial communities. In order to create an understanding of environmental management in construction it has, in addition to distancing from the positivistic methodological perspective, also been necessary to broaden the normative theoretical base that has been found prevalent within this field of research. Normative theories within management often follow a physical science paradigm and thus search for mathematical models that can be used to select the most rational and ideal solution to a predefined task or problem, such as investment calculus and LCA. Normative management theories give directives of how decisions shall be solved by giving the decision-maker

rules to follow when deciding (Brunsson, 1998). In the initial studies of the doctoral project it was found that the theories and analytical models within the normative paradigm had limited ability to handle several of the phenomena that appeared. The normative approach, which assumes that individuals always act rationally and that it is, therefore, possible to monitor and control an organisation's relationship with the natural environment, was consequently not explanatory enough to contribute to an understanding of environmental management in construction. Going from the normative theoretical base and applying descriptive theories has opened up new windows that have made it possible to get a more comprehensive understanding and also to establish different views of environmental management in construction (Figure 1). To sum up the research process, it has been a journey through a variety of scientific disciplines. It can be concluded, that although the process has not been linear, I have during this journey travelled from the bottom left corner in Figure 1 to the top-right corner, which also has made the doctoral work multi-disciplinary.

However, although it has been necessary for me to apply theories from different scientific fields in order to understand and explain phenomenon connected with the management of environmental issues in construction projects, it has never been my intention to develop theories within these disciplines. The theory building has instead been on an aggregated level, combining and aligning empirical findings with already established theories from different disciplines. The aim in the doctoral project has accordingly not been on empirical theory testing but rather on empirically based theory building. As such, the thesis contributes to increased knowledge within the emerging theory of greening of the industry and of environmental management in construction in particular.

Studies carried out within the doctoral project

In total six studies have been accomplished within the doctoral project. Figure 2 summarizes all the applied studies.

The LCC study was foremost a theoretical study. Experience gained from applying a Life Cycle Costing analysis in construction, was theoretically examined through a conceptual discussion (Paper II).

Three of the studies have been field studies. The first was a *pre-study* and provided an initial insight into the area of environmental management on construction sites. The second one, *the CEE-study*, comprised four case studies

and was intended to develop a concept, Costs of Environmental Errors, as a means for monitoring environmental performance of construction projects (Paper I). The purpose of the concept was to detect errors made in construction, monitor them and relate them to consequences that in turn were aggregated into and presented in monetary terms. The third and closing field study, *the Tunnel Case*, is the main study in this doctoral project since it comprises all experiences gained from the other studies. It focused on communication and handling of environmental issues in a project-based organisation, which is the dominating mode of organising in the construction industry (Papers IV and V).

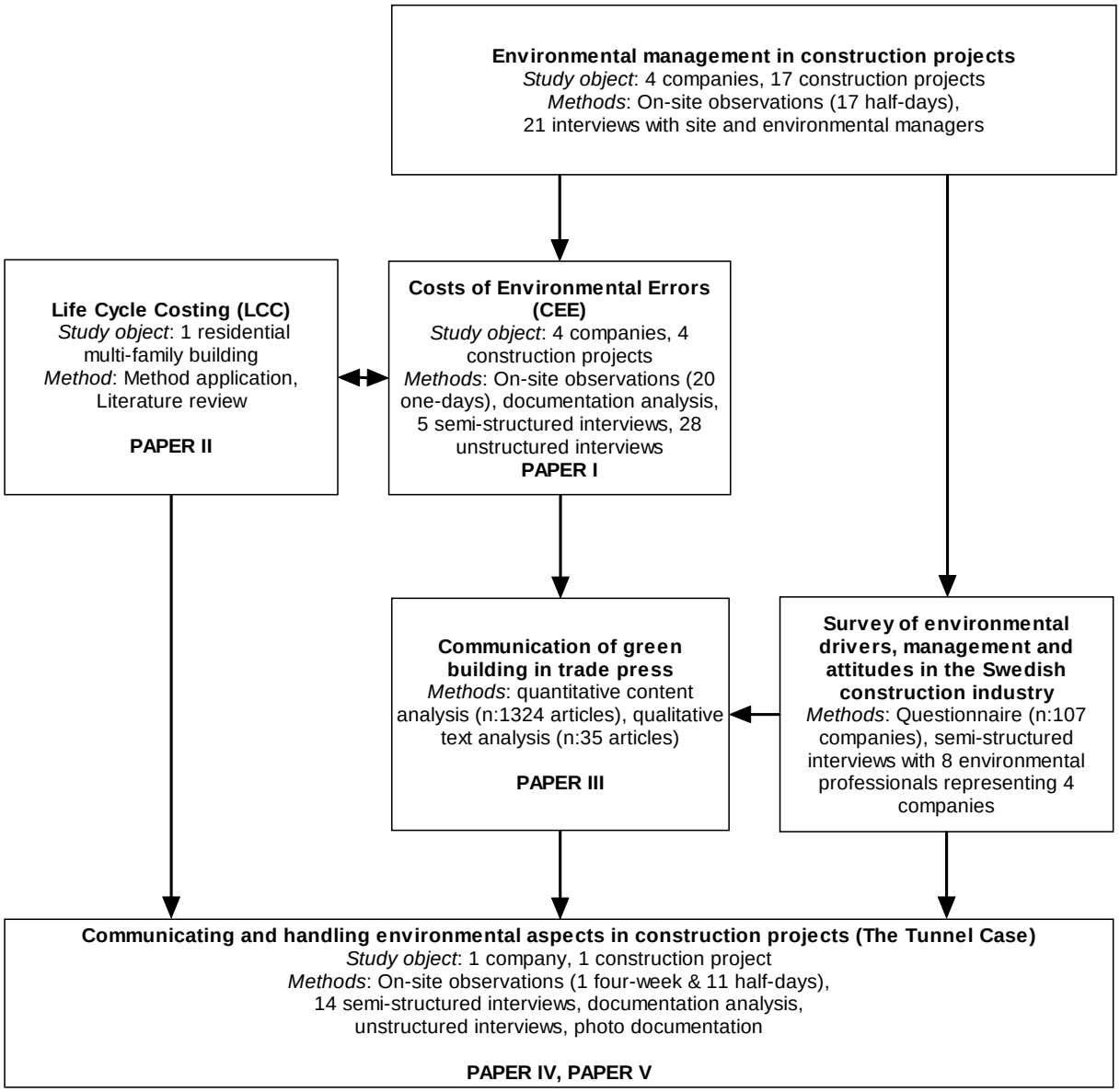

Figure 2: Studies accomplished within the frame of the doctoral project in chronological order and interrelations between them.

Doing field studies has thus made me familiar with the context, the practices and the jargon of the construction project communities. Since abstract and ambiguous terminology pervades the field of environmental concerns it has been vital that the denotations and connotations of the researchers match those of the respondents. The use of multiple sources, interviews, on-site observations, photo documentation, and text analysis provided a comprehensive view on the project members' physical workspace and their social interaction. Throughout the studies I have maintained a reflexive stance towards the study objects and my own involvement.

Since I was dealing with exploring an emerging research area, it was also desirable to map a broader picture than a field study can provide. This was achieved by means of a questionnaire survey and a text analytical study of trade press representation of environmental issues (Figure 2). The *questionnaire survey* (Baumann *et al.*, 2003) provided a general overview of the current environmental attitudes and practices of the construction industry that was useful to relate the findings of the qualitative field studies against. From both the pre-study on environmental management in construction projects and the interviews in the CEE-study it had been observed that the main source for inspiration on 'green building' for many practitioners was what was mediated through building trade press (cf. Femenías, 2004). This led to a study of what images of green building Swedish construction trade press mediate to practitioners, *the trade press study*, (Paper III). In this text analytical study, a quantitative content analysis was combined with a qualitative text analysis (Paper III). The quantitative content analysis provided the general picture of green building discourses in the general debate from 1990 to 2003. Combining the quantitative survey with a qualitative text analysis provided a deeper understanding of the content of this discourse that has been mediated to the practitioners within the construction industry. The analysis also made it possible to theoretically discuss how this image may influence practitioners' knowledge and values about green building as well as their motivation for pro-environmental behaviour.

About publications and distribution of work

The pre-study on environmental management in construction was partially presented at the *Nordic Total Quality Management Conference* and published as a conference report (Gluch *et al.*, 1998). Findings from the study were also presented in my licentiate thesis (Gluch, 2000a). I designed and carried out the part of the study that concerned environmental management on construction

sites. The report was divided into two parts of which Birgersson and Stenberg authored the first part and I the second. I was first author for the manuscript published in the licentiate thesis (Gluch *et al.*, 2000).

The study on Costs of Environmental Errors was published in a report (Gluch, 1999a) and two conference papers presented at the *Nordic Seminar on Construction Economics and Organisation* (Gluch, 1999b; Gluch and Josephson, 1999) and published in the proceedings. These conference papers were further developed and resulted in **Paper I**. The study was designed in co-operation with Josephson. I was responsible for carrying out the study and analyzing the results and authored Paper I.

The Life Cycle Costing study was published in an internal report (Fredriksson and Gluch, 1998) and a conference paper was published in the proceedings from the *International Conference Sustainable Building 2000* (Gluch, 2000b). The findings from the LCC-study served as a starting point for the conceptual and theoretical discussion held in **Paper II**. In the study I did the application of LCC and was also responsible for the majority of the literature review that served as a basis for the theoretical and conceptual discussion in Paper II. I was first author of the paper that was co-authored by Baumann.

The questionnaire survey on environmental drivers, management and attitudes in the Swedish building industry was published in a report (Baumann *et al.*, 2003) and presented at the *International Conference on Sustainable Building 2002* (Baumann *et al.*, 2002) as well as published in the proceedings from the same conference. Results from the survey served as background data for Paper III-V. I analyzed data that concerned the construction industry. I was co-author on the report and the conference paper.

The study on Swedish building trade press actually consists of two studies focusing on the same phenomenon, the representation of environmental aspects in mass media. The first study focused on the diffusion of experience from environmental demonstration projects through print media. The second study especially focused on trade press and its role in communicating environmental information to practitioners within the building sector. The second study also broadened the scope from demonstration projects to green building in general. Findings from the first study were presented at *The 10th International Conference of the Greening of Industry network: Corporate Social Responsibility – Governance for Sustainability* and at the *International Conference on*

Sustainable Building 2002 (Gluch and Femenías, 2002) and published in the proceedings of the latter. In the first study, design, data collection and analysis was carried out in co-operation with Femenías. I was first author for both conference papers. The second study was published in a working paper (Gluch and Stenberg, 2004) and presented at the *11th Annual International Sustainable Development Research Conference* (Gluch and Stenberg, 2005). An improved version of this conference paper resulted in **Paper III**. For the second study I was responsible for the data collection in the quantitative part of the study. Data collection for the qualitative part as well as design, analysis and writing of reports and papers was done in equal co-operation with Stenberg.

Finally the main study of this thesis, the Tunnel Case, has been presented at *the 2004 Business Strategy and the Environment Conference* and published in the conference proceedings (Gluch, 2004). Findings were further analysed and resulted in **Paper IV** and **Paper V**. I designed and carried out the study as well as the data analysis. Paper IV was authored together with Räisänen and I authored the conference paper and Paper V.

3 Description of the construction industry

Within environmental management as well as within the field of green building many concepts and terms are used in various ways why it is necessary to clarify for the reader how the terms and concepts are used in this thesis. Figure 3 provides a schematic picture of construction projects and its context.

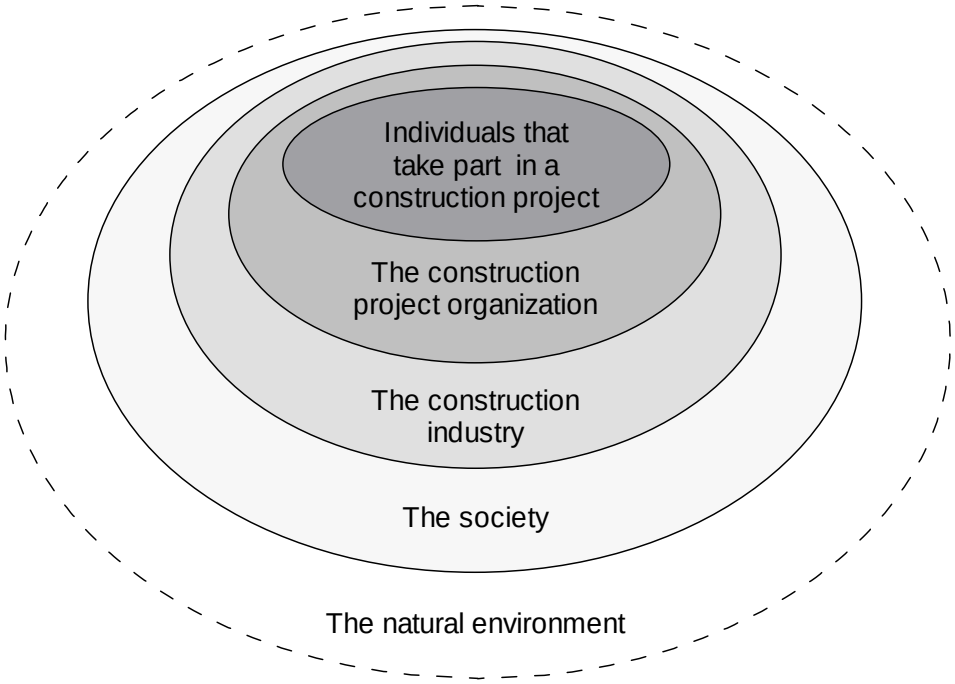

Figure 3: Construction projects and its context

The *construction industry* in this thesis is deemed to comprise the civil engineering and building construction industries. Empirical evidence has, with a few exceptions, been collected from the Swedish construction industry. The *project organisation* and its individuals has been in focus and not the project itself or the constructions, i.e. building, roads and facilities. This means that phenomena related to the construction process including the project organisation and individuals involved in construction projects have been objectives for the studies. Decision-makers in this thesis thus refer to individuals that take part in construction projects in Sweden. Moreover, the project task and/or the product, i.e. the building, have been regarded as part of the context in where the organisation and involved individuals act. Consequently, in analyzing the

empirical findings, project success, i.e. that the project achieved a predefined task, has not been an issue of interest.

Main characteristics of construction projects

A construction project is very complex, and the primary task is to build a construction, a task which is fragmented into multiple sub-tasks. The work practices within construction projects are highly distributed and throughout the construction process a great number of actors: from a wide range of companies as well as local authorities and the society, enters and leaves the project at different times. Multiple activities, material and people, consequently have to be coordinated in a restricted time, on a specific site and under differing climate conditions (Landin, 2000). Since the construction project evolves over time the project organisation is a dynamic collectivity of individuals, e.g. individuals enter and leave the project at various stages (Stinchcombe, 1985). The time-frame is often tight, and short-termed performance is favoured (Bresnen *et al.*, 2004), which creates organisational boundaries related to time, location, culture and practice that influence and put demands on communication between individuals (Harty, 2005; Styhre *et al.*, 2004).

Carrying out their core activities in projects has nurtured a decentralized decision-making culture, which is characterized by operational interdependence and organisational independence (Dubois and Gadde, 2002). The decentralized authority and responsibility lays large emphasis on the efficiency of each individual project. As a consequence, different entities within a construction firm become dispersed and loosely coupled with more room for self-determination (ibid.). At the same time, construction on an individual project level show patterns of tight couplings. This means that construction projects show features of both temporary and permanent organisations (Kadefors, 1995; Eccles, 1981) and thus also exhibit phenomena related to both organisational modes.

Concepts and terms within environmental management in construction

The term *environmental management* means different things for different people. Environmental Management can span from being regarded as everything from managing specific environmental impacts through ‘end-of-pipe’ solutions to a stage in the society’s progress towards sustainable development of global systems and thus apply a national economy perspective (for an more extensive

summary see for example Meima, 2002). In line with Meima's rather broad definition, but yet business related, *environmental management* is in this thesis regarded as the *management of the relationship between a corporation and its natural environment*. From this perspective environmental management in this thesis refers to all actions undertaken by individuals involved in the construction industry to identify, monitor, communicate about, limit, and/or eliminate their business' interaction with the natural environment.

Since terms and concepts within the field of environmental management in construction often are vaguely formulated (Femenías, 2004), there are a few that need to be briefly described since they are so widely interpreted by different people. Firstly, the concept *sustainable building* originates from the term *sustainable development* (SD), which is often related to the definition provided in the Brundtland report, *Our Common Future* (WCED, 1987), and thus incorporates social and economic aspects in addition to ecological. It can, however, be noted that most contributions on sustainable building actually marginalize it to what in this thesis is called *green building*. In this thesis, *Green building* denotes any construction project that strives to reduce the impact on the natural environment caused by the construction process and by the final product, the building, facility or construction.

A second relevant concept related to sustainable building is *sustainable construction*. In the early and mid 1990s the term *sustainable construction* was introduced as a concept that was intended to embrace sustainable development in the construction process (e.g. Ofori, 1992). However, the use of the term was found to be restrained to aspects involving the design of a healthy built environment by using resource-efficient and ecologically based principles (Hill and Bowen, 1997). Thus, social and economic aspects were left out. In late 1990s sustainable construction lost its meaning as a comprehensive concept on SD of construction processes. The meaning of the term shifted to a concept that merely treated technical solutions of the design of a building. In addition, practitioners within the construction industry have been found having problems in grasping SD. In the questionnaire survey carried out within this doctoral project, 40% of the environmental managers asked responded that they had never heard of SD, and of the remaining 60% only 40% agreed that SD was a familiar term within their firm (non-published data). Moreover, from interviews within this doctoral project it has been detected that practitioners employed within the construction industry interpret sustainable construction as something that mainly concerns durability of materials and design rather than a comprehensive concept of

sustainability. Considering these definition problems together with the fact that both sustainable building and sustainable construction in most cases have been found to include measures and activities that strive to make buildings or construction *ecologically* sustainable, I have instead chosen to use the term *green building* to encompass both concepts.

4 Management for Green Building

The first international conference on Green Building was held in Oslo in 1994 and since then, the emerging field of green building research has held recurrent international conferences that have summoned hundreds of participants. Going over proceedings from these conferences provides a general picture that shows that a majority of the research on green building has dealt with technological measures and solutions to achieve resource efficient buildings as the way to solve the building industry's environmental problems (see for example Dyrstad Pettersen, 2002; Boonstra *et al*., 2000). Only a smaller proportion of the conference contributions dealt with managerial and organisational aspects in relation to green building. In this section I will concentrate on previous research within management of green building.

Research calling for paradigm shift and rethinking of construction

A line of research addresses the need for a paradigm shift in order to promote environmental development within the construction industry. The main objective advocated for this shift is that the industry needs to reconceptualise and rethink construction in order to handle environmental issues. In an early work within this field Ofori (1992) stated that in order to achieve an ecologically sustainable development there should be changes in *thinking*, *behaving*, and *producing* within the construction industry. In so, he stated, that the industry needs to take measures that endorse the conscious consideration of environmental aspects and that these become part of the culture within the construction industry.

Work within this field takes a strategic position by conceptually defining and problematising frameworks for green building and in some cases the message is somewhat evangelic, philosophical, visionary and ideational. Within this stream many provide the industry with strategic 'musts' and recommendations. Both Ashworth (1998) and Bourdeau *et al.* (1998), for example, propose the need for carrying out 'best practice' projects. Ashworth also recommends that the construction industry must follow principles as manifested by the Natural Step Foundation (www.detnaturligasteget.se), to carry out life cycle analysis, and to recognize stakeholders and develop partnerships. Researchers within this stream

proclaim that to achieve ecological sustainability it is necessary that the construction industry adopts not only a systemic but also a holistic approach which they see as inconsistent with current industrial practice (e.g. Seaden and Mansau, 1998) and understanding (Straka, 2004). To achieve this paradigmatic change they suggest a variety of corporate strategic means. Ofori (1992) suggests that in order to make environmental issues become part of the culture of the construction industry it is necessary to make the environment the fourth client objective besides time, cost and quality. Suggestions include change of consumption patterns (Ofori, 1998); financial values of green buildings (Yudelson, 2002; Bon and Hutchinson, 2000), stakeholder influence (Roodman and Lenssen, 1995) and societal values and attitudes (Cole, 2004). Bröchner *et al.* (1999) suggests a change of procurement and tendering practice and propose a broadened performance-concept and thus takes on a similar client approach as Ofori (1992). Another strategic approach suggested by many is the use of best practice cases and demonstration projects for learning and diffusion of innovations (e.g. Femenías, 2004; van Hal *et al.*, 2000). An intention with carrying out best practice cases and demonstration projects is to make green building more tangible and visible and thus serve as reference object for inspiration. However, which is also suggested by for example Femenías, to succeed with this ambition requires a well functioning infrastructure for communication, e.g. that involved actors are committed to mediate reliable and tangible information and an existence of available and accessible communication channels. Unfortunately, Femenías also discovered that this infrastructure for communication is rather dysfunctional than functional.

Research on environmental assessment methods

Reviewing the literature on environmental management in construction provided a picture consisting of an extensive flora of methods, techniques and tools, suggested for the management of the industry environmental problems (cf. review in Cole, 2004). These tools have been suggested by researchers from the whole world as fruitful solutions to a variety of ‘identified’ managerial deficiencies within construction. Many researchers have developed methods under the assumption that there is a lack of routines and procedures for evaluating and monitoring the environmental impact from construction. Within this stream one finds guidelines, simulation models, environmental declaration, IT, management systems and environmental assessment methods.

Especially the research stream on environmental assessment has during the last ten year period established as a central field within the Green Building research. Some researchers have adopted a more narrow perspective by assessing a specific material (e.g. Borg, 2001, Jönsson, 1998), a specific part of the construction process (e.g. Sterner, 2002) or a specific environmental problem (e.g. Tam *et al.* 2004). Others have attempted to grasp a broader picture by assessing the building as a whole (e.g. Glaumann and Malmqvist, 2003; Zimmerman *et al.*, 2002), the whole building process (e.g. Häkkinen *et al.* 2002), by being nation wide (e.g. Carlsson and Lundgren, 2002; Houvila, 2002) or by comprising the whole building stock (e.g. Thuvander, 2003).

There are a few critical voices that question the direction of the assessment approach. Several researchers propose that to make the tools appealing for practitioners and useful for decision-making it is necessary to add an economic dimension to these 'environmental' methods. There are two ways to include environmental objectives into the construction industry's prevailing time, cost and quality paradigm. One is to incorporate the cost parameter into environmental assessment methods (e.g.; Yudelson, 2002; Glaumann, 1999). The other is to do the reverse, by considering environmental items in 'traditional' cost-benefit analysis methods (e.g. Sterner, 2002; Tupamäki, 2002; Bartlett and Howard, 2000; Bogenstätter, 2000; Cole and Sterner, 2000). Both variants are captured within the concept of environmental accounting. Environmental accounting developed during the 1990s by, amongst others, Epstein (1996), Schaltegger (1996), Spitzer and Elwood (1995), and Gray *et al.* (1993). van der Veen (2000:155) defines managerial environmental accounting as:

> *…the process of identification, measurement, accumulation, analysis, preparation, interpretation and communication of financial (and non-financial) information used by management to plan, evaluate and control the environmental aspects of an organisation.*

However, although a communication problem is recognized the attempts have in common that they only focus on translating the 'environmental language' into a supposed 'cost language' of practitioners and thus is missing trajectories of communication.

In sum, many of today's assessment methods to aid environmental decision-making have been developed by analysts for analysts and with an analytical mode of decision-making (English, 1998). The tools are thus based on the

principle that systematic gathering and analyzing of information is the best route to an optimal decision.

Research on Environmental Management Systems

In contrast to the many quantitative monitoring and assessment methods, there is a managerial approach that gained large industrial acceptance, i.e. Environmental Management Systems (EMS). In 2002, over 90% of the Swedish construction companies with more than 50 employees had an official environmental policy and almost 80% had implemented or were in the process of implementing an EMS (Baumann *et al.*, 2003). A construction company partly consists of a permanent organisation that has long-termed environmental strategies and goals that shall be implemented and realized in the projects where the main activities are carried out. To handle increasing societal environmental demands many companies have adopted environmental management systems (EMS) that was originally developed for permanent organisational structures (Baumann *et al.*, 2002; Ammenberg and Hjelm, 2002; Burström von Malmborg, 2002). It is therefore surprising that so few researchers within this field have laid efforts on the issue. Especially since a number of barriers that could mitigate a fruitful implementation and use of EMS in the construction industry has been identified, for example the risk of bureaucracy, over-management, excessive paperwork, and lack of commensurate information (Griffith, 1995). There are a few exceptions, Shen and Tam (2002), for example, investigated benefits and barriers of implementing EMS. Their results indicated that the benefits and barriers showed great resemblance with those of implementing assessment tools, such as time-consuming, costly, scarcity of data, and lack of knowledge among users (c.f. Malmqvist, 2002). Both courses of action share similar problems, but yet one is adopted by the construction industry and the other one is not, which indicates that something more than a ‘perfect’ tool decides whether a tool or method is adapted or not. In another study of EMS in construction (Hyödynmaa, 2002) it was found that firms tended to integrate environmental management into already established management systems, such as quality management systems.

EMS in opposite to many other environmental management practices proclaims to address the process. This might be an explanation to why it has been so widely accepted by the construction industry.

Research that evaluates environmental management practice in construction

Based on an evaluation of five environmental assessment methods, Forsberg and von Malmborg (2004) suggest that the methods provide information that may mislead the decision maker. For example, it was possible to isolate the buildings from the context and the methods neglected environmental aspects related to land-use. They also concluded that the tools put large demands upon the decision maker's knowledge and awareness of consequences from made assumptions, for example, regarding the effect of the choice of life-time parameters. Also Woolley and Fox (2000) question the direction that research on environmental assessment methods has taken and accuse the methods for being too technocratic and pragmatic and of missing the moral and ethical dimensions of green building. There is also an awakening discontent concerning limited implementation of the methods in the industry. Trinius (2002) in his evaluation of a 'green' Swedish housing expo, concluded that the use of environmental assessment methods, despite being specifically requested by the client, were not used. Practitioners' explanations for this were: lack of data, the client had not stressed the collection of information as important, lack of suitable methods, and too much economic pressure. Another problem is that it is common that although the client makes demands upon how the contractor shall act during the construction process, they often fail to evaluate whether these demands have been fulfilled or not (Eriksson *et al.*, 2003; Wallin, 2002).

Although research of implementation and use of EMS in the construction industry seem to be limited, the subject has notwithstanding gained more research attention related to other industries and organisations (e.g. Emilsson, 2005; Ammenberg, 2003; Burström von Malmborg, 2002; Steger, 2000; Tenbunsel *et al.*, 2000; Carter, 1999). Some has suggested that standards help to reduce complexity and, thus, may serve as mediating tools for environmental information and knowledge (e.g. Tenbunsel *et al.*, 2000). Emilsson (2005) studied implementation of EMS in municipalities and discovered that EMS encourages a hierarchical role culture that preserves organisational traditions and also contributes to an emphasis on formal rules. Consequently, and which have been discovered in research on EMS (Cunningham *et al.*, 1996 in Vickers, 2000), EMS rather than increasing motivation and empowerment environmental management systems have tended to restructure management roles, increase corporate control and intensify the pace of work. Related to this Emilsson (2005) observed that EMS is institutionalizing environmental practice into bureaucratic

routine work. This she suggests may hinder innovation, since the judgements due to cognitive distortions become biased towards standard-conformed solutions over non-conforming innovative solutions. EMSs have also been accused of mobilizing interests of the firm rather than those of the environment (Mouritzen *et al.*, 2000) which further complicates the EMS approach and makes processes related to EMS a worthwhile topic to investigate also for construction.

Reflections on research within management for green building

Reviewing research of *management for green building* indicates that research that specifically addresses the construction process out of organisational and behavioural perspectives are scarce or at least has not surfaced. This gap has also been recognized by Cole in his review on green building research, in which he states that "socio-cultural and human issues remain poorly covered" and that "a majority of the discussion is technically framed" (Cole, 2004: 100). It is within this gap that this doctoral thesis is placed.

As has been reviewed in this chapter, much research on environmental management in construction follows the normative tradition of research by dealing with how organisations can monitor and control its relationship with the natural environment in order to support decision-making. *Normative theories* on decision-making assume that the decision maker seeks to maximise utility (profit) and always operates with perfect knowledge and select the most rational solution (Carroll and Johnson, 1990; Cyert and March, 1963).

It is a well known that knowledge on environmental consequences from decisions often suffers from great uncertainty. This uncertainty makes it difficult for the decision-maker to make rational decisions, since it is not always possible to obtain all the information needed. In *descriptive studies of decision-making*, decision-making is instead described as a process where decision-makers seek the most satisfying decision. Decision-making is thus seen as the achievement of a choice made, in terms of objectives, from among a set of alternatives, which are based upon available information, calculated estimates, and expectations (Cyert and March, 1963). The descriptive decision-making theories recognize the individual's limited capacity for information processing (see Vlek, 2000; Bazerman, 1998, Carroll and Johnson, 1990, Kahneman and Tversky, 1979). Rather than developing rational models, research with a descriptive approach focus on understanding the behaviour of decision makers. In common for the

work on environmental management in construction is that it regards sustainable development as process and not a tangible outcome.

Departing from this perspective on management, next section provides theoretical perspectives on organising, change processes, and communication that have been used as lens when discussing the need for a more process-oriented perspective on green building.

5 Theoretical perspectives

Throughout the doctoral project theories have been combined with the purpose of explaining various phenomena related to environmental management in construction. In order to make sense of the complex phenomena that have been studied, I have drawn on several theories and used them as exploratory as well as explanatory tools. Figure 4 illustrates the perspective on projects, project organising and social processes related to project organising that has been applied in this thesis.

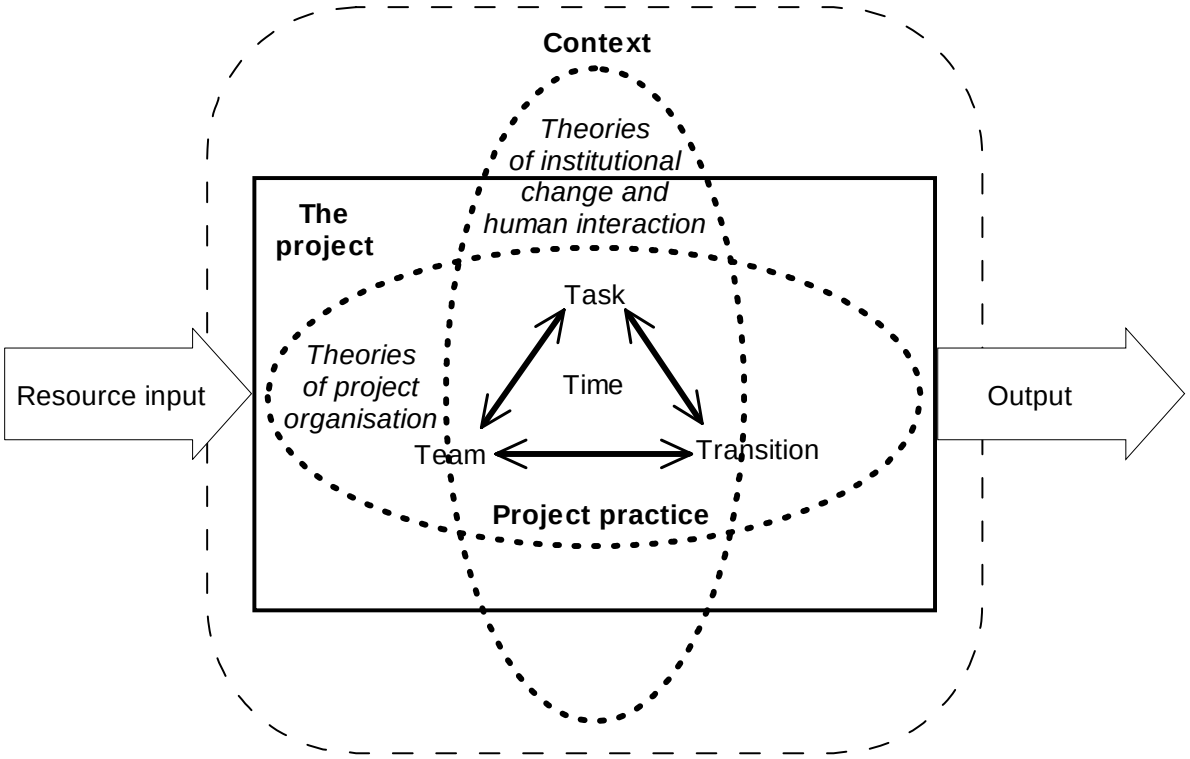

Figure 4: Perspective on projects, project organising and social processes related to project organising

Theories of project organisation

A traditional perspective on industrial projects, which has also been prevalent within construction management, is that a construction project is seen as an 'object' that can be controlled through careful planning. Thus the project is regarded as a tool that through a set of mechanisms transforms resource input

into an output that is something novel (Maylor, 1996). Social processes that go on within the project are thus not regarded. In this rather normative perspective, a project is characterised as unique, as goal-oriented, and, as having a measurable output. This means that the project can be controlled and that its success can be evaluated and measured through a prescriptive set of methods and techniques (Meredith and Mantel, 1989).

In the 1990s the normative and goal-oriented perspective on projects was criticized for not considering phenomena related to temporality, complexity and contextuality (Kreiner, 1995; Lundin and Söderholm, 1995; Packendorff, 1995). Instead the four factors: time, task, team and transition, were seen as intricately interweaved and set together to a framework for projects (Lundin and Söderholm, 1995). From this perspective, projects consist of a number of interdependent or reciprocally interdependent activities which are coordinated by a project organisation. This coordination involves communicating knowledge and combining distinctive recourses, know-how and skills of project members and to reduce the possibilities and effects of any obstruction (Söderlund, 2000). The complexity of the task also involves a number of different organisations and individuals representing a diversity of functions that form a temporary collectivity. Project organisations in general have a beginning and an end where meeting the 'deadline' is treated as both an important control mechanism and as a critical success factor (Söderlund, 2000). Bracketing the project as temporary provides the project an organisational identity (Lundin and Söderholm, 1995). It also constrains external disturbance so that project members, due to their 'isolation', are allowed to focus on their task (ibid.). A consequence from this isolation is that different projects get separated from each other (Lindkvist, 2004). The temporarity also makes plans important. Plans create space for action and make it possible for project managers to act without having the sanctions of senior managers (ibid.). However, plans also create guarding mechanisms against external influence (ibid.). For example, research has shown that organisational change is negatively associated with project success by practitioners (Gray, 2001).

Researchers have found that by bracketing the project as temporary there is a risk that aspects related to the way context and settings affect the project (e.g. issues that concern the natural environment) are locked-out and, thus, might be disregarded in the project (Labuschagne and Brent, 2005; Söderlund, 2004; Lundin and Steinthórnsson, 2003; Eskerød, 1996). Research has found that the bracketing together with the autonomy of project organisations may make

project-based organisations into little more than a series of disconnected projects (Lindkvist, 2004). Bracketing also thus leaves little room for improvement of performance and innovative potential (Dubois and Gadde, 2002; Kreiner, 1995). In addition, project-based organisations have been found to have difficulties in linking projects with business processes within the permanent organisation (Gann and Salter, 2000 in Lindkvist, 2004), as well as to establish shared understandings and a common knowledge base (Lindkvist, 2004). Construction is often carried out under time pressure with the consequence that short-term performance is favoured (Bresnen *et al.*, 2004; Dubois and Gadde, 2002), and leads to a lack of interest to share knowledge with others (Kolekofski *et al.*, 2003; Eskerød, 1996). Since the perspective on projects as temporary organisations, fails to grasp and explain several of these phenomena there is a necessity to adopt a wider perspective on projects in order to grasp the whole picture. This deficiency of the theoretical approach has recently been acknowledged by a handful of researchers (e.g. Söderlund, 2004; Engwall, 2003; Lundin and Steinthórnsson, 2003). Engwall (2003), for example, suggests that to understand the inner life of a project in depth, it needs to be analyzed in relation to experiences from past activities, pre-politics, parallel courses of events, ideas about the post project future and institutional social practices of the project's organisational context. Adapting the extended perspective on projects reconciles that the context is encapsulated in project theories and practice. The context may also comprise a social construction of the natural environment.

Temporary green reform projects have been subject for research within corporate environmental management (e.g., Dobers and Söderholm, in press; Bergström and Dobers, 2000; Füssel and Georg, 2000; Dobers, 1999). In these studies the actual project task itself has been to implement an environmental reform, why they diverge from the 'mainstream' projects of interest in this thesis. A review of organisational studies within the field of environmental management has revealed that scholars, besides these reform projects studies, have paid little attention to project organising (Paper V). Most research has concerned strategic environmental actions and processes for permanent organisations (e.g. Blomqvist and Sandström, 2004; Burström von Malmborg, 2002; Atkinson *et al.*, 2000; Ransom and Lober, 1999; van den Bosch and van Riel, 1998). Some research, that is partly relevant when studying project organising has also focused on interorganisational activities, such as environmental networks (Boons and Berends, 2004; Boons, 1998; Clarke and Roome, 1999), and cooperation between corporations and authorities (von Malmborg, 2004; Starik and Heuer,

2002). Another focus of interest, that in some aspects resembles project organisations, is small and middle-sized enterprises (SME). SMEs, similarly to project organisations, have been found to have problems in relation to implementation of environmental performance tools (e.g., Ammenberg, 2003; Petts *et al*., 1999; Tilley, 1999). Barriers that SMEs are afflicted with and that also hold for project organisations is that they lack human and economic resources, consideration of aspects related to culture and attitudes, insufficient drivers, and lack of knowledge and experience. However, although project organisations might resemble SMEs in regard to size and turnover, there are too many differences concerning organisational structures and practices to equalize them. This opens up for a research gap in which this thesis is placed.

Theories on institutional change and human interaction

Environmental performance of a product does not solely depend on technology but is also influenced by on-going acts of organising, e.g. the management of technology through for example management practices (Baumann, 2004). From an environmental perspective, the objectives in institutional theory are to create an understanding of how the natural environment enters the business agenda and how the environmental challenge is embedded into decisions, management practices and organisational structures (Füssel, 2005; Scott, 1998). In the context of environmental management, this means that researchers explore mechanisms for greening and the greening of industry is regarded as a constantly on-going process of institutional change. The institutions are in turn created by people that interact within them. Institutions thus provide a pattern for behavioural norms that is often seen as so obvious that nobody questions them. The theoretical assumption made is that greening of industry is a process where people constantly are involved in the act of organising. Applying this perspective on corporate environmental management present work joins a group of researchers which have has a similar perspective in their studies (e.g. Stenberg and Räisänen, 2006; Füssel, 2005; Meima, 2002; Bergström and Dobers, 2000; Füssel and Georg, 2000; Heiskainen, 2000; Strannegård, 1998).

Theories on organising and interpretive processes

I am aware that the micro-organisational level of institutional change, i.e. a level that concerns how different ideas, e.g. greening, enter and is dealt with by individuals, is not *a* theory but rather a group of theories (e.g. *travels of ideas* [Czarniawska and Joerges, 1996]; *sense-making* [Weick, 1995]; *activity theory*

[Engeström, 1999]) I have in this section chosen to briefly present the main ideas that unite them (for theoretical overviews in relation to greening of industry see for example Meima, 2002; Heiskainen, 2000; Boons and Strannegård, 2000).

A basic assumption that unites these theories is that ideas are institutionalized through a process where individuals collectively create meaning of them based on their previous understanding set in relation to their social context. In this process, notions of for example the natural environment are verbalized and translated into objects that in turn are translated into action. The interpretation and translation of the natural environment is dependent on contextual organisational factors such as corporate identity and how the corporations have legitimated environmental aspects (Sharma, 2000). An implication for environmental management is that individuals interpret what is 'proper' environmental behaviour and behave thereafter (Vlek, 2000). In so doing, individuals tend to overestimate their own input and want to determine their preference on the basis of self-interest (Wade-Benzoni *et al.*, 1996). They also use their own behaviour as a standard of what other people will do. This implies that people's behaviour may be characterized by what they want to do instead of what they should do. As a consequence, individuals create meaning based on their own personal interests and cognitive limits through a social process where new environmental information must compete with beliefs that people already hold (Eagly and Kulesa, 1997).

Bresnen *et al.* (2005), comment that new management initiatives, such as environmental management, are often deployed to challenge and reorganise organisational structures and practices. Kadefors (1995), discovered in her study of implementation of quality management practice that the construction process and the occupational roles where heavily institutionalised, and that changes in established practices were met with great resistance. Several researchers have pointed out that the construction industry relies on strong professional (e.g. Dubois and Gadde, 2002; Gherardi and Nicolini, 2000). Regarding each project as a collectivity where individuals are united by an endeavour to realize a project goal, the personnel employed in the project coheres to project practices that are set in the community rather than for the firms as a whole. As such, these collectivities are composed of sub-cultures in which practitioners have their own orientations, which influence their understanding.

This indicates that when dealing with environmental management and communication of environmental issues, one has to balance between adjusting to

common practice and culture on the one hand, and challenging practice and culture on the other (cf. Bresnen *et al.*, 2003 study on knowledge management). Studying implementation of new management practices (accounting models), Briers and Chua (2001) discovered a number of factors that influenced how well the practices survived in an organisation. They found that to keep the system alive it was necessary that promoting actors for the system were present on lower levels of the firm, it was also necessary that the system was made visible to the organisational members, e.g. through seminars and discussions. Moreover, it was important that the model was flexible enough so that it could be suited to the context and also that the model delivered data that made sense, for the organisational members.

Socio-cultural communication theory

Working and organising are social practices engaged in a set of activities that are situated in a specific context and influenced by a specific history. Within this context individuals are embedded in patterns of social relations in which values and social norms are established. The history and context influence these individual's identities (roles), responsibilities and behaviour (Söderbaum, 1997), as well as how environmental information is communicated.

Any collective action towards environmental sustainability entails that individuals, engaged in business, behave and make decisions that independently are pro-environmental. Knowledge on environmental issues plays here an important role for how individuals act (Kaiser *et al*., 1999; Stern, 1992). Diffusion of knowledge is dependent on communication (Bresnen *et al.*, 2003). Co-ordination, in time and space, of multiple activities, highly distributed work practices, and a great number of involved persons, influence and put demands on communication in construction projects (Styhre *et al.*, 2004). Being a social process, the ability of project members to handle the rhetoric of the project organisation is very important, if one wishes to influence or govern it (Koskinen *et al.*, 2003; Lundin and Söderholm, 1995). In order to make project members understand and apply new insight and knowledge to their own context it is important to develop a shared meaning (Bresnen *et al.*, 2003). As suggested by researchers (e.g. Stenberg and Räisänen, 2006; Häkkinen *et al.*, 2002; Malmqvist, 2002), communication and information are crucial aspects for a corporation to manage environmental aspects in the construction industry. For construction projects, poor communication has in fact been recognized as a major cause for the construction industry's inefficiency (Kadefors, 2004). In the context

of construction projects, individuals are highly dependent on timely and accurate information since they continuously make decisions that very often cause or may cause environmental impact. The communication of environmental information and knowledge is therefore a critical factor for environmental management.

Communication is a wide concept that can be studied from several different perspectives. The perspective on communication that is held in this work relates to socio-cultural communication. Socio-cultural communication theories concern in addition to how knowledge and information is transferred between individuals, also how communication processes create meaning and understanding in a social context (Räisänen, 1999). This context is both physical, i.e. the project setting in which communication occurs and where actors make sense of the information, and cultural, i.e. the values, ideologies, beliefs and norms of the community where the actors belong (ibid.). Within these contexts and through language and/or symbols individuals create meaning and position themselves. A common understanding on environmental issues in construction, therefore, needs a common language, a frame of reference that all actors can relate to and understand. This common understanding is created through action.

In a communication process language is used as a means for coordinating action (Koskinen *et al.*, 2003; Orlikowski and Yates, 1992). Language is mediated though discourse and texts (Fairclough, 2003; Scollon, 2001), as well as technical tools and genres (Orlikowski and Yates, 1992). Communication therefore is considered as an essential part of an ongoing organising process where social structures, practices and identities are produced, reproduced and changed (Orlikowski, 2002; Orlikowski and Yates, 1994). Fairclough (2003) defines discourse as a particular way of using language and other symbolic forms to represent some part of the physical, social or psychological world. Genres in organisational communication are, in turn, defined as socially recognised types of communicative action. In construction projects knowledge and information is mediated through, for example, genres such as telephone calls, meetings, documents, talk, print-periodicals, and e-mail (Gluch, 2004). Genre repertoire consists of a mix of standardisation attempts, norms, rules and prescriptions (Joerges and Charniawska, 1998). However, genres do not only serve as mediating tools to regulate and legitimate interaction, but also to normalise and control (Räisänen & Linde 2004).

In order to create a common understanding of construction work the project organisation needs to create a common reference frame (Bresnen *et al.*, 2003),

which is done through a continuous process of communication. Several scholars (e.g. Strannegård, 1998; Keogh and Polonsky, 1997) have emphasised that the way environmental issues are communicated in an organisation has a considerable influence on how environmental issues are managed. It has been shown that the choice of corporate communication mechanisms determine if environmental issues are to be interpreted as something that is purely for experts, as something that only involves costs, as something external, or if environmental issues are to be considered as a key concern for future development and business survival.

Present thesis responds to the need to create an increased understanding on processes related to communication and human interaction within environmental management which have been pointed out by other researchers as well (e.g. Cole, 2004; Dobers *et al.*, 2001).

6 Main findings

The studies carried out within the doctoral project have led to an increased understanding on how organisational features and communicative patterns and practices influence the way environmental issues are managed in construction. The papers approach problems and phenomena related to building practice and environmental management from different perspectives.

Paper I and II address it out of a decision perspective by investigating environmental accounting tools and their capability to handle the environmental issues in construction projects. Paper I also provides some theoretical explanations for the rise of environmental accounting tools. Paper III keeps the decision maker perspective but also brings on a wider perspective, incorporating an industrial and societal perspective by looking at how building trade magazines have mediated environmental information to practitioners.

Although decisions may seemingly be made on an individual level, it cannot be neglected that decision makers in fact always take part in a social practice that is in turn shaped by history and takes place in a specific context. Recognizing that individuals in construction projects interact with other individuals as well as with artefacts, Paper IV deals with how project practices influence environmental management in construction. Paper V deals with the way organising of construction companies influences on how environmental issues are handled in a construction project.

The main findings from the papers are presented in this chapter along three themes. The first theme concerns the role of environmental management tools and methods; the second the way environmental communication is influenced by project practice; and the third sets environmental management in construction projects in a wider organisational context.

The role of environmental management tools and methods

Both the LCC-study and the CEE-study sprung from the same idea; that of translating environmental issues into a monetary term (Papers I and II). It shall be noted, that the CEE and LCC studies were neither the first nor the last

attempts within construction research with an ambition to translate the environmental dimension into a monetary dimension. The construction industry's interest to inquire new tools that monitor environmental issues in a monetary dimension contradicts with building practitioner's resistance to adopt and implement already established tools that attempt to do just so. This opens up for the question: What is the tools good for?

First of all there is always a need to find ways that make it possible for decision-makers to control and simplify a complex reality. In construction projects, individuals are highly dependent on timely and accurate information since they continuously make decisions that cause or may cause environmental impact. The communication of environmental information and knowledge is therefore a critical factor for environmental management. Access to information improves the possibility for individuals involved in construction projects to gain the necessary knowledge of environmental issues to handle them better. In the CEE-study it was found that the application of CEE in construction projects made it possible to identify some problem areas, such as insufficient storage of chemicals and poor waste management routines (Paper I). The life-cycle perspective of the LCC analysis showed the long-term consequences, consequences that usually fall outside the projects timeframe, to the decision maker (Paper I). Moreover, the data gathering required intense investigation and the calculation process necessitated justification of the 'rationality' of multiple estimations. An answer to the raised question is that the main advantage of carrying out these types of analyses, and often detective work, is that the individuals that take active part in the calculation process raise their personal awareness and knowledge of environmental issues.

The study of CEE and LCC thus showed some positive learning effects, nevertheless, the studies also revealed problems with the extent to which the tools managed to account for environmental consequences (Paper I and II). This leads us to a second question; is it possible at all to integrate environmental and economical dimensions? A problem is that LCC-tools derive from normative neo-classical economic theory (Paper II). This means that they are based on theoretical assumptions that fail to help in decisions in situations of uncertainty or when the outcome is irreversible. The theoretical base also implies that LCC-oriented tools neglect items with no owner, such as air and seawater, and underrate future environmental costs. This means that such tools cannot fully take account of the environmental consequences of the investment decisions.

Another problem with both LCC and CEE concerns the availability and reliability of environmental and economic input data. In spite of possible learning benefits, stemming from the process of gathering data and actively thinking on which estimations that are made, this reliance on multiple estimations contributes to problems with the reliability of the results from the calculation. Lack of data leads to investment decisions carried out under uncertainty and that many estimates have to be made. When faced with uncertainty decision makers generally make estimations that are biased towards their own values and motives rather than being objective to the problem in hand (Hogarth, 1994). Thus, it is concluded that making estimations means that the result from an LCC analysis becomes biased towards personal values of the calculator and that the decision is based on an interpretation of the reality that the calculator either takes part in or, by other means, gets knowledge of. A straight yes or no answer on question two is not possible to provide since each decision-making situation varies. Nevertheless, the findings indicate that it due to situational differences makes the tool approach problematic. Paper II concludes that the usability of the tools are restrained by their imperfect theoretical base and for sufficiently use both the person that carry out the analyses as well as the person that make decisions based on the results from them, need to not only be aware of the tool's limitations but also on the influence from the situation as well as one's owns cognitive limitations on the results.

Another way of simplifying a complex reality is to limit the inflow of new environmental information. This seems to be a common strategy within the construction industry. The findings show that there is a lack of interest in bringing in "new information" into the project (Paper IV). Thus, in spite of the availability of a large number of mediating tools to facilitate cross-boundary communication, environmental information exchange and knowledge creation did not often take place. It was found that project members seldom sought for environmental information proactively, for preventive or long-term purposes. When they did seek information, their search was driven by need, e.g. when a particular critical situation or incident occurred or during auditing periods when focus on documentation was strong.

Some practitioners involved in construction projects referred to other ways than using environmental management tools, such as LCC, as ways of obtaining environmental knowledge. An external information source for new ideas pointed out was building trade magazines. The study on building trade magazines showed that the environmental information mediated by trade magazines focused

on a few targeted topics that mainly concerned either technical solutions or legislative measures. This means that the trade press consistently miss out informing of the industry's impact on the environment, among other things (Paper III). Information on how the reported technical and legislative measures actually influence the natural environment was also missing. A similar lack of knowledge about the environmental consequences of construction was also noticed in the field studies (Paper I).

Thus, the unbalanced information on green building provided knowledge mostly about how others act and thus one is expected to act in relation to these others. This, in turn, nourishes an isomorphic route where already common notions within the building sector set the direction (Paper III). This means that the construction industry follows a line there it is thought that its environmental problems are best solved with either technical solutions and/or legislative measures. Looking closer into the rhetoric in the articles in the trade magazines, it became clear that there was a notion that environmental issues are regarded as troublesome and difficult (Paper III). It is therefore concluded that the trade press contribute to manifesting this notion that environmental issues are negatively loaded as truths. Furthermore, the claim for tools that only monitor environmental costs and thus neglect benefits fits in with the negatively loaded rhetoric in the notion that environmental issues are perceived by the industry as a burden that needs to be minimized (Paper I and II).

The CEE study, in such, revealed several phenomena related to a problem of making sense of environmental issues in the project settings (Paper I). It was especially clear that environmental officials sought ways that could match project practices, by imitating a by practitioners accepted quality tool, as well as a cost and efficiency sensitive culture (by 'avoiding' failure and unnecessary costs). This matching was thought to raise knowledge and create consensus about environmental issues, which were found to be generally poor within the industry (Paper I, IV). This leads us to the next section that concerns how environmental communication is influenced by project practice in construction.

Environmental communication in construction projects

As emphasised previously, communication of environmental information and knowledge is an important part of corporate environmental management. Communication and interaction within a construction project and across project boundaries is facilitated, or limited, by the formal and informal linguistic and

technical mediating environmental tools at hand. In the tunnel case several mediating tools were used in the communication between parties involved in the construction project. Figure 5 describes the environmental information flow to, from and within the tunnel project and shows mediating tools used in the communication of environmental information.

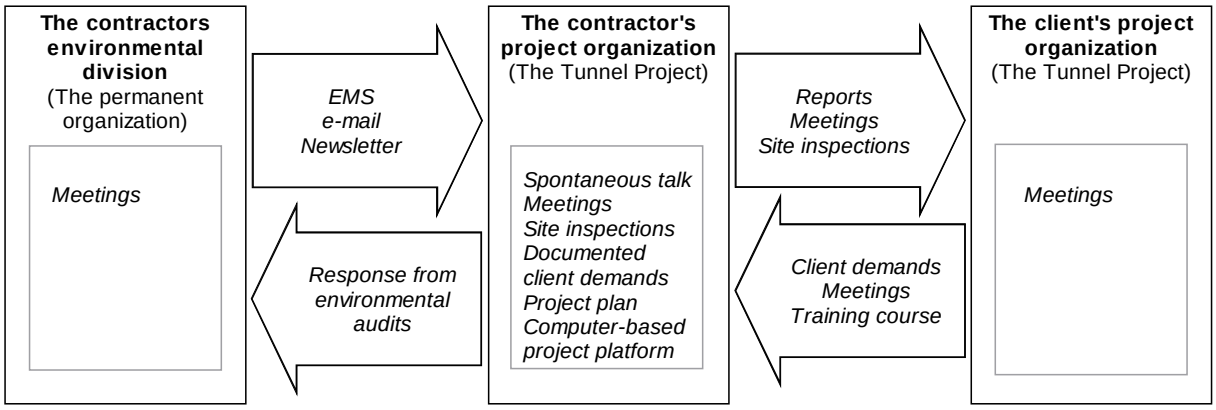

Figure 5: Environmental information flow to, from and within a construction projects and tools and genres used to mediate environmental information.

The figure shows that the contractor's project organisation used different tools and genres to communicate with each other and that many of them were face-to-face communication, e.g. meetings, talk and site inspections (Paper IV). The permanent environmental division in turn provided the organisation with environmental information through a comprehensive web-based EMS, e-mail and newsletters. In common for these mediating tools was that they were impersonal and text-based. In the tunnel case it could also be observed that the only formal communication of environmental information from the project to the permanent organisation was through the, not frequently occurring, stochastic auditing control mechanism. The communication between the project organisation and the client's project organisation was much more intense, for example the client demanded weekly environmental reporting and was carrying out site inspections.

In spite the availability of mediating tools and a rich flow of environmental information, the interviewees within the project organisation perceived that they did not get any environmental information besides the documented demands set by the client. This indicates that many mediating tools and texts, e.g. the EMS, the electronic project platform, e-mail, consisting of rich sources of written information, did not succeed in engaging project members. For example, the web-based EMS was, although its availability and appropriateness for the project, due to computer literacy, lack of specificity and relevance to immediate

problems only used as information source by a few project members. Also in those cases there were a few web-pages that were visited, pages that had been specially recommended by colleagues. The project database, although it was project specific, was not used at all since the project members perceived it as easier to ask a colleague for the same information. In order for the mediated information to generate engagement it had to be enacted-upon-for-now, resulting to appropriation-for-now. This means that in spite of many mediating tools and the large potential for interaction, there were in actual fact few windows opened for engagement through the intersection of social practices. The sites of engagement where communication and practices did converge, leading to environmental action, were mainly mediated by orders with immediate implications for the project, e.g. directives by the client. Since the clients demands are bounded to the current project there were thus no clear windows of opportunity opened for long-time learning. It was in addition, found that 'traditional' project management practice, such as meetings, talk, telephone contacts, were found to manage environmental issues insufficiently by marginalizing the message to concern trifles and/or by un-authorizing the mediators of the environmental messages (Paper IV). It shall also be noted that none of the tools neither monitored nor communicated environmental information in monetary figures. In fact, the interviewed did not have knowledge of any such tool.

Within this mediation of environmental information in the tunnel project it was observed that there existed key mediators that functioned as filters for information. The actors that were pointed out as key mediators for environmental information were the contractor's project manager, the project's environmental official and the client's building inspector. These actors had in common that they were visible by high presence in the project. The project environmental official was expected to act as an expert, and thus supporting with and filter the environmental information to and from the project which made him a potential hub for environmental communication. However, it was found that this role was restrained by several aspects related to project practice. For example, the traditionally hierarchical structure of the project organisation entailed that power was concentrated to the project manager, who had to approve all proposed action points before they could be implemented. Since the environmental officials wielded no power, they had little ability to directly influence managers or workers on site which entailed that to comply with project practices environmental information was re-routed through 'authoritative' translators, such

as the project manager and the building inspector. Moreover, due to the different organisational structures and social processes of the parties involved in the tunnel project, there was a lack of coherence concerning the status and definition of environmental activities. A consequence from this was that rather than being an anchor, the environmental official often perceived himself, and was indeed also perceived by project members, as a "nag". The dismantling of the corporate environmental division also meant that he lacked the support of an authoritative unit due to the de-coupling of the project. As a consequence the environmental official's influence in the project was marginalized. From a communication perspective, the building inspectors' role was, despite their lack of formal authority, one of the most powerful roles in the project. The building inspector role, in addition to high visibility, was strengthened by the traditional project practice as well as the fact that their visits were associated with assessment and control.

Findings such as the environmental official's lack of influence and the limited use of the EMS, indicated a lack of coherence between project practices and environmental practices and by the haphazardness of environmental communication processes to and from the project. Thus available environmental management tools were not mediating environmental information as they were expected. A reason for this lack of engagement was a mismatch in modalities. Most of the official environmental information was conveyed by means of written text, e.g. EMS demanded extensive written reporting and so did the majority of the environmental management routines on site, such as reporting and checklists, whereas the project had an overwhelmingly "talking" management culture. Consequently, the texts provided by the corporate environmental organisation and that could be found in, for example, the EMS had to be rewritten in order to adapt them to a more familiar communication culture for the project members. This process was found to involve several mediators that filtered the sender's message on its way to the receiver.

The tunnel case also indicated that environmental issues were not very highly ranked in the production phase of the project (Paper IV). Rather, environmental issues seemed to be regarded as something that was set on the top of the 'regular' work, i.e. externalities. It was also found that the implementation of administrative tools such as the EMS, checklists and chemical databases had marginalised the building industry's holistic environmental challenge to administration of a few targeted issues, for example hazardous substances. A consequence of this standardisation of environmental aspects was a

fragmentation of environmental concerns, a kind of isomorphism of environmental issues. Even though the EMS created a common environmental framework for the organisation as a whole, which facilitated communication and enabled managerial control of environmental activities, it also encouraged conformity and simplification of environmental complexity, e.g. environmental work is equated with handling of chemicals.

To make the communication of environmental information more efficient, it is suggested that environmental linguistic tools such as the discourse and genres need to be adapted to the communicative culture obtaining in the project organisation (Paper IV). It is therefore recommended that the communication culture is considered when choosing linguistic as well as technical mediating tools. Instead of risking resistance and or misunderstanding by using dominantly written formal genres and technically complex systems, it would be more efficient to nurture the prevalent speech genres and adapt discourse and systems to more direct forms, e.g. audio-recorded reports and interactive agents to help novices navigate through complex management systems. As was found in the tunnel case, the permanent organisation is currently fighting against the current praxis by being dominantly oriented toward formal written communication. This leads us to the next section that presents findings concerning tensions between corporate environmental management and project organising.

Corporate environmental management and project organising

In the tunnel case presented in Paper IV and V, environmental specialist knowledge was concentrated with a few persons on a corporate staff level while the administration of the environmental work was assigned to officials that shared this task with other tasks, e.g. quality assurance, purchasing, and work safety.

The findings showed that this way of organising resulted in the existence of two independent and separated organisational units that use different ‘language’ and with different environmental goals. This consequently created a distance between the persons that develop environmental guidance and possess environmental expertise and the persons that needed guidance and expertise in order to build in line with corporate environmental policies. The organisational distance between the project organisation and the corporate environmental division together with the lack of situation specific environmental management practice, also created mistrust towards the environmental staff’s ability to understand the project

members' reality and work situation. It was found that suggestions of changes in practice, proposed by the environmental division, were met with a defensive attitude and a resistance. For example, the project members expressed a wish that what had been outlined in project plans established at the start of the project was preferably not to be changed during the project time.

It was found that the way environmental work was organised placed large reliance on the internal web-based environmental management system as a guidance for the project members to act pro-environmentally (Paper IV). This reliance on a web-based EMS as motor for environmental information from the permanent environmental division required that environmental routines and procedures were standardized. The situation with two independent and 'different worlds' was further underlined by the top-controlled and not situation-adapted EMS. Being top-controlled the EMS not only mismatched with the project context and situation, it was also found to not fit with the culture of the decentralized and autonomous project organisation. The need for standardization of the environmental work was for example conveyed by the project members, in such a way that the environmental issue was controlled from top with very little room for flexibility. As a consequence project members were not encouraged to think innovatively and to make efforts to improve environmental management routines.

In addition, the bracketing of projects as temporary organisations, planned against a fixed time horizon, a "bracket in time", further complicated the time-perspective of environmental issues. The bracketing of construction projects was found to neither provide motivation nor prerequisites for the project members to have a long-termed and holistic environmental perspective. It also fostered an extreme focus on production efficiency on behalf of issues which effects fall out side of the project boundaries, e.g. demands from the corporate environmental staff (Paper V). The time bracketing was also reflected in a result-oriented culture where everything that was not perceived as being hands-on to current task was regarded as an efficiency obstruction. To handle this deficiency caused by tight time-frames, attempts were made to consider and envisage these effects in project plans. It was found that the project's environmental norms, set by the client, were more tangible for the project members than corporate environmental policies. This is problematic from an environmental perspective since, even if the clients set the rules, the clients have limited insight into the contractor's strategic, technical, organisational and operational practices which determine the actual game that are decisive for its outcome (Paper IV and V).

Additionally, since the body of knowledge within environmental management is still in its infancy, with innovative technologies and new discoveries constantly being made, it is important for organisations to be sensitised to sudden changes. Bracketing and locking environmental demands into plans may seriously constrain the project organisation and render its members inflexible to such changes. It is suggested that to avoid information inertia and isomorphism, the organisation needs to ensure that it does not create barriers for interaction and communication (Paper IV). Instead, it needs to ensure that there are legitimate arenas for exchanging experience and knowledge within projects and especially across project borders.

The findings presented in the last two sections have pointed to the existence of several in-built tensions between how environmental issues were organised in the tunnel project and how the project was organised. A summery of these built-in tensions is presented in Table 1.

Table 1: Built-in tensions between project organising and environmental management

	Organising the Environment	**Organising the Project**
Inter-organisational relations	Decoupled with the project organisations	Loosely coupled with the permanent organisation
Intra-organisational relations	Loose couplings between members (network)	Tight couplings between members (team)
Organisational control	Centralized	Decentralized
Organisational dependency	High and integrated	Low and autonomous
Communication	Text-based	Face-to-face
Time perspective	Long-termed	Short-termed
Performance focus	Strategic policy making and continuous improvements	Resource efficient production (foremost financial) and coping with environmental demands embedded in plans
Environmental scope	All-embracing and integrated	Targeted or embedded
Regulations	Governed by corporate and societal environmental standards and norms	Governed by the client's demands

In sum, the way environmental work was organised in the tunnel case resulted in two professional communities with different perspectives on the natural environment, where the corporate environmental unit's holistic and all-embracing perspective were found to not interplay with project practice and the project members' pragmatic, task-bounded and time-framed perspective (Paper V). Further explanations to the observations presented in this section and some proposals on how research as well as the construction industry can deal with the situation are presented and discussed in the next coming section.

7 Discussion

Since the early 1990s much effort has been spent on studying and developing green building practices. As a result there is much theoretical and technical knowledge on how to design resource efficient and environmentally sound buildings. Furthermore, intensive efforts of co-operative branch organisations, such as the Swedish Ecocycle Council for the Building Sector, and top management within construction companies have raised a general environmental awareness among practitioners. As presented earlier in this thesis, there are also a large number of analytical environmental management techniques and tools that, for example, assess and monitor the environmental impact from the built environment and provide standardised guidance on what practices ought to be followed. Nonetheless, these efforts do not seem to have influenced the project practice and culture to any higher extent. For example, it was found that neither building techniques nor the buildings seem to have undergone any marked changes in this period (Paper IV and V). So far the efforts have rather contributed to a perspective where environmental concerns have been narrowed down to a few targeted topics. This means that environmental issues tend to be dealt with piecemeal rather than as part of an integrated and holistic picture, missing out on the holistic nature of environmental concerns (Paper III, IV and V).

It was found that many of the methods proposed by researchers have failed to attain acceptance among practitioners, which has resulted in a resistance to adopt the tools as well as to change building practices (Paper II, Paper IV and Paper V). The construction industry's built-in resistance to change is often stated as a reason why the construction industry hesitates to adopt new ideas, such as new management practices (e.g. SOU, 2000; 2002). In my field studies I observed that the construction projects studied were constantly subjected to changes and that project members had to be innovative to cope with these. I therefore mean that there must be other reasons for their unwillingness to adopt new green ideas. Another common explanation to the resistance to adopt tools proposed by researchers is that the industry must change attitude (e.g. Teo and Loosemore, 2001). Although the attitude towards environmental work varied among the interviewees there was a general perception that environmental issues were important in construction and should not be neglected. Consequently, raising

environmental awareness among practitioners is not sufficient enough to make practitioners change their behaviour and project practices. This indicates that there, in addition to awareness, are other, less tangible aspects of social processes that affect how environmental issues are handled. Some of these have been revealed in the present doctoral project and their possible influences on green building will be further elaborated in this discussion.

Based on the work in this thesis, I mean that the prevalent perspective on environmental management in construction is too product-oriented. The product-oriented perspective entails limited scope for creating an understanding of on-going processes of environmental management in construction, for example what lies behind and beyond the building industry's resistance to change. In line with Wolff (1998) amongst others, a change towards more environmentally responsible behaviour in the building industry needs less focus on tool production and more on understanding the management process, and for example, the role tools play in this process. A changed perspective would take into account that individuals when acting with or without the support of tools, use cognitive skills and preconceptions which are influenced by aspects such as values and norms (Kolekofski and Heminger, 2003; Vlek, 2000), how well environmental concerns have been legitimized in the organisation (Abertny and Vagnoni, 2004; Briers and Chua, 2001), coordination of communication (Orlikowski, 2002), situational practice (Bresnen *et al.*, 2005; Bresnen *et al.*, 2003; Koskinen *et al.*, 2003), and organisational context (Bresnen *et al.*, 2005; Koskinen *et al.*, 2003; Sharma, 2000; Söderbaum, 1997).

In its exploring of on-going organisational and social processes in relation to environmental management in construction, this thesis has presented a variety of phenomena that influence the way environmental issues are handled, such as practices, roles, cultures, artefacts, and other institutionalised processes. The advocated change of perspective is metaphorically illustrated by shifting the product-centred *Green Building* to the process-centred *Building Green* and thereby emphasizing the importance of on-going processes. The relevance of changing the perspective from Green Building to Building Green will here be discussed through four phenomena that have been identified in the doctoral project as influential on processes related to the handling of environmental issues in construction.

The need to create meaning of a complex reality

The overview of green building research presented in chapter 4 showed that management research within the 'green building' field has mainly followed a normative path, for example by suggesting various assessment tools. As a consequence, the research agenda is locked into a perspective that is product oriented and solution driven. It was also noted that a majority of the tools, methods and practices tended to be generic; i.e. the tools and methods were designed for an assumed and general decision-making situation, and thus intended to fit all decision-makers, organisations and/or construction projects. The methods also mainly focused on the product, i.e. the building or the facility as such, i.e. as a 'closed' system. A consequence from having this standardised and generic approach is that the suggested tools, methods and practices do not account for contextual and complex social arrangements and organisational processes that occur in construction projects and affect the outcome, i.e. the product. An explanation given to why there is a lack of enthusiasm among practitioners in construction to adapt, use or apply environmental management tools and methods in practice is that practitioners do not understand the environmental discourse used in for example environmental tools (e.g. Cole and Sterner, 2000). Instead environmental tools using economic discourse were suggested as an alternative. The economic discourse was motivated by the fact that construction projects are driven by economic factors which means that an economic mindset already exists. This would entail a better familiarity with economic discourse. Being autonomous entities, exceeded cost frames are in fact considered a project failure (Kreiner, 1995). However, despite the change in discourse also the application of these environmental tools seems to lack penetrating power in practice.

The strongest motive to why environmental managers and officials acquired the Costs of Environmental Errors approach was that by monitoring environmental errors they hoped to find a way of comprehending the complexity of environmental issues, but also to develop a language that would help create meaning of the complexity in relation to current project practice. A problem with many of the tools is that they are developed under the assumption that communication is a linear process that involves a message (e.g. environmental information) that originates from a sender (e.g. environmental experts) and sent to a receiver (e.g. practitioners). With this rather mechanic albeit traditional perspective on communication, the complexity of contextual factors involved in environmental management in construction is overlooked, which means that for

example social and cognitive processes remain invisible. The importance of considering these less tangible aspects is brought up in the present thesis. One such example is the influence of the language nuances and tone of the trade press mediated environmental information of how green building may be interpreted and in turn handled. Another such less tangible aspect, is silences, which both the trade press study and the tunnel case showed examples of. Trade press, for example, did not mediate information about actual or possible consequences of a particular action (Paper III), and in the tunnel case environmental concern had been pin-pointed to a few targeted issues rather than the complex and multifaceted environmental situation that the construction industry are faced with (Paper IV). Moreover, aspects such as appropriation of information, time and the resources at hand, and if the information was communicated in a language that was aligned with the language used in the specific project situation were all important for the way tools were and are used. All these aspects can not be solved by translating the environmental dimension into economic figures.

In order to create meaning and understanding of environmental issues, individuals interpret and translate the environmental language with respect to their personal pre-understanding, context and action (c.f. Dammann *et al.*, 2002; Dobers and Strannegård, 2001; Bergström and Dobers, 2000; Joerges and Czarniawska, 1998). The practitioners have been, as previously mentioned, accused by environmental experts, such as researchers, of not understanding the environmental discourse. On the basis of my empirical findings I would rather argue that there is a lack of a congruent *use* of the environmental language. Since it was found that practitioners had limited knowledge of environmental issues and lacked interest in searching for and acquiring new knowledge (Paper I, Paper IV) this entailed that their interpretations would risk being biased towards past personal experience (Czarniawska and Joerges, 1996; Wade-Benzoni *et al.*, 1996). For example, some interviewees had problems separating issues that concerned the natural environment with safety issues because occasionally these issues overlapped, for example concerning handling of chemicals, but also due to the fact that safety affects an individual's personal, immediate well-being and thus may be perceived as more tangible on a personal basis. This resulted in them using the environmental language, but in the context of safety instead of that of the natural environment. That individual project members' hold different subjective views on what green building entails, even if it, for example, might be true that costs in general are more tangible and powerful in arguments, a cost analytic tool will not be adopted if the numbers achieved from it do not make

sense in the connection with the subjective worldview of individual project members (Briers and Chua, 2001).

The weak legitimacy of environmental issues

To override differences in worldviews, environmental officials on an operative level could function as communicative mediators and bridge the gap between the project and the permanent environmental division. However, a finding from the tunnel case was that environmental officials instead of being important actors for organisational and collective learning were regarded as "nitpicking nags". This was found to partly be a consequence of their loose coupling with the environmental division and partly with their lack of influence on the project. For example in the tunnel project it was important who communicated environmental information (Paper IV). In order to gain hearing in the project organisation, which is in line with Wallström's (2004) findings, the environmental officials either had to be an established actor in the organisational context or at least familiar with the 'rules of the game' as well as with the 'language' used in construction. Bresnen *et al*. (2003) similarly found that the success of new management functions depended on interpersonal and cultural aspects more than on technological and procedural mechanisms. Thus, the way environmental issues are managed in construction, which in turn has an effect on the final construction, partly depends on how well environmental issues are imbued with legitimacy in the construction project. A way to enforce environmental issues in construction projects is to strengthen the position and role of the environmental officials in construction project. As it is today, it seems as persons assigned administrative environmental work in construction projects, due to the complexity of environmental issues need to have a strong organisational identity as well as integrity so that when needed they have the authority to oppose current project practices in order to handle their environmental assignment.

Consequently, even if corporate staff categorises environmental concerns as a top priority in environmental policies, this does not become a fact for the organisation until all organisational members are convinced that it is a top priority. This they will only do when they perceive environmental concerns as relevant to their everyday work situation (Füssel and Georg, 2000). To convince members of construction projects I argue that environmental aspects as well as environmental management tools need to be made visible and that their status be raised in the organisation. To make this happen environmental management practices must be aligned with project practices. Coherence between these

practices would not only facilitate environmental official's work, it would also raise the status of environmental issues. Raised status might contribute to more focus and resources being placed on improving the environmental performance of the product, e.g. greener buildings, roads and facilities.

The mismatch between environmental management practice and project practice

In the Environmental Barometer Survey of the Building Industry, corporate environmental managers' when asked what factors positively influenced environmental work pointed to image, satisfied top-management, as well as satisfied personnel (Baumann *et al.*, 2003). In contrast, the project members were found not to perceive the first two factors as something that was a major concern for the project. In fact these factors were perceived as something that goes on in a different world.

Each construction project organisation regards itself as a professional community (Bresnen *et al.*, 2003; Dubois and Gadde, 2002), where individuals with similar professional backgrounds are united in their endeavour to realize a novel and unique project goal. This means that the project members create meaning in respect to the community rather than for the construction company as a whole. Instead the project organisation is united by project goals set by the client. This means that the project organisation has to adapt environmental practices set by their company with that of the client's and subcontractor's actions and practice. In the tunnel case, for example, it was found that the client had a mandate to set the main direction for the environmental work and that environmental policies set by the construction company were partly set aside during project time. In the tunnel case, the project due to its vulnerable location had been a target for many environmental evaluations prior to the project start. In addition the client is a large actor on the market with a developed internal environmental competence, which affected the level of the demands. Despite this, environmental issues were found to be bounded by the project time and thus concerned momentary disturbances rather than long-term environmental concern. Consequently, this might entail that long-term environmental goals of the construction company are forgotten and also a risk of not attaining green building.

I have previously argued that many available tools for environmental management in construction are product-oriented and thus neglect processes. EMS is a process-oriented tool, and as such, it seems as it has gained more

acceptance in the construction industry. However, the tunnel case revealed some problems related to communication processes that indicate that the tool may not work as expected. The web-based EMS was for example, although its availability and relevance for the project, only used by a few project members. Being text-based the EMS was found to contradict the face-to-face communication culture that dominated in the project organisation. Manoeuvres within the system's infrastructure also presupposed a familiarity with the system and a certain level of computer literacy that was not found among all project members. Koskinen *et al.* (2003) have found similar results in their study on knowledge acquisition. They found that databases only complemented personal networks and that project members only used databases when colleagues directed them to a specific items in the database. Rather than turning to databases, individuals sought knowledge from trusted and capable colleagues, which was also a finding in this doctoral project. Organising environmental work through a standardised EMS was also found to marginalize and bureaucratise environmental work, which also corresponds to observations made by other researchers (e.g. Emilsson, 2005). As such environmental work was perceived as necessary administrative routines for maintaining a level considered as hygienic, and efforts other than the minimum were considered as a burden.

EMS is not only a guiding tool and a source of environmental information it is also a corporate control mechanism with the purpose of facilitating continuous improvements of a firms environmental performance. In the case of construction, to enable continuous improvements, EMS demands reporting from inside the organisation, i.e. the construction projects, to a higher organ within the construction company. A key to tacit knowledge sharing is that members of an organisation have access to a wide range of project activities, to ideas of other people, to information and to opportunities for participation (Koskinen *et al.*, 2003). The empirical findings showed that the loose coupling between the project and the environmental division in the permanent organisation resulted in two separate and independent organisational units. Units that in turn used different language and that partly had different environmental goals. In addition, limited space and interest for sharing information with others outside the construction project (cf. Kolekofsky *et al.*, 2003; Eskerød, 1996), limited time to appropriate new knowledge, as well as the existence of multiple filters, indicate that the feedback loop necessary for tacit knowledge sharing and continuous environmental performance improvements may be distorted or even broken. If

there is a wish to build green and to make continuous improvements in the construction industry it is necessary to revise the EMS approach.

The marginalization and labelling of environmental concerns

The mismatch between the communication practices within the project and those of the permanent organisation and that the tools used to mediate environmental information were often neither suited to the situated practice nor to the purpose of the message, together with the environmental officials lack of operative authority and limited ability to influence have led to a marginalisation of environmental concerns. This may in turn lead to an increased risk of carrying out actions that might contribute to environmental impact, but also limits the possibilities for learning in the project and across its boundaries.

According to results from the questionnaire survey, those employed within the construction industry perceived that environmental work had a negative influence on short-term profit, cost savings, and on productivity (Baumann *et al.*, 2003). The findings presented in this thesis have shown that these three aspects are prioritized in construction projects. Firstly, it has been shown that time-bracketing limits project member's ability and motivation to dwell on long-term environmental impacts and profits. Similar observations have been made by e.g. Labuschagne and Brent (2005), Bresnen *et al.*, (2004) and Dubois and Gadde (2002). A consequence of bracketing was that the perception of the natural environment was bound to only encompass issues that were visible in a specific project, which automatically precluded other environmental issues. What is made visible was also often determined by the client's focus which may not always agree with the permanent organisation's environmental policies and long-term performance goals.

In order to unconditionally focus on production aspects, there are mechanisms in construction projects that deliberately lock out external influences. To avoid disturbances that might affect the production demands, for example environmental, are locked into non-changeable plans (Kreiner, 1995). Corporate environmental policies were in turn embedded in predefined project plans which diminished the scope for the project organisation to react to societal and environmental changes. In the tunnel case it was also found that the project organisation placed emphasis on environmental concerns that were defined as 'important' for production by rhetorically detaching them from their environmental connotations. However, rhetorically detaching a few pinpointed

environmental concerns, this way of itemizing may send signal that what is left is not important. This view on environmental issues may make the environment a side issue not highly ranked by the project members, a detail that can be negotiated away. It may seem as though this is a minor problem since the project in fact takes care of the issues most important for the project. However, in common for the issues that were emphasised was that they were very important for a current situation, i.e. for the project here and now. This means that environmental issues that may be of importance for the actual outcome of the project may be less attended to, for example choice of material.

Applying building green

It has been found that the prevalent product-oriented perspective ignores many process-related aspects that are important for the environmental quality of the physical outcome of construction; i.e. the product or the building. For example environmental officials had to find ways to motivate and legitimize environmental management practice (cf. Meima, 2002). In line with Füssel (2005) this thesis has recognised that greening is part of on-going processes of change. These processes are in turn created by people that interact within them which call for a changed perspective on green building. Recognizing that social processes influence how environmental issues are handled in construction, a way forward is to develop environmental management practices that are flexible enough to be adjusted to local circumstances and that recognize that environmental management is part of an on-going organising process. Consequently, if one aspires to achieve green building it is necessary to consider the processes that influence the construction of a building, road, and/or facility. This is why it is important to focus on *building green* in order to achieve *green buildings.*

8 Conclusions

This thesis has attempted to link aspects of environmental management techniques with those of organisational and social processes. It has also attempted to align different management perspectives relevant to the greening of construction. The results have shown that for example environmental management in construction projects is not aligned with centrally controlled and generic environmental management practice. The results have also shown that the temporary perspective of construction projects conflicts with the long-term principles of sustainable development. The discussion in chapter 7 stressed that in order to achieve green building there is a need to adopt a perspective that integrates technical and social aspects of environmental management. The advocated shift from *green building* to *building green* is not just a play on words; it also signals that to manage environmental issues in construction there is a need to go beyond the normative and rationalistic technological view and look at the on-going work and communication processes in order to understand as well as achieve greener building. Exploring social practices and organisational features of construction projects and their relation to environmental management has yielded the following conclusions:

- When developing tools and decision strategies it is important to recognize, understand, and be able to forecast on-going processes related to environmental management in construction and to have a realistic view of the roles of the tools in the decision-making process.

- Developing tools that are generic, i.e. that are supposed to fit all organisations, fails to recognize and understand these processes. The outcome is tools that lack enough flexibility to become situation-adapted and adjusted to project practice. In the contrary, a too rigid tool may end up constraining activities, resulting in negative outcomes for the project. So even if the learning effects from implementing and applying environmental management tools should not be neglected, this may entail that the tools rules rather than facilitates.

- It is suggested that it would be wise to revise the EMS approach. It has been shown that environmental work governed by a top-down controlled environmental management approach matches poorly with the decentralized and autonomous decision-making culture of project organisations. A process-oriented EMS may serve the purpose for guidance, but since the feed-back is interrupted, this limits the ability for organisational learning. It is therefore concluded that for a more vital environmental management approach in construction, it is necessary to stimulate innovative environmental actions within the projects, instead of today's administrative actions. This requires in turn that top management is aware and reflects on the discrepancies between the permanent organisation and the construction projects. They should then encourage the "isolated" project members to share their new project specific insights and experiences with their peers and management.

- If organisations rank environmental issues as a top priority and also want this to be reflected in the construction projects, the position and role of the environmental officials need to be authoritative within the project organisation. Strengthening the environmental official's profession would facilitate environmental concerns receiving legitimacy within the whole organisation. It is important that the environmental concerns as well as the environmental officials are made visible in the project. A strong, united and more visible position would strengthen the environmental discourse in the organisation, and lay the ground for a common understanding and less apart meanings of what green building is and why it is necessary to build green.

- To break the isolation between the project organisation and the permanent environmental division there is a need to find ways where environmental management and project professionals can team up. The top management can encourage the establishment of communicative interdisciplinary communities and strengthen their vitality by supporting the project organisation members participation in a communities of practice. Top management can also nurture the creation of these communities by offering communicative arenas where people can meet and exchange information and knowledge. However, to make it work three things have to be considered. Firstly, it is important to consider the communicative culture of the organisation so that fruitful and open discussions can be

held. People in the business like to talk so why not use that and create communication spaces that encourage and facilitate talk. Even though this seems time-consuming, it might save many work hours if experiences could be shared more systematically. Secondly, the top management needs to support the creation of professional communities. They also need to influence the composition of these communities so that they do not become too homogenous. Thirdly, equality in the discussion requires that the authority of persons that belong to the environmental unit must be powerful enough so that environmental issues are legitimised within the organisation.

In sum, there is a need to recapture the holistic perspective on environmental concerns that was proposed by the "early evangelists". The way environmental management has developed has transformed environmental concerns into administrative tasks laid on top of regular work with the risk that the environmental challenge becomes institutionalized to encompass only a few targeted aspects and thus loosing the holistic environmental perspective necessary for a better handling of environmental issues in construction.

Outlook

Throughout the work I have discovered certain recurrent areas of importance for environmental management in construction but that have not been the main objective of the different studies. Areas that also have been found to be insufficiently described in the literature. It would therefore be worthwhile to continue research of these. One such area is the professional role of environmental officials and the like, a role that does not seem to have established a clear identity and function in the organisations. A second interesting area concerns environmental communication processes in construction. Some of these communication processes have been found to serve other functions than the formal communication processes, which would be worth further examining. A third area of interest is to contribute to the development of the communicative arenas that have been suggested as a means for environmental knowledge exchange in project-based organisations.

Such research would benefit from cooperation between different scientific disciplines, for example between technicians and organisational theorists, but also from a close cooperation with the construction industry. The area has a large improvement potential that would especially benefit from an inter-disciplinary

approach where for example the two communities, project management and environmental management, could team up in a flourishing cooperation.

In the field of civil engineering where management studies are relatively rare, this thesis makes a contribution to both practitioners that are struggling with environmental management practices as well as researchers within a variety of scientific disciplines.

In parts it may seem that I have depicted a rather pessimistic picture of the construction industry's and the building research community's perspectives on green building. It might appear as if there are solely problems and no bright points. As closing words I therefore want to add that I truly believe that the industry has the possibility and willpower to move from what practitioners perceived as a rather indifferent *green building* approach to a more proactive *building green* approach.

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PAPER I

Costs of Environmental Errors (CEE) –
a managerial environmental accounting tool or a symptom of managerial frustration?

Gluch, P. (2001)

Greener Management International, **31**, pp. 87-99.

Costs of Environmental Errors (CEE)

A Managerial Environmental Accounting Tool or a Symptom of Managerial Frustration?*

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This paper has two aims: (1) to evaluate the usability of CEE as a managerial environmental accounting tool; and (2) to explain theoretically why 'new' environmental management tools, such as CEE, are continuously being developed. The CEE concept was evaluated in a multiple case study within the construction industry. Environmentally related errors and causes and costs connected with the environmental error were identified and measured. The study identified 243 errors and 78 different kinds of causes.

The conclusions are that CEE is powerful enough to achieve results when measuring negative deviations from specified norms and improvement areas can be identified. CEE identifies industrial costs as well as enhancing the understanding of which kinds of cost can be related to the failure. However, the existence of multiple environmental norms, the ambiguous formulation of norms and the construction sector's poor knowledge of the content of the specified norms complicate the usability of CEE. CEE as an environmental decision-support tool is thus not comprehensive and there is a need for complementary tools. Creating consensus, keeping score and communication appear to be the most likely theoretical explanations of why decision-makers are interested in new tools, such as the CEE concept.

- Costs of environmental errors
- CEE
- Environmental accounting
- Tools
- Integration
- Construction projects

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* My thanks to Dr Henrikke Baumann, Chalmers University of Technology, Sweden, for her supervision and for valuable comments on this article. Thanks also to Professor Roger Flanagan, University of Reading, UK, for valuable comments. This research was financially supported by MISTRA, Foundation for Strategic Environmental Research, and by SBUF, the Development Fund of the Swedish Construction Industry.

STUDIES OF POOR-QUALITY COSTS (PQC) HAVE BEEN GIVEN GREAT ATTENTION within the Swedish construction industry and have contributed to a discussion of new considerations concerning quality improvements in construction (Hammarlund *et al.* 1989; Josephson and Hammarlund 1996). With an increased focus on environmental effects caused by the construction industry, the idea of undertaking a similar study of costs associated with environmental failures in construction was raised. A project, with participants from the same network of researchers and construction companies as for the PQC studies, was thus carried out in 1998 (Gluch 1999). In order to separate it from the study in this paper, this earlier project is called the 'CEE project'. Costs of environmental errors (CEE) are defined as: 'financial costs that arise because the business's products and/or processes deviate from specified environmental norms' (Gluch 1999: 22).

One aim of this paper is to discuss the conceptual idea of CEE, which was tested within the construction industry. Environmentally related errors were identified in several cases and the causes and costs identified and estimated. Evaluations concerning the usability of the CEE concept constitute empirical evidence for the conclusions in this paper.

The second aim is related to a phenomenon observed in today's business environment: there is a strong business interest in developing decision-support tools that provide 'hard' environmental data. There is a corporate interest in quantifying environmental shortcomings and relating these shortcomings to financial consequences (Öhlund 1997). In order to motivate increased environmental efforts in a business, several financial managerial environmental accounting tools exist with the purpose of guiding decision-makers towards good decisions from an environmental perspective. Decision-support systems may be computer-based, paper-based or simply people-based procedures. Epstein (1996) lists several: full-cost accounting (FCA), total-cost assessment (TCA), life-cycle costing (LCC), life-cycle cost analysis (LCCA), environmental reporting, full-cost pricing, eco-accounting and total quality environmental management (TQEM). Nevertheless, firms hesitate to use the figures they receive from these decision-support systems (Ljungdahl 1999), which is a paradox or perhaps may be a symptom of the diversity of environmental decision-support tools available today.

For example, environmental reporting practices have developed during the past decade, but it is the descriptive information on activities in companies and sometimes quantitative records on environmental loads that have increased, not the reporting of financial quantitative measurements. Lack of distinct definitions and uncertain input data are obstacles to the provision of financially related environmental information. Another issue is that financial investors do not demand or emphasise environmental reporting when making capital investment decisions (Ljungdahl 1999). Some of the managers interviewed in Ljungdahl's study regarded environmental reporting as a passing trend, and showed some scepticism towards environmental accounting. Regardless of this, new financial environmental accounting tools, such as CEE, are continuously being developed. The second aim, therefore, is to explain theoretically why this is the case.

The concept of CEE

The identification of errors and failures is not a new approach for detecting possible improvement opportunities. This approach is used in areas such as strategic management and quality management. Therefore, the idea of CEE was that it could be a useful tool to support managerial decision-making (Gluch 1999), with the purpose of measuring financial environmental consequences caused by construction projects.

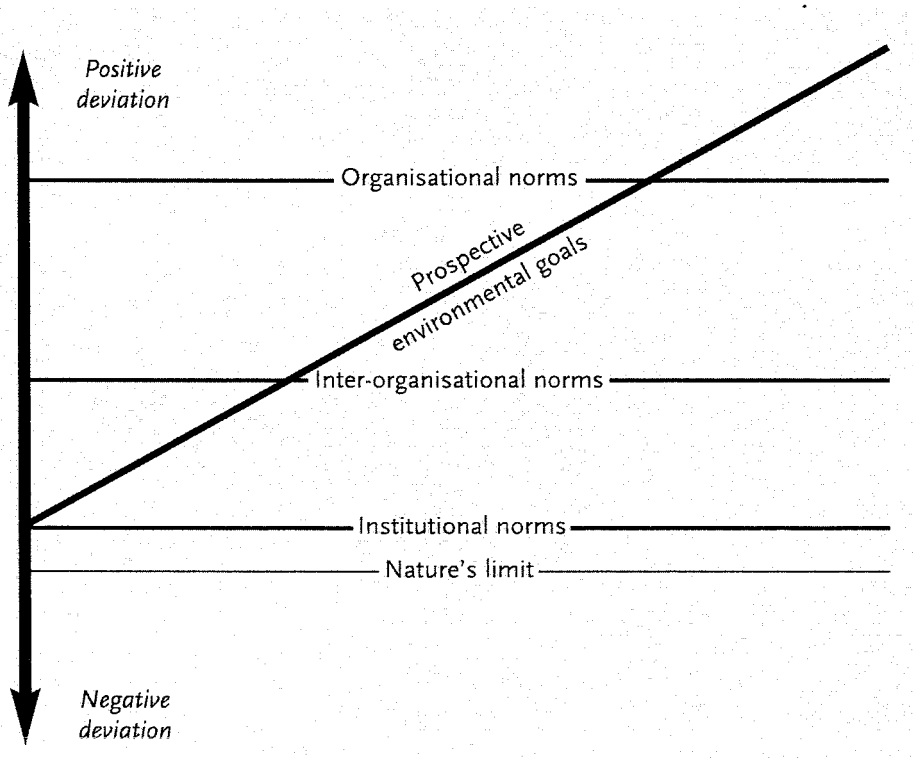
CEE is complex. It includes three concepts with several interpretations: environment, error and cost. A rather broad definition of environment was used in the CEE project. Environment was, in accordance with ISO 14004, defined as: 'surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation'. In view of the business perspective of the CEE project, this definition fitted the purpose of the project.

An error often refers to the discrepancy between demands set for the final use of the product and the product itself. When it comes to environmental demands, deviations are difficult to evaluate, since there are several levels of environmental norms. Whether a deviation caused by a certain action has occurred or not is therefore difficult to decide. The CEE project recognised this ambiguity, and environmental norms were classified into three groups: **institutional**, **inter-organisational** and **organisational**.

Institutional norms, such as environmental legislation, can be seen as the lowest level to attain. Inter-organisational norms, such as client requirements, are environmental specifications expressed in contractual agreements. These norms are by definition an obligation for the organisation. Organisational norms, such as environmental policies, elaborate a standard on the company's performance level. In Figure 1, these three groups of norms are ranked according to their importance.

Prospective environmental goals can, depending on context, be seen as an informal environmental norm that can be used for measuring deviations, even though they are not seen as a traditional norm. Prospective environmental goals are illustrated in Figure 1 by a diagonal, which shows the large variation, ranging from goal-setting that just fulfils institutional norms, such as legal demands, to more visionary outlooks. Prospective norms are usually used as targets in the process of improvement within organisations. For example, in order to attain an ecologically sustainable community, the Swedish

Figure 1 FOUR GROUPS OF ENVIRONMENTAL NORMS, RANKED ACCORDING TO THEIR IMPORTANCE FOR FULFILMENT. POSITIVE OR NEGATIVE DEVIATION IS IN RELATION TO EACH ENVIRONMENTAL NORM.



government has set a number of overarching environmental goals. To fulfil these regulations, the Swedish construction sector has outlined a number of industry-specific environmental goals through the co-operation of the Ecocycle Council of the Building Sector.[1] However, environmental goals in the construction industry are often broadly and vaguely formulated (Gluch 1999). In addition, nature itself also sets a 'norm' or a limit of what it can bear, beyond the norms used in the CEE project. This 'norm' is hopefully fulfilled when businesses comply with institutional norms such as legislation. Nevertheless, because nature has no voice to raise when businesses exceed this limit, this assumption cannot be tested.

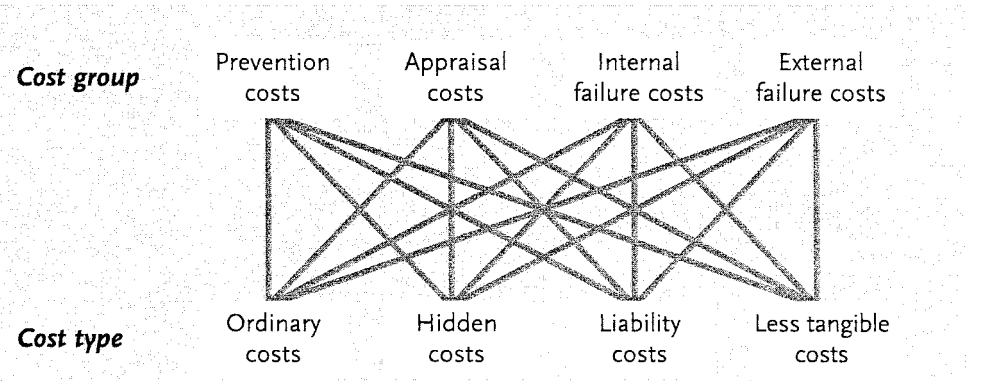
There are several instruments of control that affect firms' financial results in a negative way. This increases the importance of mapping the costs of the industry's environmental impact. Welfare and social economists have defined environmental costs in several ways, although these definitions are seldom suitable for managerial applications. Different firms use different definitions of environmental costs, which results in confusion about the 'true' figures for environmental costs (van der Veen 2000). Four of these definitions are presented below (van der Veen 2000):

- The costs for business impacts on the environment and society for which firms are not legally accountable
- The financial burden for firms as a consequence of environmental regulation
- The costs of environmental measures
- All costs that are relevant for environmental management

This implies that there is more than one 'right' definition, and each is suitable for a particular purpose. Different categories of purposes for analysing environmental costs can be distinguished, including internal communication, external communication, policy formulation, capital budgeting, negotiations and cost allocation (van der Veen 2000).

Due to the study's origin within the quality area, the cost categories used in the CEE project were of the same types as in PQC (Harrington 1987; Josephson 1994; Linnanen *et al.* 1995; Sörqvist 1998). As Figure 2 shows, the costs were divided into four groups: **prevention**, **appraisal**, **internal failure** and **external failure** and each group was divided into four types: **ordinary**, **hidden**, **liability** and **less tangible**.

Figure 2 COST CATEGORISATION OF CEE



1 www.kretsloppsradet.com/engelsk.htm

CEEs were identified mainly for internal use and from a business perspective. In the CEE project, the observers referred to environmental costs as costs that arise due to prevention or correction of the environmental impact caused by, for example, construction or use of a facility (Gluch 1999). The kinds of prevention cost to be considered in CEE were restricted to those that were directly related to the defective action: that is, costs to prevent the error from being repeated. Costs for end-of-pipe solutions, with the purpose of preventing a repetitive deviation, were also taken into consideration.

A multiple case study

The CEE project was a multiple case study with four cases. The CEE concept was tested in practice, thus enabling an analysis of its usability. The case studies were carried out over periods of four to seven weeks and covered the entire construction process; different business areas were represented. The cases were chosen so that the entire construction process could be studied; housing and civil engineering projects as well as new construction and refurbishment were represented. The study used direct observation in combination with document analysis. In addition, several interviews were carried out. Four engineers (observers) from each construction company participated in the study with the researcher. The observers were introduced to the CEE framework, with its definitions of environmental norms and costs. In each case, meetings between the researcher and the observers were conducted, where there was an exchange of ideas about CEEs and the research process. Each case was concluded with an extensive interview with each observer on CEE and environmental management in construction projects. The observers were encouraged to comment on the researcher's interpretations and results and on the case study report. For a more extensive evaluation and discussion of the research method, see Gluch and Josephson 1999.

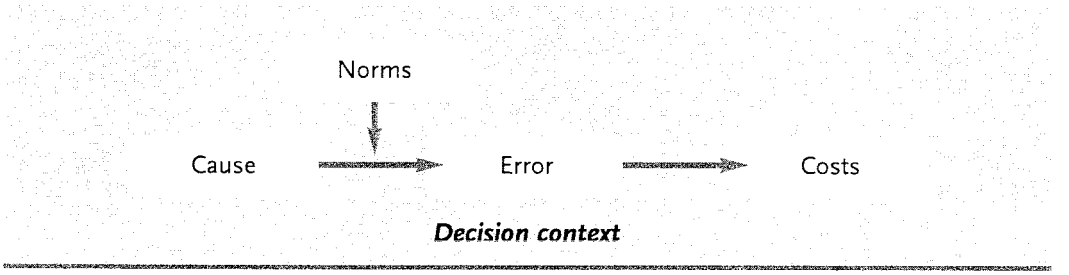
Identification of errors, costs and causes

The causes of an environmental error were identified and categorised and costs connected with the environmental error were quantified or estimated. The error, cause and cost were studied in accordance with an error model, described in Figure 3. CEEs were studied in an analytic chain sequence, where the event (*the error*), the previous events (*the causes*) and the subsequent events (*the consequences*) were documented in a standardised report chart (Gluch 1999; Gluch and Josephson 1999).

Table 1 describes the cases in terms of type of construction project, contractual form, stage of construction and the environmental norms used in each case.

Figure 3 CHAIN OF ERROR MODEL IN A DECISION CONTEXT: CAUSE, ERROR, AND COSTS (FINANCIAL CONSEQUENCES)

Source: modified from Nowak and Carr 1985; Josephson 1994



Case	Description			
	Type of project	*Contractual form*	*Stage*	*Environmental norms*
A	Medium-sized housing project	Managed by the contractor	Completed	▸ National legislation ▸ Environmental policy ▸ Industry-specific environmental goals†
B	Large-sized civil engineering project	Design–build contract	Ongoing*	▸ National legislation ▸ Client requirements ▸ Environmental policy ▸ Internal environmental goals‡
C	Medium-sized housing project	Design–build contract	Ongoing*	▸ National legislation ▸ Environmental policy ▸ Internal environmental goals‡
D	Medium-sized refurbishment project	Traditional contract	Ongoing*	▸ National legislation

* At the time of the study

† Industry-specific environmental goals set higher or equal to national environmental goals

‡ Internal environmental goals set higher or equal to industry-specific environmental goals

Table 1 DESCRIPTION OF FOUR CASES

Results of the case study

In the four cases, 78 different causes were identified and categorised in five sub-groups, as shown in Table 2. The results show that poor planning was mainly responsible for the frequently occurring incidents, but social factors caused the most severe incidents,

Table 2 CATEGORISATION OF IDENTIFIED CAUSES

Factors	%*	Explanation
External causes	5.1	Causes beyond control of the person that possesses the responsibility: for example, unexpected weather conditions, the supplier's routines, and disagreement between theory and reality
Informative causes	6.4	Causes based on deficient communication: for example, lack of experience or knowledge, and ambiguous or misinterpreted instructions
Poor planning	37.2	Causes related to unexpected needs, drawings received late, delayed time-schedule, and insufficiently planned acquisitions and/or sub-orders
Social causes	20.5	Causes based on insufficient commitment, laziness, stress, forgetfulness, lack of practice, carelessness and negligence
Technical causes	30.8	Causes with a technical origin, such as breakdown of technical equipment, insufficient techniques, and divergent technical conditions

* Distribution of the causes of the environmental errors detected in all four cases during the time of study

such as accidental emissions. There appeared to be a need for new technical solutions to attain sustainable construction.

In total, 243 deviations from specified environmental norms were identified within the four cases. These were categorised as shown in Table 3. Local disturbance was the most commonly occurring negative deviation (Table 3), and was due mainly to strict client requirements, especially for noise levels in Case C. Clients' requirements appeared to be more specific than other norms and were more easily identified. Further negative deviations appearing in the study were unnecessary use of resources and diffusion of xenobiotic substances. Incidents with emissions of xenobiotic substances also violated client requirements and were easy to identify. The industry sector goals, set by the Ecocycle Council of the Building Sector, emphasise a reduced use of natural resources and emissions of xenobiotic substances, which can explain why this type of error appears more frequently than, for example, errors of the type of choice of material.

Most types of error could be associated with the costs of prevention, appraisal and internal failure. The easiest to quantify were prevention costs that were mostly of the ordinary cost type and thus were reported in business accounting systems. The largest

Table 3 EVALUATION OF IDENTIFIED ERRORS (NEGATIVE DEVIATIONS FROM SPECIFIED ENVIRONMENTAL NORMS)

Type of error	*Explanation*	*No.**	*Restricting specified environmental norms*	*Cost group†*	*Cost type‡*
Hazardous waste	Defective handling of hazardous waste. Hazardous waste has not been managed in a proper way, or equipment for handling the waste has not been provided for.	39	▸ National legislation ▸ Environmental policy	▸ Prevention ▸ Appraisal ▸ Internal failure	▸ Ordinary ▸ Hidden ▸ Liability
Choice of material	Choice of material does not fulfil criteria set in environmental norms.	8	▸ Environmental policy ▸ Industry-specific goals	▸ Internal failure	▸ Ordinary ▸ Hidden
Unnecessary use of natural resources	Unnecessary use of natural resources caused by, for example, damaged material, poor waste management, unnecessary energy use and unnecessary transportation	49**	▸ Environmental policy ▸ Industry-specific goals	▸ Appraisal ▸ Internal failure	▸ Hidden
Diffusion of xenobiotic substances in the environment	For example: discharge of petroleum products, diffusion of chemicals and exhaust gas, and use and/or storage of unhealthy or hazardous petroleum or chemical products	45	▸ National legislation ▸ Client demands ▸ Environmental policy	▸ Prevention ▸ Appraisal ▸ Internal failure	▸ Ordinary ▸ Hidden
Local disturbance	Disturbance such as noise, dust and odour	66	▸ Client demands	▸ Prevention ▸ Appraisal ▸ Internal failure	▸ Ordinary ▸ Hidden

* Number of errors detected in all four cases during the time of study
† Cost groups identified in the study
‡ Cost types identified in the study
** Unnecessary energy use not included

cost group in CEE was internal failure, i.e. costs that rise before the product is handed over to the client. These include costs for unnecessary use of resources: for example, poor waste management, damaged material, and change of material that did not fulfil set environmental criteria. Furthermore, salary costs for time consumption connected with increased production intensity caused by, for example, disturbance and material change are included, as well as costs connected with measures taken to restore environmental damage caused by, for example, diffusion of xenobiotic substances and poor handling of hazardous waste (see Table 3). Appraisal costs constituted mostly managerial measures to assure that the error did not reappear. Internal failure and appraisal costs were mostly of the hidden kind. Ordinary costs comprised different types of rental cost (for example, additional sanitary personnel and equipment) and handling of material and waste. However, the majority of CEEs were so-called hidden costs, such as time consumption when correcting the error; these were particularly difficult to measure. The liability costs identified mostly related to waste management and included increased fees for handling unnecessary waste. Less tangible costs, such as costs connected with image and goodwill, were not identified.

The strength of CEE as a managerial environmental accounting tool

The multiple case study shows that some principles for quantification of CEEs are possible to identify. In spite of multiple norms and different environmental cost groupings and types, the study shows that the theoretical perspective of the CEE concept is powerful enough to produce results when measuring deviations. The concept enables an identification of incidents related to the defective action when norms are specified. The definition of CEE identifies industrial costs as well as enhancing the understanding of the kinds of cost that can be related to failure. Nevertheless, business accounting seldom considers environmental items and therefore does not separate environmental costs from other costs. This implies that the total amount of CEE was not recorded. Furthermore, it is important to emphasise that a large share of environmental costs burdens society and the environment but not the firms.

The existence of multiple environmental norms that decide whether an action is defective or not complicates the theoretical approach to the definition of CEE. Four environmental norms were specified in the CEE project, but these norms can be divided even further. When choosing norms, it is important to determine whether it is avoidance of violation of norms and regulations, or avoidance of harm to the environment that is the objective for measuring the organisation's CEE. The answer to this is related to the company's objective. The objective often depends on the company's level of enthusiasm, strategy and knowledge (Welford 1998). It is hoped that the norms are set so that, by exceeding them, one avoids harming nature. However, the case studies show that several of the norms were vaguely formulated, which caused an ambiguity in interpretation.

The so-called hidden costs are difficult to detect, yet these costs are often chronic in character and can be significant. It is easy to imagine that handling them requires extensive organisational changes. The studies identified that knowledge of the content of the specified norms was generally poor within the construction industry (Gluch 1999).

CEE can, to a certain extent, be used as a tool by the organisation when measuring environmental performance. In accordance with PQC, CEE integrates different dimensions of decisions, which simplifies the decision-making process. Nevertheless, it is important to stress that CEE is not suited for comparing firms, because different firms include different parameters, use different methods and perform different cost estimates. A comparison would therefore result in ambiguous interpretations.

CEE only points at costs and not benefits, which is another problem. This can result in a warped view of where to put future efforts for improvement. Nevertheless, identifi-

cation of possible improvement areas is the principle purpose of identifying errors or failures, and is accomplished even if the costs and not the benefits are in focus. This indicates that CEE as a managerial environmental accounting tool is not complete, since the tool perhaps does not identify the ultimate improvement area. Complementary tools are needed to detect improvement areas not connected with costs. It is also very important to bear in mind that environmental decision-making is multidimensional and uncertain and that the tool can provide only either rough estimates or retrospective measurements.

Explanations for the managerial need to develop CEE

In studies of environmental managers' attitudes towards accounting (Wycherley 1997; Ljungdahl 1999), it was found that environmental managers were sceptical towards results achieved from environmental accounting systems, probably because available accounting systems insufficiently reflect environmental costs (see also Schaltegger 1996). People have a tendency to avoid hard data and instead rely on their intuition and on simplifying strategies and heuristics (Tversky and Kahneman 1974; Mintzberg 1975). Tversky and Kahneman (1974) explain this reliance on rules of thumb as a mechanism for dealing with the complex environment surrounding decisions. But, if decision-makers rely so strongly on simplifying strategies instead of hard data and do not trust accounting, why are they so interested in developing decision-support tools that provide hard data? This manifested and laudable need in business to develop such tools provides the background for this theoretical analysis and discussion. Six underlying explanations for the phenomenon are analysed and discussed in this section: consensus creation, scorekeeping, communication, legitimacy, responsibility allocation and institutional isomorphism.

Creating consensus

Ajzen and Fishbein (1977) found that behaviour was correlated with norms when there was high awareness of the consequences. Consequently, one incentive for developing unidimensional tools that integrate different dimensions into a quantitative measure is the raising of awareness within the organisation and thus the creation of a consensus. Since quantitative measures make the integration of different dimensions of decisions easier (Bazerman 1985) and thus more accessible, the use of quantitative measures to express the environmental effects of construction projects can be useful to support managerial decision-making. A study of errors can therefore provide an indirect standard of value, showing problem areas within the organisation and consequently increasing consensus within the organisation. This, in turn, contributes to the setting of management priorities. By defining unacceptable behaviour such as errors, organisational members can also increase their knowledge of minimum acceptable behaviour, in accordance with March and Simon 1958.

Keeping score

In spite of the uncertainty or ambiguity of the state of the environment, organisations are expected to produce results, which implies that organisations must adjust with norms of rationality. In order to handle this, Thompson (1967) suggests that organisations must keep score to assess their performance and, to do this, organisations have to trace consequences, which assumes an extended understanding of causes and effects. This justifies the firms' approach in measuring environmental errors (effects) and in identifying causes.

> Traditionally in the economic model of rationality, the utility is profit, and the assumption is that profit is maximised . . . People and organisations do make choices in multidimensional situations, using some sort of calculus which facilitates preferential ranking of effects regardless of the dimension on which they occur. In classical economic theory the monetary scale plays this role, allowing the economic man to compare all possible effects in terms of a common denominator (Thompson 1967: 85).

The quotation from Thompson 1967 explains why there is a desire to translate errors and causes into monetary terms. This is preferable since the monetary dimension is well known and understood in different lines of the organisation.

Communication

Czarniawska (1999) emphasises the importance of mutual understanding and correspondence. She states that decision-makers bring new sets of symbols into use, not because they serve the purpose better, but because of a claim that these will better fulfil the correspondence criteria between different participants. She states that the official objective of all the frenetic translation of words to numbers and numbers to words is control. In addition, translations build connections between different actions, vocabularies, worlds, and times and places. These findings give possible explanations of why new decision-support tools are developed. Firms simply like to find new numbers that can help them to communicate.

Legitimacy

Jansson (1993) found that investment calculus was used for purposes besides accounting for the consequences of different alternatives. In line with Meyer and Rowan's (1977) contingency theory, Jansson (1993) found, in his study of the use of investment calculus, that one purpose of the calculation included many organisational actions that were made under preconceived notions of the normatively appropriate, the socially accepted and the legitimate. Jansson calls this the logic of suitability, meaning that the decisions depend on the situation, the role of the decision-maker and the suitability for that particular role.

Organisations also use legitimacy creation to control their environment. In order to eliminate uncertainty, organisations use decision-support tools to devise and negotiate an environment. Hence, decision-makers develop ways to monitor and comprehend complexity in their environment. These statements can serve as explanations for the development of managerial environmental decision-support tools. In order to create legitimacy, the method, tool or procedure must be rooted deeply in the organisation.

Responsibility allocation

Brunsson (1999) sees decision-making as an institution that serves several different purposes. By 'institution' he means that decisions are socially constructed. Creating rationality in decision-making can be interpreted as an attempt to simplify the distinction between different alternatives. It can also be seen as an attempt to create or hinder an action, to take or avoid responsibility for a decision outcome, and to create and maintain legitimacy in an environment with ambiguous norms. Managers are given the freedom to choose whether or not to take responsibility by using decision-support tools. It is easy to imagine the implications: that managers adopt decision-support tools and hold the 'computer' responsible for the outcome of the decision when the future outcome is uncertain. Since environmental consequences are uncertain or at least difficult to predict, decision-makers may thus feel some security in having a decision-support tool to blame in case of failure.

Institutional isomorphism

Both Meyer and Rowan (1977) and DiMaggio and Powell (1983) speak of institutional isomorphism as a way of coping with a continuously changing environment. This implies that organisations are structured by phenomena in their environment and tend to become isomorphic with them. The perspective suggests that organisations evolve in the direction of increasing compatibility with environmental characteristics. DiMaggio and Powell (1983) identify three mechanisms of institutional isomorphism: coercive, normative and mimetic isomorphism. Mimetic isomorphism results from uncertainty, which encourages imitation. For example, when organisational technologies are poorly understood or organisational goals are ambiguous, organisations may model themselves on other organisations. In order to receive legitimacy, organisations tend to model themselves on organisations that they perceive as successful or legitimate.

Choice of theoretical perspective

Creating consensus within the organisation is a strong motive for the accomplishment of the study of errors or failures in construction. One effect of the CEE project was the focus on problem areas within the organisation. The organisational member's involvement in the study contributed to an increased level of knowledge of environmental issues within the organisation. The study contributed to enhanced learning within the project organisation, which can lead to managerial decisions where environmental issues are prioritised. The studies resulted in increased commitment to environmental standards and the identification of possible performance improvements.

Relating costs to errors served as a strong reason for studying the costs of environmental errors in construction. The identification and correction of errors are seen as important, since errors have a tendency to multiply throughout the organisation (Welford and Gouldson 1993), especially as the correction of errors is time-consuming and costly and these costs tend to increase with time. Therefore, the initiators of the CEE project, who expressed frustration over how to handle environmental issues in construction, highlighted the absence of methods that integrate environmental and economic dimensions in construction (Gluch 1999). To solve this, they searched for a tool that provides both quantitative unidimensional measurements and could also be understood in all layers of the organisation. The study of CEE measured the organisation's performance. To enable assessment of their performance, organisations have to trace consequences, which assumes an understanding of cause and effect. This justifies the firms' approach to measure, to *keep score*, of environmental errors and effects and identify causes. This explanation is based on a more rational point of view than other explanations of why CEE was 'invented'. However, the culture of the construction industry, with its low profit margins, justifies Thompson's theory as an explanation of the phenomenon.

Decision-makers develop ways to monitor and comprehend complexity in their environment by translating errors and causes into monetary terms, as was done in the CEE project. This can be seen as a way of *communicating*. The objectives stated by the initiators of the CEE project were similar to the statements made by the observers of the CEE study: if they could integrate the costs of the environmental consequences into the organisation, they would handle their environmental problems better.

In the case of CEE, the study participants dealt with a new approach and definitions, implying that *legitimacy* creation was not a purpose of the accomplishment of CEE.

All interviewees stated that handling environmental issues in a temporary organisation, such as a construction project, is difficult. The theories on the *allocation of responsibility* can serve as an explanation of why managers feel they need environmental decision-support tools such as CEE. However, even if this could be inferred by reading

between the lines of the interviews, it is not possible from this study to unequivocally assert that this theory explains the phenomenon of CEE.

If the phenomenon is looked at on a different level—an organisational instead of an individual level—the accomplishment of the CEE study can be seen as a symptom of *mimetic isomorphism*. Since successful studies of PQC have been conducted within the same group of professionals, a reason for developing CEE may be the common wish to use familiar concepts in a new area. By imitating earlier successful concepts, researchers found an acceptance for the approach within the organisation, and the chance of the 'imitation' gaining legitimacy is therefore higher. The initiators simply wanted a tool that creates control of environmental problems caused by construction. In doing so, they may believe that the most efficient and time-saving method is to imitate earlier successful approaches such as PQC. Environmental aspects tend to be integrated into the quality dimension (see e.g. Hughes and Willis 1995). Hamner and Stinson (1995) took an approach similar to CEE: for example, in their paper on 'Environmental Compliance Costs'. Copying tools and methods used in quality management is also a familiar pattern in the Swedish construction industry (Gluch *et al.* 2001). However, it is not easy to integrate quality dimensions with environmental dimensions. For example, Wolff (1998) provides several reasons why caution should be used when transferring familiar concepts and methods from other disciplines to the environmental area. The complexity of environmental issues and their genuinely interdisciplinarity are two reasons. Environmental issues are also unusually charged with value and emotion and are linked intimately to society's built-in uncertainties and risks. A further reason is the faster dynamic development of the environmental dimension over the quality dimension, which is often client-related. Nevertheless, since isomorphism is observed at an overarching level of the organisation, and the CEE project was undertaken with a narrower perspective, imitation of quality tools was not emphasised as a reason for the accomplishment of the CEE project.

Conclusion

CEE can produce results when measuring negative deviations from specified norms. The usability study shows that the study of CEE in project organisation results in the identification of areas for improvement. CEE helps to identify industrial costs and enhances the understanding of the kinds of cost related to failure. Since business accounting seldom distinguishes environmental items, the total amount of CEE was not recorded. In addition, environmental issues are associated with genuine uncertainty since they depend on a silent stakeholder—the natural environment. This in turn contributes to a rapid change of norms, and, since norms are important items in CEE, these result in a major discrepancy in CEE as an environmental management tool. Furthermore, the existence of multiple environmental norms, the ambiguous formulation of definitions and norms, and the construction industry's poor knowledge of the content of the specified norms, as well as the large share of non-quantifiable hidden costs, complicates the use of CEE. Another limitation is the focus on costs and not on benefits, implying that CEE has poor extensibility as an environmental decision-support tool. Thus, the study of CEE's usability indicates a discrepancy between the initiator's enthusiasm and the practical use of CEE.

A number of theoretical explanations of why support tools are needed for managerial environmental decisions have been analysed and discussed. These are consensus creation, scorekeeping, communication, legitimacy, responsibility allocation and institutional isomorphism. It is shown that all six can contribute to an increased understanding

of the phenomenon. Nevertheless, creating consensus, keeping score and communication are the explanations that, if seen from the scope of construction projects and from interpretations of the interviews with the observers, offer better explanations of why the study of CEE was accomplished. The aim of this paper has not been to find all possible theoretical explanations for the invention of CEE as a managerial environmental decision-support tool, but to point to a number of explanations that satisfy the second objective. It is important to keep in mind that there is no one superior theory that explains the phenomenon. Further research is needed within this area to gain a full understanding of the role of managerial environmental accounting tools such as CEE.

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PAPER II

The Life Cycle Costing (LCC) approach:
A conceptual discussion of its usefulness
for environmental decision-making

Gluch, P. and Baumann, H. (2004)
Building and Environment **39**, pp. 571-580.

Available online at www.sciencedirect.com
SCIENCE DIRECT®
Building and Environment 39 (2004) 571–580
BUILDING AND ENVIRONMENT
www.elsevier.com/locate/buildenv

The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making

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Received 17 April 2000; accepted 16 October 2003

Abstract

Ten LCC-oriented environmental accounting tools suggested as useful in environmental decision-making have been identified. However, their implementation in the building industry seems to be limited, which opens up for a conceptual discussion. The purpose of this article is to discuss theoretical assumptions and the practical usefulness of the LCC approach in making environmentally responsible investment decisions. LCC's monetary unit and extended scope may speak in favour of using LCC but LCC fails to handle irreversible decisions, neglects items that have no owner and does not consider costs to future generations. Moreover, LCC does not take into account the decision makers' limited ability to make rational decisions under uncertainty. LCC's practical usefulness is constrained by its oversimplification to a monetary unit, the lack of reliable data, complexity of the building process and conceptual confusions. To handle these inconsistencies in future development of environmental decision support tools three research solutions are proposed.

Keywords: Life cycle costing; LCC; Decision support tools; Building; Construction; Investment decisions; Environmental management

1. Introduction

Many traditional cost-accounting systems lead to incorrect investment decisions concerning environmental costs [1–5]. One problem is for example that demolition and recycling costs appear outside the boundary of the traditional accounting system. A popular way of solving this problem has been to suggest the use of life cycle costing (LCC) which includes such costs [6–9].

However, this may not be an appropriate solution since LCC was originally not developed in an environmental context. 'Traditional' LCC is a type of investment calculus used to rank different investment alternatives [7,10]. Another objection concerns the system boundaries of LCC. The main difference between traditional investment calculus and LCC is that the LCC approach has an expanded life cycle perspective, and thus considers not only investment costs, but also operating costs during the product's estimated lifetime. However, such an expansion of the system boundaries does not include all environmental costs. It is important to emphasise that a "traditional" LCC does not become an environmental accounting tool just because it contains the words *life cycle*. This fact may seem trivial, but since LCC is often used in an environmental context it cannot be enough emphasised since ambiguity is one reason why individuals make bad or at least irrational decisions [11,12].

The history of LCC began in the US Department of Defence in the mid-1960s [13]. In the mid-1980s attempts were made to adapt LCC to building investments [14]. Recently several research projects have been carried out aimed at developing the LCC methodology for the construction industry and placing LCC in an environmental context. One example is Abraham and Dickinson's [6] study of the disposal of a building in which LCC calculation is used to quantify disposal costs. Sterner [7] developed a model for the evaluation of tenders, where she uses LCC methodology to calculate the total energy costs for buildings. Aye et al. [8] used LCC to analyse a range of property and construction options for a building. Bogenstätter [9] advocate the usability of performing an LCC calculation in the early design phase. He developed a model using specific characteristic values of LCC, i.e. standardised typological figures. He suggests defined specifications from similar buildings as key solutions to the usability problem.

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doi:10.1016/j.buildenv.2003.10.008

Despite an increasing enthusiasm to propose the LCC approach as useful in an environmental context, the adoption and application of LCC in the building sector remains limited [15–17]. Cole and Sterner [18], Flanagan et al. [19] as well as Norman [20] suggest that practitioners' 'imperfect understanding' of LCC's merits is the main cause of the limited adoption of LCC. The authors indicate that there exists a gap between theory and practice. However, neither of them sufficiently explains underlying reasons to this gap. Moreover, the actual incorporation of environmental consequences in the LCC approach is not sufficiently clarified. Furthermore, lack of incentives to use LCC has been pointed out as a reason to why the approach has not been more extensively adopted by practitioners [18,19]. In order to investigate whether LCC is as promising as enthusiasts suggest, this article discusses LCC from the perspective of how useful and appropriate the LCC approach is for environmental decision-making in general and for environmental considerations in building investment decisions in particular. The discussion is made from a business perspective, typically when LCC is used in an investment decision context where at least two alternatives are compared.

2. LCC-oriented environmental accounting tools

Traditional accounting techniques have been found inadequate for the handling of environmental issues [1,2] and a lack of tools that elevate environmental issues by 'translating' environmental issues into monetary terms is often assigned as the stumbling-block [7,13,21,22]. The development of corporate accounting tools that consider environmental issues started in the early 1990s by amongst others Epstein [13], Schaltegger [23], Spitzer and Elwood [24], and Gray et al. [25]. Corporate environmental accounting has been defined as

> *…the* ***process*** *of identification, measurement, accumulation, analysis, preparation, interpretation and communication of financial (and non-financial) information used by management to plan, evaluate and control the environmental aspects of an organization.* [26, p. 155].

'Traditional' LCC is vaguely defined by the building and construction assets standard ISO15686 as: *a technique which enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors both in terms of initial costs and future operational costs*. Thus, in an ideal case, LCC is used to optimise product performance and lifetime cost of ownership [27]. Through an inventory ten LCC tools have been identified, see Table 1.

Table 1 shows the variants of the LCC tools, with a more or less-stated environmental approach, that have been developed during this last decade. Originating from this tools researchers have developed tools that in turn are adapted and applied for different contexts, such as building investments (for example [6–9]). By adjusting some variables in the equation, the tools become "environmental". The tools have been given different 'names', but are similar in their approach and structure. Words like 'full', 'total', 'true', 'whole' and 'life cycle' indicate that there has been an effort to develop traditional accounting approaches for use as environmental accounting tools.

In common for these modified environmental accounting tools is that they attempt to include environmental impacts as costs into the corporate accounting systems. The environmental accounting tools aim at allocating where a resource is used and to measure it [32,33], in other words, an attempt to detect costs hidden in overhead accounts [34].

3. Theoretical assumptions in the LCC approach

The development of LCC and similarly structured tools and methods has its origin in the normative neoclassical economic theory which states that firms seek to maximise profits by always operating with full knowledge [35]. According to the theory, decision makers must have consistent preferences; they also have to know their preferences as well as the available alternatives [36]. Thus, they must have access to information about the consequences of selecting each alternative and be able to combine this information with the expected utility, which in turn discounts or weighs outcomes by the probability of their occurrence. This implies that the behaviour of the 'economic man' in neoclassical economic theory is always rational. However, descriptive decision-making studies [36] have shown that individuals do not make rational decisions, especially when uncertainty is involved because of complex and long-term consequences, which is typical for environmental decision-making.

There are four inherent limitations in neoclassical economic theory that restricts its use in an environmental context:

- It cannot handle decision-making under genuine uncertainty since it assumes that the decision-maker is always rational and has access to complete information concerning alternatives and outcomes.
- It assumes that alternatives are always available. With such a view irreversible changes, such as extinction of species, are not considered as a problem since they can be 'replaced' without changing the ecosystem.
- It ignores items that have no owner, such as the natural environment.
- It over-simplifies multi-dimensional environmental problems since it assumes that everything can be expressed as a one-dimensional unit, such as monetary figures.

Table 1
Corporate environmental accounting tools

Concept	Definitions/description	Cost categories
Full cost accounting (FCA)	Identifies and quantifies the full range of costs throughout the life cycle of the product, product line, process, service or activity [28]	Identifies and quantifies (1) direct, (2) indirect and (3) intangible costs
Full cost environmental accounting (FCEA)	Embodies the same concept as FCA but highlights the environmental elements [24]	Varying
Total cost assessment (TCA) (I)	Long-term, comprehensive financial analysis of the full range of internal costs and savings of an investment [28,29]	(1) Internal costs and savings
Total cost accounting (TCA) (II)	Term used as a synonym for either the definition given to FCA or as a synonym for TCA [28]	(1) Conventional costs, (2) hidden costs, (3) liability costs, (4) less tangible costs
Life cycle accounting (LCA)	The assignment or analysis of product-specific costs within a life cycle framework [30]	(1) Usual costs, (2) hidden costs, (3) liability costs, (4) less tangible costs
Life cycle cost assessment (LCCA)	Systematic process for evaluating the life cycle cost of a product or service by identifying environmental consequences and assigning measures of monetary value to those consequences [5,31]. LCCA is a term that highlights the costing aspect of life cycle assessment (LCA)[a] [28]	Add cost information to LCA
Life cycle costing (LCC) (I)	Summing up total costs of a product, process or activity discounted over its lifetime [24,27,28,30]	Varying
Life cycle costing (LCC) (II)	A technique which enables comparative cost assessments to be made over a specified period of time; taking into account all relevant economic factors both in terms of initial costs and future operational costs [ISO15686].[b]	Varying
Full cost pricing (FCP)	Term used as a synonym for FCA or LCC [28]	See FCA and LCC
Whole life costing (WLC)	Synonym to TCA (I) or LCC [7]. More specifically defined by Clift and Bourke [16] as 'The systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset"	(1) Initial costs and (2) operational costs

[a]Life cycle assessment (LCA)—an environmental management tool for evaluating the environmental impacts of products and services from cradle to grave in their life cycles [32].
[b]This definition is not developed in an environmental context, it is defined in a building and construction assets standard [ISO15686].

These limitations entail that tools based on the neoclassical theoretical paradigm will always be beset with severe shortcomings concerning their use in handling environmental aspects. Furthermore, even though it is not an assumption for neoclassical economic theory, the use of discounting as a technique to handle the problem with time value of money is so routinely used as well as preferred by practitioners that it is well worth discussing [37–39]. This since

- using discount rates that rely on principles based on today's knowledge may result in future costs from decisions being given relative small weight in the LCC calculation.

These limitations in relation to environmental applications of LCC are discussed more extensively in the following section.

3.1. Decision-making under uncertainty

The environmental consequences of a decision often occur long after the decision was made, and not necessarily in the same location. Furthermore, environmental decisions have cumulative effects on ecological systems, which are difficult to detect [40]. Environmental decisions, being closely coupled with society's built-in uncertainties and risks, are genuinely uncertain since the way ecological systems as well as social systems change in the future need to be considered in the decisions [41]. Issues that are not considered as problems today may well be in the future, in the same way as today's environmental problems were not anticipated yesterday. Environmental decisions therefore are characterised by considerable uncertainty at all stages of the decision-making process, such as the problem definition, possible outcomes and probabilities of the outcomes [42].

Buildings, for example, are long-term investments associated with large environmental impacts over a long duration. To estimate environmental costs so far into the future may result in an LCC calculation that is faulty [43], i.e. the calculated LCC may have little resemblance to future real cost. Investment decisions for a building are affected by business, physical and institutional uncertainties [44]. Physical

risks are often due to uncertainty as to a building's design or a material's functional characteristics and performance change during the building's lifetime. Such uncertainty may involve building material that through new scientific evidence has become unsuitable, as for example asbestos cement sheeting and CFC. Business uncertainty is connected to unpredictable fluctuations in the market and institutional uncertainties reflected in the effect of changing regulations on construction and real estate. Many political decisions can instantly change the "rules of the game". For example, building materials may become prohibited, as with the asbestos. It is also easy to envisage that materials and components that are difficult to recycle will be expensive to dispose of in the future both for technical reasons and due to increasing disposal taxes. In addition to political decisions, external market factors, institutional regulations and environmental changes may also lead to changing conditions. The modernity of a real-estate project is affected by customers' (tenants') increased awareness of environmental issues, which implies that buildings that are not continually adjusted to environmental norms or to presumptive regulations run the risk of becoming outdated rather quickly.

An analysis that relies on estimation and valuation of uncertain future incidents and outcomes is therefore problematic. There are numerous techniques available that attempt to decrease the uncertainty of future consequences, for example scenario forecasting, sensitivity analysis, probability analysis, decision trees and Monte Carlo simulation (see, for example, [19]). However, these techniques presuppose that decision makers are aware of the nature of the uncertainties that can be expected during the building's lifetime. A study of risk management [45] revealed that real-estate managers when conducting a sensitivity analysis of LCC only considered tangible aspects such as interest rate, rental degree and increase or decrease of rent. Furthermore, when estimating risk and uncertainty the property managers relied more often on their intuition and rules of thumb than on techniques, such as sensitivity analysis. This implies that easily accessible information and subjective values to a large extent influence the parameters considered in estimating risk and uncertainty, i.e. the result from the LCC are biased.

3.2. Irreversible decisions

Neoclassical theory assumes that alternative options are always available. However, the consequences of the decision to invest in building projects extend across a long period of time and many decisions lead to irreversible outcomes [42,46]. For example, in building a road it might be necessary to blast primary rocks. This encroachment on nature radically changes the topography, which is not restorable. So, when considering environmental aspects in decision-making, the basic assumption of the existence of available alternatives is not in accordance with current environmental reality. The depreciation of future consequences can often be of significant importance in an environmental context where the issue is to balance today's benefits with tomorrow's costs or vice versa. The large number of components in a building implies that several subsequent decisions must be made during the building's lifetime. The investment process therefore contains sequential decisions, meaning that earlier decisions will influence subsequent decisions. Since irreversible changes take place in ecological systems as well as in sequential decisions it is not possible to ignore irreversibility as the neoclassical economic theory does.

3.3. The role of market mechanisms

Property rights are the rights to use resources. In economic theory property has a wider meaning than in everyday language; it can refer to any good or resource [47]. Similarly, the environment is a resource and hence a property. For example, many people own land and they are able to take action when damage is done to assets they own, but they do not generally own the rivers or the air through which pollution travels. The lack of well-defined property rights, as in the case of air and water, makes it difficult for a market to exist, which problemises the concept of a market. The market system is central in neoclassical economic theory since it is a mechanism for generating an efficient allocation of resources. Environmental damage and pollution leads to market mechanisms ceasing to function because of ill-defined property rights of the natural environment (Coase theorem in [47,48]). In other words, neoclassical economic theory ignores items that are not given a market value. Consequently, due to LCCs basis in neoclassical economic theory LCC handles environmental aspects insufficiently.

3.4. A monetary unit

With the purpose of simplifying a complex reality, which is necessary out of a practical perspective, 'environmental' LCC aims at translating environmental problems into a one-dimensional monetary unit. However, a problem is that LCC in its attempt to translate environmental problems into a monetary unit may oversimplify reality. Neoclassical economic theory presupposes that all relevant aspects have a market value, i.e. a price. As mentioned in the previous section, there are items that are not possible to price. This leads to monetary calculations being incomplete with regard to environmentally related costs. Many economic theorists suggest different ways to put a price on environmental items for example through environmental taxes [47,48], but others argue that it is impossible to catch all relevant aspects of complex environmental problems into one monetary figure [49]. The monetarism of LCC consequently result in loss of important details which in turn limits the decision maker's possibility to obtain a comprehensive view of environmental problems. Söderbaum [49] argues that organizations that

wish to comply with (and survive in) a complex reality must work with more holistic pictures and models than for example environmental 'LCC'. He suggests that organisations use additional methods to complement the monetary.

3.5. Discounting of future costs

If it does not matter when costs and benefits incur they can be added without consideration. However, if the timing of costs and benefit flows is important, the investment calculus needs to reflect this. A common technique is the use of discounting. The time value of money, expressed as a discount rate, depends on inflation, cost of capital, investment opportunities and personal consumption preferences [10,37,38]. If the discount rate is set to 0% this means that the timing does not matter; the higher the discount rate the more importance is given to the near-present.

The most common technique of making incoming and outgoing payments from different times comparable and thus possible to add is discounting future payments to a net present value (NPV). As shown in the box, using the interest rate 5% the future demolition cost of 1000 is calculated to an NPV of 90 (Example box).

An alternative given by for example Gray et al. [25] is to use an environmental hurdle rate technique. This technique is exemplified in the box by three hurdle rates: a 'green discount rate' for costs that do not contribute to negative impact on the environment, a 'yellow rate' for costs that have an uncertain contribution to negative impact on the environment, and a 'red rate' for costs that have a certain negative impacts on the environment. If 'red rates' are set to 0% in the LCC calculation, 'red' types of costs do not get discounted over time and therefore cause a more significant contribution to the total result when discounted. The use of 'red rates' is valid as long as future damage is assumed as negative as today's. For example, discharging toxic waste tomorrow should be as negative for the environment as discharging toxic waste is today. However, from an environmental point of view, the timing of the emissions depends on the state of the environment, which can improve or deteriorate with time. In addition waste management technology may also improve in the future. Because of such developments, it may be more viable that certain environmental costs are considered as green or yellow and thus discounted in the LCC calculation. This reasoning illustrates how complex and difficult it is to handle environmental costs and how over-simplification can misguide environmental decisions-making.

Another way of handling the time problem is to indicate which costs may be expected to increase more than other costs. A differential escalation rate can thus be used to indicate relative price changes [10]. In the box, costs for demolition are assumed to increase more than other costs. With a relative price change of 3% demolition costs are discounted at approximately 1.9% while all other costs are discounted at the interest rate of 5%. This entails that the future demolition cost of 1000 is calculated to an NPV of 380.

EXAMPLE BOX

Basic assumptions: For a building, the demolition cost is estimated to a value of 1000. The lifetime of the building is estimated to 50 years and the discount rate is set to 5%.

$$\mathrm{LCC} = \sum_{t=0}^{T} P_n (1+i)^{-t},$$

n is number of estimated payments P over time t discounted with the interest rate i.

If the future payment for demolition is discounted with the interest rate the NPV is calculated to **90**.

Problem: However, due to an impending risk that demolition waste from the building causes a large environmental impact one can presume that demolition, due to, for example, new tax regulations, increased costs for disposing demolition waste or demand for new more expensive demolition methods, render in large future environmental costs.

Hurdle rate principle:

$$\mathrm{LCC} = \sum_{t=0}^{T} P_{n,r}(1+r)^{-t} + \sum_{t=0}^{T} P_{n,y}(1+y)^{-t} + \sum_{t=0}^{T} P_{n,g}(1+g)^{-t}$$

$P =$ payment, $r =$ 'red' rate, $y =$ 'yellow' rate, $g =$ 'green' rate, $t =$ time

If using the *hurdle rate principle* environmental cost due to demolition is discounted with a red discount rate, i.e. $r=0\%$, in the LCC calculation. The result from the LCC calculation will then be that future demolition costs are calculated to an NPV of **1000**, thus the same as if the real-estate building would have been demolished today.

Price rate principle:

$$\mathrm{LCC} = \sum_{t=0}^{T} \left[P_n \frac{(1-e)^t}{(1+i)^t} \right]$$

$P =$ payment, $i =$ interest rate, $e =$ escalation rate, $t =$ time

Analogous, using the *price rate principle*, the relative price for demolition is likely to increase and can therefore be estimated to increase more than other types of costs in the calculation, say a relative price change of 3%, i.e. $e = 0.03$. The result from the LCC calculation then shows that future payment for demolition is calculated to an NPV of **380**.

The examples given in the box illustrates how important the setting of discount rate is for the LCC calculation. Neoclassical economic theory, as all economics, involves value judgements [46], i.e. the information from today's financial accounting systems reflects only what the economic leaders currently consider as important [23]. Consequently, by using discount rates that rely on principles based on today's knowledge of future costs may get a relatively small weight in the LCC calculation. The examples also reveal that when discounting in LCC calculation for a building a large number of estimations are required. Consequently, depending on the method, very different results are obtained.

4. LCC-oriented tools in practice

Even if not theoretically accurate, the results from an LCC calculation might provide at least an indication of which strategic decisions should be made. We have identified following issues as critical for the practical usability of LCC:

- The availability and reliability of environmental data.
- The perceived benefits of using LCC in investment decisions.
- An understanding of conceptual definitions and methods.

4.1. Availability and reliability of environmental data

Performing an LCC analysis is a data intensive process due to the complexity of the building process and the many components of a building. The final result is, therefore, dependent on the availability and reliability of the input data [15,43]. Table 2 exemplifies the range and diversity of the data needed to perform an LCC.

In the absence of real data, as the case is for planned buildings, forecasts can be based on past experiences. Data on costs [50–52], lifetimes [53] and energy use [54] of different building types and building components can be collected from estimation standards [1] that provide data for an 'average' building. However, because of regional differences, the location of a building has a large effect on its final life cycle cost, for example, taxes and fees can vary and the location can also be more or less sensitive to environmental impacts, which makes the data received from standards not applicable for the situation in hand.

A more specific source of data is corporate historical data. A practicable way of tracing historical environmental costs could be through the corporate accounting system. Unfortunately, LCC suffers from the fact that a companies' accounting systems cannot handle environmental costs that have occurred elsewhere [13,23]. Furthermore, it is difficult to specify environmental costs from other costs in the corporate accounting system [13,23]. The insufficient recording of environmental costs in corporate accounting systems is identified as a major obstacle for the successful implementation of corporate environmental accounting tools [13]. This leads to a 'catch 22' situation, where corporate environmental accounting tools such as LCC cannot be implemented unless the environmental costs are measured.

Table 2
Examples of input data needed to perform an LCC for a building

Investment cost data	Operation and maintenance data	Project specific data
• Building costs	• Administration	• Type of building
• Site costs	• Energy	• Type of design
• Design fees	• Water	• Type of building material
• Salvage value	• Waste water	• Location
• Demolition costs	• Material	• Lifetime periods
• Other	• Cleaning	• Other specific data
	• Maintenance	
	• Insurance costs	
	• Rates	
	• Taxes	
	• Other	

Other obstacles to LCC implementation are poor quality of the data and a lack of industrial standards for describing the life cycle behaviour of buildings [7,18,55,56]. A way to clarify responsibility of execution of LCC calculations could be to formalise the use of LCC via contractual agreements [18]. This is suggested to avoid unclear responsibility since many actors and companies in the building process are involved only for a limited period of the buildings lifetime. This means that different actors feel different degrees of responsibility. Furthermore, data are sparsely recorded since "sharing" of data between different actors is not custom practice. This results in incomplete data being recorded in different accounting systems by different companies. In addition, studies show that environmental impacts of buildings are insufficiently identified [55,57,58]. A basic prerequisite for specifying environmental costs in corporate accounting systems is although that the environmental impacts are identified in the first place.

Given the lack of data and poor quality of existing data, it is difficult to produce LCC calculations supporting 'good' environmental decisions. Many assumptions and estimations must consequently be made, which implies that the result from the LCC calculation is naturally beset with a high degree of uncertainty. The uncertainty in forecasting future consequences causes decision makers to perceive LCC calculations as unreliable [18].

4.2. Perceived benefits from using LCC

In order to use LCC in investment decisions for buildings, the decision makers must perceive benefits from using it. The decision makers' limited capacity of processing

[1] The estimate standards exemplified with here are Swedish. Equivalent standards can probably be found in other countries as well.

large amounts of complex information results in lack of attention for new problems such as environmental problems [59]. Structuring the information flow by using unidimensional tools that integrate different decision dimensions (e.g. environment, economy, quality, time) may be a way of limiting the information flow and improving the decision-making [60]. Consequently, using LCC might bring clarity by translating a complicated reality to a, for the business world, familiar dimension, money. By translating the information to a monetary dimension it is possible that decision makers would include environmental concerns in the investment decision. However, even though LCC might translate environmental information into more familiar units, uncertainties pose special problems concerning cognitive and motivational influences on decisions, that is the decision maker's personal view of reality affects what parameters that are considered in the calculation [61,62]. Despite access to identical input data when making the decision, personal values and motives systematically affect for example which estimations and assumptions are included in the calculation. This results in different decision-makers arriving at different results and choices when using LCC-oriented tools.

An indirect benefit from performing an LCC for a building investment decision is that it may not be the actual monetary figures that provide the decision maker with insight, but instead the actual involvement in the process of carrying out an LCC [3,59]. Thus, collecting data, estimating future events, identifying environmental aspects to consider and so on might be the actual benefit, i.e. learning about the complexity and diversity of environmental costs from doing the LCC calculation. Learning capabilities is thus a rational benefit from non-rational behaviour and should not be neglected in the development of decision support tools. However, too structured tools may make decision-making mechanical [63]. By only operating the tool and/or only using the one-dimensional result in making their decisions the consequence may instead be that learning is restrained and that established values are conserved. Accordingly, results from analytically structured decision support tools may entail inappropriate reliance on the forecasts accuracy and consequently fail to identify relevant environmental features for the investment decision.

4.3. Conceptual confusions

Table 1 showed that there is much effort made on developing LCC-oriented environmental accounting tools among researchers. A closer look at Table 1 reveals a diversity of confusingly similar concepts of corporate environmental accounting tools. Some methods have different names, but similar principles in their algorithm (e.g. Life Cycle Costing and Full Cost Accounting); others have the same name, but different principles for the calculation (e.g. life cycle accounting and life cycle analysis) or the same name, but different principles for calculation as non-environmental versions of LCC (e.g. "environmental" life cycle costing and "traditional" life cycle costing). This diversity is likely to cause confusion among practitioners, which hinders them from adopting LCC-oriented environmental accounting tools. Evidence of such confusion has been found. Stenberg [64] reports that practitioners have problems in differentiating tools from each other, and they refer to, for example, life cycle assessment (LCA) when they actually mean an 'environmental' LCC.

Another conceptual confusion concerns which life cycle is used in the life cycle approach. It is important to acknowledge that different kinds of life cycles are considered in LCC. Furthermore, the life cycle represents a lifetime and is an estimated variable, not a constant. Four different lifetimes for buildings may be used in LCC: economic, technical, physical and utility life [10]. Economic lifetime is an estimate of the building's profitable time. Technical lifetime is the estimated number of years until the technology renders the building obsolete. Physical lifetime is the estimated period in which it is physically possible to use the building. Finally, the buildings utility life is the estimated time the building can satisfy established performance standards. So, depending on the choice of life cycle the time perspective differs, which affects the results from the LCC calculation when discounted to a net present value. In LCC, the economic life is the most common since the calculations most often have a cost minimization perspective [10]. Adding to the confusion there is another type of life cycle approach used in the environmental tool life cycle assessment. The life cycle in LCA does not represent a time as in LCC. The life cycle in LCA represents a physical chain of material flows related to a product, from resource extraction to waste management [65].

The diversity of different concepts of corporate environmental accounting tools, the multifaceted grouping of environmental costs and the inconsistency in estimating the life-cycle cause if not confusion, then at least ambiguous results. This not only makes the LCC-oriented tools difficult for the decision maker to use, it also undermines their confidence in the result from LCC [18]. The consequence from this distrust may be that they hesitate in using these tools.

5. Summing up from a user perspective

The discussion of LCC-oriented tools' has identified both pros and cons for the user, concerning their usefulness for environmental decision-making in building investments, see Table 3.

From a user perspective it seems to be a good idea to link environmental issues with financial consequences when implementing environmental issues in a corporate decision-making context. However, LCC-oriented tools are grounded in neoclassical economic theory, developed for pure financial analysis and the focus is therefore different from that of environmental analysis. From an environmental

Table 3
The usefulness of LCC-oriented tools for environmental decision-making in building investments: Pros and cons

PROS	CONS
LCC...	LCC...
... uses a familiar unit, money.	... fails to handle decisions under uncertainty
... gives an indication on which aspects to consider	... fails to handle irreversible decisions
... limits the information flow by simplifying multi-attributed alternatives.	... neglects items without owner, such as the environment
... may entail learning by participating in the calculation process	... over-simplifies environmental problems into a monetary dimension
... has a life cycle perspective	... underrates future environmental costs
	... suffers from poor availability and reliability of data
	... relies on many estimated variables due to the complexity of the building and building process
	... results are biased towards the decision maker's personal values
	... may restrain learning if too mechanically used
	... is beset with conceptual confusion due to many similar LCC-oriented tools and inconsistent life cycles.

perspective the theory is incapable of incorporating uncertainty, irreversible decisions, items with no owner as well as future costs. The consequence is that environmental dimensions are insufficiently accounted for LCC fails as an appropriate tool for environmental decision-making.

However, LCC-oriented tools may still be useful in practice if the decision maker is aware of the tool's inherent limitations. Furthermore, the decision maker's participation in the LCC calculation process may contribute to learning effects, which in turn may increase his/her knowledge concerning environmental issues.

Still, LCC is afflicted with serious practical problems, foremost concerning poor availability and reliability of input data. Lack of data implies that the investment decision is carried out under uncertainty which means that the decision-maker must make many estimates. When decision makers are faced with uncertainty they generally make estimations that are biased towards their own values and motives rather than being objective to the problem in hand [11]. This renders the reliability of LCC as an information provider for environmentally responsible decisions questionable.

6. Three research approaches to future development of environmental decision support tools

Making environmental decisions is complex. There are several tools available today that intend to structure and simplify this complexity and support the decision maker in making environmental considerations in a building investment situation. However, as argued here several of these are insufficient for the problems environmental decision-making is afflicted with. To solve some of these problems future efforts in the development of decision support tools must be made. Three areas of research are identified:

(1) Further development of tools that integrate environmental and micro-economic dimensions. This approach follows the device 'little is better than nothing' and is foremost supported by the decision makers' familiarity with economic units. It is advocated by, for example, Epstein [13]. However, in order to raise the decision makers' trust in the results from LCC, the availability and reliability of data must be secured. Furthermore, to avoid ambiguity a joint platform of definitions and groupings must be developed.
(2) Extend the system boundaries by complementing LCC-oriented tools with tools that focus on physical measures, for example LCC and life cycle assessment. This approach is suggested by several researchers (for example [7,8,49]) and recognises the environmental aspects more extensively. However, if too mechanically used by the decision maker this approach has shortcomings in recognising the decision maker's cognitive skills.
(3) Improve the understanding of environmentally related decision-making and use of tools. This approach acknowledges that individuals in making decisions use cognitive skills which are influenced by both personal values and perceived benefits. Recognising the decision-maker's behaviour, an extended approach and a way forward is to develop and use decision strategies that also consider cognitive aspects.

The development of corporate decision support tools for the building industry that consider environmental dimensions in ways that follow approaches 1 and 2 has been ongoing for at least a decade. Success in making it attractive and 'understandable' for a wider adoption of LCC in the building industry seems to be limited though [17–19]. For example lack of data, lack of contractual agreements, too laborious analyses, and lack of standardisations are mentioned as obstacles. A life cycle perspective is good since it extend the system boundaries and incorporates some costs that incur in the future. By, in addition to LCC, using an environmental assessment tool, such as LCA, in the investment decision both long-termed costs as well as environmental impacts are considered. However, an improved bad concept is still a bad concept. In addition to LCCs imperfect theoretical base other aspects must be recognised of why these tools are not considered as useful by the practitioners themselves. Approaches 1 and 2 often build on the notion that decision makers are rational and use decision support tools to rationally evaluate options (alternatives) in order to

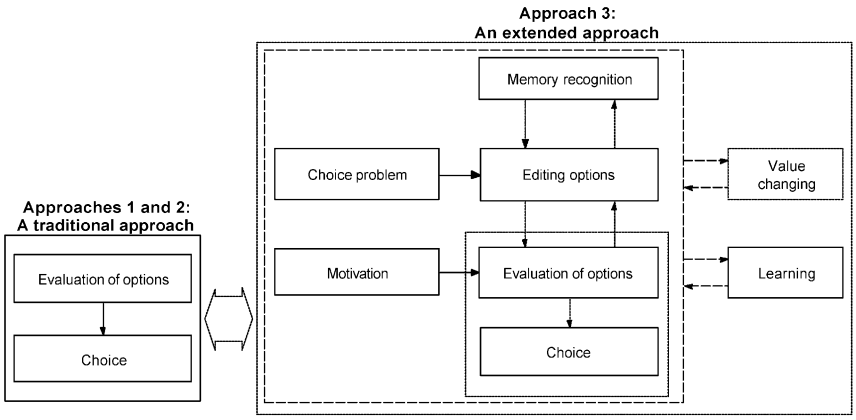

Fig. 1. Extending the investment decision context (modified from Gärling et al. [66]).

make a choice. Furthermore, approaches 1 and 2 provide the decision makers with tools based on the principle that systematic gathering and analysing of information is the best route to an optimal decision.

A change towards more environmentally responsible behaviour in the building industry requires less focus on tool production and more on understanding the decision making process and the role tools play in this process. As a complement to developing tools, according to approaches 1 and 2, it is necessary to develop a wider understanding of how decision making takes place. As illustrated in Fig. 1, approach 3 considers the decision maker's situation and behaviour and thus recognises the importance of other decision processing aspects in addition to making a rational choice among alternatives. The development of environmental decision support tools that goes beyond the rational choice has long been a neglected area of study [40,46]. Such an extended perspective upon the decision-making context gives rise to an area of research where researchers with different background should cooperate. The outcome from future research may be that tools that involve people in the decision process, such as brainstorming about the issue and about decision options, are developed in addition to structured analytical tools.

Acknowledgements

We would like to thank Dr. Christine Räisänen, Chalmers University of Technology, Sweden and an anonymous referee for valuable comments on this article. This research was financially supported by MISTRA.

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PAPER III

How do Trade Media Influence Green Building Practice?

Gluch, P. and Stenberg, A.-C. (2006)

Building Research and Information **34**(2), pp. 104-117.

Building Research & Information (2006) **34**(2), 104–117

How do trade media influence green building practice?

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The influence of the media is explored in terms of what images of 'green' building are mediated to practitioners by Swedish construction trade magazines. These textual images may influence practitioners' knowledge and values about green building as well as their motivation for complying with pro-environmental behaviour. A quantitative content analysis and a qualitative textual analysis of 1324 articles were undertaken. Findings show that 'green' building is often presented in general terms using abstract nomenclature characterized by indistinct and ambiguous terminology. The majority of trade magazine articles transmit information that lacks objectivity and critical reflection, thus reinforcing the idea that environmental challenges could be solved by technical solutions and/or controlling measures. Moreover, the protection of the natural environment is rarely referred to as a motive for pro-environmental behaviour. Consequently, since practitioners are not encouraged to problematize environmental aspects, they may end up accepting the simplified version presented to them by the trade press. A link is established between trade magazines' conveyed image of 'green' building and possible implications on practitioners' actual environmental behaviour.

Keywords: communication, diffusion, environmental behaviour, 'green' building, knowledge exchange, professional magazines, trade magazines, Sweden

Cet article traite de l'influence des médias en termes du choix par les magazines professionnels de la construction en Suède des images de bâtiments écologiques médiatisées à l'intention des spécialistes. Ces images textuelles peuvent avoir une influence sur la connaissance des spécialistes et sur les valeurs concernant les bâtiments écologiques ainsi que leurs motivations à se conformer aux comportements pro-environnementaux. Une analyse quantitative du contenu et une analyse qualitative du texte de 1324 articles ont été effectuées. Les résultats montrent que les bâtiments écologiques sont souvent présentés en termes généraux utilisant une nomenclature abstraite caractérisée par une terminologie indistincte et ambiguë. La majeure partie des articles publiés dans la presse professionnelle contiennent des informations qui manquent d'objectivité et de réflexion critique, ce qui renforce l'idée que les défis environnementaux pourraient être réglés par des solutions techniques et (ou) des mesures de contrôle. De plus, les auteurs invoquent rarement la protection de l'environnement naturel comme motivation de comportement pro-environnemental. En conséquence, les spécialistes n'étant pas encouragés à considérer comme problème les aspects environnementaux, ils peuvent finir par accepter la version simplifiée qui leur est présentée par la presse professionnelle. Un lien est établi entre l'image des bâtiments écologiques transmise par les magazines professionnels et les incidences possibles sur le comportement environnemental réel des spécialistes.

Mots clés: communication, diffusion, comportement environnemental, bâtiment écologique, échange de connaissances, magazines professionnels, Suède

Building Research & Information ISSN 0961-3218 print/ISSN 1466-4321 online
http://www.tandf.co.uk/journals
DOI: 10.1080/09613210500491613

Introduction

> If you want ecology and environmental thinking to be accepted within the building sector be careful with your terminology. To a lot of people [these terms] work as a stop signal.

(from the trade magazine *Byggindustrin* (The Building Industry); Bengtson, 1998, p. 10)

This quote illustrates the importance placed on the choice of language in influencing people's acceptance of the 'greening' of industry. Spoken and written words are transported through different media and by different mechanisms in society. As they travel, the ideas behind textual inscriptions are translated, changed and localized through many intermediaries in different 'time–space' (e.g. Joerges and Czarniawska, 1998). Together these words constitute a discourse (i.e. an institutionalized way of thinking), which helps form networks in which social, technological, and textual systems are linked in order to construct knowledge and social structure (Räisänen, 1999). Thus, textual inscriptions are powerful instruments in any struggle for discursive dominance.

One example of textual inscriptions is trade magazines, which convey representations of 'green building' to practitioners in the Swedish building sector. Studies have shown that these practitioners frequently use easily accessible environmental information channels such as trade magazines (Ericsson, 2002; Femenías, 2004). In a survey carried of members of The Swedish Association of Environmental Management (2004), the mass media together with politicians were considered the most influential actors to move environmental work forward.

As illustrated by the statement of a chief executive officer of a large Swedish construction company (Öqvist, 1999), the trade magazines are in a position of selecting what agendas get media focus:

> Although project X was never an environmental scandal, it was blown up to be one by the media.

Even if trade magazines do not necessarily prescribe *what* to think, they set the agenda of what issues to think *about*. Furthermore, research suggests that the mass media influence the establishment of subjective norms (Chan, 1998), i.e. environmental issues that receive mass media attention are likely to become normative for green building practice. Moreover, the influences of the mass media on people's attitudes increases when people are repeatedly exposed to messages advocating a particular view (Eagly and Kulesa, 1997).

Previous research within the area of mass media and the environment has focused on the subsequent effects of media coverage of specific industrial environmental incidents or crises (Lee, 1986; Dyer *et al.*, 1991; Castenfors and Svedin, 2001; Anderson, 2002), e.g. the Exxon Valdez incident. Some studies have also focused on strategies for mass communicating specific environmental problems such as recycling (Chan, 1998) and greenhouse effects (Staats *et al.*, 1996). Others have had a longitudinal approach studying the fluctuation of media's focus and interest on environmental issues (Gooch, 1995; Djerf-Pierre, 1996; Thøgersen, 2003). However, mass media representation of the building sector and building practices, green building in particular, is a field of research that is not well accounted for.

The influential role of the mass media as a transmitter of environmental information suggests this is a worthy field of enquiry. A study with the main aim of exploring how newspapers and trade magazines present Sustainable Building (SB) was carried out a few years ago (Gluch and Femenías, 2002a). That study suggested that the media conveyed a biased image of SB favouring normative technical solutions to the environmental problems facing the building sector. The limitation of the study was that it focused on SB as applied to 'green' demonstration projects. Therefore, it failed to be representative of the building industry as a whole where SB is still not adopted (Baumann *et al.*, 2002). Gluch and Femenías, nevertheless, touch upon two interesting issues that warrant further examination: the role and characteristics of the transmitter of information, e.g. the trade magazines; and the influence that trade magazines have on readers' behaviour concerning green building. The present paper focuses on the second issue and has a twofold aim:

- to explore the images Swedish trade magazines mediate to practitioners concerning green building[1]
- to examine the possible implications these images have on the practitioners' environmental behaviour and on future green building practices

Drawing on Ajzen and Fishbein's (1980) Theory of Reasoned Action (TRA) and a process theory of communication (as originated by Shannon and Weaver, 1949), the present paper examines the information mediated by the building trade magazines to practitioners within the building sector. The study has a complementary methodological approach, combining a quantitative content analysis and a qualitative textual analysis of 1324 articles presented in trade magazines between 1990 and 2003.

Theoretical framework

Multifaceted perspective on green building

The building sector is responsible for a large part of society's total environmental impact. The industry

uses approximately 40% of the energy and material resources and generates 40% of the total amount of waste (CIB, 1999). Building projects are also machine- and land-use-intensive operations. Moreover, the building sector causes diverse and extensive environmental impacts on land, water, air and human health. Environmental impact derives from all five stages in the building process: briefing, design, construction, operation and demolition (Figure 1). Consequently, decisions made in this sector extensively affect the environment and any move towards sustainable development would need to focus on the building sector.

To handle the environmental impact that derives from the building sector, numerous environmental management measures, with varying success, have been developed. From policy and control measures, such as governmental, financial, organizational, process-oriented and more or less advanced tools, to social issues and technical solutions (Figure 1).

Process of mediating information

Practitioners in the building sector mostly obtain written information concerning green building from easily accessible channels. Experiences from building projects are seldom documented in reports. Even if experiences are reported, they are seldom read by practitioners (Femenías, 2004). Therefore, trade magazines have an important role to play in mediating information about green building practices to practitioners.

In Shannon and Weaver's (1949) process theory of communication (Figure 2), a message originates from an information source. This information source may, in the context of green building, be a practitioner with personal experiences from a building project or may be a project-specific document. The message is encoded by a transmitter, e.g. a journalist, and mediated through a channel, e.g. a building trade magazine, to a receiver, e.g. the reader of the magazine. The receiver in turn decodes the message based on

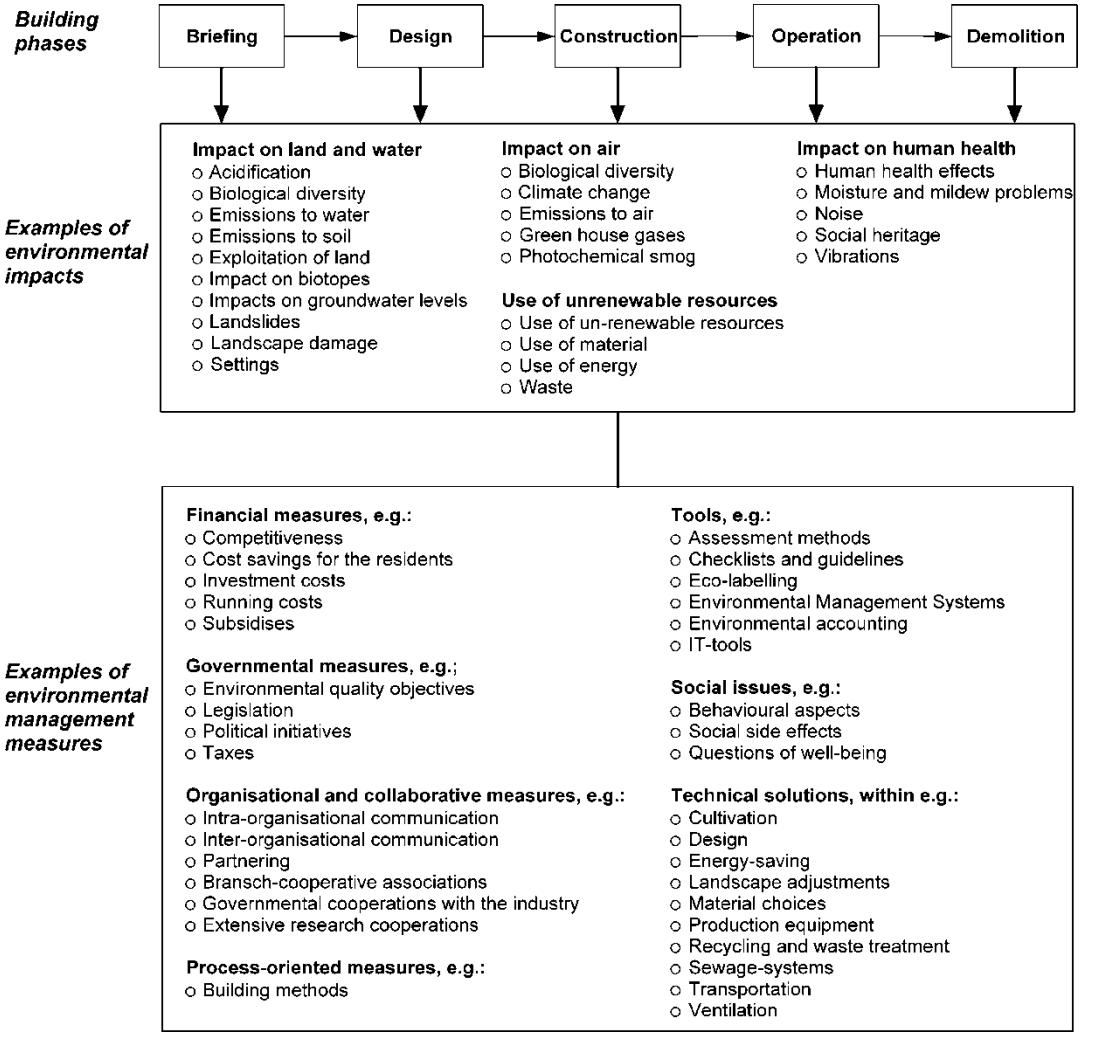

Figure 1 Identification of environmental impacts from the building sector and examples of environmental management measures

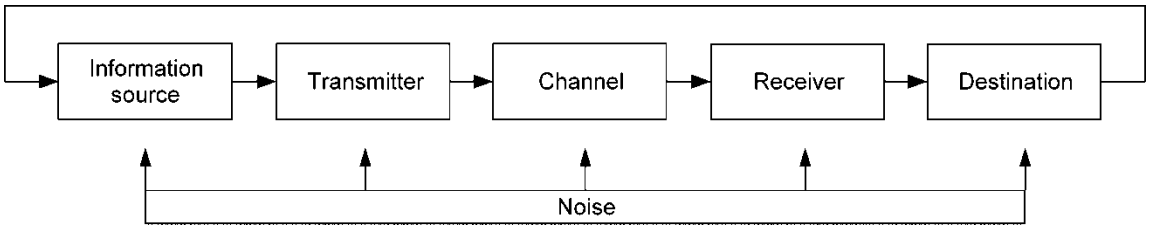

Figure 2 Process model of communication

knowledge and experience and interprets it in relation to his/her purposes. Throughout this communication process, the original message is continuously subjected to various noise that distorts the message before it reaches the receiver. The result is that the message that reaches the receiver may differ from the one sent by the information source.

Factors determining the practitioner's environmental behavior

Ajzen and Fishbein's (1980) TRA is based on the assumption that people make systematic use of the information available to them. In the theory, the intention to behave in a certain way is the immediate antecedent of actually behaving in that way (Figure 3). Two main factors determine people's behavioural intention: their attitude toward the behaviour and subjective norms.

TRA has been tested and applied in a number of studies of *environmental behaviour* (for a review, see Kaiser *et al.*, 1999). It has also been applied to waste management behaviour in the construction industry (Teo and Loosemore, 2001) to investigate the attitudinal forces that shape behaviour at the operative level. The reviewed studies have shown that the relationships between intention and actual behaviour are also valid for environmental behaviour.

However, several studies show a weak or absent relationship between attitude and environmental behaviour. Kaiser *et al.* (1999), for example, tested TRA and found that the missing link was factual *knowledge*, i.e. knowledge of issues and behaviour strategies is a significant precondition for whether or not attitudes predict environmental behavioural intention (e.g. Stern, 1992; Fransson and Gärling, 1999; Kaiser *et al.*, 1999). In fact, Stern found that when people who are actively engaged in environmental issues were compared with less actively engaged people, the single factor that most clearly differentiated the groups was their respective knowledge about the specific problems and possible actions to take in order to deal with them.

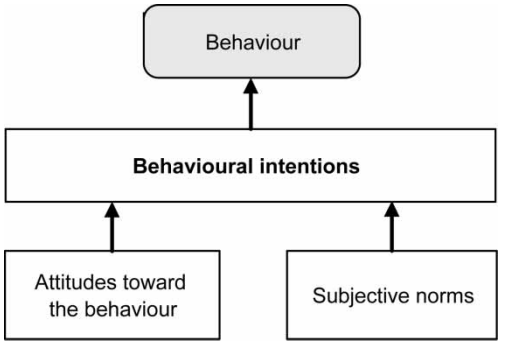

Figure 3 Theory of reasoned action (TRA): factors determining people's behaviour (Ajzen and Fishbein, 1980, p. 8)

Besides attitude, intention is according to TRA determined by a person's subjective norms (Figure 3). These have also been recognized for environmental behaviour (Kaiser *et al.*, 1999). A factor that is recognized as important for pro-environmental behaviour is the *motivation* to comply with subjective norms. In a study of recycling behaviour, Ebrero and Vining (2000) showed that the *motive* underlying environmental behavioural intention made a difference to the actual behaviour. Especially beneficial motives, such as the conservation of resources, community involvement and social concerns, are strong predictors for certain behaviours (Oskamp *et al.*, 1998).

Moreover, subjective norms for pro-environmental behaviour originate from social and moral *values* (Nilsson *et al.*, 2004). Values are related to the willingness to take pro-environmental action as well as to beliefs about environmental consequences (for a review, see Fransson and Gärling, 1999). Real-life decision-making is characterized by uncertainty at all stages of the decision-making process, from problem formulation to assessing the probabilities of possible outcomes (Gough and Ward, 1996). This applies especially to environmental decisions, since changes in ecological systems as well as in social systems need to be forecasted (Wade-Benzoni *et al.*, 1996; Wolff, 1998). This uncertainty nourishes ambiguity about which actions are most important when handling environmental problems (Wade-Benzoni *et al.*, 1996). To comply with this situation, practitioners most often rely on norms that are established within their community, e.g. environmental and technical communities (Sellerberg, 1994). The greater the extent to which technologies are uncertain or goals are ambiguous within a field,

the greater is the rate of isomorphic change, e.g. imitation (DiMaggio and Powell, 1983). Imitation nourishes the establishment of community norms. In the decision-making process, trade magazines serve as agents of socialization mediating how one relates to the environmental challenge, i.e. which societal norms and values that are current.

Furthermore, other factors that are not recognized in the line of TRA but that in the discipline of environmental psychology appear as factors underlying behaviour are, for example, mood (Gärling *et al.*, 1997), self-identity (Manetti *et al.*, 2004), effort (Schultz and Oskamp, 1996), behavioural experience (Ebrero and Vining, 2000), and perceived behavioural control (Ajzen, 1985). Although these factors are important for behavioural patterns, they are beyond the scope of the present analysis.

Aggregated framework

The image presented by trade magazines influences the way practitioners involved in the building process perceive the notion of green building. Figure 4 shows an aggregated framework where the process of communicating information is linked with the practitioner's decision-making process, i.e. how information about green building is spread to practitioners in the building sector and how this information may influence their behaviour. Although the focus in the present study is on building trade magazines, the aggregated framework shows that practitioners use other information channels as well. Placed in the context of green building, the present analytical model combines TRA with the theory of communication (Shannon and Weaver, 1949; Mohan *et al.*, 1997).

The information mediated by trade magazines may be transformed into knowledge as well as provide motives for certain behaviour. Moreover, as a part of the building community, the building trade magazines not only provide an arena for the exchange of information and ideas, but also are influential in setting social norms and values among practitioners within this community. Therefore, these three factors underlying behaviour will serve as a point of departure for the present analysis and discussion. *Knowledge* refers to the perceived nature of the challenge how the environmental challenge is handled. *Motives* refer to the reasons for handling the challenge. *Values* refer to how the challenge is related to.

Methodology

Using a hermeneutic approach (Bertrand and Hughes, 2005), the present study explores the images Swedish building trade magazines mediate to their readers about green building. The study's empirical material consists of trade magazine articles found in the database Byggtorget.[2] Byggtorget is a collective database including housing, construction, environmental and sanitary engineering, with over 250 000 records from more than 500 print periodicals. Abstracts (shorter news items are displayed as full-text), keywords and the title of each article as well as information about the year, author and publication are also given. Links to full-text documents are also often obtained. Byggtorget was searched for articles in building trade magazines from 1990 to 2003. The words build*, house*, construct(ion)*, infrastructure*, road*, tunnel* and bridge* were matched with environment*, ecolog(y)*,[3] sustainab(le)* and green*. Only articles from trade magazines that explicitly describe their

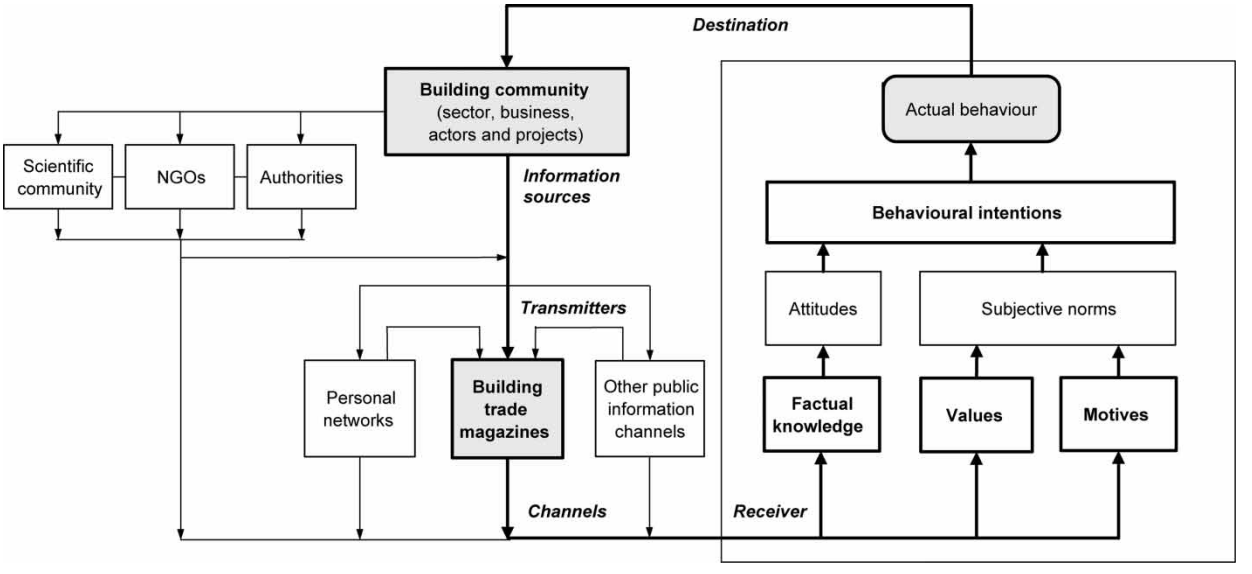

Figure 4 Trade magazines' influence on the practitioners' environmental behaviour and on future green building practices

target readers as *decision-makers* within the building sectors, e.g. developers, architects, consultants, clients, contractors and suppliers, were chosen. With the ambition of being as inclusive as possible, the search resulted in a corpus of 1324 articles. Collected data were stored in a new database and the articles were coded with respect to the framework of environmental impact and environmental management measures shown in Figure 1.

The ten most frequently mediated building projects during the study period represented more than 60% of the total number of articles (Gluch and Femenías, 2002b). Based on the criteria that they be completed, be client-driven and be multicriteria projects addressing several environmental aspects, 35 articles that predominantly concerned three building projects that attracted much attention in Swedish trade magazines composed a *core corpus*.[4] To deepen the analysis, it was important to investigate the articles in their original format and understand why these 35 articles were collected and copied from the original publication. Table 1 shows background information about the three building projects: the Urban Eco-village, the Ecocycle House, and the Sunhouses were chosen as study objects.

A complementary methodological approach (Jensen, 2002) was used. A rather crude quantitative content analysis was combined with a qualitative textual analysis. Quantitative analysis was used to explore the frequency and recurrence of environmental themes (for a complete list of themes and sub-themes, see Table 2) in the comprehensive data. In the qualitative analysis, by iterative reading of the core corpus's texts, different phenomena were discerned that are accounted for in the subsequent sections.

Coding the content in the corpus requires interpretation that involves a qualitative approach detecting recurring phenomena in the corpus. Once coded, a quantitative content analysis was carried out. It provides quantitative measures that show a general picture of which themes were debated in the trade magazines during the study period. It should also be emphasized that conducting content analysis involves interpretation at many stages: the selection of the cases to study, the selection of the analytic themes, the assignment of information between themes, and the interpretation of the meaning and significance of results. In this sense, the authors as researchers mediate environmental information between the information sources (i.e. the trade magazines) and the receivers (i.e. the readers of this article). In order to generate more profound information about the elements in the model of communication (Figure 2), i.e. message, information source, transmitter, channel, receiver and destination, a critical textual analysis was applied to the core corpus.

Drawing on the aggregated theoretical framework shown in Figure 4, the results from the analyses were interpreted with regard to *knowledge*, *motives* and *values*. Focus for the interpretation was the textual message and the receiver, which is considered here as an average practitioner that is called upon to make decisions that may affect future green building. Handling validity and the reliability of the study triangulation were used to code the data and in interpreting the results from the analyses.

Table 1 Features of the three cases (data collected from brochures and reports)

	Urban eco-village Beautiful ecological building, well-being and solidarity	**Ecocycle House** Experimenting ecocycle principles for ordinary people	**Sunhouses** Participative environmental and social rearmament
Number of articles	Nine appearing 1995–2002	15 appearing 1995–2000	13 appearing 1998–2003
Type of project	New development with 44 privately owned single-family row houses	Reconstruction of 18 rental apartments in a multifamily dwelling from the 1960s	Reconstruction of 255 rental apartments in a multifamily block from the 1970s
Formulated environmental ambitions	To use natural and decomposable materials and to work with an ecological expression where the interplay between nature, human and culture permeate the entire building process[a]	To combine necessary refurbishment measures with advanced measures to accomplish a resource effective and ecocycle adaptive living and real estate management[b]	To implement a comprehensive sustainable renovation concept, compromising energy conservation, utilization of solar energy and improved social conditions[c]
Built	1993–95	1995–96	1999–2000
Building proprietor	Cooperative building society	Municipal housing company	Municipal housing company
Initiator	Group of enthusiasts	Municipal housing company	Architect and the energy consultant/researcher

Sources: [a]Undated brochure from the cooperative building society (HSB); [b]Botta *et al.* (1999); [c]undated brochure distributed by Solar Housing through Innovation for the Natural Environment (SHINE).

Table 2 Occurrence of themes/sub-themes in the corpus (number of articles)

Policy and control measures	**678**	**Technical solutions**	**735**	**Environmental impact**	**298**	**Environmental issues in general**	**291**
Tools	253	Material choices	270	Air emissions and hazardous substances	148	Environmental issues in general	291
Governmental measures	237	Recycling and waste treatment	211	Use of unrenewable recourses	57		
Process-oriented measures	138	Energy-saving measures	166	Groundwater levels and water emissions	55		
Financial issues	111	Indoor climate measures	124	Emissions to soil	47		
Interorganizational and collaborative measures	83	Design measures	98	Moisture and mildew	28		
Other managerial measures	36	Sewage systems	83	Noise	11		
		cultivation	40	Greenhouse gases and climate change	9		
		Landscape adjustments	21	Biological diversity	6		
		Transportation measures	19				
		Production equipment	17				

Information contributing to environmental knowledge

Information content

When readers of the trade magazines are repeatedly exposed to information advocating particular views, the media influences increase (Eagly and Kulesa, 1997). The overall picture given by the corpus is that green building to a large extent is a matter of Policy and control measures and Technical solutions (Table 2). This corresponds to the result from a study of how the building sector has responded to its environmental challenge (Baumann *et al.*, 2002).

As shown in Table 2, governmental measures as well as various tools constitute a large part of the theme *Policy and Control Measures*. Legislation initiatives, political issues and subsidies are examples of governmental measures that appear frequently in the theme. Mediated information about different kinds of tools is often related to material choices. Examples of frequently occurring tools are material databases, labelling, guidelines and environmental impact assessment tools. The building sector's extensive reliance on managerial tools as a solution to the industry's environmental challenge has been recognized in several other studies (e.g. Gluch, 2000; Baumann *et al.*, 2002; Stenberg and Räisänen, 2006). As shown in Table 2, a relatively high frequency of the articles in the corpus provide information about tools. This adds to the view that the use of tools is a favoured solution to the environmental problems facing the industry. Also, research reports mediated by the trade magazines focused to a high degree on the presentation of tools.

Although the theme Policy and Control Measures occurs frequently in the corpus, the information content that mediates more tangible knowledge mostly considers technical solutions. *Technical Solutions* presented in the articles involve foremost material choices, recycling and waste treatment, and energy-saving measures. These sub-themes correspond with some of the issues that have been given top priority by the building sector (e.g. Swedish Environmental Advisory Council, 2000; The Ecocycle Council of the Building Sector, 2003; The Swedish Construction Federation, 2003). The core corpus shows that energy-saving measures received the most detailed coverage, while information about other technical solutions was not as well represented. Examples A and B in Example box 1 show how energy-saving measures were presented in two articles. Regarding material choices, the articles did indeed provide information about which materials that were considered as *environmentally friendly*. However, the articles lacked reflection about why a certain material is better than another from an environmental point of view (see Example C).

Environmental measures, such as Policy and control measures and Technical solutions, aim at managing specific environmental impacts that derive from the building sector. In accordance with several of the branch-overreaching priorities (e.g. Swedish Environmental Advisory Council, 2000; The Ecocycle Council of the Building Sector, 2003; The Swedish Construction Federation, 2003), emissions to air and hazardous substances are the most prominent sub-themes within the theme '*environmental impact*'. This focus on hazardous substances has also been noticed in other studies (e.g. Stenberg and Räisänen, 2004) and can be traced back to an environmental incident in 1997: the Hallands Ridge case. As a substance in a chemical grout injected in the tunnel walls,

acrylamide leaked out to nearby watercourses, killing fish and making cattle ill. This incident was heavily exposed in the media and had a large impact on measures to limit and/or prohibit the use of hazardous substances in the Swedish building sector.

The core corpus shows that the majority of the articles (two-thirds) provide information in such general terms that it does not contribute to an increase of the practitioners' knowledge about green building. This implies that only one-third of the articles provide information that can be used as exemplification and inspiration for future environmental decisions. Most of the time these articles present information on measures and solutions used or to be used in the building project, as illustrated in Example D.

Example box 1 Knowledge

Example A: A new facade will be set up 5 cm outside the old one, resulting in an air space between them. Solar panels will heat the air in a closed system. When the sun provides heat in the spring and summer periods, the use of district heating may be decreased. ... Water is heated in the solar panels, and subsequently stored in accumulator tanks in the basement. ... Presence detectors and low-energy lamps will be placed in the stairwells.

Example B: In one of the yards there is a three-storied house with its long side towards the south. In this house, an air heating system with double walls was installed. The solar heating, which is collected in air-solar-panels installed on the south facing, circles through the air space between the old wall and the additional insulation in the remaining facings. The joints in the concrete structure that previously were 'cold bridges' are now used to transport the solar heat inside the building. Heating, hot and cold water, and electricity are measured and debited individually for each apartment, and the tenants only pay for their own consumption.

Example C: On a bare hillock, Stockholm's first ecological housing area is being prepared with ecocycling, renewable energy, sound and natural materials.

Example D: The Ecocycle House has been designed for natural ventilation in combination with a temperature-controlled roof fan. The outdoor air is transported into the apartments through the air space inside the additional insulation via air intakes behind the radiators. Damp air is transported through the stairwells via ventilators above the doors. The indoor air is evacuated through separate channels in each apartment via ventilators.

Furthermore, a common feature of mediated information is the absence of criticism and reflection by the transmitter. There are a few articles with a critical message in the core corpus. For example, the Urban Eco-village is criticized for being too energy-intensive. However, the trade magazines did not comment on the fact that the principal aim of this building project was to use *renewable* energy sources *not* to minimize the use of energy. Thus, by neglecting the context in which the project was realized, the authors of the article based their criticism on incommensurable factors.

Media silences

Articles that relate to environmental impacts were very few. Besides the impact of hazardous substances, the core corpus lacks a problem definition concerning environmental impacts from the building sector. Moreover, justifications for the choice of environmental solutions were hardly ever provided to the reader. Scrutinizing the frequency of themes and sub-themes (Table 2) involved in the green building discourse reveals that there are additional issues that are scarce in the corpus. For example, albeit the media focus on tools, information about Environmental Management Systems (EMS) is lacking. From the mid-1990s onwards, EMS rapidly gained stable ground within the industry. In 2002, 77% of the companies in the Swedish building sector had or were in the process of implementing an EMS (Baumann *et al.*, 2003). Therefore, it was assumed that EMS, both for marketing purposes in the early and mid-1990s and concerning implementation and usability during the late 1990s and early 2000s, would have been mentioned frequently in the trade magazines. Instead, this issue appears in only 2% of the articles and then foremost as a news item informing that, for example, a company has been certified in accordance to ISO14001.

Another example of silence in the trade magazines' representation of green building concerns transportation issues. Although a prioritized issue by the Ecocycle Council of the Building Sector (2003) and the Swedish Construction Federation (2003), transportation receives little media interest (Table 2). Furthermore, landscape damage is an issue that ought to be of interest for the building sector due to its land-use-intensive operations. A questionnaire survey carried out by Baumann *et al.* (2003) showed that among 207 respondents, 56% regarded landscape issues as an irrelevant environmental issue. Thus, neither the industry nor the trade magazines seem to consider landscape damage as a prioritized issue. An explanation for this result may be that using and making irreversible marks in the landscape is a prerequisite for the actual existence of the building sector and thereby it is not considered as an environmental problem that needs to be solved. Or is it something

that the sector would like to draw attention away from by silencing it?

Information sources and transmitters

A majority of the articles in the core corpus did not mention documented sources at all or mentioned them in such an unspecified way that the reader cannot easily trace the original source. However, through the overall picture given in the core corpus it is possible to recognize, through examining the phrasing and use of vocabulary, that much of the information conveyed in the articles originate from a limited number of sources. This suggests that the journalists rely on a limited number of sources. There is thus a strong intertextual chain between the different articles in these magazines.

The most common transmitter of information in the core corpus is a journalist. The type of information source that appears most frequently is short interviews. These are most often with actors that are part of the *building community*. A large number of different actors figure in the articles in the core corpus; however, only a limited number are cited. Frequently, the same actors are relied on as sources of information about the building projects. These spokespersons usually are practitioners representing the client. In articles about the Sunhouses, for example, three promoters of the project, the chief executive officer of the housing company and the two initiators, together or solely figure as main spokespersons in ten of 13 articles. This entails that the mediated information in these articles is based on a few persons' views and is therefore also biased towards these persons' interests and opinions as to what environmental measures are important to consider in future building practice. A minority of articles are written by practitioners, most often architects. These often rest upon personal experience.

In the whole corpus 8% of the articles show that there has been some kind of research contribution behind the information provided. However, due to the vested interest of a small number of researchers the *scientific community* was over representative (37%) in the core corpus. *Authorities* as information source are absent in the core corpus and did not stand out in the corpus either.

Mediated motives

Economic motives

Economic motives related to green building mostly reflect costs from a business perspective, such as investment costs or competitiveness. In addition, lowered running costs and cost savings for the residents of a certain building are brought up as an economic benefit. However, articles that highlight economic issues from a macro-level perspective, e.g. regarding national and global sustainable development, are few. Articles that emphasize different environmental costs are not found in the corpus. In the core corpus, most articles describe environmental management actions as a success, contributing to raising the status of both the housing companies as well as the housing areas. Another economic motive emphasized in the core corpus is the positive effects from a marketing point of view (see Examples E and F).

Social motives

In the core corpus, social aspects are recurrently described as persuasive arguments and motives for carrying out green building projects (see Examples G and H). Thus, in the articles green arguments are used not only to promote environmentally related initiatives, but also to promote other goals, e.g. physical and social refurbishment.

Example box 2 Motives

Example E: Everyone is impressed and the superlatives are piled upon each other in the descriptions of the project. Last year, the Ecocycle House received the public housing sector's environmental award. ... The project has helped raise the status of the whole area.

Example F: Taking part in this European Union project is good from a marketing point of view. It gives publicity and people want to live in the Sunhouses.

Example G: A dull concrete jungle ... will be transformed into an attractive living area where the inhabitants take responsibility for their living environment. The housing area will be a place where different people cooperate to create a long-term sound and safe living area.

Example H: From social misery to a unique ecological endeavour. For a long time ecological living has been a privilege for the upper-middle class in specific eco-villages. But in Norrköping, the housing company brings ecology into a low-status suburb.

Example I: The urine-separating toilets have been well accepted by the inhabitants. In particular, they like the wall-hung model that facilitates cleaning and the comfortable wooden seat.

Universal motives

Different measures responding to governmental pressure frequently occur as motive to comply with pro-environmental behaviour. Such a measure is the corporate environmental initiative to establish the Eco-cycle Council of the Building Sector (ECBC) in 1994, which was the Swedish building sector's response to the governmental 'threat' of legislating a producer responsibility for the sector. This initiative was later followed by several other cooperative initiatives at different levels of society and industry, e.g. the joint cooperation between industry and government, The Building/Living/Property dialogue. The way these two initiatives are described by the trade magazines may have functioned as a catalyst for corporate environmental work since it shed light on the importance of handling green issues.

The present study reveals that nature seems to be of secondary importance in the trade magazines' mediated information on green building. Protecting nature is not displayed as a motive to act in a pro-environmental way. Either the effects upon nature and environmental aspects are considered as well known and taken for granted, or environmental aspects of building are not yet fully identified and therefore ignored in the articles. For example, articles about material issues often focus on choosing *environmentally correct* materials, also labelled *eco-cycle adapted*, *environmentally friendly*, *reliably tested*, *natural* or *healthy* materials, implicitly understood as either material without hazardous substances or materials developed with environmentally adapted technique. However, the criteria for choosing materials are not well accounted for and the specific quality attributed to the materials remain vague. Nevertheless, other motives that do not easily explain the presented solutions, such as bad maintenance, poor thermal aspects, social problems, user-friendliness and aesthetics, are provided to the readers, as illustrated by Example I.

Mediated values

Values are determinants of pro-environmental behaviour; they are related to the willingness to take pro-environmental action as well as to beliefs about environmental consequences (for a review, see Fransson and Gärling, 1999). Thus, trade magazines serve not only as providers of knowledge and motives as to how and why one should act in a certain way, but also as agents of socialization, mediating how one should relate to the environmental challenge. That is, trade magazines may affect and possibly change societal norms and values. Besides this effect on its readers, the information mediated by the trade magazines also reveals and reinforces established norms and values within society.

Example box 3 Values

Example J: Beauty and recycling in the first urban eco-village.

Example K: The Ecocycle House serves as a model.

Example L: In the name of the environment one [building] was built a couple of years ago. It was equipped with enormous German roofs, a coarse facade, pompous balconies and all the technical machinery that ever can be desired. The reconstruction is eco-technically ambitious but in contempt of the house's original architecture.

Example M: It is not only a question of choosing the right building material; great emphasis is also put on [the buildings] giving a beautiful expression.

Example N: [Green building] projects are not as extreme as many people think. It is rather the opposite; the ordinariness dominates here as well. . . . The Ecocycle House does not demand a special 'ecological' tenant to live and feel at home. Neither does the Urban Eco-village, even if many people were or became engaged during the realization of the project.

Example O: Anyone who thought that ecology is necessarily bound to antique technology is wrong. At the Ecocycle House it is quite the reverse. Everything is hi-tech and super-computerized.

Tone

That the majority of the articles has a positive tone (illustrated by the headlines in Examples J and K) and convey an idyllic picture that foremost was criticized from an aesthetic point of view (see Example L) mediate values to the readers that green building is positive. However, in spite of this positive image of green building there seems to be an implicit wish to distance today's green building practice from that of the past. Several articles in the core corpus 'excuse' the green ideas in the building projects by, for example, emphasizing its ordinariness and that green building is neither particular nor peculiar. This presupposes an attitude among practitioners that green building is perceived as negative. This need to emphasize the common place of green building in turn implicitly strengthens the feeling that green building is in fact ugly, cumbersome, uneconomic and only for 'green' people. Examples M and N illustrate how the authors, by stressing the ordinariness and the beauty of the buildings, disassociate themselves from previous

green building discourses, e.g. the eco-village movement. To counteract this predefined conception, terms such as 'hi-tech', 'super-computerized' and 'ultramodern technology' are deliberately used. As Example O shows, this move reveals that there seems to exist a reference point of green building as a low-tech area.

Linguistic nuances

Green building is presented in general terms using an abstract nomenclature characterized by indistinct and fuzzy words. Terms such as, 'environmental', 'green', 'ecological', 'eco', 'natural', 'environmentally friendly' and 'sustainable' are compounded with terms such as 'building', 'construction', 'living', 'adjustment', 'habits' and 'perspective' to form new words and concepts. This use of indeterminate qualifiers combined with determinate nouns suggests that the authors rely on already established pictures and apprehensions of green building. In common for the use of these compounds is that what they represent is very unclear and undefined in the articles. The compounds, e.g. SB, Ecological Building and Eco Village, appear to be stand-alone buzz terms in the articles assuming that the readers have a clear perception of their meaning.

To bring new concepts into use may be a symptom of a correspondence problem between parties (Czarniawska, 1999). The shift of vocabulary may not be rational in the sense that they serve a better purpose but that they may communicate the issue in a 'better' way, e.g. less value-laden. This phenomenon also appears in the present study, which indicates that some concepts become charged with unfashionable values, resulting in shift in the use of concepts over time. For example, Ecological Building was in the late 1990s replaced by SB as a media catchword. Although SB, in addition to ecological aspects, according to 'the textbook' also embraces social and economical aspects, these two concepts describe the same ideas in the trade magazines. The shift of vocabulary suggests that green building is trend sensitive.

Discussion

The intention in this paper has been to explore how green building practices are presented (encoded) in building trade magazines, and to analyse and discuss how the mediated information may influence practitioners' environmental behaviour (decisions). Although carried out within the Swedish context, the aim is to provide additional insights in how the media, as an agenda setter, affect practitioner views on green building. Thus, the understanding of the linkage between trade magazines' conveyed image of green building and possible implications on practitioners' actual environmental behaviour may be generalized beyond the focus of this particular study.

Results concerning knowledge, motives and values set in the context of trade magazines influence on the practitioners' environmental behaviour is summarized in Figure 5.

A starting point in this study was that the media play an important role in shaping the agenda of what issues to think about. However, when the trade magazines select what issues that get media focus, they simultaneously exclude others. This partial media silence may be due to a political interplay between the trade magazines and the members of the building community. Although Stenberg and Räisänen (2006) address how different agendas of the media and the building community interplay, little attention has been paid to this area of research. Generalizing from the corpus indicates however that stories arise in two ways. Many articles originate in an unexpected incident with a negative outcome, for example an environmental accident or mistake, which then receives mass-media interest and thus reaches the general public's attention. Another origin is through spokespersons who represent or promote, for example, a specific building project, a technical solution or a company. These practitioners, whose input to the trade magazines is illustrated by the feedback loop (Figure 5), have occasionally received almost campaign-like attention by trade magazines, where their views have become the common perception for green building practice.

By the choice of themes (Table 2), with a focus on environmental measures, trade magazines mainly mediate information that contributes to knowledge about environmental behaviour, i.e. how to act, while information contributing to an enhanced knowledge about the environment is missing. This entails that environmental motives supporting why it is important to consider environmental issues in building projects are undermined. Consequently, practitioners involved in building projects may not comprehend why environmental aspects are important to consider and thus are unable to identify relevant environmental problems and foresee the consequences of their decisions. The content in the majority of the articles also transmit rather unreflective, biased and less tangible information. Only because a hand-full of researchers has proactively mediated their research results in the trade magazines, the readers are provided with more substantial and constructive information of a few targeted issues, foremost technical solutions. That Swedish building trade magazines fail to provide their readers with a more balanced image of green building result in them nourishing and heightening an already common notion within the building sector that the industry's environmental challenge shall be solved with either technical solutions and/or controlling measures (normative tools and/or legislation). Since people approach new ideas in terms of what they

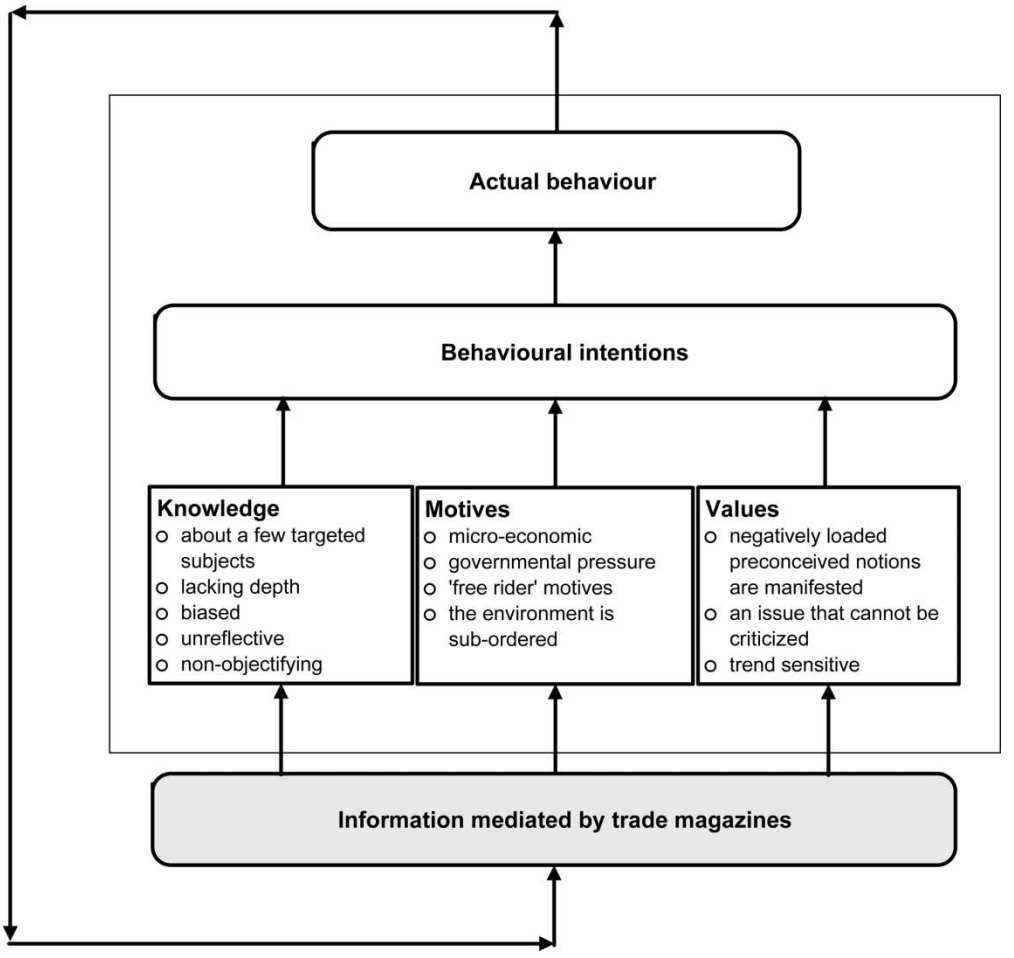

Figure 5 Results concerning the knowledge, motives and values set in the context of Swedish building trade magazines and practitioners' environmental behaviour

already know (Czarniawska and Joerges, 1996) this bias towards measures and the scarcity of problem definitions regarding environmental impacts may result in an increased emphasis on already known environmental measures. Consequently, benefits from other issues may be ignored, resulting in an unbalanced allocation of resources and means as well as a stagnation of the development of green building practices. Besides lack of environmental motives, other issues that are important for the development of green building practices are also neglected in the corpus, such as behavioural perspectives of green building practices, intra-organizational issues, and not least the meta-analytical question of how to communicate environmental information. The inclusion of these issues in trade magazines would contribute to a broader picture of green building practices.

The positive tone in the articles uncovers that the trade magazines have a rather opportunistic attitude towards green building. One would suppose that the positive tone in the articles would also mediate positively loaded values. However, the rhetoric in the core corpus suggests rather the opposite. By presupposing that the readers have preconceived notions that green building is afflicted with negatively loaded values, this may be manifested and accepted as the truth. If often repeated, these perceptions may lay the ground for biased norms and values within the industry, which may impede pro-environmental behaviour. Moreover, recurring shifts of terminology reveal that green building is trend sensitive (perhaps even perceived by practitioners as a passing trend), characterized by conspicuous and 'selling' attributes, and thus not of importance other than to serve as 'reputation management'.

Conclusions

The focus has been on the trade magazines as *information channels*, on the *encoded message*, and on the *receiver* of information. Thus, the characteristics of the transmitter, i.e. the filter and also encoder of the message, are only marginally covered in the present

study. The core corpus provided a few examples where the transmitter of the message is also the information source. Nonetheless, the most common transmitters were journalists. Often, these journalists lack special training in environmental issues (Anderson, 2002). Therefore, as also noticed by Anderson, there is a risk that they either do not grasp the scientific information or they simplify the complexity of the information in a way that distorts the original message. This problem would easily be reduced if the journalists, in opposite to what this study indicates, were more reflective towards their original sources and more actively strove for multifaceted reporting.

When regarding the rather pessimistic results of the present study, it can, however, be questioned whether or not the trade magazines should serve as main media information carrier for practitioners. Either the industry must rely on additional less biased information channels or the trade magazines must improve their reports. Making practitioners aware of the relationship between the media's conveyed image of green building and their actual environmental behaviour, i.e. how they are influenced by the information they are exposed to, may contribute to them recognizing the importance of selecting variable channels for information. Since the receiver is generalized to an average decision-maker within the building sector as a whole, the present study fails to address individual variances between practitioners. In that sense it must of course be taken into account that practitioners, depending on their profession, use other information channels as well, e.g. public information channels and personal networks, and that trade magazines probably have varying degrees of influence. How decision-makers perceive the trade magazines' image of green building depends on factors such as accessibility, factuality and relevance of the information, but also their cognitive ability, psychological predisposition and experience (Bazerman, 1998; Jarlbro, 2001). More research is needed to understand *how* the receivers and decoders of the message perceive, filter and make use of the information.

For the senders of information, e.g. researchers, the present paper also emphasizes the importance of the way green building is mediated. In order to avoid misinterpretations, it is important that researchers are over-explicit when communicating research results. Researchers would also do well to reflect over their channels of communication, for example if more researchers published articles in trade magazines, it would raise the standard of the medium and more researchers would follow suit. Researchers (as well as other stakeholders) that have a desire to influence actors in the building sector, i.e. change their behaviour, need to acknowledge a number of things when they communicate their research. First, they need to communicate their messages in a way that provide the practitioners with tangible information that can be transmitted into factual knowledge. Second, they have to provide the practitioners with motives for complying with pro-environmental behaviour. In doing so researchers need to translate their research of causes and effects into a language that is accessible to practitioners by using terminology and a vocabulary that nurture pro-environmental values instead of degrading them.

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Endnotes

[1]The phrase 'green building' is used throughout to denote any building project that strives to reduce its environmental impact.

[2]See http://www.byggtorget.se

[3]The Swedish word for ecology is *ekologi*, which also covers, for example, ecological (*ekologisk*).

[4]A complete list of articles in the corpus can be provided from the authors.

PAPER IV

Mediating Environmental Concerns in Construction Projects

Gluch, P. and Räisänen, C. (2005)

Submitted to *Construction Management and Economics.*

Mediating Environmental Concerns in a Construction Project

Pernilla Gluch[1] [2] and Christine Räisänen[1]

Submitted to *Construction Management and Economics*

ABSTRACT

Due to a decoupling from the contractor's permanent organisation, construction projects tend to be self-sufficient, often leading to encapsulation. This isolation may have negative effects on the communication flow of the projects with the risk of serious negative outcomes for the project. Drawing on socio-cultural theories of social interaction, this paper examines the ways in which environmental information is produced and distributed in a large construction project. Using qualitative interviews, observations and close reading of documentation, we have studied a large tunnel project. The focus has been on the interdependency between situated practice, the positioning of the mediators of environmental information, and the appropriateness of the linguistic and technical mediating tools used. The study reveals a mismatch between the communication practices within the project and those of the contractor and client organisations. The principle mediators of environmental information, despite their active presence on site, wield little influence since they lack operative authority. Moreover the tools used to mediate environmental information are often neither suited to the situated practice nor to the purpose of the message. The result of these flaws is a marginalisation of environmental concerns, an increased risk of environmental impact and limited possibilities for learning in the project and across its boundaries.

Keywords: Environmental information, communication, construction project, mediating tools, socio-cultural perspective

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INTRODUCTION

> *"We have me [as environmental informer]. I write and send messages in paper documents. Everyone throws them away. Now e-mail is supposed to be more used; it is better for the environment, but getting the information is up to each individual. There is an infinite amount of information; I give them hints about what is realistic."* (Environmental Manager, Construction Company)

This quote highlights some critical issues concerning the distribution and consumption of environmental information in projects. The most striking feature is the implied low status assigned this type of information. Another aspect that can be gleaned from the quote is the assumption that environmental issues can be itemised and sorted in categories of more or less "realistic," i.e. important. Furthermore, the criteria for the classification seem to be determined arbitrarily by one or a few people. On the basis of this person's world-view, situational context and preferred discourse, he/she interprets, evaluates and condenses what is thought to be realistic or important environmental information and mediates it to a group of heterogeneous users. How the information is then received and acted upon by these users largely depends on the needs of the receiver, the persuasive force of the mediator, the mediating tools used in the communication process and the urgency of the communicative situation.

In the context of use of construction projects, individuals are highly dependent on timely and accurate information since many of their actions may cause environmental impact. How environmental information and knowledge are appropriated by project members and acted upon is therefore a critical factor for environmental management, and needs to be paid more attention. As with many other crucial aspects of organisations, environmental concerns are subject to an incommensurable tension between the long-term strategies and goals of management and the short-term, time-pressed reality of the project (Gluch, in prep). What place does environmental information play in the discursive and social practices of a project?

Drawing on a study of a large cross-functional, inner-city tunnel project, we examine the communicative practices that underpin environmental behaviour and analyse the possible effect of these practices on environmental management within the project and across project boundaries. Consequently, we bring together two issues of current interest: environmental aspects of project-based organising and the relationship between environmental communication and environmental action. Specifically, we explore three issues: 1. the situated practice wherein environmental information travels and is used, 2. the roles and positioning of the mediators of environmental information, and 3. the influence of the technical and linguistic tools used to communicate the information. We argue that management in construction firms and projects need to problematise the communication processes and the mediating tools used to convey environmental information across organisational boundaries.

THEORETICAL FRAMEWORK: MEDIATED SOCIAL INTERACTION

This study draws on socio-cultural theories, such as mediated action theory (e.g. Wertsch 1991, 1998), situated action (e.g. Lave & Wenger 1991, Chaiklin & Lave 1993; Engeström 1993, 1999) and mediated discourse (e.g. Fairclough 1992, 2003, Scollon 1998, 2001). The assumption underpinning these theories is that communication takes place in dynamic, ongoing and situated interaction between

actors, contexts, subject matter and artifacts. It is in this interaction that information, may be co-constructed and appropriated, i.e. becomes part of a persons stock of knowledge. For this to take place requires mediation. A common view in these theories is that all action is mediated by means of culturally constructed tools such as language and/or technical tools. The mediating tools are the resources we use in order to participate in a social community or practice. They can be defined as all the devices that we use to act and interact in society (Wertch 1998; Blåsjö 2004). Since it is impossible to influence others' action through our thoughts, we have to give our actions semiotic form so that they may be understood (Wertch 1998).

The implication of this perspective for a study of communication practices is that we cannot reduce the unit of analysis to either actors or communication tools, as is often the case, nor can we adopt a narrow transactional model of sender-receiver/writer-reader. Rather we need to look at communication as social practice, involving message in the form of text, interaction and context. In this practice there exists an inherent tension between the mediational tools provided by the social practice and the ways in which these tools are applied and appropriated in their particular contexts-of-use (Wertsch 1998, Orlikowski 2000). Thus it is not only the mediating technological tools or the texts that generate organisational communicative structures, but rather the ways in which the community of users recurrently engage with the given tools to enact particular structures of use.

Communication is an essential part of the ongoing organising process through which social structures, practices and identities are produced, reproduced and changed (Orlikowski and Yates, 1994). Communication practices develop by means of mediational discourses and genres. In the current framework, discourse is defined as a particular way of using language and other symbolic forms to represent some part of the physical, social or psychological world (Fairclough 2003). Discourses are associated with different groups of people in different social positions e.g. the discourse of management in an organisation, and they compete with other discourses e.g. the discourse of technical experts. Important for our purpose is that discourses differ in their perspective and their representation of social and technical events; what is included or excluded, the level of abstraction and the relationships between processes and actors are critical factor in how environmental information is understood. For example the discourse of an environmental management model depicts a rational, positivist linear process while the daily acts of implementing environmental directives in a project may be rife with uncertainty, entailing ad hoc decisions based on previous knowledge, experience, intuition, and affect.

Discursive practices in organisations are represented by repertoires of genres that enable participants to align with and interact in social practice. Genres in organisational communication are defined as socially recognised types of communicative action, e.g. meetings, environmental inspections, error reports, that are habitually enacted by participants of the organisation to realise particular social purposes (e.g. Räisänen 1999). Genre repertoires are means by which modern organisations organise their activities (e.g. Orlikowski and Yates 1994). Such a repertoire consists of a "mix of standardization attempts, norms, rules and prescriptions that have been more or less firmly sedimented through time" (Joerges & Czarniawska 1998:371). However, genres do not only serve as mediating tools to regulate and legitimate interaction, but also to normalise and control (Räisänen & Linde 2004). Genres are then manifested in concrete local social events such as texts, e.g. the message of a particular environmental memo,

or in other multi-modal forms, technical graph. Texts are events or actions that manifest the causal effects of both the social action and the discursive practice and agency. They are tools by which we engage in social practices, but not the only tools. It is therefore important when studying communicative practices in organisations to avoid privileging the text or the linguistic tools, but to view them as one of several mediating tools.

In order for a message to be appropriated by a receiver, engagement has to take place followed by some form of enactment. Scollon (1998, 2001) refers to the real-time, unique social space in which mediated action occurs as a site of engagement and defines it as a moment when a text leading to action is in actual use, not just passively present in the situation. A site of engagement is "a window that is opened through the intersection of social practices in which participants may appropriate a text for mediated action" (Scollon 2001). For example, in a construction project a site of engagement may be created when an environmental inspector sees an environmental infraction and calls it to attention. In this time and space, several mediated practices come together, the practice of inspection, the practice of being inspected, the practice of recording as well as the repertoire of genres linked to these practices. In all these practices identities are imputed to the participants – and sometimes contested – which will influence the ways in which the participants appropriate and act upon the inspector's observation. The concept is useful for evaluating the potential of various mediating tools, modalities and mediators in eliciting action based on the information conveyed.

To sum up, a mediated action approach to communication in organisations means that the focus is on actors in ongoing social interaction as well as the material means used to mediate social action. In the following we apply this framework to empirical findings.

METHOD

This paper draws on a qualitative study – comprising on-site observations, text analyses and semi-structured interviews – of a large inner-city tunnel-construction project, henceforth referred to as the Tunnel Project (TP), conducted over a one-year period in 2003-2004. Four weeks were spent on site to become familiarised with the context, the practices and the jargon of the project community. During this time, internal and external paper documents, the company intranet and the management control systems were scrutinised. Over 500 written and digital documents were screened for environmental information. In addition, over the year, 11 of the weekly environmental site inspections were monitored. These half-day inspections were photo documented.

Semi-structured interviews were made with 14 persons involved in the production and dissemination of environmental information to and from the project. These interviews lasted between one and two hours, and were recorded and transcribed in full. Interviewees were informed that the focus of the study, was on the communication practices concerning environmental information rather than communicative practices in general. However, we allowed space for the interviewees to elaborate on related issues raised during the conversations.

Since abstract and ambiguous terminology pervades the field of environmental concerns it is imperative that the denotations and connotations of the researchers match those of the interviewees. The knowledge acquired from the comprehensive field observations mitigated the risks of ambiguity and misunderstandings. On four occasions, informal

conversations were carried out with the environmental official on site (EO_{TP}). These provided rich material, which was documented in field notes.

The use of multiple sources, interviews, field observations, photo documentation, and text analysis provided a unique view of the project members' physical workspace and their social practices. Throughout this study we have tried to maintain a reflexive stance towards our study object and our own involvement.

CASE DESCRIPTION: THE SETTING

The Tunnel Project (TP) – owned by the Swedish Road Administration (SRA) – is organised as a design-build contract. Due to political and technical vulnerability of the Tunnel Project, the client (SRA) has demanded more control over the TP than usual. The goal of the Tunnel Project is the construction of a 400 m concrete tunnel running under the city centre. The contractual sum exceeds 80 million Euro and the building contractor is one of the largest construction companies in Sweden, here called IntCon. The project was initiated in 2001 and was estimated to be completed in the spring of 2006 (see also Gluch 2004). The project has a high degree of complexity and is politically vulnerable. Thus it has had many project-specific technical and environmental difficulties to navigate and a multitude of unanticipated complications to solve.

The contractor, IntCon, is certified according to ISO 14001. During an intense certification process in 1998-1999, environmental concerns were strongly promoted by top management. However, after the implementation of an environmental-management system in the organisation, the environmental division was gradually disbanded and remaining actors were decoupled from the line organisation. Environmental middle managers were replaced by administrative environmental officials on the operative level.

The Tunnel Project employs approx. 120 people of which about one fourth are managers and foremen. The project team is varied, consisting of a number of specialists with different skills, education and market value. Moreover the team members change over time, which gives rise to disruptions and realignments throughout the project trajectory.

The management of the Tunnel Project is shared by two project managers; one with contractual responsibilities while the other is responsible for planning and production. Within the project there is a strict chain of command as in most construction projects, which means that all action points have to pass through the project managers and/or task manager to be realised. The workforce is divided into four specialised task groups, each led by a task manager from whom they take their orders. Each specialised group has its set of foremen, craftsmen and subcontractors. The technically-oriented task groups were found to have strong organisational alignments with each other, i.e. the same group of people move from project to project.

The client, the Swedish Road Administration (SRA), is a public authority whose overall responsibility is to develop and improve the Swedish road transport systems in the direction stipulated by the Swedish Government and Parliament, for example concerning environmental impact of road transport systems. The client has an 'in-house' project manager who carries the final responsibility for the Tunnel Project.

However, due to the project's magnitude, the majority of the members of the client project organisation were external consultants, especially the building inspectors whose role it was to mediate between the client and the project.

ROLES OF THE ENVIRONMENTAL MEDIATORS: VISIBILITY AND INFLUENCE

In the TP setting, described above, the communication paths and spokespersons for environmental concerns were defined à priori. Some of these spokespersons were consultants, hired on a temporary basis to alleviate the tasks of the Tunnel project managers and the client project manager.

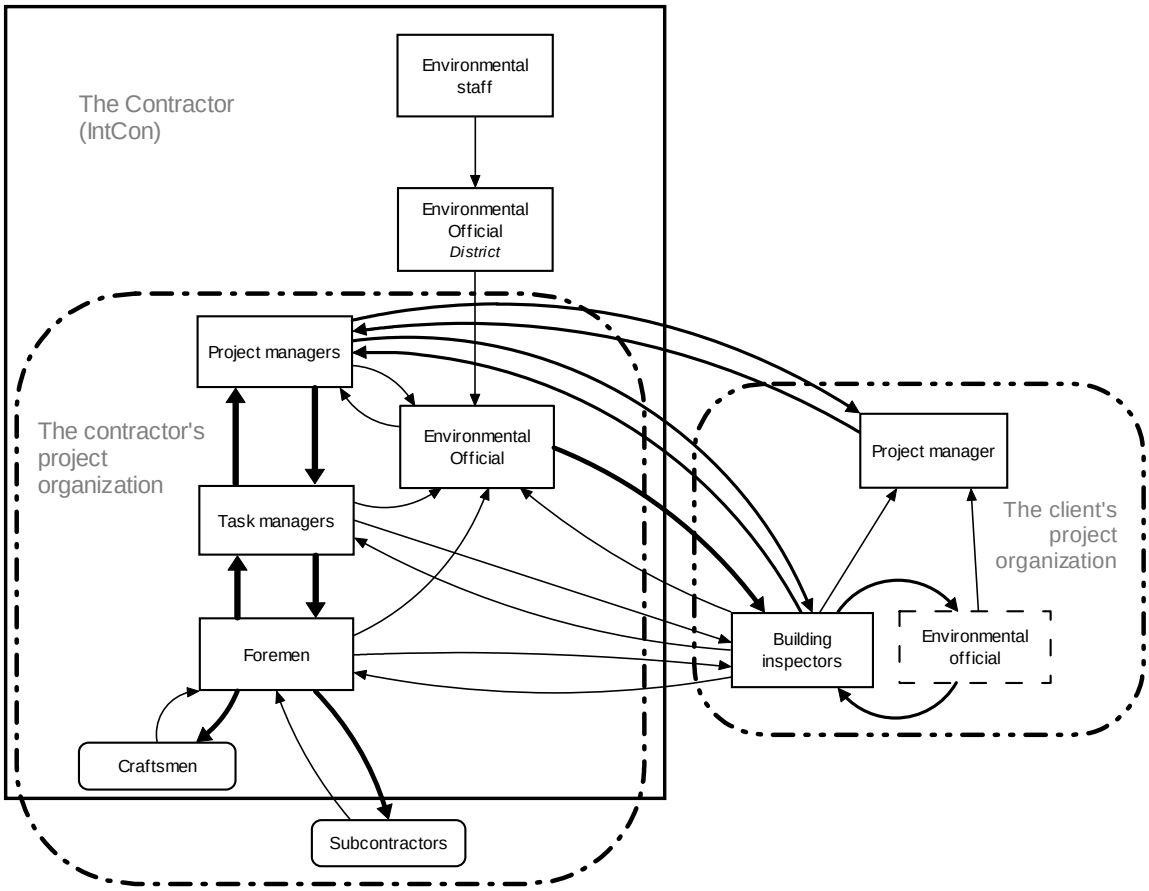

Figure 1: Mediators involved in the environmental discourse and their interaction with each other.

Figure 1 shows that there are three main categories of actors identified as important mediators of environmental information in the TP project: the project managers, the contractor's environmental officials and the client's building inspector (see Fig. 1).

The project managers

The hierarchical project organisation entailed that power was concentrated to the project managers, who had to approve all proposed action points before they could be implemented. The supervision of environmental concerns in the project was delegated to an on-site environmental official, EO_{TP}, appointed by the contractor. The EO_{TP} had no decision-making mandate or operative power. In addition, he had dual areas of responsibility: quality and environment.

Note that the client also had a project manager to ensure that the client's demands were met. In terms of environmental issues, however, this project manager had a hortatory rather than operative role. His contact with the project was through formal meetings aimed at information exchange between the two parties. He therefore had very low visibility in the TP but wielded power by proxy, e.g. through the building inspector.

The environmental officials

The environmental official (EO) was considered by top and TP management as the focal point for environmental action. For a project of this magnitude, there were several EOs, one per district in the contractor permanent organisation, one on site and one in the client organisation (Fig 1). The EO on site (EO_{TP}) had high visibility and access to all the sources of environmental information available in the three relevant settings. He was expected to act as support and filter of the environmental information to and from the project. The other officials' tasks were mainly administrative and as support, e.g. reviewing and summarising published environmental information and new governmental laws and directives. There were indications that the environmental officials had to deal with situations in which their personal beliefs and ideology conflicted with the production-focused and time-pressed agenda of the project. Handling this balancing act between personal and professional convictions and fulfilling project-goals according to cost and time specifications, could put undue pressure on these officials, who perceived themselves to be rather isolated in the project milieu.

However, due to the different organisational structures and social processes of the involved parties, grounded on different ontologies and work-views, there was a lack of coherence concerning the status and definition of environmental activities. Rather than being anchors, the EOs often perceived themselves, and were indeed perceived by project members, as "nags" (see quote in table 1). Since the EO_{TP} wielded no power, he had little ability to influence managers or workers on site. The dismantling of IntCon's environmental division also meant that he lacked the support of an authoritative unit due to the de-coupling of the project. The building inspector, among others, described the EO_{TPs} job as something nobody wants to do; "*it's not the most fun job. There is too much lecturing and that is not so popular […] They [construction workers] are very focused on the actual production and would gladly skip this environmental stuff*".

Due to lack of man-power, the EO_{TP} had to take on dual areas of responsibility as mentioned earlier. Since quality assessment had been his principle area of concern, this had to have implications on the time and commitment devoted to environmental work.

Although the client also had an EO, this role seemed to consist solely of administrative tasks ministered from within the client organisation. Therefore the role had no visibility on site nor did it wield any influence. In fact, the EO_{TP} and client EO did not even communicate directly with each other. Rather, all the information was mediated through the client's building inspector. This situation created friction among EOs on both sides and the project setting since it overtly undermined their authority. They also feared the risk of environmental damages that such an imposed information detour could cause. They felt that their intentions could be distorted en route to their receivers or that information could arrive too late to influence decisions.

The client's building inspector

From a communication perspective, the inspector role was one of the most powerful roles in the TP project. The building inspector had high visibility, strengthened by the fact that his visits were associated with assessment and control. Although he had no real decision-making authority, he could be the source of negative attention on the project. For environmental, as well as other concerns, these building inspectors acted as mediators between the client organisation and the Tunnel Project. They were civil engineers with no formal environmental responsibilities, but with mandates to enforce action. Their appointment sometimes seemed to be based on expressed interest in the task rather than on documented experience, as revealed by an interviewee.

Summing up

The key mediator's role for environmental communication in the Tunnel Project is presented in Table 1.

TABLE 1: KEY MEDIATORS AND THEIR ROLE

Players	Role	Data from TP
Project management	Project leader Authority Accountability for project results	*"Sooner or later most issues land on or pass my desk and my ears…."*
The contractor's EO	Administrator Support Lobbyist	*"…, if there is something specific I need information about and I don't have time to search I ask the EO."* (Foreman) *"One disadvantage with this job is that you sometimes are regarded as a nag and as difficult because you make demands. You say: 'You cannot use this product.' 'Yes I know but only for this time, we are in a hurry, we have a deadline to meet' and, well, sometimes you have to turn a blind eye to it, but at least you try to make them think ahead so that it is not regarded as 'oops do we have to do that as well'. (EO)*
Building inspector	Consultant Controller	*"99 times out of 100, communication goes through us [building inspectors]." (Building inspector)*

MEDIATING TOOLS

Communication and interaction within the TP and across the TP boundary is facilitated, or limited, by the formal and informal linguistic and technical mediating tools at hand. Linguistic and technical tools, however, cannot be separated. In the following we describe the most important tools for mediating texts in the TP.

Paper mediation

The client's environmental control programme
Due to the political and technical vulnerability of the TP, the client demanded more control over the project than was customary. From an environmental perspective, this control was dictated by means of a detailed Environmental Control Programme. The ECP was a separate and formal paper document, specifically designed for the TP and

accessible to all project members. It specified the client's contractual demands on environmental performance and on environmental information routines between the client and the contractor. For example, detailed restrictions on levels of environmental impact on water, land, vegetation and air, levels of noise and vibrations, and handling of chemicals, material and waste were itemised as were the types of documents needed to be written. At the same time, the ECP was a flexible document, which could be revised in accordance with unexpected societal changes, for example tighter regulations. As a consequence, the contractor had to remain updated on regulatory changes, for example the sudden prohibition of a material or chemical.

The ECP was a "living" and highly visible document in the TP. It also influenced the behaviour and decisions of both parties. The interviewees regarded the ECP as the most important document partly because they could not ignore it, but mostly because it provided rapid answers to many of the environmental queries that arose on site. However, as with all texts, problems arise in their interpretation. The message of the sender is not always interpreted as intended by the receiver. Moreover, a sender may, for various reasons, imbue a text with ambiguity, especially when the contents concern complex issues with juridical consequences. This ambiguity is an inherent characteristic of legal discourses. In the case of the ECP, as the quote below shows, the two parties were not always in agreement concerning the interpretation of the text**.**

> *I realized that we [both parties] had read it in different ways. When I read it from the client's point of view it says one thing, and for the contractor it says something different. Then one thinks 'yes it can be interpreted in that way' but one [still] uses it to enforce one's point of view because we in turn have to report to the authorities." (The client's EO)*

Project plan

The project plan is the TP's utmost steering document. The project plan embeds the client's environmental demands, as stated in the call for tenders, as well as IntCon's environmental norms and policies. One problem with the project plan is that it is established in the design phase of the construction process, based on a fixed project goal. It is therefore inflexible and may contradict the changes made in the ECP, and since it is a highly visible as well as influential document, these contradictions may cause conflicts.

Reports

Reports are an important genre in that they document processes, incidents and decisions, thereby creating a paper trail of accountability in cases of dispute. The client required a large repertoire of report types such as weekly and quarterly environmental reports, critical incident reports, and reports of deviations from the specifications stipulated in the ECP. Members of the TP perceived the reporting routine as unusual and bureaucratic.

The most common type of report was the weekly environmental report produced by the EO_{TP}, giving the Tunnel Project's environmental status. An examination of these reports showed that they were based on a form requiring the author to fill in the empty slots. The similarities of the reports surveyed seemed to indicate that there was a certain carry-over rather than news value. In addition, an analysis of deviation reports revealed that they often consisted of cut-and-paste sections from other deviation reports. Only 10 of the 75 deviation reports examined included preventive measures. This suggests that these reports were probably produced on-the-hoof, as a routine response to a routine

demand. Their perspective is therefore mostly short-term, which in turn would lead to short-term solutions. As the quotes in table 2 illustrate, reports are standardised genres that are obligatory, but do not have high visibility as long as the project runs according to plan. In fact, reports were seen as a necessary evil for a community that preferred to talk.

Summing up

Paper-based tools and their role for communication of environmental information in TP are summarized in Table 2.

TABLE 2: PAPER MEDIATION TOOLS AND THEIR ROLE

Mediating tools	Role	Data from TP
ECP	Controlling Enforcing environmental action Continuously actualizing environmental issues Inviting interpretation and negotiation of environmental aspects	*"I think the program is very good. This is the first time I work according to such a comprehensive environmental document. It is an advantage that all specifications can be found in one document." (Task manager)* *"… [with the ECP] it is not 'in section that and that' now it is simply 'in the ECP', that's make it easier [to communicate]." (EO)* *"We received complaints about how we handled the pumping of water. An intensive discussion ensued around this issue. It ended by them [the client] calling the local environmental authority for advice because they were the ones that had set the demands [in the ECP]. And the authorities said 'it's OK everything is in order'. So, when we follow regulations we are told 'But this was our intention; this is how we intended it.' 'But we cannot know what they intended, we can only do it as it is written." (EO)*
Project plan	Institutionalizing Embedding the corporate environmental policy and the EMS	*"When you start a project corporate environmental policies are embedded in the project plan, like 'we are going to work like this in this project'." (Project manager)*
Reports	Controlling Institutionalizing	*"It is very formal. All communication must be written and documented… It is too formal, you should not need to write a letter about everything when you can pick up the phone and call or why not make a visit, it is not far." (Site manager)* *I skim through the reports. They are rather repetitive. So, bla, bla, bla, I skim through them and there is nothing of interest and sometimes I get tired and I ask the EO_{TP} 'Hey ... , do you photo-document everyday? (The client's building inspector)*

IT-mediation

EMS on the corporate intranet
On IntCon's permanent level, the environmental management system (EMS) on the intranet was considered the most important mediating tool for communicating environmental information. The EMS is part of a large management system that encompasses all the business areas of the organisation on a national level.

The comprehensiveness of the IT system demands computer skills and frequent use to enable rapid access to relevant information. In the time-pressed circumstances of the TP, the system was considered too cumbersome to use. Interviewees complained about the opaque logic of the EMS architecture, which was not readily understood. Moreover they deplored the fact that the system designers seemed to presuppose familiarity with the system, which meant that novices, who might be most dependent on the tool, had difficulties using it. Thus the motive for using the EMS differed widely; some found it to be a helpful tool while others ignored it.

One typical mode of using the tool according to the interviewees was to access only those pages that the user was familiar with or that had been specially recommended by a colleague, e.g. the chemical database. Another function of the EMS mentioned in the interviews was as a management-control tool to ascribe accountability to individuals or groups. Since IntCon became certified in 1998 and the EMS was implemented, responsibility for keeping informed seems to have shifted from IntCon's environmental managers to individual project officials and project members. This explains why the interviewees felt that they received less information concerning environmental concerns than they had previously.

While the environmental officials regarded the EMS as an important strategic text, for others its authority remained symbolic in that it represented the organisation's ideological stance rather than the local pragmatic day-to-day dealings on the project level. Therefore, although the EMS was a visible tool for the mediation of environmental information, they were not used as diligently as was the client's ECP.

The computer-based project platform
Yet another communication tool for the mediation of environmental information was the TP-specific computer-based project platform to which all managers and foremen in the contractor's project organisation had access. This platform was developed at the request of the managers and foremen in the TP, who felt they needed a repository for all the texts comprised in the TP repertoire of genres e.g. environmental reports, memos and minutes from meetings. For example, the EO_{TP} told us he stored environmental documents he considered useful for the project such as checklists and templates. However, even though the platform provided the project with readily accessible information, very few project workers actually sought the documents stored on the platform. For example, the site manager complained that the minutes were rarely read, which gave rise to time wasted re-capping information and answering unnecessary questions during the meetings.

Availability and easy access to information on a common project platform, therefore, did not seem to improve information transfer and appropriation. Interviewees stated that they never or seldom sought information on the platform, but relied on their colleagues

to provide them with the information, or they expected to be informed by peers and managers, e.g the EO_{TP}. The reason for the neglect of the project platform can be explained by "overkill". There were simply too many mediating tools and texts resulting in inertia among employees. Furthermore, as the project platform showed, there was overlap between the purposes and foci of these tools, resulting in information overload.

Electronic Newsletter, E-mail and internet

IntCon also has an electronic newsletter service for all EOs. On alternate weeks they receive an update of environmental news published in the media worldwide over the past two weeks. The newsletter covers a wide range of environmental topics. The EO_{TP} stated that he was very selective with the information he chose to forward to project members; it had to be of particular and specific interest for the project, which according to him was seldom the case.

E-mail was used in the TP to distribute information such as calls to meetings, minutes and reports. It was also a means of communication with IntCon. E-mail was therefore an important mediating tool for environmental information management. However, several of the interviewees had an ambivalent relationship to e-mail as a communicative mode. On the one hand, they acknowledged that e-mail was a rapid and informal communication tool, which used efficiently, would save them time and effort. On the other, much due to that facility and speed, the tool was also seen as a nuisance and time waster, e.g. double postings, incomplete and irrelevant messages, overload of or insufficient information.

These problems are mostly due to the fact that organisations have yet to devise practical procedures for e-mail, tailored to the local needs within that organisation. Furthermore, as we shall see in the following section, the TP was a "talking culture," which meant that information tended to travel by word of mouth in a very specific hierarchical order. There was therefore an inherent discomfort in dealing with written documents. This meant that despite the visibility and potential influence of e-mail in the dissemination and interpretation of environmental information, it remained a dormant tool in the context of the TP. Very few of the interviewees mentioned that they used the Internet as a mediating tool to seek environmental information.

Summing up
Mediating IT tools and their role for environmental communication in the TP setting is provided in Table 3.

TABLE 3: IT MEDIATION TOOLS AND THEIR ROLE

Mediating tools	Role	Data from TP
EMS on the intranet	Guiding Controlling Targeting	*"There is where everything is written with references and all." (Project manager)* *"Information can only be found on the intranet, nobody distributes papers anymore… Apparently you have to search for all necessary information." (Foreman)*
Project platform	Collecting	*"The [platform] idea was good, and it worked until the workload increased…. I don't think many read minutes no matter how accessible these may be… There is environmental information everywhere. It is available if you search, but not many read the documents." (Project manager)*
Newsletter	Informing generally	*"It takes up anything and everything and is neither directed nor applicable to our work situation." (EO)*
e-mail	Informing Instructing	*"One receives an e-mail that minutes have been posted on the platform. "This news is absorbed and then one erases the e-mail and forgets all about it. People do not read the minutes. If one instead would receive a paper copy in ones hand one would have read it. Perhaps this way of working [digitally] has not settled yet." (Project manager)*
Internet	Information search tool	*"There is some information to be found on Internet, you can enter the municipality's homepage and find an environmental link on local prescriptions on for example demands on machinery." (Task manager)*

Oral mediation

Project meetings
Formal meetings are regarded as the most important forum for exchanging environmental information between different individuals and groups in the project organisation. Project meetings are held on different levels and everyone in the project organisation has the possibility to attend at least one of these types of meetings. According to a project manager, it is not unusual to spend all one's working hours attending meetings. The meetings, however, are perceived as lacking in discipline and/or purpose, which is the reason the EO_{TP} chose not to attend. The motivation for his decision was that he felt he could spread the information more effectively using other means than meeting.

The project managers have weekly meetings with the client. The minutes of these meetings revealed that many of the issues were official and formalised points and suggest that these meetings mainly function as check points where action points and queries were documented in case of future dispute. In turn, the TP managers conveyed the information from the meetings to the task managers at weekly internal project

meetings. The task managers acted as filters and informed their task groups at task-group meetings.

Common for these meetings were their administrative and formalised character. The environmental topics that came up for discussion at these meetings tended to be the topics specified in the ECP. Other topics that were not of key importance to the project, such as waste management, were marginalised and relegated to a rag bag of environmental topics.

Informal talk
By far the most commonly used mediating tool and channel for information exchange was speech. Many of the environmental incidents were dealt with on the hoof through face-to-face communication or by telephone. Especially face-to-face communication was emphasised by the interviewees as the most common and preferred mode of interaction to handle day-to-day situations. However, there was an awareness of the transience of talk, and the need of written documentation to back up decisions and prompt action.

Although there was a notion that the printed word was more effective than speech, the latter still dominated in the project setting. An implicit understanding seemed to prevail that construction workers neither want to write nor do they want to read, and oral communication is facilitated due to co-location on site. However, routine environmental work and day-to-day issues seldom occurred as conversation topics during breaks, rather it was critical incidents, anecdotes, and jokes that were exchanged, such as unplanned tomato cultivation among the reinforcement bars and pigeons building a nest with metal wires. How well environmental information was enacted through talk remained a good question and seemed to depend on the individuals' attitudes and beliefs concerning the environment.

Interpersonal contact
One kind of communicative interaction that functioned well between the project and IntCon was that between personal contacts that had been previously established. These interpersonal relationships created networks between people that shared expertise, interests, common backgrounds, age, gender or work tasks, and were most often maintained through telephone contact. The problem with professional networks, as several interviewees stated, was that they weaken and die if they are not sustained.

Training courses
Courses and workshops are also mediating tools for acquiring and enacting environmental information, and need therefore be mentioned. IntCon offered their employees a one-day mandatory introductory environmental training course. This course provided basic information on environmental aspects in construction with special emphasis on the EMS and IntCon strategies. Particular for the TP case was that the client also required that everyone on site attend a half-day course on environmental and safety aspects. This brief but focused course highlighted the environmental topics represented in the ECP, e.g. issues that were liable to high penalty fines if not obeyed. Other environmental topics, e.g. waste management and contaminated soil, e.g. those relegated to the aforementioned "environmental-concern's ragbag" were not addressed in this course. This categorisation of environmental concerns may explain the fundamental contradiction expressed by interviewees where on the one hand they perceived that they did not receive information, yet they considered that they had

sufficient information to do their jobs. When the interviewees talked about the lack of environmental information, they were referring to topics relegated to the ragbag and not the specific topics itemised and highlighted in the ECP and the course.

Summing up

The above exposition on oral mediation tools are summarized in Table 4.

TABLE 4: ORAL MEDIATION TOOLS AND THEIR ROLE

Mediating tools	Role	Quotes
Meetings	Controlling Targeting environmental action Institutionalizing	*"…if there is something that we think is not functioning as its supposed to we bring it up for attention on the weekly meeting with the contractor. Then it at least becomes registered in the meeting protocols."*
Informal talk	Setting of communicative culture Sharing exceptional incidents, anecdotes and funny stories	*"There are two ways to be informed in the coffee room, if someone done something good he talks about it himself and if someone done something foolish someone else talks about that." (Site-manager)* *"You can never know if they have perceived the information correctly until you see the result. It can go wrong even if you are very clear." (Task manager)*
Site inspections	Visualizing environmental aspects	*"We [the task managers] take turns and participate in [formalized] site inspections every other week. It is not very much to make remarks on." (Task manager)*
Interpersonal contacts	Organisational learning	*Everything is packed in your personal experience box ready to be used in next project and one is not keen on sharing one's knowledge with someone else." (Project manager)* *"There are no functioning channels for organisational learning. I guess I can turn to the EO_{TP} and tell him but then it have to be on my own initiative. To exchange experience between projects and with others is not stimulated at IntCon." (Task manager)*
Training course	Provides either too general or very situational information	*"They [IntCon] offer ready packages where only half of it is relevant and the other half you already knew." (Task manager)* *"[I think] everyone sees it [attending training] as an inflicted must."(Foreman)*

DISCUSSION AND CONCLUSIONS

Figure 2 presents mediating tools used in the TP setting related to organisational units.

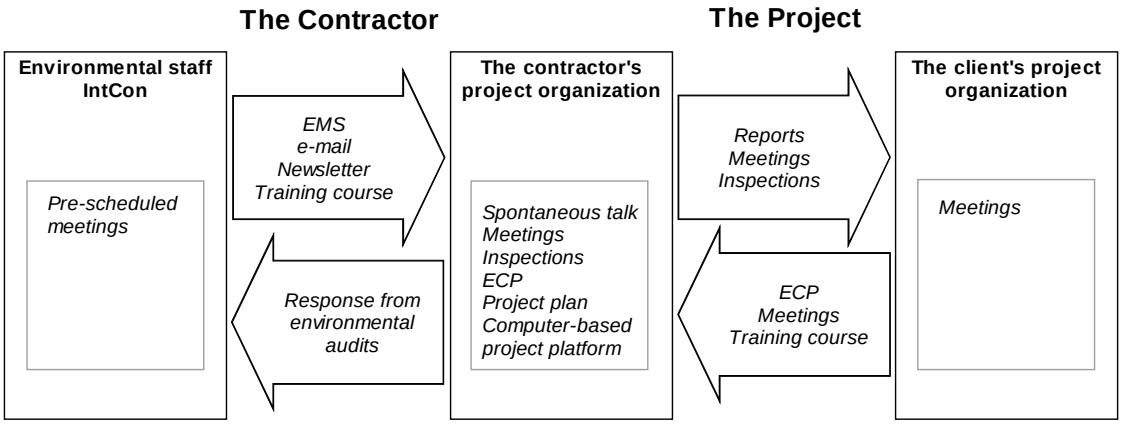

Figure 2: Environmental information flow: Mediating tools.

This paper has explored the relationship between environmental communication and practices in a project context. Who communicates with whom and why? What is communicated and how? Most importantly, what can we infer to be the implications of these discursive exchanges for the management of environmental concerns in projects?

Our point of departure has been to see the tunnel project as a collectivity, a community of practice (Lave and Wenger 1991) governed by experts with similar professional backgrounds united in their endeavour to realize a novel and unique project goal. Coherence in the project community exists because of the professional homogeneity of the group; they belong to the same field, have a common language, and are united by a stated project goal and project stage gates stipulated in the client's ECP and iterated in the project specification. However, even in seemingly homogeneous groups, individuals have their own personal understandings based on their status in the project, and their personal values, beliefs and orientations. These are manifested in the way they talk, the tools they use, and the way they act and interact (e.g. Fairclough 1992, Scollon 1998, Engeström 1999). This situation was especially obvious concerning the subordinate project level of environmental work, where contradictions prevailed between what was written or said and what was done.

As Engeström (1999) noted, the relationship between discourse and practical activity is wrought with tension. He critisises discourse analytical approaches for their tendencies to equate discursive action with physical action, which results in too much credence given to the textual transcripts of interviews. What is actually going on is a conflation of a variety of factors that are not transparent in the text (e.g. Fairclough 2003; Räisänen 1999). For example a discursive event has a history involving past events and actors; the discourse is mediated through tools that carry positive or negative value for the interlocutors; who may or may not engage in the discourse; which will then not lead to the intended action. Most importantly in this ensemble of humans and tools, there exist contradictions caused by the power position of the human and/or the tool, which as we have seen will cause discrepancies between intentions and actions. These factors are not mirrored in the transcripts alone, which argues for a triangulation approach to qualitative research.

In our analysis we examined the roles played by human mediators of environmental information and knowledge and the tools used in the mediation to, from and within the project.

This study indicates that environmental issues were not very highly ranked in the production phase of the project. Rather, environmental issues seemed to be regarded as extra work on top of what is regarded as regular work. The implementation of administrative tools such as the EMS, checklists and chemical databases marginalised environmental concerns to administration of a few targeted issues, for example hazardous substances and energy efficiency. A consequence of this standardisation of environmental aspects was a fragmentation of environmental concerns. Even though the EMS created a common environmental framework for the organisation as a whole, which facilitated communication and enabled managerial control of environmental activities, it also encouraged conformity and simplification of environmental complexity, e.g. environmental works equated with handling of chemicals.

The specification of environmental issues in the ECP entailed that project members including environmental officials had no need to seek environmental information

proactively, for preventive or long-term purposes. When they did seek information, their search was driven by need, e.g. when a particular critical situation or incident occurred or during auditing periods when focus on documentation and justification was strong. Moreover, they seldom sought information outside the sphere of the project or company. This reliance on the client's classification of environmental priorities could lead to bias and lack of discrimination and complacency should unexpected symptoms of environmental ills arise. Aggravating this risk are, as many researchers have pointed out, the time constraints and costs governing the pace and focus of projects, resulting in a stressful work climate and limited time for reflection and learning (eg. Bresnen et al., 2003; Zika-Viktorsson 2002; Ollila 2002; Styhre et al., 2004).

As a consequence of the relative communicative inertia in the TP, project members seemed to rely, directly or indirectly, on information conveyed through project officials. Thus these functioned as filters for the environmental information travelling in and out of the tunnel project, with the potential to influence environmental practices in the project. However, although some of them had high visibility in the project, they had little possibilities of mediating strong environmental identities for themselves through their discourse and actions since their authority was limited. Instead, their roles and positions in the project community were indeterminate, resulting in lack of engagement on the part of their interlocutors and a feeling of isolation on their own part.

This isolation was accentuated by the decoupling of the Tunnel Project from the rest of IntCon, giving rise to structural contradictions in terms of both practice and communication (cf. Dubois & Gadde 2002). The project's traditional hierarchical chain of command contrasted with the contractor and client's flatter organisations resulting in re-routings of information through additional translators to comply with project practices. For example, environmental officials had to go via project managers or foremen to get an action point implemented, which accentuated their lack of authority and risked further distortions of the original message.

In spite of the large number of mediating tools to facilitate cross-boundary communication, environmental information exchange and knowledge creation did not frequently occur. The main reason for this lack of engagement was a mismatch in modalities. Most of the official environmental information was conveyed by means of written text, dominated by managerial discourse whereas the project was an overwhelmingly "talking" culture (cf. Styhre *et al.*, 2004; Styhre *et al.*, 2006). This means that in spite of the large potential for interaction, there were in actual fact few windows opened for engagement through the intersection of social practices. The sites of engagement (Scollon 1998) where communication and practices did converge across organisational boundaries, leading to environmental action, were mainly mediated by orders with immediate implications for the project, e.g. directives in the ECP, the project plan, or during site inspections.

Other mediating tools and texts, e.g. the project platform, the EMS and e-mail, were rich sources of written information that did not succeed in engaging project members due to their lack of specificity and relevance to immediate problems. Thus in order for the mediated information to generate engagement it has to be enacted-upon-for-now, resulting to appropriation-for-now. There were no clear windows of opportunity opened for real appropriation and long-time learning.

Conclusions and recommendations

The present study indicates that environmental aspects in construction projects today are perceived as extra work, disengaged from the real business of production. This perception is strengthened by the lack of coherence between project practices and environmental practices and by the haphazardness of environmental communication processes to and from the project.

To make the communication of environmental information more efficient, the environmental linguistic tools such as the discourse and genres need to be adapted to the communicative culture obtaining in the project. It is therefore recommended that the communication culture be considered when choosing linguistic as well as technical mediating tools. Instead of risking resistance and or misunderstanding by using dominantly written formal genres and technically complex systems, it would be more efficient to nurture the prevalent speech genres and adapt discourse and systems to more direct forms, e.g. audio-recorded reports and interactive agents to help novices navigate through complex management systems. Both the client organisation and the contractor are currently fighting against the current praxis by being dominantly oriented toward formal written communication.

Bracketing the project organisation in time and space is a mechanism that allows the project member's to focus on the project task (Lundin and Söderholm, 1995). In the TP the bracketing seems to be a cause of the lack of interest in seeking "new information". Since the body of knowledge within environmental management is still in its infancy, with innovative technologies and new discoveries constantly being made, it is important for organisations to be sensitised to sudden changes. Bracketing however may seriously constrain the project organisation and render its members inflexible to such changes (Kreiner, 1995). To avoid information inertia, the organisation needs to ensure that it does not create barriers for interaction and communication (Persson 2005). Instead, it needs to ensure that there are legitimate arenas for exchanging experience and knowledge within projects and especially across project borders.

If these organisations, as is stated in their official documents, rank environmental aspects and considerations as a top priority, this commitment must also be enacted in the activities of the project. This means that the role and position of the environmental officials need to be strengthened. Not only does the environmental official need to be visible in the project, his or her identity needs to be backed up by operational authority. As is today, the role is mainly administrative. The mediating linguistic and technical tools for communicating on a day-to-day basis need to be tailored for the needs of the situations they serve and the purpose of the message. For the environment as well as the organisation, this is an imperative for future sustainable development.

ACKNOWLEDGEMENTS

Gluch thanks the Adlerbertska Research Foundation and the Centre for Management of the Built Environment for financial support.

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PAPER V

“It’s about time” – for Environmental Management to team up with Project Management

Gluch, P. (2005)

Submitted to *Business Strategy and the Environment*

“It’s about time” – for Environmental Management to team up with Project Management

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Submitted to *Business Strategy and Environment*

ABSTRACT

Drawing on a qualitative case study, organizational and social mechanisms that influence the interplay between environmental management and project management are studied. Findings show the existence of built-in tensions in the relationship between how the environmental work respectively how the project is organized and managed. An effect from these tensions is that organizational units within the corporation, due to isolation, partly strive towards different goals. This way of organizing also restrains the environmental organizations ability to communicate environmental information as well as the project organizations ability to handle environmental issues properly. It is concluded that top management need to support the establishment of communicative communities of practice by offering arenas where members from the two units can team-up. It would also be recommended that researchers within environmental management cooperate with researchers on project management to achieve a wider understanding on how to handle negative effects from these tensions.

Keywords: Project-based organizing, project organizations, environmental management, organizational structures, social practices, communication

INTRODUCTION

Project-based organizing of companies, which is still an increasingly occurring mode of organizing (Bresnen et. al 2003; Lundin and Steinthórnsson, 2003; Packendorff, 1995; Midler 1995), is mainly characterized by being permanent organizations that carrying out their core activities in temporary projects. The permanent organization and the project organization differ considering time-frames, tasks, organisational settings, and internally also in context. A challenge in project-based organizations is to align permanent structures of the company, e.g. management systems, with the temporary organisation and operational activities performed within projects. This alignment between the temporary and the permanent has been documented to be marred with problems; for example concerning knowledge management (Styhre et. al., 2004), organizational change processes (Bresnen et. al., 2005), management practices (Labuschagne and Brent, 2005) and adoption of innovation (Dubois and Gadde, 2002). All these examples affect how the permanent organization's long-termed environmental strategies and goals are implemented and realised in the projects as well as how these are interpreted and managed in the project settings.

To handle increasing societal environmental demands many companies, also those with project-based organizations, have adopted environmental management systems (EMS), methods and tools that were originally developed for organizations with more stable organizational structures (Baumann *et.al.*, 2002; Ammenberg and Hjelm, 2002; Burström von Malmborg, 2002). However, in spite of academic, industrial and societal efforts and despite the availability of a multifaceted smorgasbord of systems, methods, and tools, there is a noticeable lack of enthusiasm among practitioners in project-based organizations to adapt, use or apply them in their day to day work (Gluch, 2000; Cole and Sterner, 2000, Gluch and Baumann, 2004). In addition, the academic debate on whether these means will ever be compatible with project-based organizing seems to be lacking or at least has not yet surfaced. Drawing on findings from a case study this paper makes an attempt to partly fill this gap. The aim of the paper is to increase the understanding of how organizational features and management practice of projects influence on how environmental issues are managed in the project-based organization.

LITERATURE OVERVIEW ON PROJECT ORGANIZING AND ENVIRONMENT

A majority of research and industry efforts addressing environmental management in projects share the same common objective, that of applying a normative theoretical perspective on projects (see overviews in Gluch, 2000; Gluch, forthcoming). This perspective assumes that projects are tools that are intended for goal achievement. It also means that projects are regarded as objects that can be controlled and manipulated through a prescriptive and normative set of methods and techniques. Important assumptions in this normative perspective are that a project is characterised by being unique, being goal-oriented, and, what is especially underlined, by having a measurable output (Maylor, 1996). However, methods and techniques developed based on this rather normative perspective on projects, disregard the organizational context and the inner work of a project. Recognizing this, an alternative theoretical perspective considering projects as "temporary organizations", emerged in the 90s (c.f. Engwall, 2003; Lundin and Söderholm, 1995; Packendorff, 1995; Kreiner, 1995). Besides the highlight on temporality, this perspective also stresses complexity and contextuality as

important characteristics of a project. While the normative project management approach views the project as a universal tool that make things happen, this perspective on projects as temporary organizations focuses instead on understanding what happens inside the project, i.e. emphasis is on studying different phenomena and characteristics of projects, such as decentralization (Lindkvist, 2004; Dubois and Gadde, 2002), autonomy (Eskerød, 1996), complexity (Baccarini, 1996), differentiation (Lindkvist, 2004), bracketing (Kreiner, 1995; Dubois and Gadde, 2002), and operational and contextual uncertainty (Kreiner, 1995; Turner and Müller, 2003), organizational learning (Styhre et al, 2004; Bresnen et al, 2004), and standardization (Räisänen and Linde, 2004). So what about these and other organizational phenomena and their relation to corporate environmental management? In a review of topics of articles in the leading journal on project management, *International Journal of Project Management (IJPM)*, 3 articles out of 339 addressed the topic 'safety, health and the natural environment' (Themistocleous and Wearne, 2000). This study covered the period 1984-1998, screening the journal for articles addressing this topic up to present adds three more articles to that list. However, except for one paper (Labuschagne and Brent, 2005), the articles applied the normative approach by suggesting monitoring or controlling tools for environmental management, failing to address organizational aspects related to this topic. Worth mentioning is nevertheless Labuschagne and Brent's conceptual article, which criticises current project management practice for having a time-frame that is not consistent with core principles of sustainable development. Even if it is not possible to make conclusions based on articles published in one single journal it undeniably indicates that the project management research community has paid little interest to phenomenon related to the greening of project-based organizations.

So, how about researchers on corporate environmental management, have they paid more attention? Organizational features influence corporations and professional organizations, this is a well acknowledged fact, and much research has been carried out on how different organizations manage the environmental challenge facing them. Most organizational studies concern strategic environmental actions and processes on a corporate organizational level (e.g. Atkinson *et.al.*, 2000; Ransom and Lober, 1999; van den Bosch and van Riel, 1998, Burström von Malmborg, 2002; Blomqvist and Sandström, 2004). Although Atkinson *et. al.* (2000) have explored how different organizational structures affect the way environmental aspects are perceived and managed in corporations, their conceptual discussion raise questions for debate rather than a thoroughly in-depth investigation. In addition, project-based organising, even though it may in part resemble matrix structures, is not issued in their article. Research has also focused on inter-organizational activities, such as environmental networks (Boons, 1998; Clarke and Roome, 1999, Boons and Berends, 2004), cooperation between corporations and authorities (von Malmborg, 2004; Starik and Heuer, 2002), cooperation between corporations and non-profitable organizations (Starik and Heuer, 2002) as well as cooperation in the name of industrial ecology (Korhonen et al, 2004), or temporary green reform projects (e.g., Dobers and Söderholm, in press; Dobers, 1999; Füssel and Georg, 2000; Bergström and Dobers, 2000). SMEs, similarly to project-based organizations, have been found to have problems in relation to implementation of environmental performance tools (e.g., Petts et al, 1999; Tilley, 1999; Ammenberg, 2003).

A tool that has been suggested as especially useful for product development projects is Product-Oriented Environmental Management Systems (POEMS). The tool aims at

integrating environmental issues related to the products with those that relate to the process (cf. Rocha and Brezet, 1999; Ammenberg and Sundin, 2004). However, it appears as the initiative has ceased on a conceptual level since its implementation in industry seems to be limited or at least not very well debated.

In sum, it seems that the academic field of environmental management neither has paid much attention to studying project-based organizing.

A QUALITATIVE CASE STUDY

This paper draws on a case study conducted over a one-year period in 2003-2004. By having a long tradition in carrying out their core business in projects and the organizational mode itself is well manifested in the organization, which make the construction industry is a relevant representative for project based organizations.

Study object

The target of the present research was a large international construction company (IntCon). IntCon was chosen not only because it is a project-based organization but also due to its strategically pro-active commitment towards greening and the fact that the company is often seen as setting standards for Swedish construction industry. The object of interest in the study was an inner-city tunnel project where IntCon was the contractor and the Swedish Road Administration (SRA), a public authority, the client. IntCon is certified according to ISO14001 and the company group supports the United Nations Global Compact and is, since 1999, listed on Dow Jones Sustainability Index. Although ratings in sustainability indexes have been questioned as a standard of value on environmental performance (Cerin and Dobers, 2001), they indicate that top management of IntCon has adopted an active environmental strategy.

The construction part of the Tunnel Project started in the autumn of 2001 and is planned for completion in 2006. The task of the Tunnel Project was to construct a four-lane car tunnel in a way that it could meet the demands set by the society, the client, the contractor, the project organization, the project members and the environment. The project was organized as a design-build contract. In design-build contracts, the client is only responsible for the briefing, where overarching specifications concerning different performance aspects are set. The contractor is thereafter responsible for the whole process of leading and co-coordinating the design and construction phases. Figure 1 provides a schematic organizational chart of actors that, in different ways, influence the Tunnel Project. There are, however, three main actors; IntCon, the project team and the client. An extended case description can be found in Gluch (forthcoming).

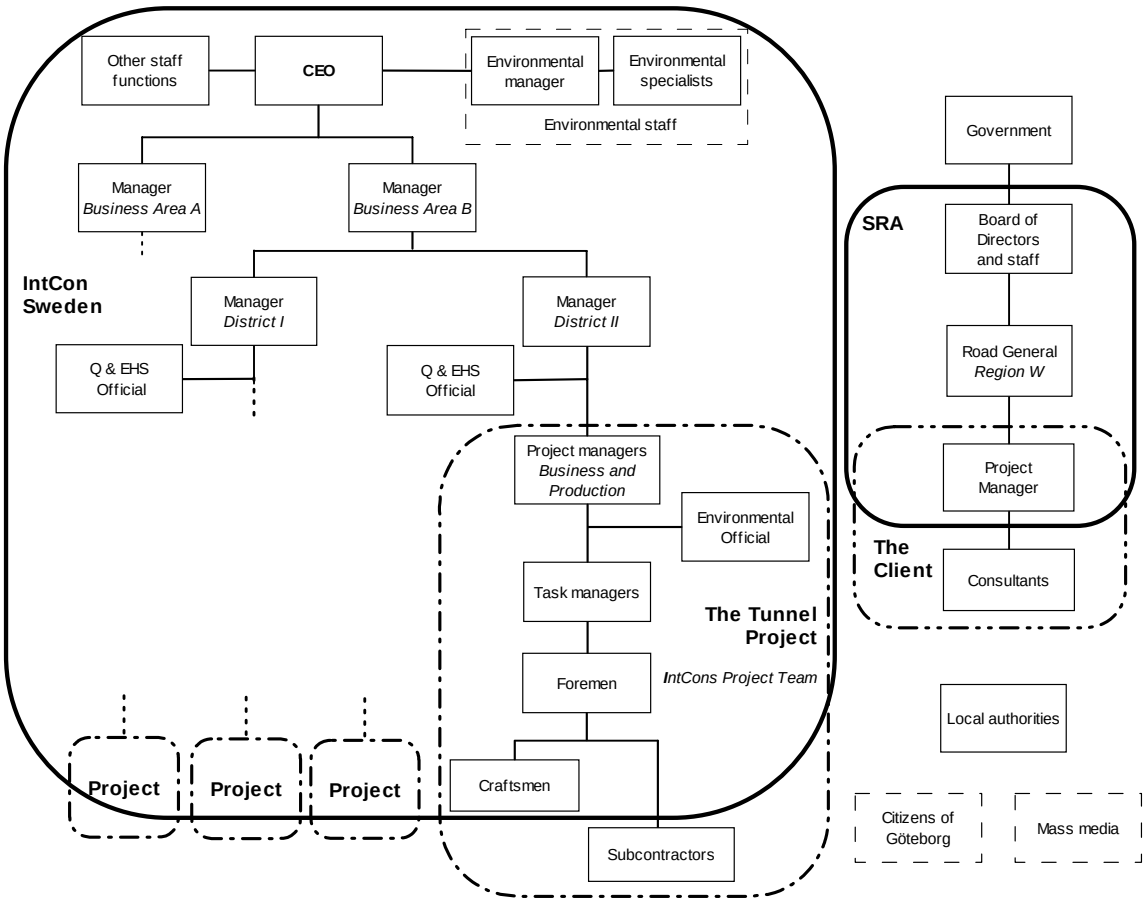

Figure 1: Schematic organizational chart of actors involved in the Tunnel Project.

Method

The study comprises on-site observations, text analyses and semi-structured interviews with persons in the project organization as well as with persons belonging to IntCon's corporate environmental organization. These interviews, 14 altogether, lasted between one and two hours, and were recorded and transcribed in full. Four weeks were spent on the construction site to become familiarised with the context, the practices and the jargon of the project community. During this time, internal and external paper documents, the company intranet and the management control systems were scrutinised. Over 500 written and digital documents were screened for environmental information. In addition, over the year, 11 of the weekly environmental site inspections were monitored and photo-documented. The use of multiple sources, interviews, field observations, photo documentation, and text analysis enabled triangulation and also provided a unique view on the project members' physical workspace and their social interaction.

ORGANIZING THE ENVIRONMENT IN INTCON

This section presents results from the case study on how the way environmental management was organized affected how environmental issues were handled in the Tunnel Project.

The environmental unit

The decision to obtain an ISO14001 certification was an immediate response to the company's involvement in an environmental accident, the Halland's Ridge Case (HRC), in 1997. In the Halland's Ridge Case, a toxic grouting agent injected in the tunnel walls leaked out to nearby watercourses killing fish and making cattle ill (Danielsson *et.al.*, 1998). The certification process in 1998-1999 was very intense and affected IntCon's whole organization. In an initial phase IntCon mobilized with a strong environmental organization, managed by influential actors in the company. Environmental concerns became a guiding principle and were strongly promoted by top management.

After the environmental certification the substantial environmental unit was gradually reduced and the handful of people that remained from the former environmental unit were isolated and decoupled from where the production takes place, i.e. the projects. The following quote illustrates this isolation, were the environmental specialist, although his office is located 500m from the construction site, had no insight nor were informed of environmental activities in the project.

> Interviewer*: If there was a large oil leakage at the Tunnel Project and rescue-service had to be contacted, would you be notified?* Environmental specialist: *I guess I would not be informed about it, if I receive information about the incident it would probably be through the newspapers.*

This handful of people, with an environmental manager in charge constituted an environmental staff, and were appointed to be environmental agents for the organization (see Fig. 1). In their role as agents and as environmental specialists in the organization they had to be keen and open to societal changes as well as organizational needs. However, being decoupled from where the production takes place the interviewed expressed being torn by a situation where they, due to limited time-resources, was set in interdependence (Lewicki et. al., 1994). Being few also put them in a position of somewhat ambiguous role as both generalist and specialist. They perceived the situation as they were carrying out a balance act where on one hand they had to manage the difficulty of combining a strategic, policy-based, all-embracing and long-termed perspective relevant for IntCon's whole business and on the other hand they had to gain profound expertise within a targeted field of knowledge. The members of the environmental staff were also placed at different locations which not only decoupled them from the project organizations but also made them loosely coupled with each other, which did not nurture networking and the creation of a fruitful experience sharing community.

Maintaining the environmental management system needed extensive administration that exceeded the capacity of the handful people in the environmental staff. To handle the increased administration, environmental officials with a pure supporting role were assigned on operational level, on district and/or project, which created a satellite network of environmental administrators working rather independently from each other

(see Fig. 1). The administrative environmental task was on this level also often combined with other administrative tasks, for example quality, safety and purchasing. To simplify routines IntCon had a management system that integrated quality and safety aspects with environmental aspects, which to a high degree determined how these administrative tasks were distributed on an operational level. Furthermore, the persons in this administrative position had neither an influential authoritative position nor formal responsibility in the organization which undermined their role and their possibility to take action. This way of organizing also made these environmental officials loosely coupled from both the environmental unit and and the production focused project organization. The organizational manoeuvre of having a centralized environmental staff with a distributed satellite network of administrative environmental officials was also perceived as a degradation of the former environmental unit. This in turn was interpreted as if environmental issues on a corporate level had shifted from being strategically important into bureaucratic administration of papers.

Environmental management practice

By concentrating the environmental expertise in a few persons on a corporate staff level and distributing the administrative environmental work onto officials with foremost a building technology background, much reliance was placed on the internal web-based environmental management system as a guidance for the project members to act pro-environmentally. Relying on a web-based EMS required that environmental routines and procedures were standardized. This standardization of the environmental work, however, conveyed that the environmental issue was controlled from top with very little room for flexibility.

As one of the pillars for ISO14001 is continuous improvements, it is important to find ways to measure and communicate environmental performance within the company. This requires well developed routines for two-way communication. The communication between the strategic level and the operative level was in the bottom-up direction foremost based on a mandatory yearly report, and in the top-down direction either through optional search on the intranet or through ‘anonymous’ send outs by e-mail (see also Gluch, 2004). As illustrated by the following quote, the organizational distance between the environmental organization and the project organizations made the environmental organization impersonal which hindered a smooth communication between the parts.

> *Sure, I can call some environmental dude on my division, I don’t recall his name, but there are many that call him and he does not have time helping us. (Foreman)*

Being unfamiliar with the environmental unit, members of the project organization instead addressed inquires to persons that already were among their established personal network. As a consequence, inquires were addressed to people who did not have the most solid knowledge within a specific area.

The use of ISO14001 as a governing instrument also demanded extensive reporting which required a text based communication culture. This, however, was found to be conflicting with the oral face-to-face communication that was emphasised by the interviewed to be the most common and preferred mode of interaction in the Tunnel Project (Gluch, 2004), and reporting routines were perceived as unusual and bureaucratic.

ORGANIZING THE TUNNEL PROJECT

The preceding section presented how environmental management organizing and practice in IntCon affected how environmental issues were handled in the Tunnel Project. This section will instead focus on the influence of project organizing and practices.

The project organization

The project team at the IntCon's Tunnel Project consisted of approximately 120 persons, of which approximately 40 were managers and foremen. IntCon has a decentralized organization where each project is an autonomous unit with a project manager(s) that is held responsible for actions and decisions taken within the project, for example financial result and environmental performance. The project management of the Tunnel Project consisted of a one business manager, that had the contractual responsibility, and a production manager, that was responsible for the planning and control of production (Fig. 1). The Tunnel Project was a complex construction comprising many project-specific technical and environmental difficulties to navigate and a multitude of unanticipated complications to solve. Being a complex project the Tunnel Project also required a variety of technical experts that in the tunnel project were coordinated in specialised task groups each led by a task manager. Although they possessed no formal responsibility they, due to their technical specialisation and/or expertise, were in a position where they possessed a mandate to take actions. To ensure that the client's demands on environmental reporting were met as well as to undertake administrative commitments with regard to the corporate environmental management system IntCon also had a person especially assigned to administrate environmental and quality aspects. However, this person did not have any formal environmental responsibility for the project's environmental performance.

While the project members were employed in the project they were also temporarily decoupled from the mother organization where they are employed between projects. The work by the technical task groups with 'traditional' construction work, for example concrete work, resembled Eccles' quasifirm (Eccles, 1981) by having tight organizational bounds between the members, i.e. the same persons were found to stay organizationally together from one project to another (see quote below).

> *I have worked with most of the foremen and workers in my task group for several years now. I know them inside and out; we're almost like a touring circus. (Task manager)*

These persons did not find the loose coupling from their mother organization as problematic since they perceived that they had all competence needed within their task group. Task groups, with a more specialised task, for example advanced foundation work, however, were more troubled by this double organizational belonging. These persons were found to be more negatively affected by the isolation in the project and thus expressed more explicitly that they experienced it as important to belong to, and keep up contact with, a knowledge sharing community. The notion in the following quote illustrates an almost resign acceptance of this situation.

> *The project is the project and, well, here you are... the project is very isolated. (Task manager with a specialist role)*

The project members' also perceived that the project had so tight time-frames that it did not leave much room for networking activities outside the scope of the project. So, they experienced difficulties in keeping up contact and previously established contacts faded. As an example, the environmental official in the Tunnel Project described his contact with other environmental officials at IntCon as 'occasional' in the beginning of the case study and 'hardly ever' a year later. Additionally, there was no systematic or controlled exchange of environmental information between different projects within IntCon. Except for what was examined in internal audits there were no routines for the project organization to communicate environmental experiences from the Tunnel Project to the rest of IntCon. Experience from the project thus stayed within the group of people involved in the project. Whether the members in the project organization got information from other ongoing construction projects depended to a high degree on the personal networks and on which kind of communities of practice one belonged to. Many of the interviewed project members also experienced it as being up to each and everyone to make contacts and to search for the right persons to communicate with. The members of everyone's personal network also seemed to be a result of coincidences rather than a deliberate move to find persons to exchange knowledge with. Consequently, most personal networks seemed to be homogenous groupings, i.e. a group of persons that share profession, educational background, gender and age.

Project management practice

Due to the Tunnel Projects environmental vulnerability the client demanded a lot of control over the project and had also especially pinpointed environmental issues as an important issue. As a result the project to a high degree was regulated by the client's stipulated environmental demands. For example, detailed restrictions on levels of environmental impact on water, land, vegetation and air, levels of noise and vibrations, and handling of chemicals, material and waste were specified in a specific environmental plan. This environmental plan was a flexible document that needed to be promptly revised in accordance with societal changes and acquired experiences, which made it a 'living' document. This was found to invite the project members to contingently interpret environmental issues which in turn kept these issues alive throughout the project. In this way the contractual document in addition to being a control mechanism of the client also came to play symbolic role in the project. IntCon's internal environmental policies were in turn embedded in the general project plan.

The project organization members were not familiar with IntCon's environmental organization and whom to contact if they had queries either. A consequence from the organizational distance between the permanent organizations and the project organization was that it created mistrust towards the environmental staff's ability to understand the project members' reality and work situation. This in turn nurtured a defensive attitude and a resistance towards suggestions of changes in environmental routines. The project members expressed a wish that what had been outlined in project plans established before the project started was preferably not to be changed during the project time. As the next quote indicates, changes were thought to negatively affect practice within the Tunnel Project.

> *It feels as there is too much that is foisted on us, checklists and demands and other things, 'now you have to check that and that', Sometimes I perceive it's only as a showcase, especially if you know that you will not be able to fulfill the demands set on you. (..) I mean, we do not only work with green issues, we also have to produce something and make money. (Foreman)*

This perspective of 'living in different worlds' is further stressed by that the top-controlled environmental management system, did not agree with the culture of the decentralized and autonomous project organization. The result were found to be two communities with different worldviews were the environmental staff's holistic and all-embracing perspective does not interplay with the project members' pragmatic, task-bounded and time-framed perspective, which the following quote demonstrates.

> *"When we are engaged in a project it is the project time that decides the environmental boundaries, we look at the small scope of the project." (Project manager)*

Additionally, despite the extensive project time of six years, many of the interviewed expressed that they did not have time for anything else but the immediate task at hand. For example, the interviewed seldom read environmental information that was not directly applicable to the project task at hand and due to perceived shortage of time they seldom or never searched for information or read anything for preventive purposes.

TENSIONS IN PROJECT-BASED ORGANIZING

Construction projects are characterized by being a combination of human capital and material-input, coordinated at a specific site. The primary task is to erect a construction, with a strong focus on production, for now there is still a prevalent notion that a successful project is the one that has achieved the highest quality with the lowest input of financial resources in due time. The case study has revealed that there are several in-built tensions between how the project is organised and how environmental issues are organised. The main findings from the analysis of the case study are summarized in Table 1.

Table 1: Summing up empirical evidence from the IntCon Case

	Organizing the Environment	**Organizing the Project**
Inter-organizational relations	Decoupled from the project organizations	Loosely coupled with the permanent organization
Intra-organizational relations	Loose couplings between members (network)	Tight couplings between members (team)
Organizational control	Centralized	Decentralized
Organizational dependency	High and integrated	Low and autonomous
Communication	Text-based	Face-to-face
Time perspective	Long-termed	Short-termed
Performance focus	Strategic policy making and continuous improvements	Resource efficient production (foremost financial) and coping with environmental demands embedded in plans
Environmental scope	All-embracing and integrated	Targeted or embedded
Regulations	Governed by corporate and societal environmental standards and norms	Governed by the client's demands

Being autonomous entities, the project organizations easily become decoupled from each other, which together with the decentralized organizing has the consequence that the projects are separated from the processes of the permanent organisation (Lindkvist, 2004). Thus, having a decentralised and autonomous organisational culture has the disadvantage that much experience gained in the organisation is also unavailable since it is difficult to make it common goods for the organisation. Similarly to what Dubois and Gadde (2002) suggested, the present study found that the loose coupling between the project and the permanent organization resulted in that organizations outside of the project, for example the environmental unit, become anonymous to the project members.

Especially construction has a business culture that by long tradition is decentralised where business relations preferably are made with persons that are familiar (Eccles, 1981). Out of this perspective, an anonymous centralized environmental unit and the EMS governance, and especially the top controlled issue of chemicals, were perceived as an unconventional move that was met with a certain distance. However, limited environmental knowledge, especially in chemistry, together with a fear of repeating the Halland's Ridge Case, made the issue of chemicals especially easy to control from top. The effort has indeed resulted in an increased and much needed awareness on environmental impacts of chemicals in construction. On the other hand, the field studies revealed a side effect of this intense and authorized focus on chemicals; communication of environmental issues has come to solely concern chemicals in construction (see the following quote).

> *In the minds of many [at IntCon] and also in mine, if you say environmental issues we automatically think: chemicals. Environmental issues equal chemicals. (Project manager)*

Consequently, other environmental issues, for example waste management, were disbanded and/or neglected in favour of the handling of chemicals.

To comply with stated project goals the project organisation tends to isolate itself from its context. Temporary bracketing of the project decreases the risk of interventions and unwanted disturbances (Kreiner, 1995). However, the bracketing of projects as temporary has the consequence that when a project is finished it is laid aside and the next one starts. Often projects also overlap with an overhanging risk that the newer project attracts more attention than the older, resulting in that the evaluation-phase of the project, when reflections upon the project and collective experience can be gathered, is lost. Moreover, even though environmental impacts caused by the construction process may exceed the project closure, the environmental boundaries were, as found in present study, mentally restricted to the time span of the project. That is, in a project the environmental problems are regarded as 'momentary', i.e. they occur during the project time and when the project is finished, they are considered a closed chapter. As a consequence, the project members' commitment to environmental issues is constrained by the project's time and space boundaries. As also recognized by Labuschagne and Brent (2005) this restrains them from having the holistic and long-termed perspective that is necessary for a sustainable development of the business.

A way to make the project consider environmental impacts that occur outside the project's time boundaries, and that was also done in the Tunnel Project, is to consider these by embedding them in project plans and contractual documents. However, project

plans are designed with respect to a set of assumptions based on a number of actors' idea about the world at the time of the textual inscription. Project plans also simplifies the world by making the future unusually explicit so that precise definitions of boundaries, tasks, resources and their allocation are enabled. Nevertheless, as we all know, the natural environment is not static, it changes. Contextual uncertainty is created outside the project span and authority, which makes it impossible to predict in advance (Kreiner, 1995). For the project this change causes problems since the assumptions made in the design phase may not be accurate at the time of delivery or at any time in between. For example the conception of needs, desires and requirements that the project is meant to meet may change in response to incidents that happen under the project time. In addition, too much trust in that environmental aspects are included in project plans and other specifications also has the consequence that a set of green truths based on past experiences were sedimented and institutionalized in the organization.

Bracketing projects provide an identity and isolating project members allows them to focus on their task by minimizing any disturbance to plans or other threats to achieving their pre-defined tasks (Lundin and Söderholm, 1995). However, as has also been pointed out by (Christensen and Kreiner, 1997), bracketing means that the project manager can only be held responsible for the project's efficiency and not for its relevance since the effects from the project appear after the project's 'closure'. Striving to be as efficient as possible, requirements other than the minimum requirements are considered by the project members as an obstruction. Consequently, changes in environmental routines, irrespective of its influence on efficiency, may be regarded as a 'burden'. So, on the one hand the de-coupling of a project provides a good foundation for creating a project that meets its in advance stated goals. On the other hand, the bracketing in time and scope jeopardize its possibilities to cope with contextual changes (Kreiner, 1995).

The arrangement of having loose couplings (networking) in the permanent organisation and tight couplings in the projects has in previous research been found to favour short-term productivity of individual projects on the expense of long-term effects for the company (Dubois and Gadde, 2002). This phenomenon also appeared in the present study where pure production task was prioritized over all other issues. The incentive for devoting energy and time to environmental development and innovations was very restricted unless earmarked resources were allocated by the client. In addition, environmental issues crucial for the project's accomplishment, and thus closely related to production, were not considered by the project members as environmental. So, what is the problem with that?, one may think. The issues receive large attention, and are hopefully also handled properly in the project. No, the problem is rather on a motivational and authoritative level. By rhetorically detaching environmental issues that are defined as 'important' for production, this way of itemizing also sends signals that what is left is not. This marginalises and labels the 'remaining' environmental work as work added on the regular work, i.e. work that one preferably would be excused from. This biased notion on environmental issues made the environment a side issue not highly ranked by the project members, simply a detail that can be negotiated. This fact put the environmental official on site in an awkward position where he/she had to go in defence for the interest of environmental issues against the more powerful interest of accomplishing the project with as little interaction as possible.

DISCUSSION AND CONCLUSIONS

From this study it can be concluded that environmental work governed by a top-down controlled environmental management approach does not match with the decentralized and autonomous decision making culture of the project organization. The result was two "isolated" organizational units that used different 'language' and partly strove towards different goals. The way of organizing was found to create a distance between the persons that make strategic environmental decisions and the persons that shall realize them within the operative units of the projects. This made the project organisation a self-regulating environmental organization with the consequence that the project member's motives for behaving pro-environmentally were biased towards short-termed performance, which restrains flexibility and innovativeness. Moreover, the temporary bracketing of the project restricted the project member's ability and motivation to perceive and handle long-termed environmental impacts. Environmental issues not closely related to immediate production were marginalized which pinioned the environmental official on site's ability to authorize actions apart from the minimum. Moreover, the embedment of environmental policies into predefined project plans, foremost based on the client's needs and interest, diminished the scope for the project organization to react on societal and environmental changes.

A commonly suggested solution to handle this situation is that the clients need to raise their environmental competence (e.g. Ofori, 1992; Bröchner et al., 1999). Another is to avoid institutionalizing and dead-locking predefined assumptions into normative plans (Kreiner, 1995; Christensen and Kreiner, 1997). In the Tunnel Project the client had large environmental competence and much resource to specify and authorize their demands. Moreover, as they demanded much control and paid much interest into making sure that there was a continuous dialogue with the contractor, they had deliberately chosen to not lock demands in written textual inscriptions but instead allow the environmental plan to be a 'living' document that encouraged reflection, in terms of discussions on interpretation and negotiations, so that communication was evoked. That is, in the Tunnel project the client's environmental plan was used as a combination of a symbolic artefact and a regulating standard. However, despite the measures taken, there were, as illustrated in this paper, still deficiencies in the management of environmental issues in project settings. This indicates that suggested solutions are not enough. Indeed, it is true that the client has a position where they can set the rules for the game. However, the client has little insight into the contractor's strategic, technical, organizational and operational practices behind the actual game, which has in this paper been shown as decisive for how environmental issues are interpreted and acted upon. In this perspective, it seems vain to debit the client with the main environmental responsibility as norm setter.

As I see it, a solution lays in breaking the "isolation" between the organizational units within project-based organizations by finding ways where environmental management and project management professionals can team-up. Although the establishment of communities of practice is a bottom-up process (Wenger, 2000), the top management can encourage their vitality by supporting the project organisation member's participation in a variety of networking activities. Top management can also nurture the creation of these communities by offering communicative arenas where people can meet and exchange information and knowledge. However, to make it work two things have to be considered. Firstly, it is important to consider the communicative culture of the organization so that fruitful and equal discussions can be held. Secondly, equality in the

discussion need that the authority of persons that belong to the environmental unit must be powerful enough so that environmental issues receive righteous legitimacy within the organization.

Epilogue: A research proposal

The study has shown that the organisational features and social practices of project-based organisations are mismatched with centrally controlled environmental management practice. In addition, the study has shown that today's prevailing project practices clash with the long-termed principles of sustainable development. To reach and suggest solutions to how the tensions between corporate environmental management and project management emphasised in this article are handled, more studies are needed.

A majority of the research efforts up to date have held the normative perspective on projects, where projects are regarded as controllable and possible to manipulate through a set of prescriptive techniques. However, since the outcome from environmental decisions most often are uncertain, irreversible and often happen outside of the boundaries of the firm, a normative perspective fails to acknowledge environmental issues properly (Gluch and Baumann, 2004). If the tool perspective on projects is too limited and inflexible, the perspective on projects as temporary fails to acknowledge many green issues due to its bracketing. Studying projects as temporary organizations provide insights to the inner workings of the project as well as how the organization relates to its environment from a project perspective (Lundin and Steinthórnsson, 2003), but does not grasp how the environment relates to and affect the project. This deficiency of the theoretical approach has recently been acknowledged by a handful of researchers (e.g. Engwall, 2003; Söderlund, 2004; Eskerød, 1996; Lundin and Steinthórnsson, 2003). Engwall (2003), for example, suggests that to understand the inner life of a project in depth, it needs to be analyzed in relation to experiences from past activities, pre-politics, parallel courses of events, ideas about the post project future and institutional social practices of the project's organizational context. There is thus a necessity, not only among researchers but also among practitioners, to adopt this broader perspective on projects in order to grasp the whole picture. Adapting the extended perspective on projects reconciles that also the context is encapsulated in project theories and practice. The context may then also comprise a social construction of the natural environment. This is where researchers interested in organizational aspects related to the greening of industry can largely contribute. With the increasing 'projectification' of industry, scholars should pay closer attention to this area of research. The area has large improvement potential that especially would benefit from an inter-disciplinary approach where the two communities, project management and environmental management, could team up in a flourishing cooperation.

ACKNOWLEDGEMENTS

Many thanks to the Adlerbertska Research Foundation and the Centre for Management of the Built Environment for financial support.

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