Analysis and representation of rhetorical construction of understanding in design teams' experiential learning

Simone Stumpf

This thesis is submitted for the degree of Doctor of Philosophy of

University College London

Ph.D. Computer Science

August 2001

Department of Computer Science

University College London

Abstract

Every analysis and representation is embedded in a particular paradigm that structures what is highlighted or neglected. One of the thesis contributions is to identify four main paradigms in design and compare these to designers' experience of designing in practice. Most closely aligned to the experience of designing is individual experiential learning. The thesis clarifies this paradigm in relation to team designing and contributes extensions that locate the team design process in the rhetorical construction of understanding.

An analysis of design team discourse is derived through a method of discourse analysis. In the thesis, a coding scheme based on the New Rhetoric is developed to study the use of argumentation in designers' interaction. Understanding of the micro-level process of team experiential learning is furthered by a detailed analysis of design team discourse, illustrated by excerpts drawn from a design exercise transcript. Results show that designers increase the presence of statements to focus the team's attention, organise their understanding through associations based on the structure of reality, keep notions flexible through association establishing the structure of reality and attempt to reframe the team's understanding through dissociations. How these distinct rhetorical means are used in the unfolding of the design discourse is discussed, especially in attempts at establishing a team frame. Team frame in this sense means a shared perspective of what the design problem is and how it is to be solved. Results of submitting the coding scheme to a reliability test are presented.

Akin to the influence that paradigms have for the analysis, so in turn they determine appropriate representations for describing and supporting design team activity. An examination of models of the designer, design task and design process leads to the proposal of characteristics and criteria for representations that capture team experiential learning. Comparisons between discourse analysis studies of how teams establish team frames and an examination of design discourse and design process representations motivate the capture of the micro-level and macro-level process in team experiential learning. The thesis sets out a new representation that emphasises the unfolding nature of design discourse as a ‘frame rationale’. A variety of representations about learning experiences make aspects of design team’s experiential learning more visible. These representations can be used to enhance reflection-in-action or reflection-on-action. The thesis shows how frame rationales can be used to identify and support instances of team reframing within design teams and provide another facet in the basis for learning situations.

Table of Contents

Acknowledgements

This thesis could not have been written without the support of a whole raft of people. I would like to use this space to pass on my gratitude to all those who have helped me over the last few years.

There are individuals who, whilst not involved in my particular research area, lent a hand to critique and hone my work. I would like to express my thanks to Simon Attfield, Sacha Brostoff, Ismail Ismail, Sophie Phillips, and the UCL Design Group who have commented on the thoughts that have found their way into this thesis.

Thanks must also go to the participants in experiments I carried out. Alas, to preserve their anonymity, they must remain nameless; they know who they are.

I would like to give my acknowledgements to Rianne Valkenburg who graciously provided me with transcripts, videos and time to talk about Schön's work. Furthermore, I would like to thank Prof. John Worthington for inviting me to the LEAF workshop and for discussing designers' dependence on language in early stages of designing. I am also grateful to Alistair Blyth for his time and open ear. My thanks also need to go to Petra Badke-Schaub and Gabriella Goldschmidt, who supplied material that stimulated my thinking.

A big 'thank you' goes to John Dowell, Anthony Finkelstein and Angela Sasse for their help in the process of completing this thesis.

Janet McDonnell, my supervisor, was always on hand to advise on the content and structure of my work. Without her I would not have got as far as writing this thesis: she knew when to cheer me up, distract me from getting bored, push me to complete work and nail me down on deadlines. She deserves a medal but, unfortunately, she will have to make do with my deepest gratitude.

When I needed practical help, she was there. When I was frustrated, she was there. When something made me happy, she was there. My final acknowledgement has to go to Kathleen Bryson for all the years she has been there for me.

Chapter 1 Introduction

1.1 Introduction

Research into designing, linked with the rise of design methodology – the study of "principles, practices and procedures of design" (Cross, 1984) – has gained impetus over the last forty years. Designing is investigated not only to provide better support for designers, but also to gain a better understanding of what designing actually is.

Traditionally, design has been understood nearly as a synonym with construction. The emphasis in this version of designing is on the creation of material artefacts, such as buildings and products. Consequently, most research into designing has been driven by fields such as architecture and mechanical engineering. A shift however can be noticed to apply the term 'design' to fields where abstract artefacts are created, such as computer software and systems engineering, town planning, management and policy planning. The underlying rationale for extending research into designing to these areas is the belief that, elementally, design activities do not differ from field to field, only domain knowledge does. Therefore, one of the aims of design research is to shed light on these elemental ways of designing.

Design research is, however, not an objective enterprise; it is grounded in certain assumptions that curtail the description and idealise what is going on. It has been pointed out that assuming design works similarly to science emphasises *technical rationality* (Schön, 1991). This entails the separation of problem-setting from problem-solving, applied knowledge from theoretical knowledge and professional learning from scholarly teaching. A description of designing that redresses this separation highlights

the role of the designer as a 'reflective practitioner' (*ibid.*) whose design activities comprise the integrative qualities of problem-setting and problem-solving. In the description of the designer as a reflective practitioner, emphasis is placed on the role of experiential learning in design. This thesis concerns itself, firstly, with identifying differing views of what designers are and do and how they influence what count as elemental design activities. Secondly, a particular view of designing – *experiential learning* – that experienced designers feel is intuitively right (Dorst, 1997) is examined as to its assumptions about designers, the design task and design processes. Analyses of experiential learning are illustrated using examples drawn from a traditional design field and a design field that deals with products that are more abstract: product design and software systems design.

Moreover, the rise of the industrial age has pushed design into a fast-paced world. Design projects have grown larger; specialisation of domain knowledge of designers has increased. Consequently, designing is less often seen as an individual enterprise and moved to be shared within a team. Speed, quality and efficiency in design are not solely due to what the designers know, but depend crucially on how teams work. A reorientation to a certain degree has taken place: communication skills of designers have to be added to their technical skills. Communication has been seen as crucial in the work of design teams; individual designers bring many perspectives to the problem.

Whilst research into teamwork has either stressed the social aspect of design team processes (Minneman and Leifer, 1993; Bucciarelli, 1994; Brereton *et al.*, 1996; Cross and Clayburn Cross, 1996;) or the resolution of conflicts of viewpoints (Olson *et al.*, 1992; Finkelstein and Sommerville, 1996; Brooks and Jones, 1996), research into how experiential learning operates in design teams and is effected by verbal interaction have

received little attention. In this thesis, it will be examined how designers use verbal communication when they are designing in a team. Team designing will be investigated using a background of argumentation theory to illuminate how *team experiential learning* is carried out.

Lastly, design research builds knowledge of what designing is and this also forms the basis to suggesting ways for supporting designing. Whilst the view of design as a science tends to offer support through formal methods and prescriptive life cycle models, support for experiential learning has only received scant focus. In this thesis, representations that can be used to support team experiential learning are proposed and examined.

1.2 Problem Statement

Design research is influenced by assumptions and perspectives; viewing designing as *experiential learning* has only recently gained attention. Problems remain: it is still unanswered how experiential learning is effected in design teams and how experiential learning in teams can be supported. The problem statement that results from the problem area can be stated as:

How can *design teams' use of verbal interaction* be *analysed* as a means to *describe team experiential learning*, resulting in *descriptive representations* that can be used to *support design teams' experiential learning*?

The main points of this problem statement – indicated in italics – can be summarised as follows. This thesis examines designing viewed from the background of a particular perspective – *experiential learning*. The thesis will clarify this perspective with respect to teams to serve *descriptions of design teams' experiential learning*. It will show how

to *analyse* team design discourse as a record of *verbal interaction* using a background of argumentation theory in order to highlight the rhetorical construction of understanding. Characteristics of *descriptive representations*, viewed from a team experiential learning perspective, are outlined. Results from the analysis of team design discourse will be presented which are used to develop a descriptive representation of rhetorical construction of understanding as part of team experiential learning. Descriptive representations for *supporting design teams' experiential learning* will be developed and evaluated.

1.3 Research Questions

Each individual area that this thesis addresses in answer to the problem statement in itself can be formulated as a research question. The area of the examination of designing viewed from a particular perspective of experiential learning provides the answer to **research question 1**:

How is the description of designing influenced by perspectives, assumptions and prescriptions?

The clarification of this perspective with respect to teams to serve descriptions of design teams' experiential learning is answered by **research question 2**:

How can notions about individual experiential learning be extended to capture team experiential learning?

In order to show how to analyse team design discourse as a record of verbal interaction a background of argumentation theory is used. This highlights the rhetorical

construction of understanding and the idea of establishing a team-frame (defined in chapter 3). **Research question 3** can be formulated as:

How do designers establish a team-frame in early design episodes through rhetorical construction of understanding?

The area of characteristics of descriptive representations, viewed from a team experiential learning perspective, is illuminated through **research question 4**:

What characteristics need to be captured in representations of team experiential learning?

In combination with research question 4, results from the analysis of team design discourse will be presented which are used to develop a descriptive representation of rhetorical construction of understanding as part of team experiential learning in answer to **research question 5**:

How can a representation of the team experiential learning process be constructed?

Finally, the use of descriptive representations in supporting team experiential learning will be examined through **research question 6**:

How can descriptive experiential learning representations be used by design teams?

1.4 Contributions

This thesis contributes to the study of design and the representations of team experiential learning in the following ways:

1. Identification and comparison of design paradigms (in chapter 2)
2. Clarification of experiential learning design paradigm (in chapter 3)
3. Identification of elements of argumentation that correspond to experiential learning (in chapter 4)
4. Development and application of a coding scheme to investigate design discourse (in chapter 4)
5. Identification of characteristics for representation of team experiential learning (in chapter 5)
6. Development of frame rationale as a way of representing team experiential design process (in chapter 6)
7. Demonstration of team experiential learning representations in learning situations (in chapter 7)

1.5 Thesis Structure

The thesis aims to answer the research questions outlined over the next seven chapters. Chapters 2 and 7 deal with description and support: chapter 2 describes the way that design paradigms influence descriptions of designing; chapter 7 describes the use of descriptive representations in design teams as support within the experiential learning design paradigm. Chapters 3 and 5 focus on the team experiential learning paradigm in particular: in the former, experiential learning with respect to teams is clarified, whereas in the latter characteristics that descriptive representations need to display are identified. Chapters 4 and 6 emphasise dynamics of the team experiential learning design process, investigating team design discourse and descriptive representation, respectively. The summary outline structure of the main chapters is shown in Figure 1.1.

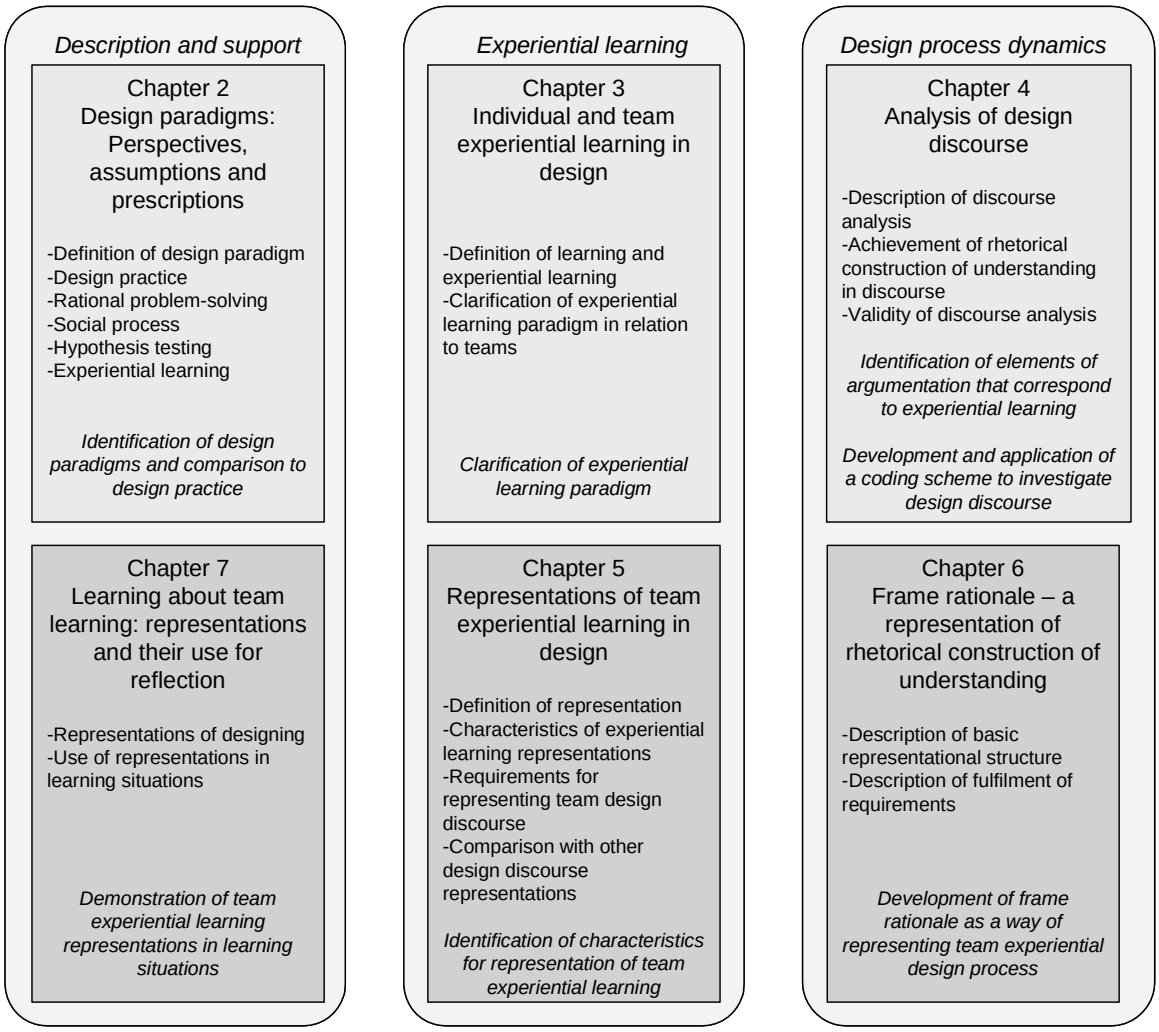


Figure 1.1 – Thesis structure outline

In chapter 2, perspectives, assumptions and prescriptions are examined that underlie how designing is viewed. A definition of design paradigms is provided in section 2.2. Dimensions of designing are described viewed from within a particular design paradigm; models of the designer, design task and design process are identified that capture these dimensions of designing. A model describes designing, yet it also idealises; corollaries – such as the attitude to learning and notions underlying techniques, methods and representations – are determined by design paradigm models. In the remainder of chapter 2, these models are used to structure the identification of design paradigms and their comparison with design practice. In section 2.3, design practice is outlined by drawing on what designers feel matters in designing. Sections 2.4

to 2.7 each identify and structure design paradigms that underlie descriptions of designing. These design paradigms are clarified as rational problem-solving, social process, hypothesis testing and experiential learning. It is noted that, whilst experiential learning comes closest to what designers think is going on, the notion of experiential learning in teams needs to be clarified.

Chapter 3 clarifies experiential learning in relation to design teams. To do this, in section 3.2 the traditional understanding of learning is examined and contrasted with the notion of experiential learning and particularly with experiential learning in design. In the remainder of the chapter, the descriptive models are considered in turn. Section 3.3 takes into consideration the model of the designer viewed in the light of team experiential learning. In particular, the designer as a participant in argumentation and the role of designer in design teams is investigated. The notion of rhetorical construction of understanding is introduced. The model of design task is investigated in section 3.4. The notion of team-frame as a shared perspective of the design task is discussed and defined. Following on from this, section 3.5 discusses the model of the micro-level design process. In particular, the construction cycle of framing, naming, moving and reflecting is introduced. These individual modes of the construction cycle are further investigated. Conceptions of frames and framing are outlined in section 3.6. Conceptions of frames and framing as explaining individual sense-making, world-making, understanding social behaviour and organising experience are identified. A discussion how framing is understood in individual experiential learning is given in section 3.7. A distinction between frames and framing is introduced in section 3.8. Naming, moving and reflecting are discussed in sections 3.9 to 3.11, respectively. The macro-level design process is examined in section 3.12, paying particular attention to when this process goes right or wrong. Finally in section 3.13, corollaries are discussed

that result out of descriptive models of team experiential learning and their impact on representations.

The way that a team-frame is achieved through and in discourse is the focus of chapter 4. To this end, discourse analysis as a method is introduced in section 4.2. The development of a coding scheme to be used in team design discourse analysis is described in section 4.3. The application of the coding scheme is then illustrated through an example, described in section 4.4. Elements of argumentation that correspond to experiential learning are identified and results and illustrations of the analysis of team design discourse are given in section 4.5. It is shown that designers bring premises into presence and highlight them from the background frame of reference. Premises allow focus of attention to be detected, and what names are applied to things in the situation. Associations based on the structure (ABS) of reality introduce organisation and evaluation into the design discourse. Associations establishing the structure of reality (AES) on the other hand enable designers to establish new premises by either generalisation or similarity by making use of the plasticity of notions to drive the solution development forward. These notions function as keywords that encapsulate understandings and positions in the design discourse. Dissociations can be used as markers for potential reframing. Opportunities to affect the team frame arise when dissociations are introduced by an individual, however further agreement by other team participants is needed for reframing to actually occur. This agreement can be given explicitly or implicitly. In the latter instance, dissociations and ensuing associations are used as rhetorical identifiers for implicit agreement for reframing. Attempts at reframing can be rejected at the team level, either explicitly or implicitly. Implicit disagreement with dissociation can lead individuals to hold conflicting frames. In section 4.6, the

question of validity of this analysis is addressed and evidence of inter-coder reliability provided.

Chapter 5 highlights how aspects of team experiential learning suggest certain representations that describe designing. Representations also form part of the reflective turn in design research (Glock, 2000), which makes them into tools for support of design practitioners. In section 5.2, representations in design are defined. Section 5.3 concentrates focus onto team experiential learning in particular; characteristics appropriate to dimensions of designing that descriptive representations should capture are proposed. In section 5.4, the results of discourse analysis, together with the characteristics of the design process outlined in the previous section, are used as the basis to formulate requirements that design discourse representations of team experiential learning need to satisfy. In section 5.5 two current ways of representing team design discourse are examined with respect to these requirements. Whilst design rationale and linkography representations can capture certain aspects, they do not fulfil all requirements that are proposed in section 5.4.

Chapter 6 proposes a new representation for team design discourse, called frame rationale. In section 6.2, an example transcript is reproduced that is used throughout this chapter to illustrate the frame rationale representation. The basic representational structure of a frame rationale as a formal abstraction of design discourse is described in section 6.3. Sections 6.4 to 6.7 then deal with each requirement identified in chapter 5. Section 6.8 shows how frame rationale captures the unfolding of design discourse and how salient features can be investigated.

Chapter 7 attends to the use of descriptive representation and their use for reflection in design teams. In section 7.2, experiential learning in design is revisited and measures for experiential learning are proposed. A set of learning situations is described in section 7.3, for which the use of descriptive representations is illustrated. The use of frame rationale for reflection is discussed in section 7.4: whilst the use of frame rationale by designers themselves does not provide any conclusive learning, frame rationale allows a researcher to analyse design discourse and develop 'critical instances' that can be used by designers to reflect on their design discourse. In sections 7.6 to 7.9, descriptions of characteristics following from the model of designers and design task, discussed in chapter 5, are turned into representations that design teams can use to support their reflection. Results from the analysis of these representations are presented.

Chapter 8 concludes this thesis with a chapter summary and a review of key claims and contributions. Areas for further work are suggested.

Chapter 2 Design Paradigms: Perspectives, Assumptions and Prescriptions

2.1 Introduction

The description of and the support given to designing, as a whole usually referred to as design methodology, does not take place in a theoretical vacuum. Design methodology can be described as "the study of principles, practices and procedures of design" (Cross, 1984). However, this study is dependent on researchers' views of designing in the first place. This chapter sets the scene by, firstly, discussing the notion of design paradigms in section 2.2, which includes perspectives, assumptions and prescriptions that underlie studies that researchers carry out and the methods and techniques proposed to support design activity. Secondly, this chapter outlines concerns of design practice in section 2.3. Perspectives, assumptions and prescriptions are structured into design paradigms in the remaining sections of this chapter, based on a literature review.

2.2 Design paradigms

The analysis of design episodes forms an important part in informing the way design is seen, either as a precursor to fuller theoretical pictures of designing or to suggest better practical ways of doing design. However, each analysis is embedded within a design paradigm, which determines, amongst other things, how the analysis is carried out, what features are attended to or disregarded and what outcomes are expected. A design paradigm, just like a metaphor, raises certain features and suppresses others, places emphasis on different aspects of designing, and can hence better explain certain aspects than others that are inherently neglected (Snodgrass and Coyne, 1992; Coyne and

Snodgrass, 1995). Dorst (1997), for instance, has provided an example of how the different paradigms of *rational problem-solving* and *reflective practice* influence the way that design is viewed and hence, what an analysis of a design episode highlights.

Whilst there is an ebb and flow of particular design paradigms in terms of their take-up both within the design community and the design research community, nonetheless more than one co-exist at one time. Moreover, since design paradigms focus attention on certain aspects whilst neglecting others, researchers may employ a complementary amalgamation of design paradigms to study designing. The question of which is the better design paradigm to describe, explain and support designing still remains. An overriding criterion of validity that has been put forward is that a design paradigm must measure up to how designers encounter designing in everyday instances, i.e. a comparison between the design paradigm and human experience of designing (Snodgrass and Coyne, 1992; Coyne and Snodgrass, 1995).

2.2.1 Definition of Design Paradigm

A design paradigm in the context of this thesis is a coherent collection of archetypal models through which aspects of designing are interpreted[1]. Models in this sense mean idealised and simplified viewpoints of particular dimensions of designing. These models can be divided into descriptive models and prescriptive models, i.e. models that aim to represent what designing is and models that should be imitated, respectively.

All design paradigms have something to say about describing certain dimensions of designing. These dimensions can be broken down into the *model of the designer*, *the design task* and *the dynamics of the design process* (Dorst, 1997). The model of the designer outlines how important features of designers – what they do and how they

[1] Kuhn (1962) has also pointed out the role of paradigms in general as devices which give a scientific group a common language for communication.

behave – are viewed through a design paradigm. A view of the intricacies of how the design task is understood by the designer is given by the model of the design task. The model of design process dynamics describes the activities that a designer carries out during designing and this can be further subdivided into micro-level processes and macro-level processes. In this respect, a macro-level process dynamic takes place over the whole course of the design, whilst a micro-level process forms the smallest unit of design activities that the model recognises.

Whilst these models above certainly aim to describe dimensions of designing, they are also idealised. In themselves, they set standards that dimensions of designing should attain. Consequently, there are prescriptive models of designing that cater to the features that the design paradigm highlights and that embody a set of teleological notions appropriate to each design paradigm. These notions form the basis of corollary dimensions of designing, i.e. dimensions that follow from the idealised view that is taken towards designing. These corollaries include a body of methods and techniques that aim to either attain a standard or to ensure that designing does not deviate from a norm. Methods are a set of overarching formal procedures that should be followed in macro-level design activity, whereas techniques form smaller informal actions that aim to achieve a particular purpose in micro-level designing. Furthermore, teleological notions also underlie representations that tie in with the respective models. Since prescriptive models deal with the attainment of a standard of designing – the performance of a skill – attitudes to learning can be identified for each design paradigm, which circumscribes what is to be learned by a designer and how learning is thought to be effected.

In short, models of designer, design task and design process dynamics are the basis for methods and techniques, representations and learning. The descriptive elements seen through design paradigms, at the same time, are idealised and thus normative. These norms form the basis of corollary dimensions to correct when things are going wrong or safeguard against things going wrong. Learning in particular is associated with a longer-term view of how designers can be trained or train themselves to do designing 'right' or better. These models and corollaries are shown in Figure 2.1.

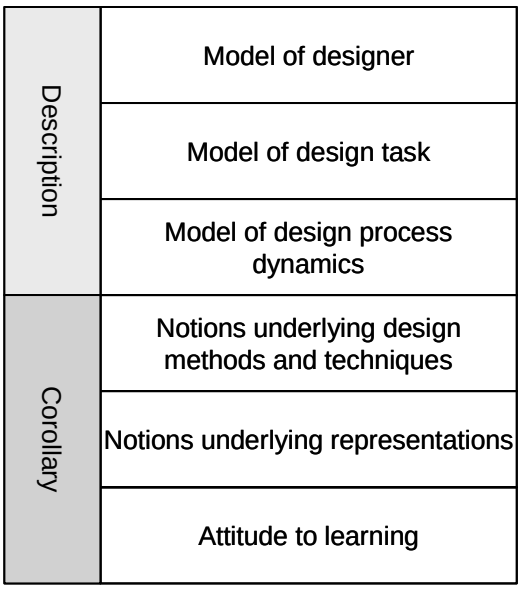


Figure 2.1 – Design paradigm models as descriptions and prescription

With the discussion of the role that design paradigms play in influencing how designing is described and prescribed in mind, attention can be turned to identifying current design paradigms. Based on a literature review, four main design paradigms can be pinpointed and structured: *rational problem-solving*, *social process*, *hypothesis testing* and e*xperiential learning.* These are discussed in turn in sections 2.4 to 2.7 and contrasted with how design is perceived in practice. For the purposes of this thesis, it is of particular interest to note the relevance of the model of the designer for a team setting. In this respect, multi-functional (such as project teams quite often are), designer-client and peer design teams are treated equally, as expressions of a generic team setting, in which two or more people need to provide input to lead to a designed end-product. First, however, a view of design practice that outlines the concerns felt by design practitioners is provided in section 2.3.

2.3 Design practice

Design paradigms illuminate to a greater or lesser extent the description and prescription of designing. To begin with, an outline of the experience and practice of designers themselves is presented, which will be contrasted in subsequent sections against design paradigms.

In this exploration, the structure of models of designer, design task and design process, etc. is used to highlight issues in design practice. The basis of the view presented here is mainly drawn from personal experience of what designers say they find important and complemented with writings by design practitioners.

One view – reflected in design education – expresses the understanding of designers as 'designer-heros', working in isolation to solve problems they are employed to address. However, in practice this view of the designer does not seem to hold (Cuff, 1991). Team work becomes the main focus of practice, where different parties communicate with each other. Indeed, this involvement as a participant in communication seems to present some of the initial problems, particularly in architectural or construction design:

> "When the architects and clients got together, it was hard to follow the thread of their conversation; they left meetings with no more decisions made than at the outset." (Cuff, 1991, p.4)

From a subjective point of view, this state of affairs is not necessarily confined to contacts between design practitioners and clients within a participative context. This practice of being involved in communication is also played out in a team of design practitioners. Problems that are perceived to have their roots in communication have been noted (Brooks and Jones, 1996; Gotel and Finkelstein, 1995).

Turning our attention to the specifics of the design task in practice, we can observe that the task is perceived to be ‘wicked’ and too complex for one person (Rittel and Webber, 1984). To address this complexity requires team work. Cuff (1991) notes that design problems in practice include ‘countless voices’ of influence, the perspectives of which are distributed across participants. The dynamics and complexity of design problems in practice lead to a continuous sense of discovery and uncertainty. Only gradually is the design task constrained, so that individuals in a team can bring their expertise to bear on working out their allocated subtasks. Again, communication features highly in this and practices are proposed that ensure that the communication is rich enough for the co-ordination of effort to function correctly (Wheelwright and Clark, 1992). Indeed, the design task does not appear to be given from the outset. Often, it is the case that the design task is fashioned through communication and thus crystallises out of team interaction, co-ordinating values and perspectives. Only when the design task has been fleshed out by the team can individual design occur. But even then, individual interpretations can affect and unbalance earlier established team constraints and need to be integrated (Bucciarelli, 1994), leading to a changing appreciation of the design task.

This description gives an indication of how the macro-level process is viewed in practice. There appear to be two distinct phases to any team design activity: a complex, language-rich phase in which the project is defined and clarified, and effort co-ordinated across the team; a slightly simpler, object-heavy phase in which the individual expertise is applied to the interpreted design task. In the micro-level process, the language-rich phase plays itself out by individuals putting forward their case, which then needs to be shared and co-ordinated across the team.

The methods and techniques that are offered in practice often are imposed by the professional organisations, rather than individual designer themselves, and centre around managing the macro-level process. For this, simple 'waterfall' guidelines are used which control the flow through a design project. Following these waterfall guidelines entails the production of outputs in the form of specifications and documents, which detail the current knowledge about the problem. This is usually seen as beneficial once the object-heavy phase has been reached, but causes concern in earlier, language-rich, phases of design because the guidelines are perceived to be at odds with what actually takes place in practice.

Learning in practice is perceived to be two-fold: a designer should learn from one design project to the next, building on his or her experiences. However, individual designers also tell a further story: each design task is perceived as essentially unique and requires its own adapted design process, hence there is individual learning during an individual project as well. Moreover, there appears to be another kind of learning at a team-level. This learning concerns the learning about each other as individual designers with unique perspectives and the understanding that is created out of interaction[2].

Having discussed concerns of design practice, attention is now turned to the identification of design paradigms. The paradigms were categorised as *rational problem-solving, social process, hypothesis testing* and e*xperiential learning.* These are now discussed and contrasted with design practice in turn, paying particular attention to the relevance of the model of the designer for a team setting.

[2] I would like to express my gratitude to Professor John Worthington, University of Sheffield and Deputy Chairman, DEGW, London for inviting me to a workshop entitled "Applying systematic feedback in the briefing process ", 15 June 1999.

2.4 The *rational problem-solving* design paradigm

The *rational problem-solving* paradigm (Simon, 1969) is the most widely held design paradigm amongst design researchers, reflecting the rise of an information-processing approach to thinking in general, and designing in particular. In terms of the model of the designer, a rational computation machine serves as a metaphor for the designer who algorithmically processes problems to churn out solutions. In this process, she is only restricted by memory and time, which forces her to 'satisfice' i.e. choose solutions which are good enough, rather than optimum. The model of the design task states that the problem is there to be seen; it can be objectively perceived by everyone who looks at it. In this respect, a difficulty that can be perceived through the design paradigm is the complexity of design problems: they are ill-structured and ill-defined (Simon, 1984). However, by formalising the problem it is possible to find ways of decomposing it into well-structured and well-defined sub-problems:

> "The whole design, then, begins to acquire structure by being decomposed into various problems of component design, and by evoking, as the design progresses, all kinds of requirements to be applied in testing the design of its components. During any given short period of time the architect will find himself working on a problem which, perhaps beginning in an ill-structured state, soon converts itself through evocation from memory into a well-structured problem." (*ibid.*, p.155)

These sub-problems are then amenable to an algorithmic approach of applying 'operators' in order to result in a solution, much like a calculation. Once all sub-solutions to all sub-problems have been found, it is necessary to integrate them to provide the overall solution to the original problem. The micro-level process dynamics follow that of a search or optimisation cycle: first analyse the problem to find a set of requirements that have to be fulfilled and can be used as a function against which to test the solution. Then generate a solution by applying the operators and test the solution

against the evaluation function. Evaluate the outcome of this test; if the solution succeeds, then stop – if not, enter the search cycle again.

In the normative stance implied through the design paradigm, designing can go wrong in the analysis phase when the problem is under-specified by considerations being forgotten or not noticed, and in the synthesis phase when the integration of sub-problems disturbs their interrelations. Decomposition and integration as a macro-level process is expressed through methods, which aim to regulate these into stages, such as the 'waterfall' process. As a basis of these stages, it is necessary that the analysis of the problem is adequate, and thus a formalisation of sub-processes is required to ensure that a well-structured and well-defined problem is available as input to a problem-solving process. Techniques incorporating the exhaustive listing of constraints and grouping them carefully to uncover a structure of more or less 'self-contained' components are aimed at supporting analysis (Alexander, 1964). Furthermore, using rational evaluation techniques, such as an application of Multi-Attribute Utility Theory (MAUT), is seen to ensure that the matching of problem specification and solution generation is adequate (Blandford, 1993; Pugh, 1991). As part of these methods and techniques, certain representations are expected in the form of specifications and drawings, which form a set of constraints and describe the problem in unambiguous terms.

The attitude to learning expressed through this design paradigm is related to the view of how design problems are constituted. Since problems are there to be objectively perceived, the designer learns by accumulating knowledge about design problems: new constraints, new goals, new operators, ways of decomposing problems, etc. Once these have been stored in long-term memory, the designer can refine the way this knowledge is retrieved.

This design paradigm's main attraction to the design community is that designing, ultimately, can be reduced to an algorithm (or heuristics) to be carried out by the designer – it is clean, rational and proceeds in logical and sequential steps. However, this contradicts what most designers feel when they are designing: designing is messy. Also, crucially, the paradigm only makes claims about the individual designer operating in an objective reality, since a team – again within this metaphor – is only a change in capacity: more memory, hence quicker operations. However, this does not relate to how, again, designing is perceived in practice: designers have different viewpoints; they disagree. Some design researchers felt that the *rational problem-solving* paradigm was not highlighting these particular problems and a new design paradigm had to be fashioned that moved beyond this 'first-generation' approach (Rittel, 1984) and highlighted the communicative interactivity that can be observed in design.

2.5 The *social process* design paradigm

The 'second-generation' design paradigm of *social process* seeks to overcome the shortcomings of *rational problem-solving* (Rittel, 1984). Designing is viewed as involving the negotiation and interpretation of designers' social constructions (Bucciarelli, 1994), which are dependent on their values and perspectives. Rather than a self-reliant designer, this means that a designer is intricately involved with other designers in a team situation: the individual designer does not know best, since the problem is too complex for one person. Therefore, the designer is just one participant in a process of argumentation, contributing her viewpoint and expertise, to solve 'wicked' problems (Rittel and Webber, 1984).

Wicked problems, in contrast to ill-structured and ill-defined problems, are characterised by the lack of a definitive formulation of the problem, a lack of a way to

tell when the design is finished, no true or false answers, a lack of a closed set of solutions or operations, and the absence of classifications of similar problems.

From this stance, designers use argumentation and persuasion to move towards consensus about perspectives taken towards the problem (Minneman and Leifer, 1993), uncover differences in perspectives and develop their understanding of the design problem and solution as a macro-level process. Shaping the problem-setting continues side by side with problem-solving, as the way a problem is viewed impinges on the way it can be solved. To achieve consensus at the macro-level, individual designers need to perform an argumentative process (Rittel, 1984) on the micro-level by adopting a dialectical approach (Toulmin, 1958) of proposing issues that define the problem and positions that solve these issues. In turn, these alternative positions are supported or denied by arguments (Olson *et al.*, 1992).

Design methods and techniques as part of a *social process* paradigm centre on ensuring that the argumentative process moves ahead correctly. To this effect, techniques are proposed that make certain that the issues, positions and arguments considered cover an adequate spectrum by performing a Design Space Analysis (McKerlie and MacLean, 1994; MacLean *et al.*, 1993; MacLean *et al.*, 1996). The aim is that, by moving through questions that structure and delineate possible features of a design artefact, options that solve them and criteria that evaluate the ‘grade’ of these options, further questions, options and criteria become apparent. Furthermore, although argumentation is generally seen as a good thing, conflict resolution and voting ensures that commitment to options takes place eventually, rather than being deferred indefinitely. Hence, voting procedures to manage conflict have been the focus of some of these techniques (Lee and Lai, 1992; Lee and Lai, 1996). Finally, the value of individual viewpoints and its negotiation

within a team have also gained attention (Stahl, 1993; Stahl, 1998; Stahl, 2000). The outputs from these techniques are usually in the form of a rationale, which shows the argumentative structures. Various systems, both paper-based and computer-supported, have been developed to capture and structure these argumentation-based rationales (Kunz and Rittel, 1970; Conklin and Begeman, 1988; Potts and Bruns, 1988; Lee, 1990; MacLean *et al.*, 1996; Conklin and Burgess-Yakemovic, 1996). These vary in terms of notation used, detail captured and support given for decision-making procedures. All, however, conform to the notion of interrelated networks of issues, positions and alternatives.

Learning as perceived through the *social process* paradigm is based on an understanding of designing as an argumentative process. Hence, the way that a particular designer learns is by critically challenging his or her own perspectives and knowledge, and that of other participants involved in designing, to find good reasons why something is to be believed. Furthermore, there is a correct process of argument construction that the designer needs to learn, which follows the structure of a good dialectical argument (Freeman, 1991). Of crucial importance in this respect is the use of Critical Thinking as a way of epistemology and rationality (Rescher, 1977; Toulmin *et al.*, 1984; Walton, 1989; Voss and Means, 1991; Voss, 1991; Slade, 1995; Perkins *et al.*, 1983; Perkins *et al.*, 1991).

Invoking a *social process* paradigm towards designing concentrates, firstly, on the communicational aspects between team participants. This means that language, specifically the verbal utterances between designers, forms the aspects that are attended to and highlighted when designing is analysed within this paradigm. Secondly, because designing is viewed to be carried out between equal participants – open to rational

considerations of all the aspects – moving towards a consensus, the individual role of designers in the process is devalued.

2.6 The *hypothesis testing* design paradigm

The *hypothesis testing* design paradigm is mainly associated with Hillier *et al.* (1984) and Broadbent (1984), who propose this perspective as an alternative to overcome perceived shortcomings in both the *rational problem-solving* and s*ocial process* design paradigms. The shortcoming with respect to *rational problem-solving* that *hypothesis testing* seeks to overcome is the perceived mismatch of how designers proceed by proposing a solution and then testing against it (Lawson, 1997) rather than by an analysis/synthesis process dynamic. Hence, the most striking differences that can be observed are in the realm of how the design process dynamics are viewed. Furthermore, the *social process* paradigm is criticised by the *hypothesis testing* paradigm for being too relativistic: the technical expertise of the designer is felt to be devalued against the need for consensus.

As a result, the design paradigm sets out that the designer is an insular expert who knows best how to accomplish the designs technically and it behoves her to make sure that she is acquainted with the concerns of others. Akin to a lab scientist, she first of all constructs first-cut designs, called design conjectures, which solve these concerns:

> "He will *start* with hunches, guesses, *conjectures* about these phenomena and will tend to collect data which support his conjectures." (Broadbent, 1984, p.343)

If the design task is very much constrained, one particular conjecture will dominate; however, in other situations numerous conjectures can compete against each other. A designer has the duty to test her design conjectures rigorously, especially to find disproving evidence, by using information she has gathered about the design situation as

data against which to evaluate the design conjecture. Hence, designing is treated like an experiment, which can succeed or fail. If such an experiment fails, the design conjecture has to be revised or abandoned, resulting a single design conjecture that is put forward as the solution. To summarise, the process that the designer is deemed to adhere to is of a 'conjecture/test' dynamic (Darke, 1984). This process is elaborated by separating out the pre-structuring of the design problem itself, which leads to the application of conjectures through the use of primary generators (*ibid.*). A primary generator is seen to be a (often visual) concept – or even group of concepts – that allows the designer to structure and constrain the problem. It should be noted that a primary generator is not a list of external requirements; rather, it is "a designer-imposed constraint, not necessarily explicit" (*ibid.*, p.181). These primary generators then give rise to the conjectures to be tested. However, evidence is also provided that conjectures are resistant to abandonment unless the gap between requirements and what the conjecture delivers is too great.

The proposed methods and techniques associated with this particular paradigm are allied to the process that it proposes: a collection of precedents that have been proven to be solutions in the past should be used as design conjectures and tested against the current requirements. Obviously, the more data is available to test against, the better the design will be and the more mistakes will be avoided. Furthermore, if mismatches become evident during the design stage, the conjecture needs to be revised and undergo the testing procedure yet again, or rejected out of hand. It therefore behoves the designer to behave objectively and, to a certain degree, be emotionally removed from his design conjectures. If mistakes are evident after the design has been delivered, then these instances need to be excluded as precedents and examined as to what went wrong (Levi and Salvadori, 1992). Representations that are used with these methods and techniques are sketches or models that allow real or thought experimentation or representations of

finished designs, which become established as precedents. Learning then proceeds via accumulation of precedents and what can be termed adaptive learning. If something works as a solution, it is added to the store of knowledge; if mistakes are made, then it needs to be adapted or rejected.

The strength of this design paradigm lies in its recognition of a solution-focussed approach in designing which relies heavily on precedents. However, it appears that architecture as a design field trains people to adopt a solution-focussed approach, whereas other design fields appear to favour a problem-based approach (Lawson, 1997). Moreover, the paradigm can be criticised for its conception of a self-reliant designer. The paradigm does not address what happens in a team setting, although we could speculate that cultural and professional training would ensure that precedents are shared within the team. The questions of the intricate process of sharing and developing conjectures within a team, and of how team learning proceeds remain unanswered.

2.7 The *experiential learning* design paradigm

The *experiential learning* paradigm of designing has gained popularity in recent years because it accounts for the dynamic, cyclic and unfolding nature of design, which experienced designers feel is intuitively 'right' (Isenberg, 1987; Dorst, 1997). In terms of the model of a designer, it places emphasis on an individual expert practitioner, as indicated by the way that she displays implicit skill rather than explicit control. Furthermore, the designer as practitioner is immersed in the technical knowledge, the values and judgements of quality that her design profession demands and an understanding of the difficulties of design problems (Schön and Wiggins, 1992; Schön, 1996). In contrast to the *rational problem-solving* paradigm, the problem cannot be reduced to well-defined problems, since it is a unique, value-laden and uncertain situation out of which the designer constructively shapes a problem that can be tackled:

> "But, as we have come to see with increasing clarity over the last twenty or so years, the problems of real-world practice do not present themselves to practitioners as well-formed structures. Indeed, they tend not to present themselves as problems at all but as messy, indeterminate situations. […] If they are to get a well-formed problem matched to their familiar theories and techniques, they must *construct* it from the materials of a situation that is, to use John Dewey's (1938) term, "problematic". And the problem of problem setting is not well formed." (Schön, 1987, p.4)

Although a designer might have set a problem by constructing it out of a situation, the construction process does not stop there. When the designer gets 'stuck' and the problem she has constructed does not afford a solution anymore, she enters a construction cycle. This construction cycle proceeds by a 'conversation with the situation': by interactively framing the problem and naming the things the designer attends to within this frame, she is able to generate moves towards a solution within that structure and reflect on the outcomes of these moves (Schön, 1991). In this respect, the situation 'talks back': by comparing expected outcomes of design moves and the result, the designer gains a new appreciation of the current situation. On the macro-level the process moves towards 'fitness', where the designer makes a judgement that the design satisfies the problem situation. This in itself also involves a process of learning that changes the design problem and generates new conditions of 'fit' or 'misfit' (Schön, 1990). As the designer's appreciation of the design problem changes and grows, she also changes the way that a 'fitness' judgement is applied within the current design situation.

To carry out this micro- and macro-level process, the techniques that designers apply appear to be less structured than the other paradigms. Indeed, in *experiential learning,* there might not be any methods as such, since each design situation is unique and calls for designing that is different from all other designing instances. In e*xperiential learning* there is no 'cookie cutter' method. Hence, designing is understood to proceed

by the designer immersing herself in the action of designing and a willingness to deepen her appreciation of the situation. In this regard, the designer needs to be open to 'backtalk' of the situation. The representations that allow her to do this are things with which to think dynamically and can include sketches and scenarios.

As the name implies, the *experiential learning* design paradigm is deeply connected with learning per se. Indeed, designing only proceeds by learning, by gaining new understandings. In this way, it is equivalent to a Deweyian inquiry (Dewey, 1997). Certain distinctions, however, as to the scope of learning are made. One type of learning concerns fashioning a problem out of a situation and gaining new understandings of the problem through a cycle of concrete experimentation and reflective thought, whereas another type of learning takes experiences and – through a process of reflection and abstraction – transfers new knowledge and skills onto the next design episode (Kolb, 1984). This distinction is discussed in more detail in section 3.2.

Design practitioners find this design paradigm intuitively appealing (Dorst, 1997; Blyth and Worthington, 2001; Bardwell, 1991). *Experiential learning* also appears to come closest to describing the concerns that are confronted in design practice in the language-rich phase: designing leads to a permanent sense of discovery and uncertainty; there are different influences and interpretations that change over time and the problem is created out of the situation. However, this paradigm lacks a detailed account of experiential learning in a team setting. Steps have been taken to fill in the gaps: Valkenburg and Dorst (1998, 1999), for example, try to show how framing, naming, moving and reflecting proceed in a team to enable project managers to better run design projects. Whilst irreconcilable controversy – not resolvable through simple communication – is addressed by Schön and Rein (1994), details on cooperative endeavours and how this

reflects the descriptive and prescriptive models – and resulting corollary dimensions – at the team level remain sparse. The remainder of this thesis adopts a systematic approach to apply this design paradigm to teams with a view to analysing them and supporting them.

2.8 Conclusion

In this chapter, design paradigms and their relation to design practice were discussed. A design paradigm consists of archetypal descriptive models, which influence how designers, design tasks and design process are seen and which aspects are highlighted or neglected. These descriptive models also form a idealised view which gives rise to a normative slant: deviances and dysfunctions can be identified and then prevented or corrected by using corollary dimensions, such as methods and techniques, representations and learning.

Outlining views of design practice has given us an indication of the concerns that are encountered: practice takes place among a group of participants dealing with a unique, uncertain, complex and 'wicked' design problem. Each of these participants brings his or her values and perspectives to bear on the construction of the design problems through a process of discovery. Furthermore, we can note that in the early, language-rich stages of design activity, prescriptive models do not match the way that designing is perceived in practice.

Subsequently, four design paradigms were identified by classification of the design literature as a basis for comparison against design practice, noting in particular how each explains designing in teams. These paradigms are *rational problem-solving*, *social process*, *hypothesis testing* and e*xperiential learning.* Table 2.2 shows a summary of the main notions associated with these design paradigms.

		Rational problem-solving	Social process	Hypothesis testing	Experiential learning
DESCRIPTION	**Model of designer**	Individual information processor	Participant in argumentation	Individual lab scientist	Individual practitioner
	Model of design task	Ill-structured and ill-defined, but essentially given in an objective reality and decomposable into well-defined and well-structured sub-problems	'Wicked', too complex for one person; problem depends on perspective	A design conjecture created through primary generators	Unique, uncertain, value-laden problem which the designer constructs
	Model of macro-level design process dynamics	Decompose and solve: turn ill-structured, ill-defined problems into smaller well-structured, well-defined problems and then solve each individually; at the end integrate	Move towards consensus	Converge onto single conjecture which withstands disproving data	Converge towards 'fitness'
	Model of micro-level design process dynamics	Enter a search cycle: analyse-generate-test-evaluate	An argumentative process: support/deny an issue by arguments	Conduct an experiment: (generate)-conjecture-test	Enter a construction cycle: Frame-name-move-reflect
Corollary	**Notions underlying design methods and techniques**	Formalisation of individual sub-processes and control mechanisms between them e.g. formalisation of analysis and lifecycle models	Negotiation, Voting, Conflict Resolution	Design from precedents and mistakes	'Learn by doing' and openness to backtalk
	Notions underlying representations	Specifications and drawings which outline objective reality at specific point in time	Rationales which show argumentative structure	Drawings with which to experiment; completed designs which prove the hypothesis	Things with which to think dynamically
	Attitude to learning	Knowledge building	Critical thinking	Adaptive learning	Deweyian inquiry

Table 2.2 - Design paradigms

The *experiential learning* design paradigm, supplemented by a focus of how this is achieved through a communication process on the team level, finds resonance in the way that design practitioners see themselves. A comparison between the design paradigms and a view of design practice leads us to contend that *experiential learning* is the most faithful to what designers' interpretation of designing.

However, several shortfalls with respect to the experiential learning design paradigm have been highlighted. These deal with a detailed account of what is going on in a team setting. Details on cooperative endeavours and how this reflects the descriptive and prescriptive models – and resulting corollary dimensions – at the team level remain to

be investigated. In particular, ways need to be found to describe team designing as experiential learning and how this can be represented. Finally, support of experiential learning needs to focus on how representations can be used to enable designers to reflect on designing. In the next chapter, experiential learning is examined systematically and extended to cover team experiential learning in order to set the way to analysing and supporting the learning designer.

Chapter 3 Individual and team experiential learning

3.1 Introduction

In the previous chapter design paradigms were identified, namely *rational problem-solving, social process, hypothesis testing* and *experiential learning*, that underpin descriptive models and their corollaries. These design paradigms were contrasted with design practice, which is perceived as being distributed amongst a group of participants dealing with unique, uncertain, complex and 'wicked' design problems where each participant brings their values and perspectives to bear on the construction of design problems through a process of discovery. It was further noted that techniques and methods that originate from *rational problem-solving* are not applicable to early, language-rich stages, when designers need to learn about design problems and each other. The *experiential learning* design paradigm comes closest to what designers think they are doing in this respect. Questions remain, however, in terms of the specifics of descriptive models and corollaries with respect to a team setting.

In this chapter, the design paradigm of *experiential learning* will be examined in more detail for a systematic clarification of its concepts, especially when applied to teams. The research question that will occupy us in this chapter is:

- *How can notions about individual experiential learning be extended to capture team experiential learning?*

In the first instance, experiential learning is defined for both individual and team designing. Attention is then turned towards clarifying discrete descriptive models and

corollaries with respect to individual and team experiential learning. Specifically, extensions of the paradigm to a team setting are proposed and approaches of studying these are suggested.

3.2 Learning and experiential learning

3.2.1 Learning – the traditional view

Learning in general can be defined as gaining knowledge or skill of a subject through one's own experience or being taught. Traditionally, the learner is often treated as a *tabula rasa* who acquires fixed concepts and the static relation between them (Locke, 1964). In this case, learning can be measured through outcomes, i.e. the change in the number of facts remembered. A behaviourist notion of learning can also be identified, in which skills are learned through conditioning (Atkinson *et al.*, 1993). In this case, learned behaviour is measured through its resistance to change.

3.2.2 Experiential learning

Experiential learning, in contrast, emphasises learning as a process of change that is grounded in an individual's experience. Experience provides and continuously adapts the concepts that are learned:

> "Ideas are not fixed and immutable elements of thought but are formed and re-formed through experience." (Kolb, 1984, p.26).

Experiential learning cannot be measured in outcomes because new knowledge is integrated or substituted rather than added. Knowledge in this sense can be differentiated: there is a personal knowledge that results out of direct personal experiences and social knowledge that is accumulated through abstracted cultural forms. Experiential learning can be summarised thus:

> "Learning is the process whereby knowledge is created through the transformation of experience." (*ibid.*, p.38)

Since this definition is wider than traditional types of learning, experiential learning covers *all* adaptive processes, from creativity, problem-solving and decision-making via instruction in schools and universities to learning in the workplace.

3.2.3 Experiential learning in design

3.2.3.1 An individual's experiential learning in design

Experiential learning specific to designing needs to fit into the learning cycle (Kolb, 1984). This learning cycle proceeds through concrete experience, reflective observation, abstract conceptualisation and active experimentation (Figure 3.1).

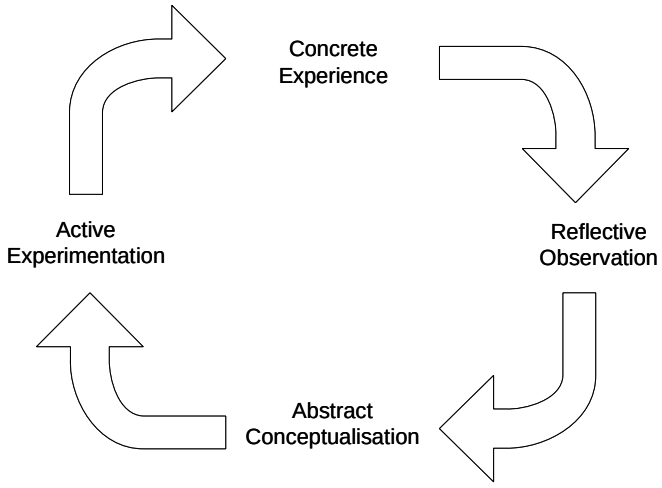


Figure 3.1 – Learning cycle (Kolb, 1984)

Valkenburg (2000) suggests that the micro-level process dynamics of framing, naming, moving and reflecting are in themselves a cyclic learning process. In her opinion, naming is equated with abstract conceptualisation, moving is equated with active experimentation, the effects of surprise are viewed as concrete experience and reflecting is equated with reflective observation. Framing, she posits, is a dynamic that comprises both active experimentation and concrete experience.

With respect to experiential learning in design, we can distinguish two modes through which learning is achieved: reflection-in-action and reflection-on-action. The former refers to designers' 'on the spot' reflective activities linked to concurrent action, whereas the latter denotes designers' reflection on their subjective practices as a whole (Figure 3.2).

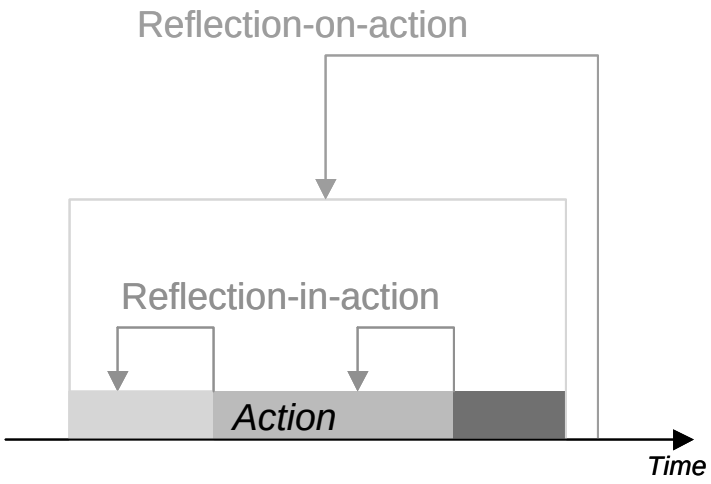


Figure 3.2 – Reflection-in-action and reflection-on-action

Reflection-in-action hinges on the experience of surprise in a particular instance of a situation. To experience reflection-in-action, one has to be in the situation, as a first-hand account, and the designer does not "separate thinking from doing" (Schön, 1991). A crucial point is that understandings are implicit and through reflection are "surfaced, restructured and embodied in further action" (*ibid.*). Reflection-in-action, triggered by outcomes of moves, can then be turned towards values and norms that underlie the designer's judgements, strategies that have been adopted and moves carried out – in short, an examination of the framing of the problem. However, reflection-in-action must not be understood as a 'stop-and-think' activity or reflection-on-action, since reflection is contained smoothly within an action. In fact, stopping and thinking disrupts reflection-in-action. This view of reflection-in-action is shown in Figure 3.3.

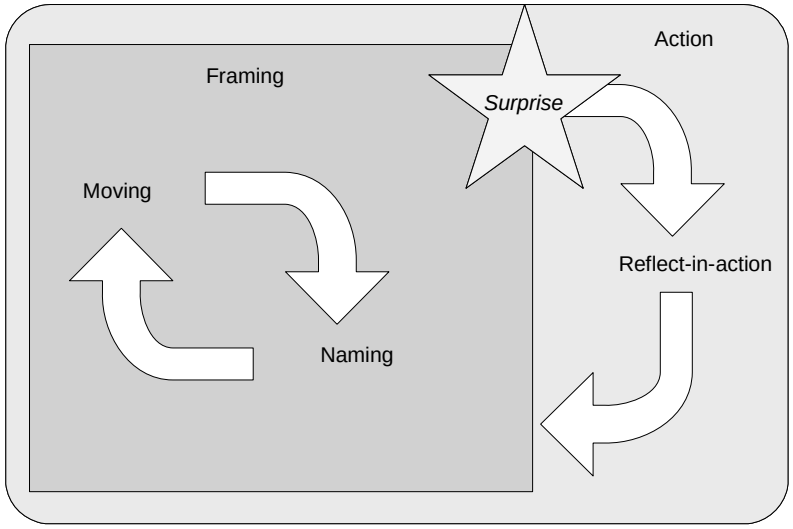


Figure 3.3 – Reflection-in-action

Reflection-on-action is a meta-activity where a completed activity itself is the object for reflection (Figure 3.4). In contrast to reflection-in-action, there is no direct connection to an ongoing activity, and the reflection will make no difference to it. However, reflection-on-action may still make a difference to further acts of designing. Schön (1987) describes this as a 'ladder of reflection', where we climb up from an activity to reflect on that activity and climb down from reflection-on-action to an activity that enacts what is learned through reflection. For example, reflecting on frames that are in operation in a design field constitutes reflection-on-action, whereas the reflection on a current frame in operation during a particular design activity encompasses reflection-in-action.

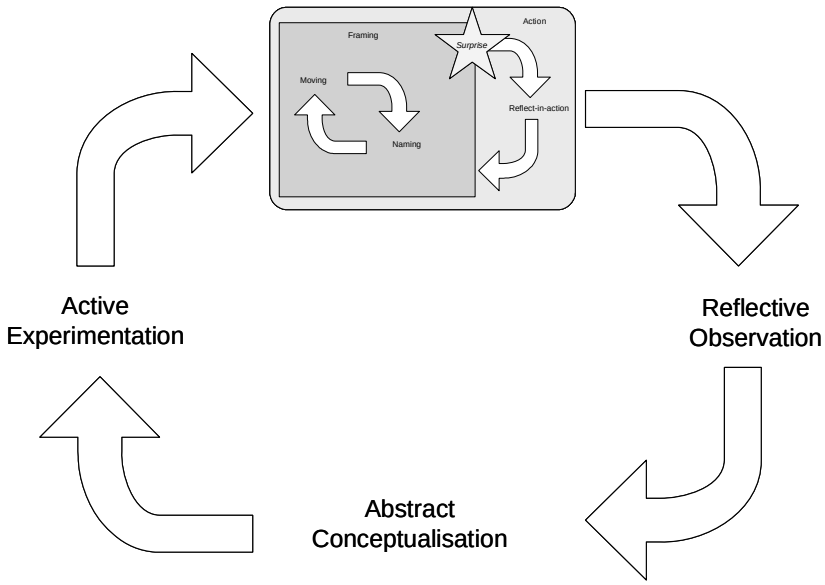


Figure 3.4 – Reflection-on-action as a meta-level learning process

3.2.3.2 A team's experiential learning in design

When attention is turned to experiential learning in design within a team setting, both reflection-in-action and reflection-on-action become more complex.

Firstly, it should be noted that the extent of experience changes subtly. Whilst designers in a team learn about a task using reflection-in-action or the way they performed tasks with respect to reflection-on-action, an individual designer also learns about other individual designers, the team as a whole and the interactions carried out. Learning must now address experiences that spring from both physical and social worlds.

Secondly, modes of knowing – and the ways learning is approached in general – alter as experiential learning is applied to a team setting. Kolb (1984) points out that there is a dual-knowledge system: one can know through direct *apprehension* of experience or through *comprehension,* which introduces order and structure into these sensations and can be communicated. In a team setting, it is not enough for an individual to merely

apprehend; the knowledge so gained must be filtered through comprehension and communicated if it is to be exploited by others. Hence, in a team setting, comprehension as a mode of knowledge creation plays a more important role than in individual designing.

Thirdly, there is also a change to the requirements of the learning process. *Personal knowledge* – the "accumulation of the individual person's subjective life experiences" (*ibid.*, p.36) – is a personal, subjective matter that is gained through both direct apprehension of an experience and socially acquired comprehensions. In a team, subjective personal knowledge is bound up with *social knowledge* – knowledge that is an "independent, socially and culturally transmitted network of words, symbols and images that is solely based on comprehension" (*ibid.*, p.105). Social knowledge cannot stand alone; it "must be continuously recreated in the knower's personal experience" (*ibid.*). Therefore, learning in teams is problematised since it requires systems of inquiry "sharing similar norms and values about how to create valid social knowledge" (*ibid.*, p.121).

With this understanding of experiential learning in design in mind, it is now possible to clarify the descriptive models of designing within this paradigm in more detail. Specifically, extensions of the paradigm to a team setting are proposed and approaches of studying these are suggested. Notions concerning the models of designer, design task, micro-level design process dynamics, macro-level design process dynamics and corollaries introduced in chapter 2 (Table 2.2) are extended in section 3.3, 3.4, 3.5, 3.12 and 3.13, respectively.

3.3 Experiential learning in design: the model of designers

Individual designing is an expression of personal knowledge: individual experiential learning places emphasis on an individual expert practitioner who is immersed in the technical knowledge, values and judgements of quality that her design profession demands. Designers tacitly 'know-in-action' (Schön, 1991, p.49), unable to describe the specifics of what they are doing[3], their mode of learning is mainly through apprehension. Designing is inherently seen as a subjective enterprise – an artistry (Schön, 1987) – particular to each individual designer (Dorst, 1997). Since there are no general paths towards good designing for all designers and all design situations, it behoves the practitioner to engage in continuous learning activity through reflective practice (Schön, 1991). This is embodied through their reflection-in-action or reflection-on-action, as modes of experiential learning in design.

In experiential learning in teams, the extent of experience, modes of knowing and requirements of the learning process change, as discussed in section 3.2.3.2. No longer can learning be confined to the situation or how the individual tackled the situation. An individual still learns about these things, but added to this is learning about the social aspects that team designing brings. In this respect, team experiential learning is not the sum of individual learning; instead, it is that and more.

Team designing deals with the role of an individual designer *within* a design team. A model of the designer in a team needs to deal with various levels of interaction that capture the extent of experiences. Firstly, there is the individual interaction between designer and the object to be designed. The individual 'conversation with the situation' is cognitive and tacit, and therefore can only be elucidated through think-aloud

[3]Knowing-in-action has been illustrated by Schön (1991) with the case of a baseball player knowing how to bat. In this analogy, he makes wider claims than merely motor skills.

protocols or indirect investigation. In addition, a conversation with the 'designing system' (Schön and Rein, 1994) adds a second level. There is a social negotiation context (Strauss, 1978) overlaid onto an individual design context. The conversation within a designing system affects the design process through communication.

To co-ordinate their team effort, designers use different modes of knowing. They arrange their individual experiential learning at the team level by externalising their personal reasoning and communicating with the other team members; they externalise their comprehension. Hence, they try to share their own focus of attention with the team, and engage in a social construction of the design problem. Designers play an active participative role in the construction of how the team views the problem and the justification of it. In effect, there is a feedback loop where the individual designer tries to effect change within the team's view, but is also affected by a change in the team's view. In this sense, the team functions as a mediating system (Witte and Lecher, 1998), where individual designers influence the team's behaviour and activities whilst at the same time they are in turn influenced by the team itself. This system can only succeed if the requirement is met that the team shares some norms and values, which allows them to integrate social knowledge into personal knowledge.

3.3.1 The designer as a participant in argumentation

The way that the construction of the team problem is achieved by a designer is by externalising his or her reasoning to other participants. In this respect, argumentation bears close links to a cognitive interpretation as a 'methodical reasoning' process (Concise Oxford Dictionary, 1982).

As part of this thesis a background of argumentation theory was chosen as a window to examine the reasoning and interactional processes that operate in designing. In the past,

argumentation has been used to that effect. Trousse and Christiaans (1996) suggest that design proceeds in a series of argumentative moves between designers sharing a discursive space. Brereton *et al.* (1996) and Cross and Clayburn Cross (1996) also comment on the persuasion that can be observed throughout design team practice. Furthermore, Fleming (1997), observing student designers working together, notes that arguments are used to explain, predict, justify and warrant their artefacts. In an extension of this observation, Fleming (1998) highlights the use of language in object-laden versus language-laden talk. Object-laden talk involves pointing, indexing and naming, showing how language is constrained and enabled by the objects that are part of the design. In contrast, language-laden talk shows the use of argument, indicating language's independence from the object and dependence on values, community, etc. Furthermore, an object is created, manipulated and revised by language-laden talk throughout a conversation.

3.3.2 Roles of designers in the design team

As individual designers play an active participative role in the construction of how the team views the problem and adopts a solution, their argumentative roles in this process can be examined. In traditional argumentation theory (see Appendix 1 for a brief history of argumentation theory), we can observe that analytical argumentation does not assign any roles to participants; indeed, it only deals with information itself and how this information is associated in a human belief system. The dialectical view of argumentation theory delineates proponent and opponent roles for participants in argumentation. With regard to dialectical argumentation, the proponent puts forward a claim, which is challenged by the opponent, as there is an element of doubt on the opponent's behalf. It then behoves the proponent to defeat the challenge by further justification.

Freeman (1991) distinguishes between the various categories of challenges with respect to a claim. He formulates these into types of questions that the opponent may ask, namely questions concerning acceptability, relevance and adequacy of reasons. However, according to Freeman, it would not be possible for a challenger to put forward a premise or for a proponent to ask a question, since this would be an eristical rather than a dialectical situation. This view, however, has been relaxed somewhat in the work of Walton (1989) who puts forward the notions of critical discussion and different argument types with their own dialogue rules. However, it can still be noted that both Walton and Freeman only consider dialectical situations, which focus exclusively on arguments based on conflict. The dialectical stance towards argument brings with it several shortcomings in examining arguments. Firstly, dialectical situations only deal with strictly delineated argument roles of proponent and opponent. Secondly, the dialectical perspective does not capture the mainly co-operative nature of team experiential learning. Thirdly, a conflict-based argument model only allows us to substantiate the extent to which the opponent disagrees based on the types of challenges made, but not why, since the opponent's beliefs never enter into focus (Crosswhite, 1997). Clearly, a richer account is needed.

To contrast, a rhetorical view of a team's argumentative processes allows participants to take roles as arguer and audience[4]. We follow assertions made by Perelman and Olbrechts-Tyteca (1971) and Kallmeyer (1996) that these roles, firstly, do not have to be distinct, and secondly, can be shared amongst the team at different times. In Perelman and Olbrechts-Tyteca's model of persuasion, the arguer has to take the audience's beliefs into account; persuasion fails if the arguer makes mistaken assumptions about the audience's beliefs. Furthermore, persuasion is used as a model

[4] The role of interlocutor as an active representation of a passive audience could also be distinguished. However, audiences need not take a purely passive role (Perelman and Olbrechts-Tyteca, 1971).

for a “discussion, in which the interlocutors search honestly and without bias for the best solution to a controversial problem” (Perelman and Olbrechts-Tyteca, 1971).

However, designers may not be explicitly aware that they are using argumentation (Kuhn, 1991) and only recognise argumentation in its pejorative form as a heated debate. Argumentation in general is a way to study reasoning and discourse behaviour by providing an overarching theory. Argumentation then brings a certain stance towards the material. One of these is that people deliberate, i.e. the course of action is not given from the outset but is constructed through some form of interaction. It is this interaction between the participants in an argumentative process that is used to drive the construction of the design task and the micro-level design process forward. We have termed this view of design team experiential learning which builds on Perelman and Olbrechts-Tyteca’s stance the *rhetorical construction of understanding*.

3.4 Experiential learning in design: the model of design tasks

Individually, a task is constructed out of a unique, value-laden and uncertain problematic situation. The design task is to solve a problem that comes out of this construction but, since the construction of the design problem is based on personal knowledge, different designers “construe the task they are asked to perform in very different ways” (Schön, 1988). Nonetheless, Goldschmidt (1996) has shown that the setting of the problem task is influenced by situational cues as much as the designer’s background of profession, role and relations (Schön, 1988). The design task does not stay static, instead it is “made and remade in the course of designing” (Schön, 1990). In this sense, Schön himself seems to prefer the term ‘design structure’ to design task. Design structure implies that a design problem has been instantiated together with ‘rules’ that allow transformations towards a solution and criteria that can be used to

evaluate the results of transformations. Crucial in this construction of the design structure is that designers identify patterns and give them meaning (Schön and Wiggins, 1992). They do so by applying a construction cycle to the micro-level process, namely framing, naming, moving and reflecting.

Whilst designers at the individual level construct tasks out of unique, uncertain, value-laden problematic situations, in a team setting these individual constructions need to be co-ordinated and shared amongst team members to a certain extent (Schön and Rein, 1994).

Valkenburg (1996, 2000) proposes that the team constructs a 'team-frame' at the team level to achieve successful team designing. This frame functions to create a common understanding of how "the problem will be approached and the way the design content should be developed" (Valkenburg, 2000, p.195). It is a result of "harmonising the individual perceptions of team members" (*ibid.*, p.26). Indeed, in Valkenburg's interpretation, a team-frame is equivalent to a shared understanding. However, a team-frame can only be recognised *post hoc,* as it is achieved through negotiation and distributed over the interaction's of team members. Team-frames only come about through their acceptance by team members.

Hence, there are various ways that a team-frame can come about. Firstly, one possibility would be that all participants adopt one particular individual frame at the team level, either electing to do so of their own accord or by being persuaded to do so by the 'owner' of a particular individual frame. Secondly, it could also be the case that the team-frame is constructed afresh. In this instance, not one individual frame dominates; instead, the team-frame is jointly constructed as the team goes along. This means that

participants need to go into the situation with an open mind and be prepared to be receptive to others' conception of the design problem.

It does not follow that the aim of a team's experiential learning effort is the development of a team-frame that is the sum of individual frames. Indeed, experiential learning in general provides arguments against this view, since all construction is embedded through direct apprehension of experience in subjective personal knowledge. Especially in multi-disciplinary teams, a more conservative approach would expect individual frames to continue their existence; only being integrated to a certain degree at the team level. We could expect successful designing to take place if a team-frame – at a higher level than individual frames – shapes a coherent view of the problem to which actions of individual designers can be aligned.

In this thesis, team-frame is defined as the *minimal* set of *agreed* networks of concepts and values forming a *normative* whole, which is achieved through the interaction between design team members. In this respect, this definition states that the team-frame is the smallest 'intersection' of individual frames and that terms in this intersection need to be agreed by all team members. As a basis, it is claimed that for people to understand each other, their way of thinking needs to accord with each other to a certain degree (Perelman and Olbrechts-Tyteca, 1971). The definition also addresses the fact that frames have a normative power; frames provide a 'normative leap' (Schön, 1990). Lastly, the team-frame does not reside within one or all team members as a direct entity, but is achieved through and contained in their discourse.

3.5 Experiential learning in design: the micro-level design process model

The micro-level process of individual designing proceeds by a construction cycle: by interactively framing the problem and naming the things the designer attends to within this frame, she is able to generate moves towards a solution within that structure and reflect on the outcomes of these moves (Schön, 1991). Schön uses an analogy where the designer holds a ‘conversation with the situation’ in which the situation ‘talks back’.

Clearly, some design activity is of a visual nature; it cannot be captured by relying on verbal externalisations alone. Sketching, and pointing to either sketches or physical objects, is not usually documented in a transcript. Therefore, it may be necessary to supplement verbal information with other contextual material to enrich the way designing is studied (Mazijoglou and Scrivener, 1998). This, however, does not invalidate our approach, which concentrates on externalised speech to which contextualising cues are added when they are needed to make sense of what is said.

An examination of the micro-level process of team designing will show evidence of the individual construction cycles externalised in the speech of participants. It has been pointed out that team members’ contributions build on preparatory contributions by other participants (Goldschmidt, 1995). This effect has been termed ‘distributed reasoning’. In this sense, cognitive operations are performed by individuals and, by externalising speech, results are passed on to others in the group (Dunbar, 1997). Results of the individual micro-level design process, such as framing, naming, moving and reflecting, are externalised by individuals and used as input for further steps. In this way, the distributed reasoning process of individuals can be used as a corpus to investigate the reasoning at the team level.

The micro-level process consisting of framing, naming, etc. needs to be externalised. As such, designers need to display some linguistic skill to achieve the micro-level design process, in particular where naming is concerned:

> "The label brings some baggage with it: anthropomorphic leanings perhaps, analogies and metaphorical implications certainly. The label has to be right. Design participants struggle over words. Naming is designing." (Bucciarelli, 1994, p.174)

Naming also involves highlighting certain facts and focuses attention of the team on them. Framing – inextricably linked with naming – is a tacit process. It will therefore be difficult to find evidence for this process. However, access to names will greatly enhance the understanding of framing. Moves are constructed by individual designers in accordance with their framing of the situation. Again, the way that designs are transformed verbally leaves behind a reasoning footprint to transform and develop design problems and solutions verbally. A detailed examination of design discourse will be carried out in chapter 4 to investigate how argumentation theory can pinpoint these reasoning footprints.

Finally, reflection-in-action as an activity in a team setting can be seen as a meta-activity. Since team designing is distributed amongst the team members, designers need to "probe the meanings that lie behind the messages they receive from other designers, and probe other designers' interpretation that *they* receive" (Schön and Rein, 1994, p.170). Team designing takes reflection to a new rung of the 'ladder of reflection', as subjective reflection by individuals on their own actions needs to be combined with reflection on other people's contributions. It appears that there is subjective-reflection-in-action and intersubjective-reflection-in-action. Schön and Rein *(ibid.)* make this distinction as being between personal inquiry and cooperative inquiry.

Since the concepts of framing, naming, moving and reflecting play such an important role in experiential learning in teams, these notions will now be examined in more detail in sections 3.6 to 3.11.

3.6 Conceptions of frames and framing

Previously, frames in design have been variously seen as "sense-making devices that establish parameters of a problem" (Valkenburg, 2000), based on an "underlying background theory about design problems and his/her goals" which is expressed as a simile, a way of 'seeing-as' (Schön, 1991). Notions of framing as context-giving on a discourse-level, as sense-making on an individual cognitive level, as guiding principles of interpretation on a communicative level or as social/cultural structures on a meta-communicative level can also be distinguished (Fisher, 1997). Whilst it appears that researchers are internally consistent as to their interpretation, it is nonetheless instructive to compare differing conceptualisations of framing and frames in the literature to enable one to understand Schön's interpretation.

3.6.1 Explaining individual sense-making

Frames, as understood by Minsky (1975, 1985), are held to have a physiological and psychological basis as data structures of individual knowledge representation in memory and reasoning. In Minsky's account, frames abstract experiences and represent stereotypical situations. A data structure of a stereotypical situation sets up certain slots (terminals) that need to be filled with information. This is achieved either by setting up expectations by assigning default values, methods (demons), or by filling in values to elaborate particular instances of a stereotypical situation, all of which can themselves be frames. Frames as data structures can then function in various roles in understanding perception and language. For example, if a room is entered, the room-frame makes one

expect four walls and a ceiling. In the particular instance of this situation, slots about the dimensions of the different parts are filled in and other default values are revised to make the frame fit the current experience. If the situation that presents itself is not congruent with a current frame, it needs to be adapted or indeed a new frame needs to be established. However, as Minsky points out, people do not only apply 'schematic thinking' by looking for a frame that fits but also think about how things are to be represented, a meta-level activity.

The way that Minsky understands frames leaves several issues that are not explained for sense-making in groups. For one, this understanding of frames only aims to explain individual cognitive activity, and does not make any claims for social activity. The only way that social activity can be explained is by the assumption of an objective reality, which results in people sharing the same frame structures. Secondly, his notion of frame has been criticised for being unable to say definitely what is in one frame and what in another, or even what should be in a frame. Finally, any meta-representational activity is not explained, specifically when frames need to be restructured and how this restructuring might take place.

3.6.2 World-making

Frames, as defined by Goodman (1978), are systems of description, which form the organising principle for multiple actual worlds. Frames, and synonymously worlds, differ in the way that concepts or entities are composed and decomposed, emphasised, ordered, deleted, supplemented or reshaped. The problem of which frame is the right one is solved by a call to their 'rightness', which lies in their power to reveal, explain, and predict what is going on. Although a notion of absolute truth is rejected and made relativistic, this does not imply that all worlds are equally good in a particular case.

Knowledge does not exist as static truth; instead, it resides in the activity of discovery and learning:

> "On these terms, knowing cannot be exclusively or even primarily a matter of determining what is true. Discovery often amounts, as when I place a piece in a jigsaw puzzle, not at arrival at a proposition for declaration or defense, but to finding a fit. Much of knowing aims at something other than true, or any belief. […] Such growth in knowledge is not by formation or fixation or belief but by the advancement of understanding."(*ibid.*, p.21)

Bucciarelli (1994) in a similar notion speaks of 'object-worlds', which, according to professional experience, attend to certain concepts and entities whilst neglecting others, and through values provide a way of 'direction for change and improvement'.

3.6.3 Understanding social behaviour

Bateson (1972) starts out from an individual sense-making perspective and then ties this in with a social structure of framing. In Bateson's version of framing, he starts by the assertion that all communication takes place at various levels at one and the same time. There is a denotative level, a meta-linguistic and meta-communicative level operating whenever we communicate with others. Furthermore, he adds that, as we move up the level of abstraction, so the number of things that remain implicit increase. These levels are all inter-related; one level of abstraction builds on another. Thus, denotative communication is only possible after the establishment of meta-linguistic rules, relating "how words and sentences [are] […] related to objects and events" (*ibid.*, p.180). A frame then is at the meta-communicative level of abstraction and forms a 'psychological concept'. Taking an analogy from the way that a picture frame and mathematical sets operate, similarities to a psychological frame can be noted: it delimits sets of meaningful messages or actions. In this respect, frames are structures that include or exclude certain messages or action, and evaluate the messages that are contained within the frame. It is easiest to see how these levels of abstractions work when one looks at

playing. For example, in play-fighting, the meta-communicative level of 'play' frames the meaning of the action 'punch' on the denotative level, so that in the context it sets one does not interpret punching as aggressive.

3.6.4 Organising experience

Linking to Bateson's interpretation of frames, Goffman (1974) aims to give an indication how experience is organised. He hopes to achieve this by examining the individual way that meaning is arrived at through the use of frames:

> "I assume that definitions of a situation are built up in accordance with principles of organization which govern events – at least social ones – and our subjective involvement in them; frame is the word I use to refer to such of these basic elements as I am able to identify" (*ibid.*, p.10,11)

First of all, he notes that there are primary frameworks at play, answering the question "What is it that is going on here?", which transform something that would otherwise be meaningless into something meaningful:

> "Whatever the degree of organization, however, each primary framework allows its user to locate, perceive, identify, and label a seemingly infinite number of concrete occurrences in its terms." (*ibid.*, p.21)

The major distinction between primary frameworks, according to Goffman, is that they are either natural or social. Natural frameworks, for example scientific explanatory systems, are due to only natural determinants and do not involve any social actor. Social primary frameworks deal with how people relate to each other; a social agent is always involved in a social framework, which guides the action. However, there are problems. Very often primary frameworks overlap, since each action has social and natural implications. Secondly, various social frameworks can be in play at the same time. Thirdly, a culture has a framework of frameworks that constitute its belief systems. At this point Goffman introduces the notion of 'keying' – a transformation of

meaningful activity under a primary framework into something that has different meanings. For example, a primary framework of fighting is keyed into play-fighting. Goffman's approach to frame analysis centres around this concept of keying and re-keying, which can give an insight into the primary frameworks that are in operation by observing how they are transformed by keyings. Hence, concentration can be focussed on bracketing cues when keying is introduced – similar to a theatre performance that is signalled by the rising and lowering of a curtain.

Furthermore, he also talks of social activity, i.e. an individual behaviour towards another individual, their interactivity and when this relationship breaks down. Again, cues that indicate this 'breaking of frame', in Goffman's opinion, can be investigated in frame analysis.

3.7 Framing in individual experiential learning

Schön (1991) views framing in experiential learning in design as an activity that an individual carries out to construct meaning out of a problematic situation. Frames in this sense are "structures of belief, perception and appreciation" (Schön and Rein, 1994) which impose an order on the situation. This posits that the designer takes a certain stance towards the problem, forming a perspective towards it. Individual framing is influenced by cultural norms, organisational roles, previous experience with similar situations and the current attitude taken to the situation. Stereotypical abstractions form the underlying mechanism that gives rise to frames and can be differentiated according to design fields. In fields where the emphasis is on perception, such as architecture, visual prototypes are translated to unique situations (Schön, 1988). Prototypes are to be understood neither as general categories nor particular instances; instead, they are 'generative abstractions'. As an example, Schön (1984) identifies spatial configurations such as "hierarchical order" and "spaghetti bowl" as types that were active within the

world of tutor-student at the MIT design studio in the 1980s. In language-driven fields, like policy and planning, generative metaphors are proposed to function much like visual prototypes. Frames as design structures are born of metaphors – "simple notions which encapsulate a complex family of ideas" (Schön, 1990) – and their translation to a particular context. Quite literally then, frames are a form of 'seeing-as' (Schön, 1991). Each design domain would therefore have a repertoire of these metaphors or prototypes, or indeed both, which are used to shape frames for a particular, unique situation.

The emphasis is not only in the bounding quality of frame but also its generative function.

> "Generative metaphor produces a selective representation of an unfamiliar situation that sets values for the system's transformation. It frames the problem of the problematic situation and thereby sets directions in which solutions lie and provides a schema for exploring them." (Schön, 1990, p.132)

What becomes important about a frame is that it allows a way into the problem and a way out: by bounding the situation in a particular way, certain paths to rectify the problem present themselves. For example, Schön (1993) cites the case where a situation of housing deprivation was framed as a problem of service fragmentation. Because one knows that if something is fragmented, or in pieces, the solution that suggests itself is to put it together again, a frame of service fragmentation leads to a solution approach of service unification. Frames hence allow for solutions to be explored. At the same time as a solution can be explored, the frame provides a context for judgement of 'fit' or 'misfit' (Alexander, 1964), whether the solution or the approach to the solution is good or bad. The designer in this instance of judgement may not necessarily be in the position to make explicit all the factors that were taken into consideration to make this judgement, although he probably could give a post-rationalisation.

What does become problematic is that each individual observer is already caught up in a frame, not something that is done consciously, therefore a designer is never an objective observer. In a designer's framing, there can be good and bad frames, and good and bad designing:

> "A generative metaphor may be judged appropriate, for example, if it leads to the creation of a design structure that directs inquiry toward progressively greater inclusion of features of the problematic situation and values for its transformation. A good design process gives direction to enquiry while at the same time it leaves design structure open to transformation." (Schön, 1990, p.139)

Reframing the situation becomes paramount when the current frame becomes inappropriate to move the design further along (Schön, 1991; Bardwell, 1991). Rather than a change within a system, it is the system itself that needs to be changed (Watzlawick *et al.*, 1974).

3.8 The difference between frames and framing

As a first point to note, it may be impossible to say definitely what a frame is. There are various interpretations of frames, each assuming different functions. For example, Minsky (1975, 1987) proposes frames as structures for knowledge representation in artificial intelligence, serving as an abstraction for individual cognitive processes. Goffman (1974), on the other hand, treats frames as instances governing social behaviour. Moreover, even if the specification of the function of a frame were possible, an exhaustive list of the contents of a frame would prove impossible; this is commonly termed the frame problem (Dennett, 1990). To help overcome this problem, a distinction between frames as an object and framing as an action would be helpful. Whilst it may be impossible to precisely define what a frame is, the action of framing might still be identified.

In Goffman's interpretation of framing, for example, frames by their social construction can only be typified by archetypal frames, such as host and guest, which are transformed through keying into specific instances by the presence of boundary markers indicating the start and end of a frame or indicators when frames are 'broken' (Goffman, 1974). Rather than listing all the necessary components that make up a frame object, it would be sufficient to see an action of framing to indicate the existence of a frame by proxy. Some might say that this would lead to nothing: rather than dealing with the real object, we are only studying a pale shadow. And to a certain degree, this objection is valid. An exhaustive description of a frame may never be known precisely, since the details of a designer's thoughts are beyond our grasp, constantly shifting and surrounded by a 'horizon' of context. However, studying framing as an action allows, firstly, to state that a frame is present. Secondly, through studying the details of framing, it can be discerned when frames are established and some possible pre-conditions for them. Thirdly, through the action of framing as a boundary marker, it can be known when a frame started, when it ended and what went on during this time. Lastly, much like a shadow, although we may not be able to make out the details of the frame itself, one can estimate the general outline of a frame; the general shape of it. In this, naming can give some clues to grasp the nature of the frame.

3.9 Naming

Naming in Schön's view has the function of highlighting aspects of a situation to which attention is directed. Although names can be given to objects, abstract notions or potential functions, i.e. any features of a situation, what they have in common is that they highlight something from the background against which they take place. To a certain degree it seems that Schön subscribes to a perspective that language structures the way we see reality and the names one gives to things indicate how important things are to us (Whorf, 1942). However, Schön's view does not subscribe to this hegemony of

language whole-heartedly. Firstly, names, like frames, are usually not made explicit by a designer and can be tacit. Only when thoughts are voiced, such as through a think-aloud protocol or through a dialogue, can one gain access to some of – but not all – the names in operation. Secondly, names can be changed according to the frame that provides the context. Even more so, naming occurs in tandem with framing. When names are used to establish a frame, it "calls to mind a constellation of concepts and relationships within various contexts in use and in its making." (Bucciarelli, 1994, p.173). So on the one hand, names can be triggers for certain frames whilst on the other hand the frame in operation determines the features that are attended to and hence the names that are chosen. Names therefore play a two-fold role in the design process, and can give us access to some qualities of the frame itself. If we know the names used, we get a handle on the relationships and concepts within the frame. For example, Rein and Schön (1993) point out that 'female subservience' in the 1960s named a concept and focussed attention on it. The naming called forth an appreciative system – for example, to whom females are subservient, the value of freedom from servitude, actions to take to achieve liberation, etc. – that formed the frame and directions for solutions within the frame.

3.10 Moving

Moving in the micro-level process denotes an intentional action. This can take the form of a physical action, such as drawing "lines, strokes or other marks" in architectural sketching (McFadzean *et al.*, 1999), or a mental process of step-wise reasoning. The defining feature in both cases is an act of developing some progress towards a solution. An intentional move cannot be made without a frame, since it is the frame that provides the boundary of the move. In fact, Schön (1991) and Schön and Wiggins (1992) talk about moves as "local experiments that test the frame". Of course, it is possible to make unintentional actions, such as doodling, slips when drawing, etc. – and even this can

further the understanding of the designer. Any action, whether intentional or not, is therefore capable of developing the appreciation of the problem and has the potential to surprise the designer with its outcomes. Problematic is the granularity of moves, since the size of moves varies widely between contexts, for example, the granularity of drawing a line on a sketch versus the implementation of a policy. This difficulty in varying granularity of moves means that descriptions of design activity need to be carefully considered in relation to the scale that the frame sets.

Hence, it may be best to define what moves are by some of the effects, rather than by giving a description of the move itself. One effect already touched upon above is that moves develop the solution. At the same time, moves contribute towards a deeper understanding of the design problem and situation through an enactment of a particular design option. Through the action carried out, a move introduces changes to the solution; that is to say, a move always has outcomes. These outcomes can be negative or positive, and designers evaluate these outcomes according to their fit or misfit. Within individual experiential learning, moves provide the engine for the creation of knowledge, since they have a direct impact on the appreciations of the designer, by either confirming them or changing them. Further moves might be made to correct what has just happened or build upon it. However, the outcomes may also surprise the designer, and may be used by the designer as prompts for reflection-in-action as indicated in figure 3.2 (page 44).

3.11 Reflecting

Surprise at the outcome of a move, both positive or negative, can lead to a reflection on the understanding of the situation, deepening the appreciation of the designer. As a result of the reflection, new moves can be made or a new frame initiated. This mode of learning is termed reflection-in-action. Schön (1991, 1987) distinguishes between two

types of reflection, reflection-in-action and reflection-on-action, as discussed previously in section 3.2.3.

3.12 Experiential learning in design: the macro-level design process model

The role of the macro-level process of designing can be distinguished from the micro-level process. Whereas the micro-level process is a construction cycle that can be broken down into framing, naming, moving and reflecting, the designer moves towards 'fitness' (Alexander, 1964) on the macro-level. In this process, the designer makes a judgement that the design satisfies the problem. The macro-level process concerns ways of telling the designer when to stop designing. Critical in this process is that this is a process of learning that changes the design problem and generates new conditions of 'fit' or 'misfit' (Schön, 1990). As the designer's appreciation of the design problem changes and grows, he also changes the way that a 'fitness' judgement is applied.

With changing appreciation comes the danger of conflicts within the appreciative system. For example, Schön (1990) points out that in the case of the design of housing service provision, there might be a value conflict arising from the importance placed on equal treatment of housing services recipients whilst at the same time aiming to keep service provision delays for everyone at bay. If these conflicts become 'intractable', the design problem becomes unsolvable and hence a 'dilemma'. To overcome these dilemmas, reflection on the appreciative system needs to be carried out. The designer may then, as a result of this reflection, realign priorities and weighting of values – sometimes values that pertain to the design process itself such as limited time resources – or introduce a 'new invention' that effectively changes the appreciation.

Whereas for an individual designer the macro-level design process strives towards fitness, the view of the macro-level process in a team needs to undergo a reorientation. Fitness is still the overriding criterion that tells the designers when to stop. However, to allow the end result to be judged according to fitness depends crucially on the frame that determines fitness criteria to be applied. It is therefore imperative that agreement exists amongst the designers as to the fitness standard. Schön and Rein make this clear when they talk about the norms that policy committees need to adopt as their goal:

> "As a consequence of the structure of the task in which they are engaged, the members of a designing system should seek to arrive at agreements about the problems they are trying to solve and the character and content of the policy object they are trying to shape." (Schön and Rein, 1994, p.169)

3.12.1 Frame convergence

The macro-level process in team designing moves towards the adoption of one team-frame. Through their micro-level processes the team members may jointly construct a team-frame or be persuaded to adopt an individual frame as the team-frame. The overriding impetus of the macro-level process is to provide a synergy between team members in what the problem is that needs to be solved and approaches that can lead to solutions.

3.12.2 Macro-level process failure

In the individual macro-level process a failure expresses itself through a designer getting 'stuck', i.e. the task that the designer has set herself is not amenable to any solution approaches. The way to overcome this 'stuckness' is by way of reframing the problem, an approach outlined by Schön (1991) in his exposition of a teacher's help in reframing the problem of a 'stuck' student, the Petra-Quist example.

In team designing, there are also instances when teams can get stuck in a similar way to an individual. Additionally, progress may be blocked because of frame conflict. Schön and Rein (1994) point to instances of frame conflicts in policy design when conflict between individual frames is evident. Between these individual frames, there will be differences in the way of what counts as data and values, which solutions are appropriate and how this move from data to solution can be justified; in our definition, there is no team-frame. Frame conflicts can only be resolved through reframing and by the establishment of a team-frame that is agreed on by all participants.

3.13 Experiential learning in design: corollaries

Prescriptions for individual experiential learning are based on the notion that each design situation is unique and calls for designing that is different from all other designing instances. On the other hand, experiential learning emphasises learning of general attitudes and behaviours that carry across design instances. As a corollary, the designer therefore should immerse herself in the action of designing and adopt a willingness to deepen her appreciation of the situation. In Schön's terms, the designer needs to be open to the 'backtalk' of the situation.

Methods and techniques to support individual design activity within the experiential learning design paradigm have been scarce. In particular, ways that prescribe how reflection-in-action and reflection-on-action are to be supported have only just begun to be outlined. Some suggested techniques deal explicitly with framing and reflection on frames. Attention is turned on frames themselves and the way to change them (Schön, 1993; Schön and Rein, 1994). For example, synectic techniques work to establish new frames by setting up analogies (Gordon, 1961; Schön, 1963).

Within a team setting, Valkenburg (2000) makes specific recommendations for the role of the project manager to become a ‘frame coach’, ‘reflection guard’ and ‘move helper’. This moves some way towards a structured method of frame reflection (Schön and Rein, 1994), in which frame-reflective discourse is encouraged. For frame reflection to be carried out, it is suggested that the focus of frame reflection in design teams should be on the stories that identify frames (Rein and Schön, 1993) and the values, norms, metaphors, appreciations and directions for solutions contained therein. As a means to improve reflection-on-action, design process failures should be examined carefully. These can be used to examine the opposing frames that lead to designers becoming ‘stuck’ or exhibiting frame conflicts. It therefore behoves designers to be aware that there is the potential for different frames and the need to examine the meanings that other designers in the team could have adopted. Supporting designers to reflect on these issues by using descriptions of designing will be demonstrated in chapter 7.

3.13.1 Representations

Representations form an important part within prescriptive models of experiential learning. Individual designers make external representations that function as virtual worlds in which they design and with which they think (Schön, 1988). Representations in team designing that focus on the frames in operation for experiential learning have been proposed by Valkenburg and Dorst (1998, 1999). In these, they code micro-level process activities at the team level to show the development of frames and moves. However, the representation does not account for individual contributions and the importance of shared frames, i.e. it falls short of showing important factors such as the role the individual designer plays in the design team and the flow of the macro-level design process. This thesis proposes that such shortcomings can be overcome by ‘frame rationales’ that capture these characteristics; the frame rationale representation will be detailed in chapter 6. Frame rationales seek to turn attention towards the way that

individuals contribute to the way that the design is understood within a team setting. In particular, frames form the context of what is considered and form a ‘rationale’ detailing why an artefact was designed the way it was. The representation in this respect functions as a way to reflect-on-action. The representation would support an explicit learning activity, one removed from the throws of in-the-moment designing. This in particular is discussed in chapter 7, where an investigation of representations and their use for reflection in teams is presented.

Representations can describe or support, however, their value is determined by the context given by a particular design paradigm. Hence, there are better and worse representations for experiential learning. To this end, we discuss representations and the characteristics that they need to exhibit to be valuable within the experiential learning paradigm in more detail in chapter 5.

3.14 Summary

In this chapter, learning in general and experiential learning in particular were defined. To summarise, experiential learning is the process whereby knowledge is created through the transformation of experience. To follow on, it was outlined what this means for experiential learning in terms of design, both for individuals and teams. Experiential learning in design is carried out through the modes of reflection-in-action and reflection-on-action.

Following this definition, the individual experiential learning paradigm was examined in detail. The model of the designer as an individual expert practitioner who needs to engage in continuous learning to make sense of unique, complex and value-laden design situations and improve design practice was described. The design task is constructed out of a problematic situation and is made and remade during the course of designing. This

is achieved through a construction cycle, which forms the micro-level process of individual designing. To facilitate the understanding of the micro-level process, different understandings of framing in the literature were contrasted. It was stressed that although a frame cannot be completely specified, evidence of markers nonetheless gives us an indication of the activity of framing. Naming highlights aspects of a situation and provides a label for things that are focussed upon. Moves are made in accordance with frames to develop a design option, whilst at the same time testing the frame itself. Surprise at the outcome of moves can turn to reflection that surfaces the understanding of designers, leading to new moves or reframing. The macro-level design process of the individual designer moves towards fitness of the solution to the problematic situation. With respect to techniques and methods that support designers' activities, an orientation to reflection-in-action and reflection-on-action was emphasised. Reflection permeates: openness to backtalk and awareness of framing is encouraged. A summary of both individual experiential learning and its extension to teams is given in Table 3.5.

		Individual Experiential Learning	**Team Experiential Learning**
Description	**Model of designer**	Individual practitioner	Practitioner within a team
	Model of design task	Unique, uncertain, value-laden problem which the designer constructs	Unique, uncertain, value-laden problem which the designers construct individually, shared amongst team as team-frame
	Model of macro-level design process dynamics	Converge towards 'fitness'	Converge towards 'fitness' and agreement of fitness standard Frame convergence Frame conflict Appreciative system
	Model of micro-level design process dynamics	Enter a construction cycle: Frame-name-move-reflect	Rhetorical construction of understanding
Corollary	**Notions underlying design methods and techniques**	'Learn by doing' and openness to backtalk	Frame reflection
	Notions underlying representations	Things with which to think dynamically	'Frame rationales'
	Attitude to learning	Individual experiential learning	Team experiential learning

Table 3.4 – The Experiential Learning paradigm and its extension to teams

The implications of the differences with respect to the extent of experience, modes of knowing and requirements of the learning process applied to teams were discussed. To

this effect, the nature of the designer in a designing system, which adds a social layer on top of an individual perspective, was highlighted. The design task is constructed individually and needs to be shared amongst the team. Because designing includes this social layer and an emphasis on comprehension as opposed to apprehension, designers need to externalise their reasoning processes. A background of argumentation theory was proposed as a window to examine the reasoning and interactional processes that operate in designing. It is this interaction between the participants in an argumentative process that is used to drive the construction of the design task and the micro-level design process forward. We have termed this view of design team experiential learning built upon Perelman and Olbrechts-Tyteca's stance the *rhetorical construction of understanding*. The way that the team's perspective towards the design task is co-ordinated is by way of a newly constructed team-frame or by adopting an individual's frame. The macro-level process, although still based on the notion of fitness, is reoriented towards the achievement of this team-frame. Macro-level process failures are likely to be due to frame conflict. Hence, problem construction and justification become a major focus of any investigation of the design process. This is addressed in the micro-level design process, which captures the rhetorical construction of understanding in a team. How this is achieved through communication and how design teams use rhetorical means to drive this micro-level process along will be examined in the next chapter.

Chapter 4 Analysis of design discourse

4.1 Introduction

So far, the theoretical underpinning of experiential learning with relation to individuals and its extension to a team setting was examined. To this effect, experiential learning and particularly individual and team experiential learning in design, were defined. With these definitions in mind, models of designers, design task and design process dynamics were clarified. In team experiential learning, differences were noted with respect to the extent of experience, modes of knowing and requirements of the learning process.

To summarise, a team-frame needs to be established amongst the designers who have made sense of the situation individually as part of the micro-level process. This team-frame is not an object that exists independently; it is achieved through and contained in their discourse. It was further pointed out that, whilst the exhaustive description of frames is beyond the grasp of any approach, the identification of framing as an action – combined with the tight coupling of names and frames – can give an indication that a frame is in operation. Designers share their comprehensions by externalising their thoughts and reasoning; it was proposed to investigate footprints that this reasoning leaves against a background of argumentation theory. The interaction between participants in an argumentative process – incorporating a rhetorical stance – that is used to drive forward the construction of the design task and the micro-level design process was termed the rhetorical construction of understanding. Frame convergence was identified – that is, agreement on the standard of fitness – as an indication of a successful macro-level design process; otherwise, the team may exhibit frame conflict. As Schön puts it:

> "From a constructionist perspective, the seeming objectivity of a consensual design world is not a given but an achievement, a product of the work of communicative inquiry." (Schön, 1988)

In this chapter, how a team achieves this consensual view is investigated in detail. As a guide the following question is posed:

- *How do designers establish a team-frame in early design episodes through rhetorical construction of understanding?*

To help us answer these question, an introduction to discourse analysis is given in section 4.2 as an orientation to the analysis method used in this chapter. An a coding scheme based on rhetoric is developed in section 4.3; this will be used as a basis to analyse discourse. We will anchor our detailed analysis using this coding scheme by reference to a particular example that is described in detail in section 4.4. We then demonstrate in section 4.5 how the coding scheme devised can be applied to transcripts of design discourse. Codes are explained with respect to their function in experiential learning and illustrated on a detailed level with coded passages drawn from an example transcript. We then show how the coded passages work together and how the coding reveals the unfolding of the design process and framing. Questions of the validity of this approach are addressed and a test of inter-coder reliability is described in section 4.6.

4.2 Method for the analysis of design discourse

The method used to analyse the design session concentrates on the verbal interaction between participants in preference to their non-verbal behaviour. However, we have made use of video evidence to provide context about gestures, deixical references and interaction partners. The detailed analysis of the transcript employed discourse analysis, which is a qualitative method to investigate conversation[5]. The aims of discourse

[5] Conversation is used here to mean both transcripts of speech and written documents.

analysis and related approaches – such as conversation analysis and argument analysis – are briefly outlined and contrasted with rhetorical analysis.

4.2.1 Aims and method of discourse analysis and related approaches

Discourse analysis examines the use of larger linguistic units, i.e. usually above sentence level, in naturally occurring speech or writing. The concern of discourse analysis can be further divided into two main foci. One of these aims to account for the effects of discourse units on smaller items. For example, topics as units are used to interpret smaller items contained within them and form a context for the interpretation of items such as deixical references (Grosz, 1977; Grosz, 1978; Reichman, 1978). Consequently, an area of investigation that plays an important role is the way these larger units can be identified by discourse markers. On a higher level, discourse analysis can be used to discover how linguistic units are employed to structure the text and the interaction. For example, flow of discourse can be analysed in terms of speech acts performed in conversation (Edmondson, 1982), the shifting between narrative and non-narrative modes (Georgakopolou and Goutsos, 1997) or rhetorical structure theory (Mann and Thompson, 1988).

Conversation analysis (CA) can be seen as a related approach to discourse analysis, taking a distinctly sociological stance. CA focuses on ‘ordinary talk’ between two or more persons and excludes any written discourse. It aims to analyse and describe the detailed procedures that underlie the production and sense-making of talk. Verbal interaction is assumed to be a highly organised and deliberative achievement on the part of the persons involved:

> "The way in which utterances are designed is informed by speakers' communicative competences: the organised procedures, maxims, methods and resources which are available to them by virtue of their membership of a natural language speaking community." (Wooffit, 1990)

Sentences and sequences of words form units that achieve specific functions in the interaction. The sequences of such units can shed light on the reasoning and interpretative procedures that people employ when they talk. It is a strictly bottom-up technique in that it is based on narrow transcripts of conversation, including pauses, intonation, false starts, etc., which allow the grouping of words into particular functional units. From the pattern of these sequences over many instances of conversational talk, the analyst is able to construct the procedures that are embodied in the talk.

Argument analysis, on the other hand, moves away from a narrow text to a broad interpretation. It usually aims to find units of arguments to reconstruct the 'logic' product contained in the protocol – usually in the form of an argument tree showing serial, divergent, convergent or linked diagrams of premises and conclusions or variants thereof (Freeman, 1991; Toulmin, 1958; Toulmin *et al.*, 1984; Mann and Thompson, 1988) – and to uncover rules of dialogues between agents of argumentation (Eemeren and Grootendorst, 1992; Walton, 1989). A usual approach to argumentation analysis includes the 'cleaning' of the protocol and the abstraction of utterances into propositions.

In contrast to these discourse analysis approaches, rhetorical analysis is not concerned with describing linguistic units or their interaction. Instead, it considers how a document or speech obtained its persuasive power. To enable this type of analysis, the larger situation that the text is made in, style, arrangement, the audience aimed at and rhetorical figures are considered and described.

4.3 A coding scheme to analyse team design discourse

A team-frame needs to be established amongst the designers who have made sense of the situation individually as part of the micro-level process. This object is achieved through and contained in their discourse; the interaction between participants that describes this process was termed the rhetorical construction of understanding. Discourse analysis can be used as a method to study designers' discourse where designers share their comprehension by externalising their thoughts and reasoning. As part of this thesis, a coding scheme inspired by the New Rhetoric (Perelman and Olbrechts-Tyteca, 1971) was developed, which highlights the selection of facts introduced to the team and argumentation schemes chosen by participants to develop the argument. The coding scheme allows the role that these units of argument play to be clarified, markers to be given that indicate when a frame starts or shifts and illuminate how teams develop their design concepts and how they negotiate terms. A detailed discussion of the application of the coding scheme to analyse design discourse in relation to experiential learning will be given in section 4.5.

The coding scheme that has been developed is an abstraction from the original classification provided by Perelman and Olbrechts-Tyteca, in that collections of basic units of argument are coded that fulfil similar functions. The main categories that have been included deal with premises, association based on the structure of reality, association establishing the structure of reality and dissociation. A generic account of the coding categories will be outlined in section 4.3.1 to 4.3.5. The coding scheme was developed to reflect our interest in persuasive terms that draw their effect from the content that they convey, rather than the form that they take. Hence, quasi-logical argumentation schemes – which can be found in Perelman and Olbrechts-Tyteca's original classification – were excluded in our coding scheme because these mainly

relate to structural form. It should further be noted that some categories are defined as collections of more basic argumentation schemes. Therefore, examples and analogies *per se* are not distinguished in codes; instead, an abstracted code is applied to show that they both establish the structure of reality. This does not mean that examples or analogies as such are not recognised, rather this approach slants the interest towards the common, higher-level functions of these types of argumentation schemes. In sections 4.3.2 to 4.3.5, this grouping into units within our coding scheme is outlined and justified in more detail. A summarisation of coding scheme can be found in Appendix 2.

4.3.1 Premises

As starting points for argumentation, premises that are considered real or preferable by the audience are recognised in the coding scheme. Real premises are defined by Perelman and Olbrechts-Tyteca (1971) as facts, truths or presumptions, whereas preferable premises are values, value hierarchies and loci. Real and preferable premises are included in the coding scheme as shown in Table 4.1.

ARGUMENT UNIT	INSTANCE	BRIEF DESCRIPTION	CODE
Real Premises – 'what is'	Facts	Premises that can be 'objectively' confirmed or that don't need justification	F
	Presumptions	Premises that are agreed upon until disconfirming evidence presents itself	P
	Truths	Premises that embody a system of beliefs	T
Preferable Premises – 'what should be'	Values	Premises that state a preference	V
	Value Hierarchies	Premises that express an ordering of values	VH

Table 4.1 – Real and preferable premises recognised by coding scheme

Real premises are coded as statements relating to 'what is'. Specifically, facts are found by looking for statements that refer to an 'objective reality' and follow from observation, that require no justification or that have conditions of verification. Presumptions are statements that are expected to be reinforced at a later point or are

believed in until some disconfirming evidence comes to light, since they conform to an expectation of what is normal and likely. Truths embody a system of thought – for example, scientific theories – that collect connections between facts.

For preferable premises – statements referring to 'what should be' – the aim is to differentiate between values and value hierarchies in the coding scheme. Statements referring to values state a preference and condone particular ways of acting, whereas value hierarchies express an ordering of values.

In practice, it was found through applying earlier versions of the coding scheme to design discourse that these distinctions between facts, presumptions and truths are very difficult to make. It was noted that often any statements that were real premises were coded as facts indiscriminately. Additionally, there are also problems in distinguishing values and value hierarchies, and values were often coded as a label for any preferable premises. Loci – so-called 'commonplaces' identified by Perelman and Olbrechts-Tyteca (1971), such as 'the whole is preferable over parts', etc. – are abstracted preferences that are only tacit and not explicitly stated in discourse. For this reason, they are not included in the coding scheme.

4.3.2 Argumentation schemes

The arguer, starting from shared premises that the audience accepts, introduces statements that she would like to have accepted by the audience through using the argumentation schemes outlined in Table 4.2.

Rhetorical argumentation schemes that provide links between statements are called associations. The connection of an already accepted statement to a concept that the arguer wishes to be accepted can occur by various means. The main ways of connection

to which we pay attention are associations based on the structure of reality and associations to establish the structure of reality, which are described in sections 4.3.3 and 4.3.4. Dissociation as an argumentation scheme will be discussed in more detail in section 4.3.5.

ARGUMENT UNIT	INSTANCE	BRIEF DESCRIPTION	CODE
Association Based on Structure of Reality	Causal	Links sequential phenomena e.g. cause and effect, means and end	ABS
	Co-existential	Links phenomena on same level e.g. essence and manifestations, persons and acts, events and characteristics	
	Double hierarchy	Links two value hierarchies or two terms from different value hierarchies	
Association Establishing the Structure of Reality	Example	Establishes a generalisation from particular cases	AES
	Analogy	Establishes a similarity of relationships	
	Metaphor	Establishes a similarity	
	Model / Anti-model	Establishes a rule of behaviour because someone else serves as a model/anti-model	
Dissociation		Separates notion to overcome incompatibility	D

Table 4.2 – Argumentation schemes recognised by coding scheme

4.3.3 Association based on the structure of reality

Association based on the structure of reality tries to exploit the reality as constructed by the audience. This can occur by providing a causal or co-existential association between two already accepted facts, or by drawing an association between two concepts in a value hierarchy. For example, a causal or co-existential link that associates an accepted premise and a statement tries to exploit the reality as constructed by the audience, i.e. it expects that the statement has to some degree already been accepted as valid and the association ‘spells it out’ for all to see. An example of this is given in Figure 4.3.

Association based on the structure of reality	"Ministers accept that vacancies in the home counties are unusually high this year. A new scheme is being piloted to give public sector workers in expensive areas interest-free loans to buy their first homes."

Figure 4.3 – Example of Association Based on the Structure of Reality (ABS)[6]

Causal associations aim to establish a sequential link between two events (as in Figure 4.3), such as cause to an effect or means to an end – or vice versa. Arguments of waste, direction and unlimited development also fall under the category of causal association. In contrast, the co-existential argumentation scheme draws on links that are on the same phenomenal level and not sequentially related. For example, a co-existential link is established when arguing from an essence to its manifestations, such as the interplay between people and their acts or groups of events and their characteristics. Co-existence transfers some qualities from an observable fact to unobservable consequences. The co-existential argumentation scheme also includes arguments by authority or sacrifice. In addition, links can be established through drawing on the argumentation scheme of double hierarchy. In this argumentation scheme, two value hierarchies are connected either as a whole or by linking from one term in one value hierarchy to another term in a different value hierarchy. This is often backed up by references to proportionality or statistical correlation.

4.3.4 Association establishing the structure of reality

Association to establish the structure of reality tries to draw a new link to a new statement. To achieve this effect examples, analogies or metaphors are used to construct a piece of reality to attend to. An example of association establishing the structure of reality is given in Figure 4.4.

[6] The use of argumentation schemes is illustrated by examples taken from an article published in the Guardian newspaper, Friday, 2 Feb 2001, pages 1 and 2, entitled "Teacher recruits to get 6% pay boost" in Figures 4.3,4.4 and 4.6.

Association establishing the structure of reality	"The unions say recruitment problems are not confined to London and the Southeast.[...] This week the Department for Education and Employment's emergency unit to deal with shortages was called into action to help a school in Middlesborough, Brackenhoe secondary, which had to send more than 100 pupils home for three days after illness hit staffing, which was already down because of two vacancies."

Figure 4.4 – Example of association establishing the structure of reality (AES)

Examples are drawn from actual and concrete cases and thus enjoy the same status as facts in terms of strength. When examples are used, an attempt is made to establish a link through generalisation by referring to a particular case. Examples are particularly effective when more than one, bearing some similarity, are given to establish the rule. Illustrations, according to Perelman and Olbrechts-Tyteca (1971), work differently as they strengthen a rule, which has already been accepted by the audience. Moreover, instead of being an example from real life, illustrations can be fabricated and hypothetical. Whilst we agree on the differentiation between example and illustration on the basis of specific, real-life instances versus made-up, hypothetical instances respectively, we do not agree with the distinction based on the establishment of a new rule versus the strengthening of an existing rule. If an illustration only strengthens a rule, the question remains how this link is established in the first place. Consider for example the following instance in Figure 4.5.

Case A - Rule establishment through an example	Case B - Rule establishment through an illustration
I got blisters when I went up a mountain and wore new trekking shoes.	*Say, if one goes up a mountain and wears new shoes, one would get blisters.*
Rule established: Wearing new shoes when climbing mountains causes blisters.	Rule established: Wearing new shoes when climbing mountains causes blisters.

Figure 4.5 – Example and illustration used to establish rule

In Case A above, a specific case – one's own experience – is generalised; by the above definition, the rule is established through an example. In Case B, the same rule can be established through a hypothetical case: the rule does not have to exist beforehand. Rather than strengthening a pre-existing rule, illustrations as hypothetical cases can be used to establish rules. However, the issue of the strength of the established rule is not the concern of this thesis: the weight that the established rule carries may be less when it is established through an illustration than when it is established through an example.

A further means to establish the structure of reality is by the use of analogy or metaphor. Analogy can be distinguished from metaphor in that analogy is a 'resemblance of relationships' that is used to transfer knowledge. Analogies usually take the form 'A is to B as C is to D'. 'A is to B' is usually known as *theme* and 'C is to D' is called *phoros*. The *phoros* is usually more concrete and the *theme* more abstract. A metaphor, on the other hand, is a condensed analogy where *theme* and *phoros* are fused. Its structure is therefore usually 'A is C' or, even more simply, an alteration of a word or phrase from its more usual meaning, for example 'an English rose'. Lastly, the argumentation scheme of model/anti-model establishes a rule of behaviour on the basis of a model, i.e. one should/should not adopt a certain kind of behaviour because someone else serves a model/anti-model. In the coding scheme presented in this thesis, these argumentation schemes are integrated by coding at a level of higher functional abstraction, i.e. that they establish the structure of reality.

4.3.5 Dissociation

One final unit of argumentation to which is paid special attention is the argumentation scheme of dissociation. This argumentation scheme can be recognised by the separation of an established notion into two new concepts. Dissociation is triggered by the feeling of an incompatibility, which is overcome by the introduction of the argumentation

scheme. Dissociation is the not the same as decomposition. Rather, dissociation is used to bring about a change in the conceptual data – the way we perceive things – that is used in the argument; it implies a creative change in the way we perceive reality. The definition of dissociation stipulates that a distinction is created between the original concept, term I, and the new concept, term II. Furthermore, term II can only be understood in comparison with term I. Term II is constructed to allow the arguer to remove the incompatibilities that appear within term I. In effect, term II involves the establishment of a norm which may allow some parts of term I to be carried over. An example of how this is achieved can be seen in Figure 4.6.

Dissociation	"Most of the 200,000 teachers who applied for the threshold payments under a new performance-related pay scheme will receive them. Unions insist these payments should be seen separately from the overall pay deal."

Figure 4.6 – Example of dissociation (D)

To code dissociations we can also make use of the fact that dissociations are often expressed in definitions, or by markers such as "really" sometimes in conjunction with "apparently", "either/or", "one of, another is" and "part of" (Perelman and Olbrechts-Tyteca, 1971). Furthermore, dissociations also can be signalled by distinctions, for example the marker "yes, but" (Goodwin, 1991), and objections that introduce new terms.

4.4 The team design discourse example

4.4.1 Experimental setting

The design exercise used to demonstrate the coding scheme in this chapter was originally set up as part of a workshop to investigate differing approaches to protocol analysis (Cross *et al.*, 1996). The design team session was videotaped and transcribed.

This material, often referred to as the Delft Design Protocols, along with the sketches produced by the designers, has been made available to design researchers throughout the world.

The team consisted of two male designers – Ivan (I) and John (J) – and one female designer – Kerry (K). Each designer had three to five years experience and all had worked with each other in the past. The designers were asked to develop a conceptual design to connect a backpack to a bicycle, for which the team had a total of two hours. The team was expected to provide drawings and a costing estimate of their finished design concept. A backpack and mountain bicycle were made available to them. Furthermore, detailed information and specification material – such as marketing reports, feasibility studies, user tests and specification drawings – were available on request.

4.4.2 Design session overview

The team spend the first five minutes of the design session reading quietly and individually through the exercise brief. This is followed by team designing where they firstly discuss the general problem contained in the brief and try to figure out what they are to design. Instead of trying to pin down the requirements, the problem is kept open and unfixed. An example of this behaviour from the discourse is provided in Figure 4.7[7].

Ivan:	Well, it doesn't say anything about going external or internal so that I think that you raised a good point […] yeah that we have that freedom right now. (9th minute)

Figure 4.7 – Ivan keeps the problem open

[7] The transcription convention used within this thesis is summarised in Appendix 3.

The team proceeds to explore implications of fixing backpacks to different positions on the bike as a way to develop solutions: projecting from front, situated within the diamond shape and attaching the backpack to the rear of the bike. During this time, they use experiments to increase their understanding about the problem situation. An experiment of hooking the backpack to the front – "like an old bike basket" (27th minute) – brings with it the appreciation that the user will find it difficult to steer the handlebars. They aim to bring the centre of gravity low with placing the rucksack in the middle – "like a motorcycle gas tank" (28th minute) – and that brings forth the problem that this position interferes with the bicyclist's knees whilst pedalling. Finally, they settle on a rearward-facing position, not before having come up with 'non-ideas' such as "just wear it" (25th minute). Once they have decided to concentrate on the back of the bicycle, John states that the problems that they have to solve concern the joining of the backpack to a frame and the frame to the bike (35th minute). Kerry, however, disagrees with him on what the problem is (Figure 4.8).

Kerry:	you've already got that nice frame on the pack it'd be nice if we can take advantage of that [...] it seems redundant to have that and the frame. (36th minute)

Figure 4.8 – Kerry disagrees on what the problem is

This disagreement is not discussed within the team, since it is interrupted by a conversation about operating the electronic whiteboard. Only later does John take Ivan aside to follow up the issue of using the frame only, but they decide that there should be a separate rack nonetheless (41st minute). The team then goes on to generate various attachment orientations and options for the frame, e.g. "it's a bag" (42nd minute). Nevertheless, Kerry is tenacious about not having a separate rack (Figure 4.9).

Kerry:	now we're kind of assuming that there's some rack to attach this to but what if the rack was really something that attaches to this and just flips down so maybe you hook it on to a bracket up here but you just flip down and it clips in here (43rd minute)

Figure 4.9 – Kerry does not want a separate rack

This idea is worked through and implications for the user are noted, such as weight, swinging the leg over the pack, low centre of gravity and attachment points to the bike itself. Ultimately, this idea is rejected, however, in favour of a separate rack (Figure 4.10).

John:	maybe it's a little bucket that it sits in (59th minute)

Figure 4.10 – John introduces a 'bucket' idea

A vertical position is tried out for the rucksack, but rejected due to the problem of the user being unable to swing a leg over it. Attaching the rack to the back of the bike also brings forth the idea of "a little trailer" (61st minute). Both these ideas are criticised with understandings gained through earlier attempts that highlighted issues of manufacturing and user handling.

The team eventually settles on a horizontal rack. Material and joining options are discussed. An earlier idea of a bucket that the rucksack sits in is reprised and then amended to a tray idea (Figure 4.11).

John:	so it's either a bag or maybe it's like a little vacuum formed tray kinda for it to sit in (79th minute)

Figure 4.11 – John suggests a 'tray' idea

This idea finds appeal and is negotiated and developed with the team working through its implications for joining, keeping the backpack straps clear of the wheels, and keeping the rucksack on the tray. For the final 30 minutes of the design session, they draw their design concept in detail (Figure 4.12), get dimensions from the bike, and calculate the cost of the product they are designing by finding estimates for individual items.

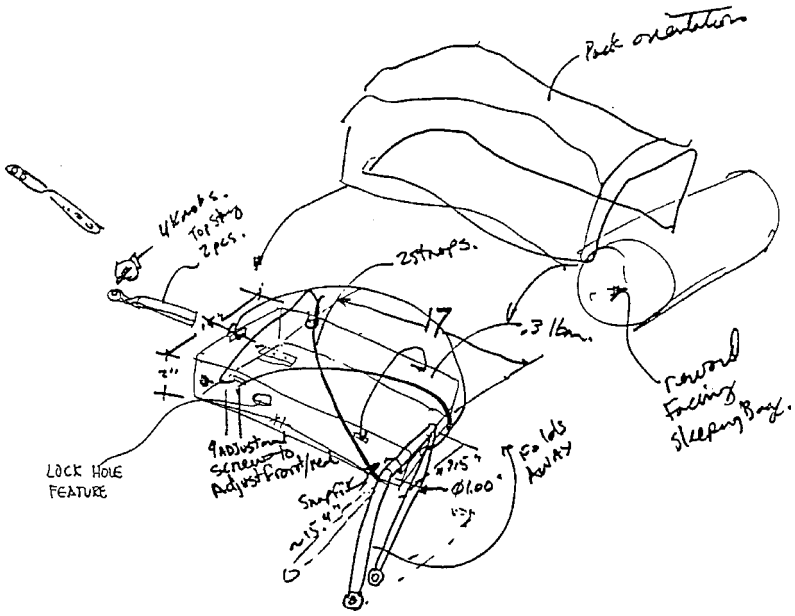


Figure 4.12 – The team's drawing of their final design concept

4.5 Analysis of team design discourse

The coding scheme identifies units of argumentation in design discourse. In the complete transcript of the example team design session lasting 2 hours, 294 associations and 19 dissociations can be discerned. Out of the associations, 121 establish the structure of reality and 173 are associations based on the structure of reality. In the sub-sections below, we provide examples of argumentation in design discourse, drawn from the example design session. This will allow us to show how designers achieve rhetorical construction of understanding and how argumentation is used in this process. We

particularly concentrate on premises, associations based on the structure of reality, associations establishing the structure of reality and dissociations and their role in team experiential learning.

4.5.1 Premises and experiential learning in design

As part of our coding scheme, real premises such as facts, truths and presumptions and preferable premises such as values and value hierarchies can be identified. Intricately connected to premises, as Perelman and Olbrechts-Tyteca (1971) note, is the notion of presence. Not all premises are expressed explicitly, although the audience agrees to them. Moreover, an exhaustive list of all premises to which the audience assents cannot be constructed. The premises not explicitly expressed nonetheless act as background for the audience and form a general 'frame of reference', which can be drawn on in the course of the argument. Out of this background, the arguer needs to select certain facts for attention.

> "By the very fact of selecting certain elements and presenting them to the audience, their importance and pertinency to the discussion are implied. Indeed, such a choice endows these elements with a *presence*, which is an essential factor in argumentation and one that is far too much neglected in rationalistic conceptions of reasoning." (Perelman and Olbrechts-Tyteca, 1971, p. 116)

This selection and focussing brings certain premises into the presence of the audience. Perelman and Olbrechts-Tyteca point to similarities of this process in visual perception, where one attends to and neglects other things to make these elements come into conscious consideration. In rhetoric, the arguer employs 'verbal magic alone' to make these facts present, since it is not sufficient for facts to exist to bring them into presence. The way that the arguer can make elements present is by employing certain speech patterns and rhetorical figures. General speech patterns to increase presence include dwelling on a subject or switching to a slow delivery. Emphasis on certain elements, by

intonation, pausing or evoking details, can also add to the feeling of presence. All of these patterns work through the amount of time, proportional to other aspects, that is spent on the establishment of presence. Rhetorical figures that can be used to increase presence are built on repetition, amplification, synonymy, imaginary direct speech and the shift into present tense. These presence markers are made use of in the representation to model design discourse, which is proposed in chapter 6.

Since by using the coding scheme the premises that are brought into presence can be tracked, one can get a ‘handle’ on what the arguer and the audience accept as valid. This defines the boundary of their attention by highlighting what they select as important and provides access to the way reality is perceived by the team. In argumentative terms, it is critical to understand the shared background of the audience; therefore, the arguer needs to be aware of the premises or ‘points of departure’ that the evaluating audience accepts as valid. This characterisation of shared background can be linked to the notion that frames set a boundary of attention and that names select what we treat as ‘things’ of the situation. Hence, it is not possible to falsify a frame by reference to objective facts since it is only the premises that the audience as a whole accepts which are counted as facts – “there are no objective observers” (Schön and Rein, 1994, p.30). Each utterance by a participant in team designing acts as an invitation to see the situation in the way of the speaker (Crosswhite, 1997), narrows the focus of attention and sets up an accepted premise. The inclusion of preferable premises gives us the ability to consider the role of values and the shaping of them in the design process. In addition, premises selected for attention are interconnected to a certain interpretation of the problem.

> "Effective presentation that impresses itself on the hearers' consciousness is essential not only in all argumentation aiming at immediate action, but also in that which inspires to give the mind a certain orientation, to make certain schemes of interpretation prevail, to insert the elements of agreement into a framework that will give them significance and confer upon them the rank that they deserve." (Perelman and Olbrechts-Tyteca, 1971, p.142)

By the selection of facts and their presentation, a certain interpretation can be pushed to the foreground, and the same fact can serve at different levels of abstraction within different interpretations. For example, "the same process can indeed be described as the action of tightening a bolt, assembling a vehicle, earning a living, or helping the export drive" (*ibid.*, p.121).

4.5.1.1 Increasing presence – examples

Having outlined how to identify facts that set boundaries for attention, we illustrate this with examples drawn from the design session. The team increases presence by various means throughout the design discourse. One way that they make, for example, 'external frame backpack' more important is by dwelling on the subject. They discuss this subject for 2 minutes before moving on to another focus of attention (Figure 4.13).

John:	it's an external frame pack is it?
Kerry:	uh huh (...)
Ivan:	that's what the memo says?
Kerry:	that's what they're building
Ivan:	it's internal (.) internal frames they're making now
Kerry:	they're getting busted by the internal frame folks but (...) they think they think an advantage would be to make this external frame also be (.) mountable to a rack or become a rack
Ivan:	yeah (.)
Kerry:	and that would be pretty cool too
John:	they could keep selling the external frame backpacks
Kerry:	yeah
Ivan:	right (...) and bicycles
John:	OK I missed that (...)
Ivan:	which part did you miss?
John:	oh the fact that I (.) I thought I (.) picked up that they were (.) going to that they were conceiving of making an internal frame pack but (.) em I guess that's not what they're saying you're saying that they make external frame packs currently?
Kerry:	mm hmm they make external
(8th minute to 9th minute)	

Figure 4.13 – Increasing presence by dwelling on the subject

Similarly, they emphasise certain elements by pausing, sometimes creating speech that can appear hesitant (Figure 4.14).

John:	it (.) it sounds to me that what they're looking for is not (...) they're kinda looking for a an interface (.) a thing that will allow you to carry or (.) or fasten an existing (.) backpack to an existing mountain bike (7^{th} minute)

Figure 4.14 – Increasing presence by pausing

Presence, as outlined earlier, can also be created by evoking details. In Figure 4.15, John specifically draws attention to the issue of "centre of gravity and shifting weight". Ivan and Kerry then evoke details of this issue, increasing its presence.

John:	[...] sounds like this issue with uh em em the whole centre of gravity and shifting weight is
Ivan:	yeah do they talk about how the people wanna use it they uh do these do the vacations they take long bicycle trips and then take short feet off uh short trips off by foot
Kerry:	mm mm
Ivan:	em so they use the bike to get where they're going and then do a little hiking sounds like the bike becomes the
John:	so you
Ivan:	it sounds like they oughta really ride the bicycle and just temporarily go to work or something but you wanna be able to ride the bicycle
Kerry:	right mm mm
John:	does it sound like
Kerry:	ride it through the country and then you get to the base of the hill and you wanna take your backpack and summit the mountain or something (18^{th} minute)

Figure 4.15 – Increasing presence by evoking details

Finally, the importance of 'fold down' is emphasised by drawing on repetition (Figure 4.16).

John:	and fold down it should fold down or at any rate be stacked away easily mm by saying folding down they're making an assumption that it's not flat to begin with which it might be (...) a quick survey has shown that there is nothing like this on the European market OK so we have like can fold or store easily it's an accessory [...](11^{th} minute)

Figure 4.16 – Increasing presence by repetition in the team's design discourse

Presence is achieved through verbal means by increasing the time that the focus is held. That design teams spend long times on certain elements has also been noted by Valkenburg (2000) in the context of an analysis of the same team discourse. Her notion is that these passages are used to pass on frames and their ownership to the rest of the team by keeping them purposefully vague. She further maintains that she sees "very little convincing going on" (Valkenburg, 2000, p.189). A naïve and pejorative interpretation of persuasion – the 'heated debate' view of argumentation referred to in section 3.3.2 – could lead one to this assumption, however, rhetoric is more than this. Rhetoric in our interpretation is the verbal expression of reasoning (Kaufer and Butler, 1996), not how the force of language is employed to sway by manipulative means. To summarise, it was shown that designers use argumentation to bring facts into presence and highlight them from the background frame of reference. Concentrating on this aspect also allows the focus of attention to be detected, and what is named as 'things of the situation'.

4.5.2 Associations based on the structure of reality and experiential learning

Arguments that are based on the structure of reality promote a link between "accepted judgements and others which one wishes to promote" (Perelman and Olbrechts-Tyteca, 1971, p.261). They are either built on facts established and brought into presence, which we are able to identify as outlined previously, or draw attention to facts that are agreed upon within the background frame of reference.

> "The essential thing is that they [*agreements*] appear sufficiently secure to allow the unfolding of the argumentation." (*ibid.*, p.261)

This characteristic enables the use of association based on the structure of reality to identify facts that originate from this background frame of reference that the audience

agrees to. Perelman and Olbrechts-Tyteca point to associations in general as bringing an organising or evaluating factor to the process of argumentation (*ibid.*, p.190). Premises and the links between them through association based on the structure of reality build up an "appreciative system" (Vickers, 1968) of facts and values.

A further distinction is made as to the focus that this appreciative system serves. In this respect, associations based on the structure of reality assume importance both in problem framing and solution development. In problem framing, associations based on the structure of reality show how the organisation of the problem is perceived. This argumentation scheme can also be interpreted within solution development. Within experiential learning, frames impose an order on a situation, allowing one to explore and solve a problem by constructing moves. Association based on the structure of reality can form an evaluative bridge between a premise in the problem frame and a premise pertaining to the solution, where one serves as justification to the other.

4.5.2.1 Organising and evaluating – examples

Having outlined how association based on the structure of reality functions to draw in further premises from the background frame of reference, organises premises into a system and evaluates premises against each other, examples are now given of how this occurs within the example design session.

In the 9th minute of the design discourse, Kerry points out that the design should use the backpack's external frame (Figure 4.17). The external frame of the backpack has already been brought into presence just before this statement. Now she links it with a premise that this rucksack sells best, and Ivan contributes with a premise that they have a best-selling bike.

Kerry:	but they wanna use it with this external frame backpack it looks like […] because the HiStar this (.) this is a best-selling backpack the mid-range HiStar
Ivan:	right and they have their best-selling bike right" (9th minute)

Figure 4.17 – Organising premises

The function of this association is to draw out an organising feature and a potential evaluation criterion by their emphasis on the 'best-selling' aspect. A more straightforward case of association based on the structure of reality can be seen in the 16th minute, introduced by John. He makes mention of the fact that mistakes are made by the user attaching the backpack to the bicycle (Figure 4.18). This is used to draw out the preferable premise that it should be easy to attach.

John:	mistakes are made attaching the fastening device to the bike so it has to be easy to attach (16th minute)

Figure 4.18 – Organising premises

Association based on the structure of reality can also be used in developing the solution. In the 18th minute, Kerry associates the fact that it is an off-road bicycle with the notion that it needs a strong attachment (Figure 4.19). In this instance the premise that it is likely to be driven on a bumpy terrain is used as a justification for a strong attachment.

Kerry:	and it's an off-road bike so you'd need a real rugged (.) rugged attachment or a rigid attachment (18th minute)

Figure 4.19 – Justifying solution ideas

Rather than serving as a justification, this argumentation scheme can also be used to evaluate solution ideas, as in Figure 4.20. John uses 'limiting the market' to evaluate the idea of designing the rack and its mounting points specifically on a particular brand of bicycle.

John:	so I (.) I guess my point is I think if you designed it specifically around mounting points (.) no mounting points on this bike (.) you might get yourself into trouble by limiting your market a lot (87th minute)

Figure 4.20 – Linking problem and solution

In this section, it was shown how association based on the structure of reality functions as a scheme that introduces organisation and evaluation into the design discourse. It is used by designers to justify or evaluate certain solution developments in relation to their current understanding of the problem. Association based on the structure of reality allows us to draw in the background frame of reference by the way that designers organise the premises.

4.5.3 Association establishing the structure of reality and experiential learning

So far, it has not been discussed how new ideas are introduced. The argumentation scheme that establishes the structure of reality plays a major part in this process. Association establishing the structure of reality draws on an accepted premise that has been brought into presence and establishes a new rule or premise. Examples and illustrations provide a reference to a particular case and try to establish a generalisation from it. Sometimes, this is adapted to argue from a particular case to another particular case. Analogy and metaphor are used in "imaginative thinking" (Perelman and Olbrechts-Tyteca, 1971, p.372). In fact, this use of analogy and metaphor is well documented in design specifically (Gordon, 1961; Schön, 1963; Cross, 1997) and other fields in general (Gross, 1990; Gilhooly, 1996; Dunbar, 1997; Smith, 1998). What strikes us as most important in this argumentation scheme is the way that it is used to develop a solution further by introducing new notions and understandings. Analogies

"facilitate the development and extension of thought" (Perelman and Olbrechts-Tyteca, 1971, p.385) and examples enable the adaptation of notions.

> "Particularly in argument by example are the meaning and scope of notions influenced by the dynamic aspects of their use. Moreover, this adaptation, this modification of notions usually seems so natural and so in harmony with the needs of the situation that it goes almost completely unnoticed." (*ibid.*, p.356).

In particular, it seems that the "plasticity of notions" (*ibid.*, p.138), which both analogy and examples afford, drives the design forward by bringing new understandings into focus.

4.5.3.1 Flexible notions – examples

Examples are now given of how the plasticity of notions is achieved through the use of association establishing the structure of reality in the Delft Design Protocol. First of all, examples and illustrations can be used to explore the understanding and introduce new premises. For example, in the 18th minute of the design discourse, Ivan and Kerry go through an illustration in which situation the product would be used (Figure 4.21).

Ivan:	it sounds like they oughta really ride the bicycle and just temporarily go to work or something but you wanna be able to ride the bicycle [...]
Kerry:	ride it through the country and then you get to the base of the hill and you wanna take your backpack and summit the mountain or something (18th minute)

Figure 4.21 – Introducing new notions

In this illustration they highlight the context of their design concept: the product they are designing must not get in the way of the user riding the bike normally and using the backpack occasionally. Their illustration is similar in use to scenarios to establish requirements (Erickson, 1995).

Designers also use examples to establish a new premise. In the following extract (Figure 4.22), John points to the brittleness of aluminium in extreme temperatures by providing a personal example. In this case, he tells a story of his experience.

John:	hold on yeah materials wise too if we used um aluminium tubing instead of er instead of steel tubing not only is there a weight savings but we could er meet the ugly spec [...] by anodising it in a bunch of different colours [laughs] [...] but the only the only thing I know that's wrong with aluminum is if you've ever skied I had my ski poles fracture on me in really cold temperatures and er I was skiing in Denver one time and my ski pole bent in half and not only did it bend in half it broke when it bent (1 hour 15 minutes)

Figure 4.22 – Introducing new notions

Rather more interesting is the use of analogy and metaphor within the design team. Individuals in the team introduce notions within these analogies. The 'bucket' notion in the design discourse excerpt (Figure 4.23) functions as a shorthand to allow the designer to express complex notions succinctly. This term functions as a keyword (Nothdurft, 1996), which encapsulates understandings and positions unfolded over the course of a discussion.

John:	well maybe a rack eh maybe it's a little bucket that it sits in [...] (59th minute)

Figure 4.23 - Introducing new solution terms by analogy

In this section, it was shown how associations establishing the structure of reality work to establish new premises by either generalisation or similarity. Particularly, it was highlighted how this argumentations scheme makes use of the plasticity of notions to drive the solution development forward. The notions function as keywords that encapsulate understandings and positions in the design discourse.

4.5.4 Dissociation and experiential learning

In this section, the argumentation scheme of dissociation is discussed, which we claim gives us a direct relationship to the notion of reframing in Schön's work (1984, 1987, 1988, 1991, 1993, 1994).

As a top-level comparison between the notions of reframing and dissociation, Table 4.24 is presented. In individual experiential learning, the discernment of a dilemma of incompatible or inconsistent demands, i.e. the perception of a misfit (Alexander, 1964), triggers surprise in the designer. Surprise provides an opportunity to reflect and allows the designer's understanding to be examined, leading potentially to reframing to overcome the misfit. In the coding scheme, dissociation is introduced to overcome a perceived incompatibility by separating an established concept into new concepts.

	Individual Experiential Learning	Rhetoric
Triggers	Surprise about misfit can lead to reframing	Perceived incompatibility can be removed by dissociation
Worlds	Frames are worlds that hold certain rules and reframing are changes between worlds	Dissociation breaks previously held links
	Reframing changes the way a problem is seen	Dissociation changes the conceptual data
Basis	Generative metaphors, which provide a direction for solution, underlie frames	Dissociation establishes term I and term II; term II is interpreted in relation to term I and provides a rule for evaluation
	Normative dualisms	Philosophical pairs

Table 4.24 - Comparison of reframing and dissociation

Schön points out that frames carry within them a view of what the problem is and how to solve it. They construct design worlds in which certain "configurations of things, relations and qualities" (Schön, 1988) hold. Reframing changes our view of the problem and consequently has an impact on the structure of design worlds. Similarly, dissociation changes our view of the conceptual data – the way that reality is – by breaking with previously held relations and concepts.

As discussed in section 3.7, Schön (1990, 1993) locates the basis of framing – and reframing – in generative metaphors[8]. These provide a structuring of the situation, supply some of the names and set a direction for solution. A dissociation works by breaking a link or concept into term I and term II, whilst at the same time establishing a rule for evaluation through the comparison of term I with term II.

> "In relation to term I, term II is both normative and explanatory." (Perelman and Olbrechts-Tyteca, 1971, p.416)

On a more basic level, both approaches involve 'normative dualisms' or 'philosophical pairs' as background systems.

On the basis of this comparison between reframing and dissociation, we suggest that a dissociation code can be used as a footprint for an attempt at reframing on the part of an individual in relation to the team-frame. This does not mean that a reframing at the team level actually takes place, similar to the situation that surprise is a necessary pre-condition for individual reframing but not a sufficient cause. At a team level, the dissociation still needs to be accepted by the audience. It is developed and negotiated by associations; the team works with the new concept and the norms established through the separation of concepts.

4.5.4.1 Changing the way that reality is perceived – example

An example of how a participant attempts to change the way that the team perceives reality is shown in the extract from the design session in Figure 4.25. An incompatibility is noted in that problems occur with a tray concept if the bag to be placed on it is too big for it. The 'tray' notion is separated into one that is a plastic rigid

[8] For our discussion, we limit ourselves to generative metaphors as a basis for framing built on language. A perceptual basis for framing also exists in visual prototypes.

tray and one that is like a net. The 'net' offers positive qualities; it is better than 'plastic tray' because it can accommodate different sized objects. However, it is only an attempt at reframing and it needs further agreement, which in this specific case is not forthcoming.

Ivan:	uh uh what if your bag were big er what if you're (.) you're on er in this tray were not plastic but like a big net (.) you just sorta like pulled it around and zipped there (.) I dunno (80^{th} minute)

Figure 4.25 – Removing an incompatibility through dissociation

In this section, it was shown that dissociation can be used as a marker for potential reframing. The notion of reframing and dissociation were compared with respect to their triggers, worlds and bases, and commonalities identified. An example of dissociation in the Delft Design protocol was given. Attention was drawn to the fact that a dissociation is introduced by an individual to affect the team frame, however that further agreement is need for this reframing to actually occur. In the next section the unfolding nature of team design discourse is discussed; it includes acceptance of framing and when reframing is rejected.

4.5.5 The unfolding of design discourse

In this section, it is discussed how association and dissociation work together to provide an unfolding of the team design discourse. It is described how a dissociation is accepted and developed. In contrast, an example of a dissociation being blocked is also provided.

4.5.5.1 Reframing acceptance

By introducing a dissociation, an individual attempts to create a new conception of reality. At a team level, the dissociation needs to be accepted by the audience i.e. the other design participants. This can occur by explicit agreement or by more implicit means. A sign that implicit acceptance has occurred is evidenced in the way that the

dissociation is taken on by the other members in the team and developed. Associations develop the new notion of reality, providing a chain of arguments that work with the recently dissociated concept and norms established through the dissociation. In terms of a process of argumentation, this finds echoes in Freeman (1991). He puts forward the notion of ‘gappiness’ – to show that further arguments are only required when a gap of connection is perceived and added reasons to support a new concept are needed. However, the notion introduced is still flexible and undergoes negotiation, with regards to the particular term that is associated with it, the elements that the new notion is composed of and which previously accepted premises can be carried forward to the new frame. It can be observed that the team works with the new concept and the norms established through the separation of concepts until a further misfit is perceived; this triggers a new round of deepening understandings.

4.5.5.2 Unfolding design discourse – example

In Figure 4.26, we present an excerpt of the transcript at the point where the team is working towards finding a design that fits at the back of the bicycle, toying with a ‘bag’ idea on top of a rack, which enables the backpack to be contained and cinched down. Although they have worked for almost forty minutes since the first time ‘bag’ was mentioned, one participant of the team notes an incompatibility and opens up the problem of what to do with the straps of the backpack (annotation 1). This incompatibility is removed by a dissociation (annotation 2). In effect, the ‘tray’ concept and the ‘bag’ concept get separated from one another, drawing out the value of containing the straps of the backpack and establishing a norm which allows some elements of the ‘bag’ concept to be taken over. One of these elements, for example, is that the ‘tray’ concept would also solve the ‘rooster tail’ problem, which occurs when rainwater picked up by the tyres splashes onto the bicyclist’s back. This was something originally identified with the ‘bag’ concept, but is now incorporated into the new frame.

Once the new concept is created, a negotiation ensues where the concept is developed and justified. This is achieved by the use of association, both based on the structure of reality and establishing the structure of reality (annotation 3). During the negotiation another incompatibility is arrived at (annotation 4). The concept ‘tray’ gets dissociated (annotation 5) to remove the incompatibility of a big backpack with the original concept, this time by the suggestion of using a kind of net. It can be observed that the proposer of the idea puts forward further grounds to strengthen his suggestion and a negotiation ensues which defines the sense the team will associate with the term ‘tray’ (annotation 6).

Coding		Transcript	*Annotation*
	Ivan	we'll just call it that for now, er, bag, put it in a bag, we're gonna need some sort of thing to do something with those straps	*1*
	Kerry	to get this out of the way	
	John	yeah	
	Ivan	yeah, either the	
D	John	so it's either a bag or maybe it's like a little vacuum formed tray kinda for it to sit in	*2*
AES	Ivan	yeah, a tray, that's right, OK	
	John	'cos it would be nice, I think, I mean just from a positioning standpoint if we've got this frame outline and we know that they're gonna stick with that, you can vacuum form a a tray or a (inaudible)	
ABS			
	Ivan	right or even just a small part of the tray or I guess they have these	
	Kerry	(inaudible) so something to dress this in	
	John	yeah	
	Ivan	or even just em	
AES	John	maybe the tray could have plastic snap features in it, so you just like kkkkkk , snap your backpack down in it	*3*
	Ivan	mmmm , I was thinking of, er	
AES	Kerry	snap in these rails	
	John	it's a multifunction part, huh	
AES	Kerry	you just snap in these rails	
AES	John	yeah, snap the rails into the tray there	
	Kerry	mm mm	
	Ivan	OK	
ABS	John	it takes care of the easy, it takes care of the rooster tail problem on your pack	
	Ivan	uh uh, what if your bag were big, er, what if you're you're on,	*4*
D		er, in this tray were not plastic but like a big net, you just sorta like pulled it around and zipped there, I dunno	*5*
AES	John	maybe it could be part, maybe it could be a tray with a with a net and a drawstring on the top of it, I like that	
ABS	Ivan	yeah, I mean, em	
	John	that's a cool idea	
AES	Ivan	a tray with sort of just hanging down net, you can pull it around and and zip it closed	
	John	(inaudible)	
AES	Kerry	it could be like a a a window shade, so you can kinda, it sinks back in, so it just	*6*
AES	John	oh yeah	
	Ivan	it retracts yeah	
AES	Kerry	you pull down, it retracts in	
	John	a retracting shade	
AES	Ivan	right right	
ABS	Kerry	so that that's not dragging in the spokes if you don't have anything attached	

Figure 4.26 – Excerpt from team design discourse (79th minute to 81st minute)

In Figure 4.26, we have shaded the areas between dissociations in differing colours to indicate where concepts are established and developed. This, however, is not to be taken as a linear process where previously gained information is discarded. Rather, as frame shifts are essentially hermeneutical, relevances from previous concepts are carried over and used to inform ongoing design.

The analysis of the transcript offers some useful insights into team processes, for example, a pattern of association clusters can be seen – especially associations extending what is attended to – surrounding dissociations. In these instances, team participants use the persuasive figures to develop and negotiate a newly introduced dissociation, giving implicit assent to the dissociation. Sometimes opportunities for reframing are not taken up, as outlined in the following section.

4.5.5.3 Rejected reframing

There are two ways that reframing on a team level does not occur; these are associated with the way that agreement to a dissociation is withheld. Explicit disagreement with the attempt at reframing is one way this occurs, where one individual effectively blocks the dissociation proposed by another. An example of where this occurred in the design session is shown in Figure 4.27. In this instance, John introduces a dissociation stating that there are two joining problems: the attachment of the backpack to the rack and the attachment of the rack to the bicycle. Kerry counters this explicitly. For her, there is only one joining problem: the attachment between bicycle and the external frame of the backpack.

John:	OK well (unintelligible) er some something comes to mind which threw out velcro because it er happens to [laugh] it has to be a [...] we (.) we have two joining problems (.) we have the frame to the bike and then we have the pack to the frame [...] the the obvious solution just says really its very its like add something to your er internal frame of the pack and increase the cost of the pack [...] I mean its an option you can buy with the pack or something but
Kerry:	you've already got that nice frame on the pack it'd be nice if we can take advantage of that it seems redundant like at this" (35th minute)

Figure 4.27 – Rejecting an attempt at reframing

However, rejection of reframing can also be achieved by less obvious means. We have observed that where dissociations are introduced but not strengthened by associations, a shift in the team's understanding does not take place. This carries with it certain dangers. Crawshay-Williams (1957) stressed that controversies arise when the group of people taking part in an argument do not in fact share the same context of statements or the context has shifted for some of the members, resulting in individual members interpreting statements in these different contexts. If disagreements with the current framing remain implicit, the team might end up with frame conflict. In this case, by holding different frames that are not reconcilable, the members of a team bring differing interpretations to facts and what actions need to be taken (Schön and Rein, 1994). Hence, instances where this implicit rejection takes place could send the design team off in a direction away from the establishment of a team-frame.

To summarise, dissociations and ensuing associations can be used as rhetorical identifiers of potential frame shifts. A misfit sets up a potential for a frame shift, which is resolved by the introduction of a dissociation. At the same time, the dissociation introduces a new way of 'seeing', which is then developed and negotiated within the team if assent has been given explicitly or implicitly. This gradual unfolding of the design discourse takes place over the length of the session:

> "Moreover, the work of framing is seldom done in one burst at the beginning of a design process. Designing triggers awareness of new criteria for design: problem solving triggers problem setting." (Schön, 1988)

However, it was also discussed instances when attempts at reframing are rejected, either explicitly or implicitly. It was highlighted that implicit disagreement with dissociations can set teams on the road for frame conflict.

4.6 Validity in discourse analysis

As pointed out in section 4.2, discourse analysis is an essentially qualitative method and therefore strongly embedded in the interpretation of the researcher (Strauss & Corbin, 1998). However, qualitative research can still make claims on validity. Gee (1999) points to convergence, agreement, coverage and linguistic detail as measures of validity in discourse analysis. To start from the latter, it is argued that the analysis is more valid the closer the analysis is tied to details of linguistic structure. Coverage concerns the range of related data that the analysis can be applied to. Agreement is a measure as to how much both 'native speakers' and other discourse analysts tend to agree with the conclusions of a particular analysis. Finally, the validity of discourse analysis is partly accorded through the number of answers it can provide to questions at various levels of description. Similarly, Strauss and Corbin (1998) offer reproducibility and generalisability as evaluation criteria for validity of qualitative research. Reproducibility deals with the notion that other researchers should be able to come up with similar findings when faced with same or similar conditions during the investigation. The criterion of generalisability measures the range of phenomena that can be investigated and explained through the qualitative analysis.

The approach that was taken as part of this thesis is to work directly from a transcript to code argumentation schemes and note how terms are negotiated. Coding therefore is

closely tied to linguistic detail. The coding scheme has been applied to a series of transcripts documenting industrial product design and software systems design; it was observed that designers use rhetorical construction of understanding in the same manner as we have described in the example design session used for illustration above, suggesting the coverage of our analysis. Questions relating to agreement and convergence are rather more difficult to answer. In the example used in this chapter, it was impossible to gain feedback directly from the discourse participants and therefore we are unable to say whether they assent to our interpretation. However, in other studies, one of which is discussed in detail in chapter 7, we were able to discuss our interpretation with participants extensively. Agreement with the findings by other researchers is also hard to obtain since our kind of approach has not been attempted previously. Similar studies based on the Delft Design protocol, however, highlight the role of argumentation and persuasion in team designing (Trousse and Christiaans, 1996; Cross and Clayburn Cross, 1996) and the use of framing (Valkenburg and Dorst, 1999).

To provide some initial indication on the consistency of the basis of our interpretation, our approach to coding argumentation schemes was submitted to a test of inter-coder reliability. Discussion of the background and derivation of our conclusions provides other researchers with a detailed understanding of our approach; it therefore offers a means of traceability.

4.6.1 Inter-coder reliability

The reliability of coding argumentation schemes was tested by calculating the Kappa coefficient for inter-coder reliability. Kappa is proposed as a measure of inter-coder agreement on category placement, and has found favour in the content analysis field. The adoption of the Kappa statistic in discourse analysis has also garnered support

(Carletta, 1996). The Kappa measurement takes into account any chance agreement that would occur by coders placing units into categories, and corrects for this.

The Kappa coefficient is given by

$$K = P(A) – P(E) / 1 – P(E)$$

where P(A) is the proportion of times the coders agree and P(E) is the maximum number of times that one would expect them to agree by chance (Siegel and Castellan, 1988). This measure does not take into account any weighting in favour of experienced or naïve judges, or indeed any indication of the severity of disagreement.

A section of the Delft Design Protocol was presented to four coders who were asked to use the coding scheme to categorise the utterances. The section was selected from the middle of the transcript, and an expert coder had found a number of different codes within this segment. In total, the transcript covered a time period of four minutes from approximately 00:56:30 to 01:00:30, running to a length of 1 ½ text pages.

For theoretical reasons, the segment can be curtailed to the sample chosen. The distribution of K for large numbers of objects N categorised is normally distributed, and significance figures can be calculated. In the sample section, N is 105, an adequately large sample. Furthermore, the aim of our inquiry was to have assurance that the work of one main coder could – in principle – be replicated by other, less involved coders. To this end, it does not need to be shown that the entire transcript can be coded correctly. Secondly, there were pragmatic reasons for choosing a small section of the transcript. The testing of coder reliability was conducted across a small sample of text since even this resulted in some considerable time commitment by the coders. Other comparisons on codings between two experienced coders without a view to gaining quantitative

evidence of inter-coder reliability had been conducted previously. However, since the two coders had already discussed a variety of segments, the choice of previously undiscussed segments of transcript was narrowed down considerably.

For inter-coder reliability, it needs to be shown that, firstly, coders are able to use the coding scheme to code the transcript and, secondly, that the way that transcripts are coded are comparable. A very low Kappa coefficient during this investigation would have cast doubt on the usefulness of the coding scheme. Kappa therefore gives an indication whether the categories that are used are inherently distinct enough and usable by other coders. Once an adequate level of K is achieved, we can assume that no severe shortcomings exist and rely on the coding of one judge.

Four coders were given the raw transcript and a copy of the coding scheme description. Only minimal instruction was given. The coders were instructed to use only top-level codes, such as association establishing the structure of reality (AES), association based on the structure of reality (ABS) and, in the case of dissociation (D), to state in brackets which terms were dissociated. Furthermore, categories were to be written against the lines of the transcripts where they were identified. Two of the coders, Adam and Barry, were considered ‘naïve’, the two remaining coders, Carolina and Doris, had previous experience of the coding scheme and applying it to transcripts. The coders were given a week to complete the coding at their own leisure, and were free to do the coding in stages, return to the transcript or go over sections they had already coded.

Coded transcripts were processed by dividing them into units based on the separate lines in the transcript, as shown in Figure 4.28.

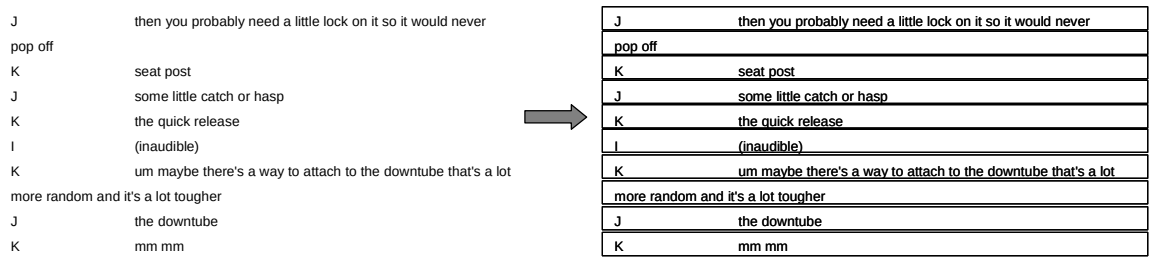


Figure 4.28 – Example of division of transcript into units

Then, for each unit the category allocated by the coders was captured. The categories were ABS, AES, D and None (uncoded unit). The number of coders who chose a particular code were summed on a unit basis to gain the scores underlying the Kappa coefficient. Kappa coefficients were calculated for the two 'experienced' coders Carolina and Doris, then calculating Kappa for Adam, Carolina and Doris and finally all four coders. This was due to the fact that an initial visual inspection without any calculation showed that codings by Barry differed the most from the other codings.

Kappa calculated for the 'expert' coders is 0.67, which indicates a moderate to high inter-coder reliability. The coefficients when 'naïve' coders are included are 0.65 when coder Adam is included and 0.54 amongst all four coders (Figure 4.29). Our best Kappa score is in the region of Kappa scores reported for a similar coding scheme based on the New Rhetoric (Warnick and Kline, 1992).

Coders included	Kappa
Carolina and Doris	0.67
Adam, Carolina and Doris	0.65
Adam, Barry, Carolina and Doris	0.54

Table 4.29 – Summary of results of kappa statistic calculation

As previously noted, the calculation of the unweighted Kappa does not take into account the severity of disagreement of the coders. Inspection of the reliability test codings

provides some indication of the way that agreement, or indeed disagreement, was reached. In the main, coders tended to agree on which utterances are to be coded as part of the coding scheme. Furthermore, the trend also points to agreement on associations. It might be the case that coders are more familiar with the argumentation schemes that form subgroups of associations such as metaphors, examples, etc. However, dissociations proved to be subtler and hence more difficult for coders. Naïve coders tend to code more dissociations, perhaps out of a misunderstanding of dissociation as decomposition. It was also the case that more than one dissociation was coded when a name for a new concept is not settled yet, i.e. each name was treated as a separate instance of dissociation. Further disagreement can be noted on the length of utterances coded, which may be due to coding from the raw transcript rather than edited statements. This conclusion is supported by other researchers who report that higher Kappa ratings can be achieved by some form of pre-processing into separate statements (Warnick and Kline, 1992). Overall, we are satisfied by the reliability of codings, especially since closer inspection of disagreements suggest that they stem from the novelty of use, rather than some intrinsic shortcoming of the coding scheme.

4.7 Conclusion

In this chapter, it was considered how designers establish a team frame in early design episodes through verbal means and the role of argumentation in this process. A coding scheme based on rhetoric was presented, which we used to analyse the use of premises, associations and dissociations in design discourse. The background method of discourse analysis was discussed, particularly associated issues of validity and submitted our analysis to a test of inter-coder reliability. We are satisfied with the level of agreement that can be detected, since qualitative analysis of disagreements suggests these are principally due to coder inexperience rather than serious shortcomings in the coding scheme.

To summarise the detailed analysis of design discourse, it was shown that designers use argumentation to bring premises into presence and highlight them from the background frame of reference. Concentrating on this aspect allows focus of attention to be detected, and the names that are applied to things in the situation. Associations based on the structure of reality introduce organisation and evaluation criteria into the design discourse. Associations based on the structure of reality are used by designers to justify or evaluate certain solution developments in relation to their current understanding of the problem. Furthermore, association based on the structure of reality allows one to draw in the background frame of reference by the way that designers organise the premises. In our discussion of associations establishing the structure of reality, it was asserted that these enable designers to establish new premises by either generalisation or similarity. It was highlighted how this argumentation scheme makes use of the plasticity of notions to drive the solution development forward. These notions function as keywords that encapsulate understandings and positions in the design discourse. Finally, dissociation can be used as a marker for potential reframing. The notion of reframing and dissociation were compared with respect to their triggers, worlds and bases, and commonalities identified. Attention was drawn to the fact that a dissociation is introduced by an individual to affect the team frame, but that further agreement is needed for this reframing to actually occur. To illustrate these findings particular instances were taken from the Delft Design Protocol.

It was concluded that dissociations and ensuing associations can be used as rhetorical identifiers of potential frame shifts. A misfit sets up a potential for a frame shift, which is resolved by the introduction of a dissociation. At the same time, the dissociation introduces a new way of ‘seeing’ which is then developed and negotiated within the

team if assent has been given explicitly or implicitly. However, instances were also discussed when attempts at reframing are rejected, either explicitly or implicitly. We have highlighted that implicit disagreement with dissociation can set teams on the road for frame conflict.

Clearly, attempts at reframing play an important role in the design process. Being able to inspect these instances through a form of representation, rather than through a lengthy process of discourse analysis, would greatly help the understanding of the process of designing and the experiential learning of teams. Representations in general are used to describe or support; from the perspective of the experiential learning design paradigm in particular we are interested in how descriptive representations of how teams operate can be used as input to support their reflection-on-action. In the next chapter, the team experiential learning paradigm will be examined to determine characteristics that can be represented to be describe team designing.

Chapter 5 Representations of team experiential learning

5.1 Introduction

Whilst discourse analysis provides a powerful and detailed description of the verbal reasoning footprints that underlie the design process at the micro-level in general, it does not allow structuring and presentation of the description in an amenable form that draws out particularities about a specific instance of designing. Instead, the description must make use of a representation. Representations function to bring an instance of designing clearly before the mind and to describe these instances as having a specified character or quality (Merriam-Webster's Collegiate Dictionary). From the perspective of experiential learning in particular, we are interested in how teams operate and how representations can be used as input to support team reflection-on-action.

Representations of the design process only deal with one aspect of designing; representations of other dimensions of designing can also be developed. In section 2.1.1, dimensions of designing were identified and related to the model of designer, design task and design process.

In this chapter, the characteristics that representations of team experiential learning need to display are identified. In the first instance, the notion of representation in design that is made use of in this thesis and purposes of representations are defined in section 5.2. In section 5.3, attention is then turned towards finding characteristics of representations that capture aspects of team experiential learning. Subsection 5.3.1 considers the levels

at which designing in teams can be described. Subsections 5.3.2 to 5.3.4 go on to identify specific characteristics relevant to models of designer, design task and design process set within the team experiential learning paradigm. Specific requirements for representation of the design process based on design discourse are proposed in section 5.4. In section 5.5, two candidate representations of design discourse are analysed and evaluated against these requirements.

5.2 Definition of representation in design

Representation in the context of this thesis means an abstraction that captures a description of designing. A descriptive representation consists of a selection of data arranged in a meaningful way for some purpose. A representation *re*-presents; it is not identical to the original presentation. Rather, a representation is created out of the things contained in the original object. A representation as an abstraction of reality is not arbitrary; it is congruent with a design paradigm. Hence, representations capture certain aspects whilst neglecting others. A design paradigm determines which things are meaningful and hence what data are selected for inclusion in a representation; a design paradigm determines what a representation describes.

Criteria for good representations in design and qualities that they need to display therefore need to be developed within a particular design paradigm. In general, a representation should bring clearly to mind characteristics that are considered important or allow this process to take place. However, it is not possible to give a straight-forward list of criteria of how this structuring should proceed because a representation is always connected to some purpose of use overlaid on a paradigm that selects data and users who afford it meaning. It is a function of all three that in the end determines how the data should be abstracted and the representation composed. Therefore, the specific

circumstances that are attached to the purpose of representing team experiential learning need to considered.

5.2.1 Purposes of representations: description of reflection-in-action/ support for reflection-on-action

Representations can have the purpose of describing experiential learning in design – i.e. model how knowledge is created – or of enabling experiential learning – i.e. support the creation of knowledge. Experiential learning in design centres on the modes of reflection-in-action and reflection-on-action to create knowledge by the transformation of experience. For example, representations such as design sketches are created to function as design worlds and have the purpose to support reflection-in-action rather than model experiential learning in design. However, the purposes of description and support are not mutually exclusive. Rather, they can integrate into the 'reflective turn' in design research (Glock, 2000) where descriptions of reflection-in-action are made visible to designers to form the basis for reflection-on-action.

Representations that support reflection-on-action need to take into account that designers need to find themselves in representations, endow representations with meaning and find relation to their experience (Glock, 2000). Representations in this sense also form a medium for learning by making things salient for the learner (Suthers, 1999), guiding the learner in a certain direction. Awareness needs to be raised about aspects that were not obvious to designers; representations need to enable them to reflect on their implicit processes. The processes of reflection and learning can then be used to develop evaluation criteria for the suitability of the representation. A further discussion of measuring learning is given in section 7.2.

In the following section, qualities of representations that describe or support team experiential learning will be examined.

5.3 Characteristics of team experiential learning that a representation should capture

A systematic analysis of the models of designer, task and process of team experiential learning – first introduced in chapter 2 and extended in chapter 3 – allows a set of characteristics to be determined that a representation of experiential learning within a team needs to capture.

Section 5.3.1 notes that descriptions can be made of design teams at the individual level and the team level. Sections 5.3.2 to 5.3.4 then propose characteristics that descriptive representations of team experiential learning need to capture, based on the models of designer, design task and design process. A single representation may not comprehensively capture characteristics of all models; however, representations of team experiential learning should at least consider a coherent subset of these qualities. A new representation of design discourse which captures the design process is proposed in chapter 6. Chapter 7 will show how complementary representations can be developed and applied to enable reflection-on-action in teams.

5.3.1 A description of design teams by focussing on individual or team characteristics

Design teams' experiential learning can be described by two different sets of characteristics. There are characteristics relating to an individual designer engaged in experiential learning and characteristics relating to the design team as a whole. Witte and Lecher (1998) propose, for example, that research into teams can be viewed as focussing on individual team members or the team overall.

For example, studies at the individual team member level look at individual contentment in the group, individual confidence in the end product, etc whereas research at the team level looks at group cohesion, group climate and group development. Hence, there are sets of characteristics at different levels: the individual level and the team level.

In this distinction between the individual and team levels, it is nonetheless apparent that individual aspects are linked to the group situation, and vice versa, through a mediating system (*ibid.*). A representation should therefore be able to highlight the link between characteristics at these two levels and allow an interpretation of a characteristic at one level in relation to a characteristic at the other.

5.3.2 Characteristics concerning the designers

Team experiential learning's model of the designer rests on the facts that the designer is a learner who externalises comprehensions, as discussed in section 3.3. Through interaction with the team, a designer as a participant in argumentation engages in the rhetorical construction of understanding. Hence, the characteristics that a representation of the designer needs to capture are related to the designer as learner and the designer as a participant in the rhetorical construction of understanding.

5.3.2.1 Characteristics of the designer as learner

Individual learning style characteristics (Kolb, 1984; Honey and Mumford, 1992) have been suggested with regards to preferences to certain modes of experiential learning – concrete experience, reflective observation, abstract conceptualisation and active experimentation – and their relation to group composition (Kolb *et al.*, 1991). In chapter

7, it is shown how learning styles describe designers and design teams and can be made available as a basis for reflection-on-action.

5.3.2.2 Designers as participants in rhetorical construction of understanding

Characteristics of designers as participants in rhetorical construction display themselves during designing. In section 3.3.2, a rhetorical stance towards the interaction of designers was discussed.

In general, it is assumed that designers co-operatively discuss a problem to find the best solution for a controversial problem. Over a normal discourse, the roles of arguer and audience should be perceived as equally shared since the arguer's train of persuasion accords with the beliefs of the audience. If this relationship goes awry, the arguer does not accord with the audience and hence feelings of illegitimate persuasion pervade. Interaction in this case has resulted in a shift from co-operation to contentiousness (Rein and Schön, 1993). Deviations from normal discourse, i.e. when this balance is unsettled, can be measured through the perceptions of individuals as to the level of abnormal, pejorative persuasion that they felt.

In chapter 7, a learning situation is investigated by using a feedback questionnaire, which gathers perceptions of individual designers. Questions are developed within the questionnaire that relate to *persuasion* as a characteristic of the designer as a participant in rhetorical construction of understanding.

5.3.3 Characteristics concerning the design task

The design task cannot be exhaustively described, since each individual designer constructs a unique, uncertain and value-laden problem. The crucial point about design

tasks in a team setting is that individual constructions need to be co-ordinated and shared to a certain extent: the team needs a team-frame, as discussed in section 3.4.

The way a design task is construed is inherently based on individuals' apprehensions, which are inaccessible to an exhaustive description. Nonetheless, what can be captured as a characteristic is an individual's *perception of whether a team-frame has been established*. This approach in effect side-steps that an individual's apprehension cannot be described; instead, designers are asked about their comprehensions about the design task.

The perceptions related to the design task are dependent on the establishment of a team-frame. If a team-frame has been established the team will agree about the design concept to be developed as a solution. Secondly, an individual will feel that perspectives are aligned if a team-frame has been established over a design session. Furthermore, terms used by team members will be perceived to be readily understandable to other group members because they have spent time negotiating the meaning and they function as keywords in the team-frame. Characteristics of when a team-frame has not been established are the perception by a designer that a multiplicity of perspectives are in operation at the same time.

In chapter 7, a feedback questionnaire is used for design sessions that questions individual designers as to their perceptions of designing over a particular session. Their individual perceptions and group averages are made available to them in graphical form to support their reflection-on-action. Questions are developed within the questionnaire that relate to *framing* as a characteristic of the design task. A detailed discussion of the

use of perceptions to support reflection-on-action will be carried out in sections 7.6 and 7.8.

5.3.4 Characteristics concerning the design process

On the micro-level, the design process proceeds by a construction cycle of framing, naming, moving and reflecting, which leaves a verbal 'footprint', as discussed in section 3.5 and evidenced by discourse analysis of design transcript in chapter 4. The aim of the macro-level process of designing in team experiential learning is agreement on the fitness criteria that tells a team when to stop designing. However, since fitness depends on the frame in operation, the macro-level process of team experiential learning is linked to the construction of a team-frame, as discussed in section 3.12. Hence, there is either what was termed frame convergence or a macro-level process failure.

5.3.4.1 Characteristics of the macro-level design process

It was already noted in section 5.3.3 that apprehensions of individual designers are inaccessible whilst their comprehensions are. Whereas characteristics in relation to the design task are based on whether a team-frame has been established, in relation to the macro-level design process the *perception of how the team-frame was constructed* becomes important.

During the construction of a team-frame, individuals must perceive that, as frame convergence takes place, they have communicated their own perspective to the team openly and co-operatively and that other team members did so as well. As a result of a smooth macro-level process, team members will have the feeling that they 'work as one' and have made good progress designing the solution. The continuous unfolding during the macro-level process gives rise to a progressive flow of what is important about the design, leading to changes in the way that individuals perceive the situation.

As a result, the perception of individual ‘appreciation’, the understanding that team members have developed, can be elucidated. Awareness of differing issues, proposals for solution and justification for design alternatives should be clear if the macro-level process has been carried out successfully.

Obviously, if the macro-level process does not result in a team-frame, perceptions about the way the design process went will become negative: the team talks past each other and they may exhibit frame conflict. Problems are framed differently and hence agreement cannot be reached on terms, the importance of values and the reasons why solutions were developed the way they were. In fact, because problems are framed differently, individuals may back their own solutions to apply to the problem; this may have some effect on the perception of argument roles as outlined in section 5.3.2.2. There may then be various solution proposals within the team, but the team cannot agree on one of them. This lack of agreement on framings, solutions, and everything concomitant to this will lead to effects of their team processes: feelings of tension within the team may appear.

In chapter 7, a feedback questionnaire is used for design sessions that questions individual designers as to their perceptions of designing over a particular session. This feedback questionnaire in relation to the design process poses questions that relate to *perspective* sharing, *appreciation* development, *progress* and *team process*. The development of the feedback questionnaire is presented in section 7.6 and the application of perception as a basis for reflection-in-action is shown in section 7.8.

5.3.4.2 Characteristics of the micro-level design process

In chapter 3, it was proposed that a team-frame is achieved through and contained in the team discourse as individuals partake in the rhetorical construction of understanding.

The analysis of team design discourse in chapter 4 found that that designers bring premises into presence and highlight them from the background frame of reference. Premises allow focus of attention to be detected, and what names are applied to things in the situation.

Associations based on the structure (ABS) of reality introduce organisation and evaluation into the design discourse. Associations establishing the structure of reality (AES) on the other hand enable designers to establish new premises by either generalisation or similarity by making use of the plasticity of notions to drive the solution development forward. These notions function as keywords that encapsulate understandings and positions in the design discourse.

Dissociations can be used as markers for potential reframing. Opportunities to affect the team frame arise when dissociations are introduced by an individual, however further agreement by other team participants is needed for reframing to actually occur. This agreement can be given explicitly or implicitly. In the latter instance, dissociations and ensuing associations are used as rhetorical identifiers for implicit agreement for reframing. Lastly, it was pointed out that attempts at reframing can be rejected at the team level, either explicitly or implicitly. It was highlighted that implicit disagreement with dissociation can lead individuals to hold conflicting frames.

These results of the analysis will be used in section 5.4 to suggest detailed requirements for design discourse representations that capture aspects of team experiential learning.

5.3.5 Summary

To summarise, representations describe or support team experiential learning. Description and support are not mutually exclusive. Rather, they form parts of the

'reflective turn' in design research (Glock, 2000) where descriptions of reflection-in-action are made visible to designers to form the basis for reflection-on-action.

In turn, the models of designers, design task and design process were examined to suggest qualities that team experiential representations should display. The model of designers suggests characteristics of the designer as learner, namely learning styles, and characteristics based on a rhetorical stance, such as the perception of illegitimate persuasion. Concerning the model of the design task, a characterisation of the design task *per se* is not accessible; nonetheless, perceptions as to whether a team-frame has been established can be captured. A representation of the design task should capture these perceptions: if successful, the team will hence agree about the design concept to be developed as a solution. Terms used by other team members should be readily understandable because the meaning has been negotiated within the team; a team-frame having been established will express itself through the feeling of team members that they 'work as one' and have made good progress designing the solution. Similarly, a representation of the design process should capture perceptions: perspectives are communicated openly and co-operatively to result in a team-frame and designers have a detailed appreciation of the problem and solution. If the design process goes wrong, the team talk past each other and they may exhibit frame conflict. In this situation, problems are framed differently and hence agreement cannot be reached on terms, the importance of values and the reasons why solutions were developed the way they were. Table 5.1 provides a summary of characteristics derived from each model to be considered in team experiential learning representations.

	Characteristics to represent
Model of Designer	Designer as learner Designer as participant in the rhetorical construction of understanding
Model of Design Task	Perception whether team-frame has been established: Framing
Model of Design Process Dynamics	Micro-level construction cycle effected through verbal means Perception how team-frame was constructed: Team Agreement Appreciations Frame conflict

Table 5.1 – Characteristics for team experiential learning representations

5.4 Requirements for representations of design discourse that are sensitive to team experiential learning

To construct a representation of design discourse that captures aspects of team experiential learning based on the macro-level and micro-level design process, it is necessary to fulfil certain requirements. Firstly, since we are interested in how the design process is achieved by the interaction of individuals, the lowest level that needs to be represented is an individual contribution. Secondly, the focus of attention and what names are applied to things in the situation need to be captured. This, for example, can be achieved through paying attention to premises and the notion of presence. Thirdly, it needs to be shown how design reasoning proceeds by the organisation and development of things that are paid attention to. Representations hence need to show organisation of premises and new or flexible notions in some way. Fourthly, it was pointed out that attempts at framing play an important role in team design process. It is suggested that any representation highlights these attempts.

Associated with these framing attempts is the agreement that is given by team participants; we have distinguished implicit and explicit agreement and disagreement in chapter 4. ‘Strength’ of agreement is not only relevant to framing; agreement may also

be given to contributions in general and the strength of agreement can vary over time. Finally, the unfolding of the design process carries with it a notion that a representation needs to capture how boundary of attention, organisation of premises, new and flexible notions and attempts at framing change over time. These requirements are summarised in Table 5.2.

Represent	Requirements
Design process	Show: individual contribution boundary of attention organisation of premises new and flexible notions attempts at framing unfolding 'strength' of agreement

Table 5.2 – Requirements with respect to design discourse representations

An evaluation of existing representations concerning these requirements will be carried out in section 5.5. A new representation of design discourse, which captures the notions discussed in this section, is presented in chapter 6.

5.5 Related approaches to representing team design discourse

The two most closely related approaches to represent design discourse are design rationale (DR) and linkography. These are briefly discussed and evaluated in relation to the requirements identified in section 5.4.

DR as an approach aims to describe design discourse within the social process design paradigm (Table 2.2, page 39), whilst linkography aims to describe the idea development achieved through design discourse. Whilst these diverging purposes should be kept in mind, it is nonetheless instructive to compare representational approaches to team design discourse that function on a node and link structure to show

design reasoning. However, the discussion of design discourse approaches is limited here to the aspects that are important with respect to team experiential learning[9].

5.5.1 Design rationale

The purpose of design rationale is to capture knowledge of how an artefact was designed. Design discourse contains design argumentation (Shipman and McCall, 1997), which forms a record of the reasons why an artefact was designed the way it was (Conklin and Burgess-Yakemovic, 1996). In particular, in this section argumentation-based DR will be examined, since it aims to show the reasoning underlying designing.

Design argumentation aims to express a record of the reasoning that led to the design of an artefact (Buckingham Shum, 1996). The reasoning is shown through a high-level dialectic structure that centres reasons and justifications on artefact-defining 'issues' (Kunz and Rittel, 1970; Potts and Bruns, 1988; McCall, 1991) or 'questions' (MacLean et al., 1989; MacLean et al., 1996). This structure of reasons, justifications and issues is based on an assumption of the argument process as dialectical and conflict-based; hence, a particular opinion needs to be justified (Toulmin, 1958). Argumentation-based DR aims to subject statements to a systematic challenge "in order to expose them to the viewpoints of the different sides, and the structure of the process becomes one of alternating steps on the micro-level […]" (Rittel, 1984). Furthermore, 'Toulmin schemes' involving data, warrant, backing, claims and rebuttals form the background theory of argumentation-based design rationale (Buckingham Shum and Hammond, 1994; Buckingham Shum, 1996).

[9] A more detailed account of DR representations is provided in Stumpf, S (1998) Argumentation-based Design Rationale – The sharpest tools in the box. Research Note 98/103, Computer Science, UCL.

To illustrate the argumentation-based approach to DR – and linkography as a team design discourse representation discussed in section 5.5.2 – the transcript shown in Figure 4.26, page 104 will be used. The snippet of design discourse can be represented in a DR notation, in this case IBIS (Kunz and Rittel, 1970; Conklin and Begeman, 1988), as shown in Figure 5.3.

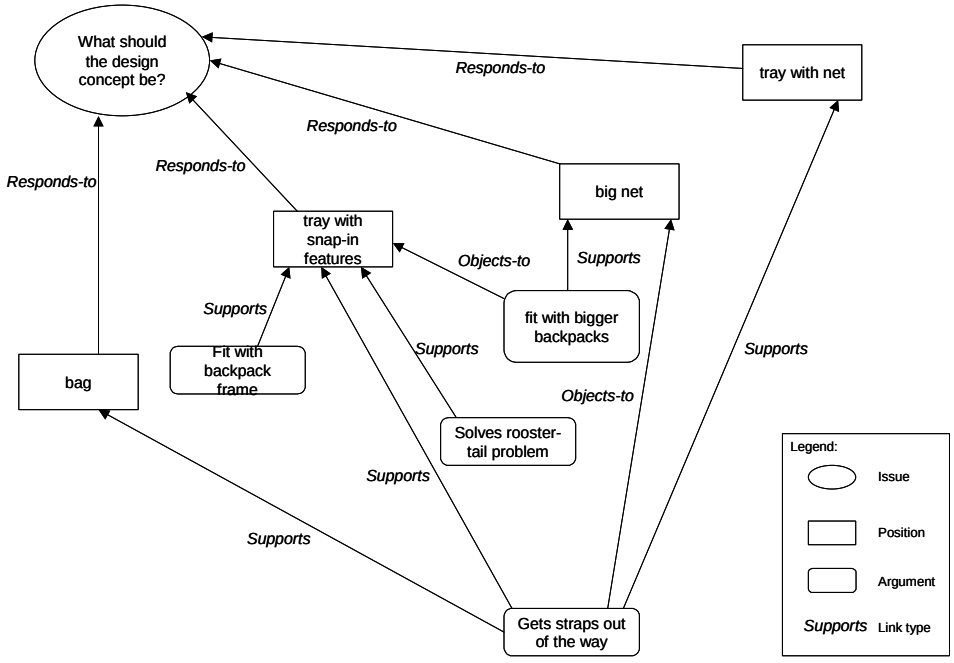


Figure 5.3 – Representation of example design discourse in IBIS notation

Issues and positions are represented as abstract products in a node link structure. The (inferred) issue this dialogue is concerned with is summarised into ‘What should the design concept be?’. Positions are identified and abstracted into ‘bag’, ‘tray with snap-in features’, ‘tray with a net’ and ‘big net’. These positions are then supported or challenged by arguments as shown.

In terms of capturing individual contributions, the representation of design discourse as DR abstracts away from the actual discourse by providing conceptual structures into which the discourse is distilled. The actual discourse on which the construction is made

is *not* represented. All contributions that do not fit into the notational categories, viz. issue, position, argument, are discarded. The boundary of attention that includes focus of attention and what names are applied to things of the situation are not captured in DR. The organisation of premises is shown as a conceptual map of justifications and elaborations in relation to positions and issues. Arguments are centred on positions, and positions in turn are centred on issues; hence, issues assume an organising function. New and flexible notions are not captured in DR: 'semantic drift' as a result of the argumentation process is neglected in these approaches (Buckingham Shum, 1999).

Attempts at framing are not visible in a DR notation. In terms of the unfolding of designing, argumentation-based DR claims to record the "design *process* as it unfolds" (*ibid.*). However, in practice, only limited support for showing the unfolding is provided. Whilst Issue-Based Information System (Kunz and Rittel, 1970; Conklin and Begeman, 1988) provide historical functions such as 'replaces' to indicate that issues come into and out of focus as the design discourse goes on, changes to the importance of individual argument elements as time progresses are not captured (Newman and Marshall, 1991). Whilst most implementations of DR's dialectic structures neglect to capture ownership (Newman and Marshall, 1991) – with associated lack of perspectives on problems – SYBIL, an implementation of Decision Representation Language (Lee, 1990), allows viewpoints to be defined.

Other argumentation-based DR approaches such as QOC (MacLean et al., 1989; MacLean et al., 1996) do not attempt to capture any unfolding of the argument based on the social interaction of participants in design teams. Agreement, and strength of agreement in particular, are usually shown as the strength that positions receive through

arguments, i.e. individuals can elect to agree or disagree with arguments supporting positions.

Representing design discourse treads a fine line between abstraction of the actual transcript into higher-level categories to show the logical structure of what designers say – and how they say it – whilst at the same time expressing the content of what is said. Obviously, emphasis on either function depends on the stated aims of the design discourse representations. In the case of argumentation-based DR the representation of structure is more important than content since it makes claims to *regulate* the interaction of designers through a dialectical framework. The content is only important as a way of providing justification and therefore only the structural aspects of solutions and their justification count. A summary of the requirements that are met by DR are provided in Table 5.4. Since DR approaches only capture a subset of requirements, DR is unsuitable for representing the design process as understood within team experiential learning.

Requirements	DR
Show:	Shows:
Individual contributions	Abstracted statements
Boundary of attention	N/A
Organisation of premises	Conceptual map of justifications and elaborations
New and flexible notions	N/A
Attempts at framing	N/A
Unfolding	Shows historical relations
Strength of agreement	Shows strength of positions as a degree of argument underpinning it; 'voting' procedures to show agreement on arguments

Table 5.4 – Evaluation of DR approach against requirements

5.5.2 Linkography

Linkography is an approach that aims to analyse design cognition in early design phases (Goldschmidt and Weil, 1998) and has been applied to think-aloud protocols of individual designers and protocol transcripts of design teams (Goldschmidt, 1995; Milne, 2000, van der Lugt, 2000). As such, it attempts to analyse the reasoning process

involving information and knowledge, the raising of ideas and their rejection to "construct a coherent rationale for a design idea" (Goldschmidt and Weil, 1998).

The approach proceeds by linking the structure of the design process and subject matter. A graphical map of links is built up in the style of a matrix by first dividing the protocol into units of subject matter and then parsing these units into individual design moves. Connections by same or closely related subject matter between moves within a unit is then marked into the appropriate cell of the matrix. Moves can therefore have more than one 'backlink' (*ibid.*), i.e. all other moves that relate to it projecting backwards in time, and also more than one 'forelink' (*ibid.*), i.e. moves related to it projecting forwards in time. Links are coded as a 'common-sense' connection (*ibid.*) based on the perceived closeness of subject matter and neither moves nor links are classified further into other functional categories, although some extensions have been made to attach categories to both links and moves (Goldschmidt, 1997; van der Lugt, 2000).

Based on the transcript given in Figure 4.26, a linkography representation can be developed, which is shown in Figure 5.5. Links of subject matter between statements are indicated by a shaded cell in the matrix. As an example, statement 7 in this representation has zero backlinks and six forelinks, whereas statement 33 has three backlinks but no forelinks.

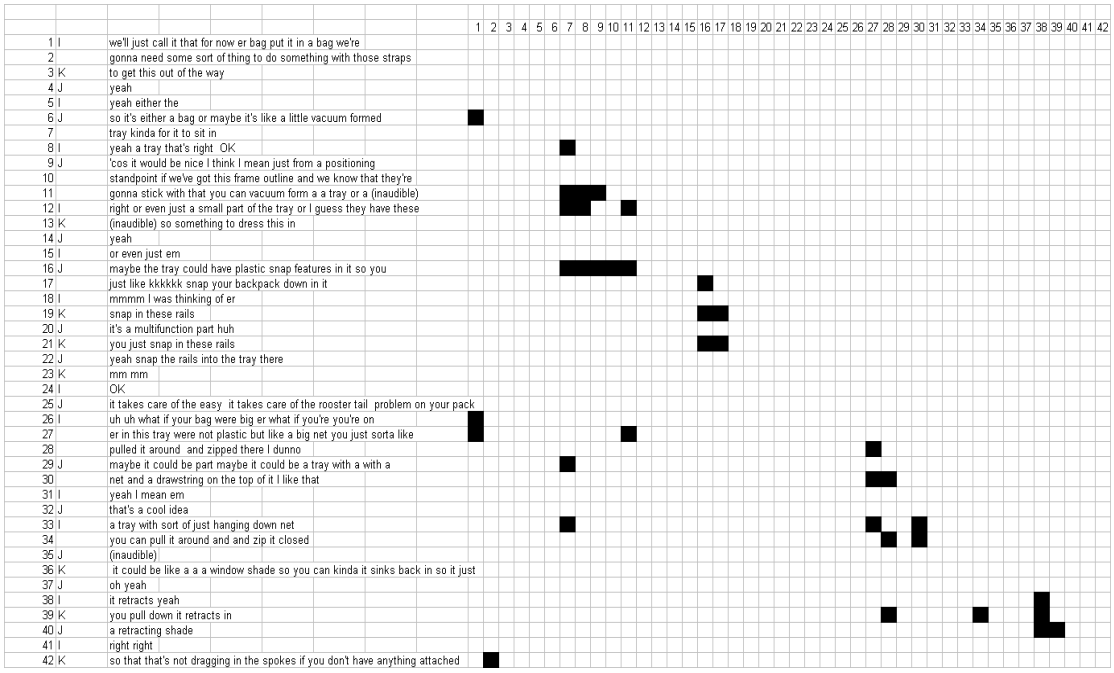


Figure 5.5 – Representation of example design discourse in linkography notation

In terms of showing individual contributions, linkography captures each individual statement. However, a choice can be made in terms of the level of abstraction of the captured statements. For example, Milne (2000) and van der Lugt (2000) both discuss their work using linkography as a representation of design team activities. Milne's approach establishes links between statements from the raw transcripts whereas van der Lugt codes links between concepts extracted from the transcript. In our sense, van der Lugt has abstracted away from the original individual contributions and then uses this to represent links between the abstracted concepts.

Whilst linkography does capture statements, it does not recognise premises as functional units. Hence, the organisation of premises is shown only through reference to subject matter or ideas and their links and transformation over time. Linkography does not capture the boundary of attention through names, but it segments design discourse into units of subject matter, which provide an indication of the focus of attention. In terms of

showing new and flexible notions, linkography does indicate new ideas, namely ones that do not have any 'backlinks' to other statements. Furthermore, flexibility is indicated in the transformation of ideas through 'forelinks' to other statements that build and modify ideas. The value of linkography lies in its structuring of design discourse in a temporal order, giving a much clearer picture of the unfolding of the design process in terms of statements and their connections. Finally, linkography lacks the notion of strength of agreement. A summary of the requirements that are met by linkography are provided in Table 5.6.

Requirements	Linkography
Show:	Shows:
Individual contributions	Statements
Boundary of attention	Units of subject matter
Organisation of premises	Links between statements
New and flexible notions	Statements without 'backlinks'; transformation of statements through 'forelinks'
Attempts at framing	N/A
Unfolding	Idea development over time
Strength of agreement	N/A

Table 5.6 – Evaluation of linkography approach against requirements

This approach is a necessarily generic one, which can be overlaid with any model of investigation by providing an appropriate categorisation system for moves and links between them. In itself, linkography only provides a graphical layout system to show up patterns of links[10], not a representation of design discourse *per se*. In particular, linkography does not capture attempts at framing and strength of agreement, and is therefore unsuitable as a candidate for representing team experiential learning in design discourse.

5.6 Conclusion

Representations are selections of data arranged in a meaningful way for some purpose. Design paradigms influence what is considered data by the fact that they highlight

[10] Van der Lugt (1999) applies linkography to find patterns of concept development for sketches.

certain aspects whilst suppressing others; they attribute meaning. Therefore, descriptive representations can only be developed within a certain design paradigm. In this chapter, specific characteristics for descriptive representations of team experiential learning were proposed.

Representations can be used for description or support. In experiential learning in particular, the distinction between these different purposes becomes blurred: a 'reflective turn' in design research suggests that descriptive representations of designing are made available to designers to encourage reflection and to function as support for learning.

The design paradigm of team experiential learning was revisited to outline a set of characteristics, highlighting aspects of designers, design task and design process. The model of designers highlights designers as learners and participants in the rhetorical construction of understanding, hence characteristics of learning styles and argument roles should be captured in representations. Whilst certain aspects of models of design task and design process are inaccessible as they are based on personal knowledge, comprehensions of designers can be captured in the form of their perceptions. The model of the design task focuses attention on the perception of the extent to which a team-frame is established, whereas the model of the macro-level design process attends to how a team-frame was constructed. The findings of the micro-level design process contained in design discourse were used to motivate characteristics for descriptive representations.

With this in mind, characteristics of design discourse representations were further investigated to develop requirements that capture aspects of team experiential learning.

These requirements dealt specifically with showing individual contributions, the boundary of attention, the organisation of premises, the establishment of new and flexible notions, attempts at framing and the strength of agreement.

Two candidate design discourse representations, design rationale and linkography, were analysed and evaluated against these requirements. It was found that they do not capture all requirements: design rationale does not show individual contributions, boundary of attention, new and flexible notions and attempts at framing, whereas linkography cannot show attempts at framing and strength of agreement. Both design rationale and linkography as they stand now are hence unsuitable for representing the design process as understood within team experiential learning.

During the design process individuals in the team reflect-in-action and share their comprehensions with the team. In a representation of design discourse against the background of team experiential learning emphasis is to be placed on showing how the designers contribute to this process through their interaction. The continuous unfolding of the design discourse gives rise to a progressive flow of what is important about the design, leading to changes in the appreciation of individuals about the problem and solution. In this form, the representation of temporal progression is paramount. Furthermore, attempts at framing and agreement need to be modelled. The current approaches to representing design discourse that were investigated in this chapter fail to capture the complete set of requirements. As was shown in chapter 4, designers use rhetorical figures to increase the presence of certain facts, organise their appreciative systems, develop their understanding and introduce flexible notions through associations. Furthermore, reframing at the team level is indicated through dissociations and subsequent agreement. Frame conflict can occur when agreement is only implicitly

given. We suggest that these observations can be used as the basis of a new representation. This representation is termed a ‘frame rationale’ that expresses how the design process was carried when viewed against team experiential learning design paradigm. The frame rationale representation is developed and illustrated in the next chapter.

Chapter 6 Frame rationale - a representation of rhetorical construction of understanding

6.1 Introduction

In the previous chapter, representations of design were discussed in general. Descriptive representations are developed against the background of design paradigms. Characteristics – suggested by models of designers, design task and design process – that representations of experiential learning should capture were specified.

In relation to characteristics of the design process, requirements for representations of design discourse that are sensitive to team experiential learning were proposed. A summary of these is reproduced here for ease of reference (Table 6.1).

Represent	Characteristic	Requirements
Design Process	Micro-level construction cycle effected through verbal means	Show - individual contributions - boundary of attention - organisation of premises - new and flexible notions - attempts at framing - unfolding - agreement 'strength'

Table 6.1 – Requirements with respect to design discourse representations

Two approaches of representing design discourse – design rationale and linkography – were compared with these requirements. This comparison showed that neither is suitable as they stand to represent the design process seen as team experiential learning.

In this chapter, a representation that captures these characteristics is presented. This representation, a ‘frame rationale’, shows how a team-frame is achieved through and contained in design discourse. To illustrate the representation we return to the design discourse example first introduced in chapter 4.

Throughout this chapter, for clarity and consistency, use is made of the example transcript introduced in chapter 4 to illustrate features of the representation proposed. In particular, the transcript excerpt used in chapter 5 is reprised to discuss specific points of frame rationale. It is reproduced here in Figure 6.2 for ease of reference. The distinct components of the frame rationale are presented separately in this chapter in sections 6.2 to 6.7. The transcript is shown coded with all the elements of the frame rationale in Appendix 4.

In section 6.2, the basic representational structure of a frame rationale is discussed. Each requirement identified in chapter 5 (restated in table 6.1) will then be addressed in turn. In section 6.3, the way the representation captures the boundary of attention is illustrated. The representation of the organisation of premises and the introduction of new and flexible notions is outlined in section 6.4, as is the notion of argument chain. The notion of contribution strength as a measure of agreement is introduced in section 6.5. The way that attempts at framing are captured in the representation is illustrated in section 6.6. The representation of unfolding as a temporal notion is outlined in section 6.7.

Ivan	we'll just call it that for now, er, bag, put it in a bag, we're gonna need some sort of thing to do something with those straps
Kerry	to get this out of the way
John	yeah
Ivan	yeah, either the
John	so it's either a bag or maybe it's like a little vacuum formed tray kinda for it to sit in
Ivan	yeah, a tray, that's right, OK
John	'cos it would be nice, I think, I mean just from a positioning standpoint if we've got this frame outline and we know that they're gonna stick with that, you can vacuum form a a tray or a (inaudible)
Ivan	right or even just a small part of the tray or I guess they have these
Kerry	(inaudible) so something to dress this in
John	yeah
Ivan	or even just em
John	maybe the tray could have plastic snap features in it, so you just like kkkkkk, snap your backpack down in it
Ivan	mmmm, I was thinking of, er
Kerry	snap in these rails
John	it's a multifunction part, huh
Kerry	you just snap in these rails
John	yeah, snap the rails into the tray there
Kerry	mm mm
Ivan	OK
John	it takes care of the easy, it takes care of the rooster tail problem on your pack
Ivan	uh uh, what if your bag were big, er, what if you're you're on, er, in this tray were not plastic but like a big net, you just sorta like pulled it around and zipped there, I dunno
John	maybe it could be part, maybe it could be a tray with a with a net and a drawstring on the top of it, I like that
Ivan	yeah, I mean, em
John	that's a cool idea
Ivan	a tray with sort of just hanging down net, you can pull it around and and zip it closed
John	(inaudible)
Kerry	it could be like a a a window shade, so you can kinda, it sinks back in, so it just
John	oh yeah
Ivan	it retracts yeah
Kerry	you pull down, it retracts in
John	a retracting shade
Ivan	right right
Kerry	so that that's not dragging in the spokes if you don't have anything attached

Figure 6.2 –Transcript excerpt used to illustrate frame rationale

6.2 Basic representational structure of a frame rationale

The ‘frame rationale’ representation is a formal abstraction for structuring design discourse. Components of the representation highlight specific aspects of design discourse; this allows the representation to highlight salient points within a ‘slice’ of design discourse, which can then be investigated using other components. A frame rationale is hence formed by a collection of complementary components.

To produce a frame rationale, initial transcripts are 'cleaned up' and pre-processed as follows. Firstly, if an utterance by one speaker is split by 'talking over' or interruption by another speaker the split utterance is concatenated. The utterance is furthermore split into clauses, which provide the basis of individual contributions. Clauses are supplemented by comments, where necessary, to complement the meaning of the utterance[11] to form a *contribution*.

The contributions can then be coded according to the coding scheme introduced in chapter 4, where argumentation schemes form links between contributions. Each contribution has attributes associated with it that capture the coding. According to the classification of the coding scheme, the abstraction distinguishes between facts (F) and values[12] (V), otherwise it remains unclassified (indicated by O). Furthermore, individual contributions are marked to indicate the participant who originated it and a time point indicating the position of the contribution within the design discourse. This allows the representation of individual contributions to the achievement of a team-frame, whilst also allowing us to describe how these contributions are received by other team members through the addition of the notion of agreement.

Agreement is a relation between two contributions and expresses the extent to which the current contribution expresses an agreement with previous contributions as a discrete measure. This can be an explicit agreement – for example, "yes, that's right" –, an implicit agreement by using an *association* argumentation scheme to link to a previous contribution, or disagreement – for example, "no" and by using a *dissociation* argumentation scheme. This aspect is covered in more detail in section 6.5.

[11] Supplementary comments cover pointing, deixial references, inaudible utterances, hesitation, etc. gathered from video evidence.

[12] For the sake of simplicity, we do not distinguish presumptions from facts or value hierarchies and loci from values (see Table 4.1), although in principle these distinctions could be made.

A *link* is a relation between two contributions and the link type is classified in terms of an argumentation scheme. In accordance with the coding scheme introduced in chapter 4 (Table 4.2), we distinguish *association* and *dissociation* argumentation schemes. Association argumentation schemes comprise association based on the structure of reality (ABS) and association establishing the structure of reality (AES), whereas a dissociation argumentation scheme is simply a dissociation (D). Contributions do not necessarily have to be linked to other contributions. Links will be discussed in more detail in sections 6.4 and 6.6.

Further structuring of the basic representation is carried out by the addition of *names* that describe in abstract terms the boundary of attention. This will be discussed in more detail in section 6.3.

Contributions and argumentation schemes between them form a network of nodes and links. Contributions do not have to be linked to any other contributions, hence a design discourse is a set of networks, which can be formally defined as shown in Figure 6.3, for the example transcript.

```
design_discourse ::=          set_of_networks
set_of_networks ::=           (set_of_contributions x
                              set_of_links)*
set_of_contributions ::=      contribution*
set_of_links ::=              link*

contribution ::=              utterance x attributes
utterance ::=                 string
attributes ::=                time x classification x owner x
                              agreement
time ::=                      integer
classification ::=            'F' | 'V' | 'O'
owner ::=                     'Ivan' | 'John' | 'Kerry'
agreement ::=                 agrees x Contribution
agrees ::=                    'implicit-yes' | 'explicit-yes'
                              | 'explicit-no' | 'none'

link ::=                      contribution x contribution x
                              linkType
linkType ::=                  'AES' | 'ABS' | 'D'

unit_of_attention::=          set_of_contributions x names
names::=                      string
```

Figure 6.3 – Definition of frame rationale abstraction

This definition has been implemented for the transcript excerpt as a Prolog program, the full listing of which can be found in Appendix 4. An extract from the program listing in Figure 6.4 shows how contributions and their attributes are implemented. In the following sections, the remaining aspects of frame rationale will be illustrated. In these illustrations, contribution time will be used as a placeholder to reference individual contributions. Since contribution time is a unique identifier, access to other contribution attributes – such as utterance, etc. – via it is trivial.

```
cont('we ll just call it that for now er bag put it in a bag',1,ivan,f).
cont('we re gonna need some sort of thing to do something with those straps',2,ivan,f).
cont('to get this out of the way',3,kerry,f).
cont('yeah',4,john,o).
cont('yeah either the',5,ivan,o).
cont('so it s either a bag',6,john,f).
cont('or maybe it s like a little vacuum formed tray kinda for it to sit in',7,john,f).
cont('yeah a tray that s right  OK',8,ivan,o).
cont('cos it would be nice I think I mean just from a positioning standpoint if we ve got this frame outline and we know that they re
gonna stick with that you can vacuum form a a tray or a inaudible',9,john,f).
cont('right or even just a small part of the tray or I guess they have these',10,ivan,f).
cont('inaudible so something to dress this in',11,kerry,o).
cont('yeah',12,john,o).
cont('or even just em',13,ivan,o).
cont('maybe the tray could have plastic snap features in it so you just like kkkkkk snap your backpack down in it',14,john,f).
cont('mmmm I was thinking of er',15,ivan,o).
cont('snap in these rails',16,kerry,f).
cont('it s a multifunction part huh',17,john,f).
cont('you just snap in these rails',18,kerry,f).
cont('yeah snap the rails into the tray there',19,john,f).
cont('mm mm',20,kerry,o).
cont('OK',21,ivan,o).
cont('it takes care of the easy  it takes care of the rooster tail problem on your pack',22,john,f).
cont('uh uh what if your bag were big er what if you re you re on',23,ivan,f).
cont('er in this tray were not plastic but like a big net',24,ivan,f).
cont('you just sorta like pulled it around  and zipped there I dunno',25,ivan,f).
cont('maybe it could be part maybe it could be a tray with a with a net and a drawstring on the top of it',26,john,f).
cont('I like that',27,john,v).
cont('that s a cool idea',28,john,v).
cont('yeah I mean em a tray with sort of just hanging down net',29,ivan,f).
cont('you can pull it around and and zip it closed',30,ivan,f).
cont('it could be like a a a window shade so you can kinda it sinks back in so it just',31,kerry,f).
cont('oh yeah',32,john,o).
cont('it retracts yeah',33,ivan,f).
cont('you pull down it retracts in',34,kerry,f).
cont('a retracting shade',35,john,f).
cont('right right',36,ivan,o).
cont('so that that s not dragging in the spokes if you don t have anything attached',37,kerry,f).
```

Figure 6.4 – Example contributions

Frame rationale captures information about design discourse; the amount of information and its differing types pose a challenge of information visualisation (Card et al, 1999). Whilst certain aspects of the information captured in a frame rationale are shown in graphical form in this chapter for clarity and illustrative purposes, a study of information visualisation and of information visualisation for the complete design discourse is not part of this thesis.

6.3 Boundary of attention

In section 4.5.1, it was pointed out that what the arguer and the audience accept as valid can be deduced by considering premises that are brought into presence. Presence indicates the boundary of designers' attention by highlighting what they select as important and provides access to the way reality is perceived. Concentrating on the aspect of presence also allows us to detect what is named as 'things of the situation'.

Frame rationale divides the transcript into *units of attention* based on items that designers imbue with presence. For this, use is made of 'presence markers' such as intonation, repetition, slow delivery, etc[13]. A unit of attention includes all contributions that relate to a particular item imbued with presence. The item imbued with presence is described by a *name*, which is recorded against each unit of attention, as shown in Figure 6.5.

```
unit_of_attention::=          set_of_contributions x names
names::=                      string
```

***Figure 6.5 – Representation of** units of attention **and** names*

Names as descriptions of *units of attention* are tied as closely as possible to the phrasing of the contributions themselves. However, this is not always possible, as supplementary information needs to be included to make the meaning clear. Furthermore, meaning is negotiated through the discourse; there is no direct mapping between *names* and meaning. Although some of the nuances of the literal meaning are removed, *names* function as keywords that allow the inspection of boundaries of attention at a higher, abstracted level.

[13] A selection of rhetorical devices used to bring premises into presence was outlined in section 4.5.1.

A temporally ordered list of *names* based on *units of attention* for each design discourse can be constructed. This is useful in finding out the shifts of attention as the design discourse unfolds. Furthermore, attention may be given to certain aspects for longer than others. Frame rationale allows this to be detected when units of attention comprise more contributions. Obviously, this must be treated with caution since contributions vary in length; the record of contributions is not directly linked to the amount of time they take up. A unit of attention further highlights the degree to which designers participate in the setting of attention through making contributions. It may be the case that only certain team members participate whilst other team members do not actively participate in the rhetorical construction of understanding by making contributions.

On the surface, *units of attention* have similarities with notions of focusing and context spaces in discourse modelling (Grosz, 1978; Reichman; 1978). However, these approaches assume a shared reality to provide the focus; instead, our approach highlights that a reality is constructed and negotiated by providing presence. A further distinction has to be made between our use of *units of attention* and the notion of focus in argument (Sillince, 1994). Focus in argument pertains to the relevance of a claim within an argument. In frame rationale, *names* or *units of attention* do not make any connection to relevance; instead, attention is linked to presence.

To illustrate how names can be attached to a unit of attention, consider Figure 6.6. Units of attention collect together contributions taken from the example transcript to provide abstract ‘names’ that can function as keywords during the design discourse. Below, we can associate the name ‘bag’ with a unit of attention containing only contribution 1, whereas ‘straps’ can be associated with contributions 2 and 3.

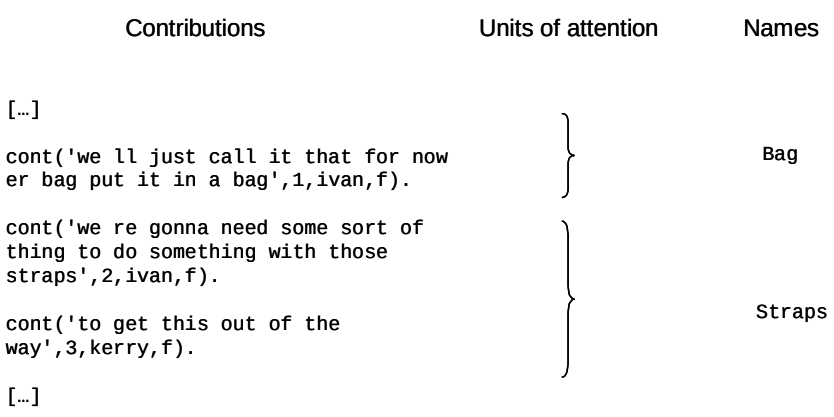


Figure 6.6 – *Units of attention* ***and*** *names* ***based on presence***

For the transcript excerpt, units of attention and names are recorded, as shown in Figure 6.7. As can be seen from the number of contributions, some of these units of attention are longer than others; 'vacuum-formed tray' in particular is attended to longer than other units of attention.

```
unit([1],'bag').
unit([2,3,37],straps).
unit([7,8,9,10,14,19,24,26,29],'vacuum-formed tray').
unit([14,16,18,19],'snap in rails').
unit([24,26,29],'net').
unit([26,29],'tray with net').
unit([31,33,34,35],'retracting windowshade').
```

Figure 6.7 – *Units of attention* ***and*** *names* ***for transcript excerpt***

Units of attention and names can also give us a simple graphical 'timeline' of attention for the transcript excerpt at a high level, as shown in Figure 6.8. In this figure, names are shown against contributions as they occur in the transcript excerpt. It can then be used to discern what is being talked about as the discourse progresses.

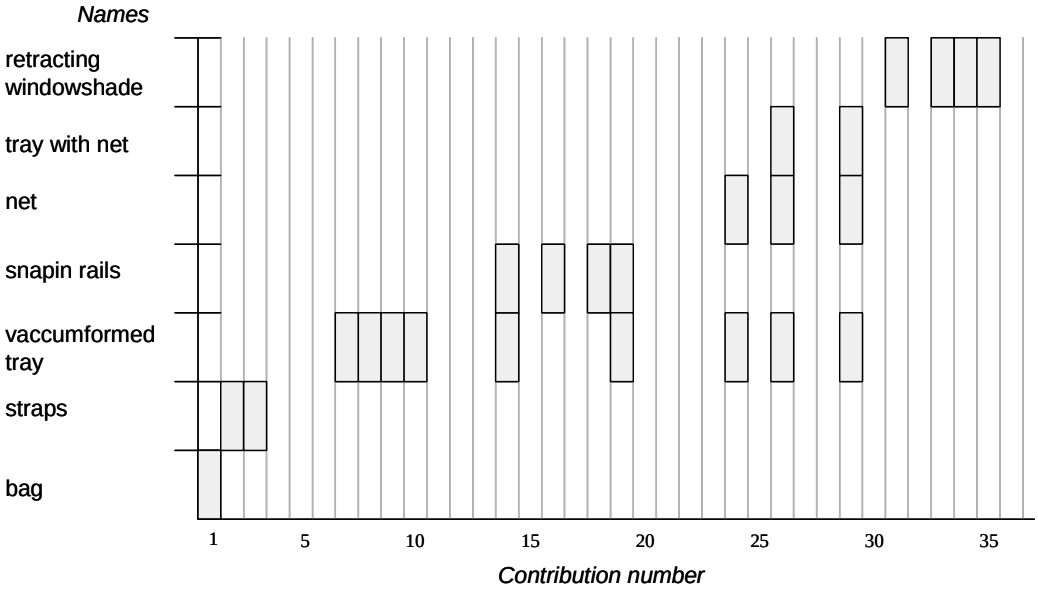


Figure 6.8 – *Units of attention* ***and*** *names* ***over transcript excerpt***

To summarise, frame rationale highlights the boundary of attention through *units of attention* and their description as *names*.

6.4 Organisation of premises and introduction of new and flexible notions

Associations based on the structure of reality (ABS) introduce organisation and evaluation into the design discourse, as discussed in chapter 4. It was noted that ABS are used by designers to justify or evaluate certain solution developments in relation to their current understanding of the problem. Furthermore, ABS draws in the background frame of reference by the way that designers organise premises. Associations establishing the structure of reality (AES) enable designers to establish new premises either by generalisation or similarity; by using AES, designers introduce new and flexible notions to drive the solution development forward.

In a frame rationale, links between contributions are tagged with the type of argumentation scheme that is used (Figure 6.9); it can therefore capture when designers introduce new notions or organise their premises by paying attention to links of type AES or ABS, respectively. Dissociation as a 'link' will be discussed in more detail in section 6.6.

```
link ::=                    contribution x contribution x
                            linkType
linkType ::=                'AES' | 'ABS' | 'D'
```

Figure 6.9 – Representation of links

A particular network of contributions, consisting of a set of contributions that are linked together by AES and ABS, is termed an *argument chain*. Individual contributions can be identified with their temporal place in a particular argument chain.

Aspects of argument chains can be related to 'chunks' and 'critical moves' that are observed in linkography representations (Goldschmidt and Weil, 1998). *Chunks* in this sense are a large number of links formed between a small number of contributions. Goldschmidt and Weil (*ibid.*) have indicated that *chunks* can be observed at instances of increased design activity. *Critical moves* on the other hand are nodes that are involved in a high number of links, both backwards and forwards in time. *Critical moves* are indicated as 'breakthroughs' in designing a concept (*ibid.*). Where we differ from this interpretation is that we do not make any claims about a minimum or optimum expanse of an argument chain for a successful product of designing.

Argument chains allow two anomalies in design discourse to be identified. Firstly, there may be contributions that are not included in a current argument chain; they do not 'fit in' (Figure 6.10). Obviously, the importance of such a 'not fitting' will relate to the importance and type of a contribution. Secondly, contributions may 'jump around' (Figure 6.11). In this case, individuals make a contribution at a certain point in time that does not fit into the current argument chain; instead, it is connected to an argument chain prior to the current one. Both anomalies can serve as starting points for further investigation of a frame rationale to examine the peculiarities of what is going on in the design discourse.

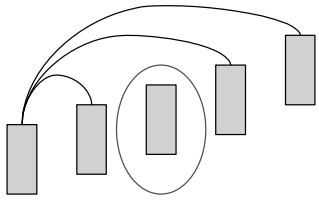


Figure 6.10 – Contribution does not 'fit in'

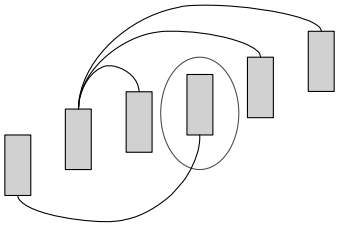


Figure 6.11 – Contribution 'jumps around'

Links between contributions and their link type are captured for the transcript excerpt, as shown in Figure 6.12.

```
%argumentation schemes %link(prevCont,thisCont,linktype).

link(1,7,d).
link(7,9,abs).
link(7,14,aes).
link(7,16,aes).
link(9,16,abs).
link(7,17,aes).
link(7,18,aes).
link(7,22,abs).
link(7,24,d).
link(24,25,aes).
link(24,26,aes).
link(26,27,abs).
link(26,28,abs).
link(29,30,aes).
link(26,31,aes).
link(31,33,aes).
link(31,34,aes).
link(31,35,aes).
link(31,37,abs).
```

Figure 6.12 – Links and link types in example transcript

From this, argument chains can be identified based on association argumentation schemes. The contribution times of the argument chains can be given as a list, shown in Figure 6.13.

```
[7,9,14,16,17,18,22]      = Arg chain 1
[24,25,26,26,27,28,31,33,34,35,37] = Arg chain 2
[29,30]    = Arg chain 3
```

Figure 6.13 – Argument chains in transcript excerpt

The structure of the argument chains is shown graphically in Figure 6.14. In this graph, AES links are shown in green and ABS links in blue. Factual contributions are shown in yellow, whilst all other contributions are greyed out.

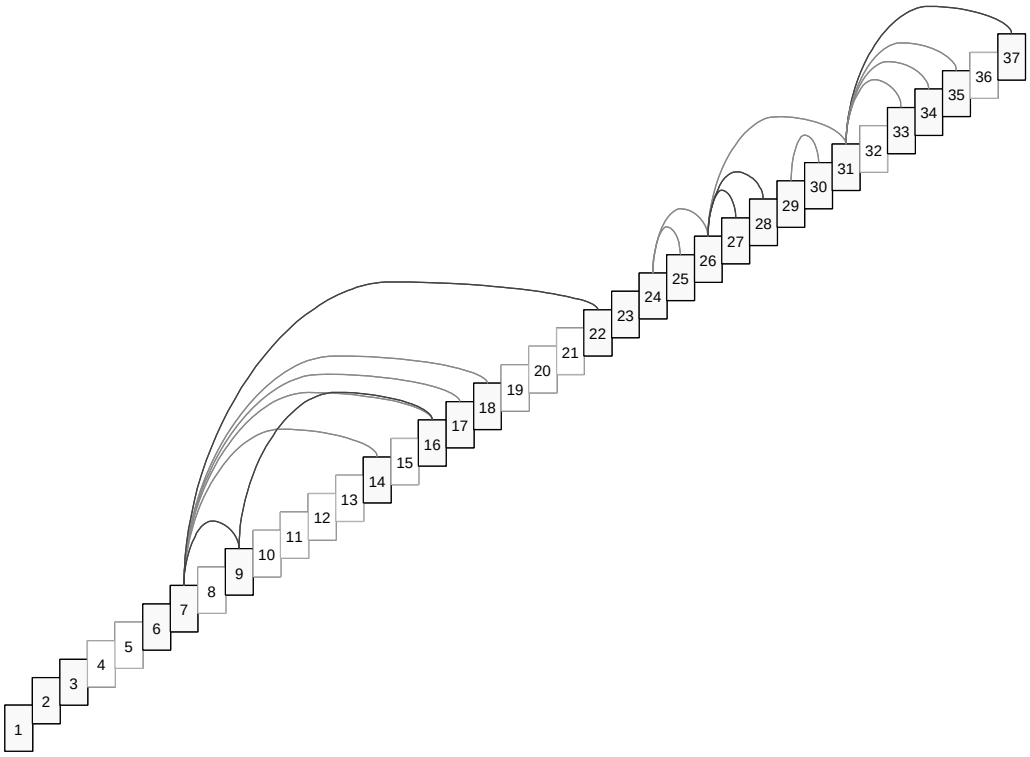


Figure 6.14 – Argument chains in transcript excerpt

In this excerpt, contributions are tightly linked compared to the wider design discourse, which makes the excerpt itself a *chunk* in the design session. Furthermore, within this excerpt we can identify two more *chunks*: argument chains [7, 9, 14, 16, 17, 18, 22] and [24, 25, 26, 26, 27, 28, 31, 33, 34, 35, 37]. Contribution 7 ("maybe it's a little vacuum-formed tray") is involved in a high number of links and is as such a *critical move*. It can be noted that argument chain [29,30] is isolated within another argument chain; it does not 'fit'.

Patterns can be observed when dissociations are introduced: there are ABS links relating to the dissociation organising and justifying the dissociations, then new and flexible notions are introduced and finally another ABS link 'ties up' the dissociation. In particular, contribution 22 ("it takes care of the rooster tail problem") and contribution 37 ("so that's not dragging in the spokes") relate to contributions 7 and 31 respectively within the current argument chains. Moreover, they restate contributions previously made in the design discourse, therefore organising premises for support and justifying the design concept.

To summarise, frame rationale highlights the organisation of premises and the introduction of new and flexible notions through the capture of contributions that are linked through *association* argumentation schemes and groups these into *argument chains*.

6.5 Strength of agreement

As outlined in chapter 4, each statement is an invitation for the audience to see things the arguer's way (Crosswhite, 1997) and builds on the assumption that to talk to each other the arguer and audience's way of thinking has to accord with each other to a certain extent (Perelman and Olbrechts-Tyteca, 1971). Strength of agreement is here put

forward as a simplified measure of the acceptance of a contribution within a team, which can provide an indication to the importance of a contribution in a team-frame. This measure given to a particular contribution highlights contributions that receive high or low agreement, which can then be further investigated. Further investigation can examine, for example, which team members were involved in a particular agreement.

Frame rationale captures the type of agreement given to contributions. Agreement is a relation between two contributions and expresses the extent to which a contribution expresses an agreement with another contribution as a discrete measure. Agreement can be explicit – for example, "yes, that's right" –, an implicit agreement by using *association* argumentation schemes to link to a previous contribution, or explicit disagreement – for example, "no". Explicit disagreement is also recorded in a frame rationale when a *dissociation* argumentation scheme is used.

In terms of contributions, we can utilise a notion of *contribution strength*. The strength of a contribution can be expressed by a discrete value, which describes a measure of the number of contributions that agree or disagree with it. For frame rationale then, the definition of contribution strength C for a particular contribution i is the sum of all agreements given by other contributions $j,k…m$, where the values of the agreements are 1 for 'implicit-yes' and 'explicit-yes', -1 for 'explicit-no' and 0 for 'none'. The result is that contribution strengths can be calculated for every contribution in a design discourse, noting the agreement that is given towards it.

Simple measures for expressing agreement of this sort have been developed for representing design rationale (Lee and Lai, 1996). Similarly, argument strength as a simple function of support or objection has been used to explain the Wason card selection task (Green, 1995) and been successfully implemented in decision support

systems (Krause et al, 1995; Fox and Parsons, 1997; Fox and Parsons, 1998). Whilst it can be argued that summations of agreements do not express the full complexity of individual belief, they nonetheless provide a first-step indication of 'team' agreement about a contribution. For this reason, value allocation for agreements and the calculation of contribution strength are kept very basic; further refinement is possible.

Obviously, there is a distinction between agreements given to a contribution by the arguer himself, and agreements given to a contribution by the audience. The first instance indicates that the arguer develops his own contribution and increases the strength in the hope that it will be accepted, whereas in the latter case the audience picks up a contribution and agrees with it on its own accord. Whilst currently contribution strength is modelled inclusively, i.e. agreements by all parties including the contribution owner, further distinctions, in principle, could be made. Furthermore, although the agreement is inclusive, it serves as a salient point that can be further investigated by analysing the distribution of agreement of a particular contribution. This strategy is illustrated in more detail below.

In the frame rationale for the example transcript, agreement between contributions are recorded, as shown in Figure 6.15. To simplify, all explicit agreements are recorded with value 1, all explicit disagreements with value –1. Furthermore, a simple rule was implemented to capture implicit agreement and disagreement.

```
%explicit agreement: agree(value,prevCont,thisCont)

agree(1,1,6).
agree(1,2,3).
agree(1,2,4).
agree(1,7,8).
agree(1,7,10).
agree(1,7,11).
agree(1,7,12).
agree(1,7,14).
agree(1,14,20).
agree(1,14,21).
agree(-1,14,23).
agree(1,16,19).
agree(-1,26,29).
agree(1,31,32).
agree(1,31,36).

%implicit agreement

agree(X,Y,Z):-
    link(Y,Z,Link),
    scale(Link,Value),
    X is Value.

scale(aes,1).
scale(abs,1).
scale(d,-1).
```

Figure 6.15 – Agreement implemented in a frame rationale

Contribution strengths can be calculated for the transcript excerpt based on the above agreements. These strengths are shown graphically in Figure 6.16. It can be observed that contribution 7 receives a higher contribution strength than the rest of the contributions modelled in this excerpt. Conversely, contribution 24 only receives a low contribution strength.

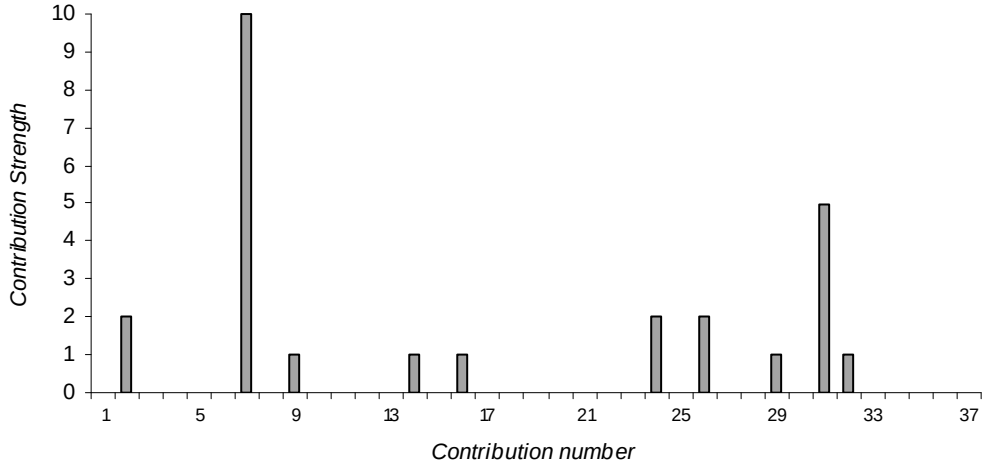


Figure 6.16 – Contribution strengths for transcript excerpt

Information about the owner of the contribution that receives contribution strength and the owner of contributions that gives agreement can then be gleaned. For instance, further drill-down into the data captured by frame rationale yields that contribution 7 is the utterance “maybe it’s like a little vacuum formed tray kinda for it to sit in” made by John, whereas contribution 24 is “this tray were not plastic but like a big net” made by Ivan. The way that certain team members participated in the rhetorical construction of understanding can be investigated through the level of agreement that was given by other team members with respect to a contribution. For example, the amount of agreement (and disagreement) for contribution 7 and 24 given by individuals is shown graphically in Figure 6.17.

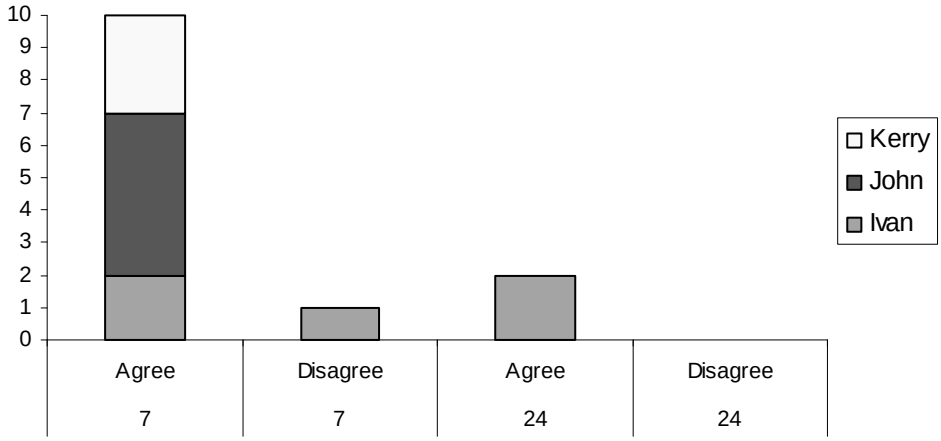


Figure 6.17 – Breakdown of agreement and disagreement for contributions 7 and 24

Certain agreements are given by the owners of the contributions themselves, as can be seen by the detailed breakdown. In the above example, contribution 7 receives agreement from both Kerry and Ivan, but also from the owner of the contribution himself, John. However, we can also note that contribution 7 has agreements by the whole of the team, whereas contribution 24 only has the owner’s agreement. With the

benefit of hindsight it can be discerned that contribution 7 was carried forward, whilst contribution 24 was not.

To summarise, frame rationale captures the notion of agreement strength through the calculation of *contribution strength*. This is a measure of agreement given to a particular contribution and allows investigation of contributions that receive salient measures. Furthermore, information about team members that were involved in agreement about contributions is captured.

6.6 Attempts at framing

As discussed in chapter 4, dissociations change the perceptual data of a situation and function as markers for attempts at reframing.

The frame rationale directs attention to any instances of dissociation in the design discourse. Dissociation is captured as a link type, although this may run counter to an intuitive understanding of dissociation as the breaking of a link. However, capturing dissociation as a type of link gives access to what a contribution is dissociated from. It captures the essence of a dissociation; namely that it only occurs *in relation* to something else. Dissociations are therefore distinguishable from contributions that merely attend to new facets of the situation. In this case, these contributions have no connecting link to previous contributions.

A further point to note is that dissociations are only markers for an *attempt* at reframing by an individual and do not signify that a shift of frame has actually occurred at the *team* level. However, use can be made of the notion of agreement to examine further the degree to which the dissociation has found subsequent agreement by the team. Each contribution receives a certain contribution strength, as discussed in section 6.5. It can

be further noted that the effect of implicit agreement to an attempt at framing is the integration of a dissociation into an argument chain by the use of subsequent association argumentation schemes.

The capture of agreement to attempts at reframing within frame rationale allows questions to be asked not only about which contributions were agreed to (or not), but also by whom and how. Whilst frame rationale cannot show frame conflict explicitly, it is nonetheless useful in finding instances of attempts at reframing that might lead to frame conflict, particularly ones with explicit disagreement. These instances form 'entry points' where the team is set on course for frame conflict unless they are resolved.

To summarise, frame rationale highlights the attempts at framing through *dissociation argumentation schemes*. Types of agreement and ownership captured for contributions that are attempts at framing allows 'entry points' for potential frame conflicts to be investigated.

6.7 Unfolding

Arranging individuals' contributions in frame rationale according to the point in time they are made can form the first step in showing the temporal unfolding of design discourse. The argumentation schemes associated with each contribution can also be ordered.

Visually, this can be expressed as a timeline of persuasive structures over the course of a transcript. Figure 6.18 shows the designers' use of persuasive schemes over the course of the whole design session introduced in chapter 4. It allows the researcher to investigate how the design discourse of a particular design session developed in terms of argumentation schemes used.

Figure 6.18 – Use of argumentation schemes in example design session

This representation of the Delft Design Protocol shows that argumentation schemes are used less in the beginning of the design episode and at the very end; these correspond to non-argumentative actions like reading through the brief individually and naming facts at the start of the design exercise or documenting decisions and summarising at the close of the design session. It can also be observed that there are more dissociations in the first half of the design sessions than the second and that they follow each other in quick succession. In the latter half of the design session, less dissociations are put forward and the argumentative activity settles down.

The frame rationale can then be used to investigate the unfolding of the design discourse. For instance, dissociations towards the close of the design sessions may spell bad news, since the team may not have time to follow them through completely. However, the question of scale will be all-important. Dissociations concerned with minor details of the design can be acceptably handled late, whereas dissociations that attempt a radical reframing of fundamental design concepts at a very late stage may have very serious consequences.

A representation of the temporal use of argumentation schemes provides an overview of the design discourse, which can be supplemented with a drill-down into information that

relate the use of argumentation schemes to other features of the design discourse. The overview of argumentation schemes shows a particular aspect of rhetorical construction of understanding that can be used to pinpoint salient activity in a design discourse. These salient points can then trigger further investigation of further aspects of design team discourse (Figure 6.16). The highlighted section in Figure 6.16 corresponds to the example transcript and it was demonstrated how strength of agreement, boundary of attention and argument chains are represented for this example in the previous sections. Hence, this overview can then be used to drill-down into information represented in Figures 6.16, 6.8 and 6.14, respectively.

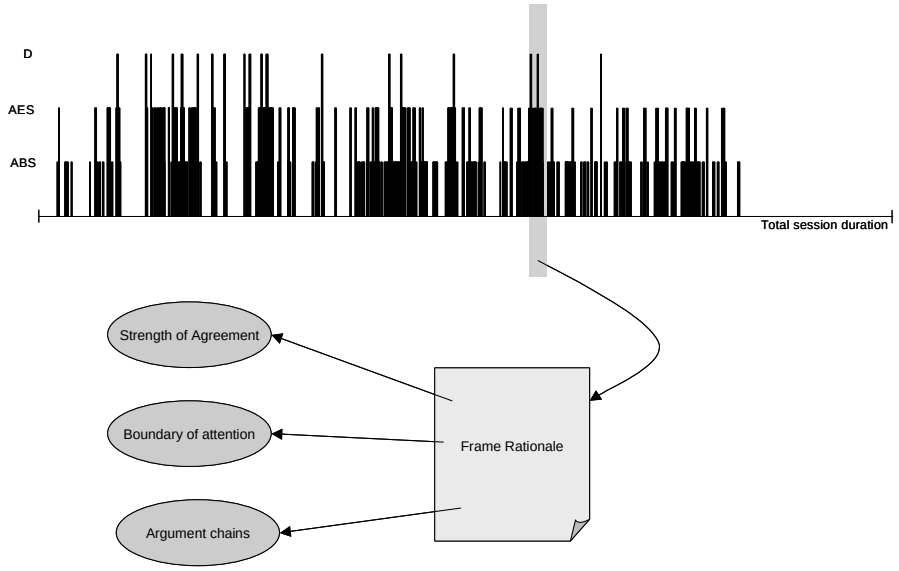


Figure 6.16 – Using frame rationale to investigate salient aspects of design discourse

Questions that may be asked during this drill-down investigation can be classified broadly into three categories. Firstly, the researcher may ask which contributions are related or how far in terms of time the contributions that are linked through argumentation schemes are separated from each other. Secondly, a drill-down investigation may pay attention to the contents of contributions involved in the argumentation schemes or what notions are introduced or organised. Thirdly, attention

may be given in particular to dissociations and the scale or their impact of them in relation to the design concept.

Information about which contributions are linked can be gained through argument chains. These highlight ABS and AES argumentation schemes between contributions and can therefore allow the connections between contributions to be examined. Addressing the second question, the content of contributions related through argumentation schemes can be gained by selecting specific argument chains and inspecting the utterances contained in contributions. This investigative strategy proceeds from the identification of salient points in the overview of the argumentation schemes via the inspection of argument chains involved and "zooms in" to individual contributions. In a complementary manner, *units of attention* and *names* allow an abstracted view of the content of a collection of contributions rather than individual ones over time.

Lastly, an exploration of a dissociation's scale in a design discourse is related to the emphasis that is placed on highlighting either the *existence* of a possible frame conflict that the dissociation may entail or the *importance* of dissociations for a team-frame. In the former case, whilst information about frame conflict is not captured explicitly, attempts at framing and subsequent agreement to this attempt are represented. We have discussed attempts at framing as possible entry points into frame conflict in section 6.6. The latter case can be explored by the strategy of inspecting argument chains and contributions, coupled with the notion of *critical moves* discussed in section 6.4, and the notion of contribution strength discussed in section 6.5. An interpretation of the importance of dissociations therefore has to be made – coupled with the benefit of hindsight – in the context of a particular design discourse.

To summarise, frame rationale highlights the unfolding of design discourse though the interplay between *contributions*, *argumentation schemes*, *argument chains*, *units of attention*, *names*, *attempts at reframing* and *agreement*, allowing salient activity to be pinpointed by a combination of overview and zoom.

6.8 Conclusion

In this chapter, frame rationale representation was proposed to structure design discourse. A basic formal abstraction was described which records contributions and their attributes, links between contributions and their type and units of attention. It was shown how this abstraction fulfils the requirements of highlighting the boundaries of attention, and the strength of agreement, the organisation of premises, the introduction of new notions, attempts at reframing and unfolding through *units of attention*, *names*, *argument chains* and *dissociations*. Examples for frame rationale were given using an illustration based on a transcript excerpt.

Descriptive representations such as frame rationale can be used as part of the 'reflective turn' in design and might be made available to designers to enable reflection-on-action (Glock, 2000). However, frame rationale as a representation of design discourse only forms one part of the arsenal that describes team experiential learning. Descriptions of designers, the design task and the design process, as proposed in chapter 5, can also be used as representations to support reflection-on-action.

The next chapter investigates how design researchers can play a part in supporting reflection-on-action by making use of frame rationales to direct learning, which focuses on encouraging designers to reflect on their design activity and develop abstract conceptualisations about designing. Furthermore, the next chapter will also give a rich account of how designers use complementary representations of team experiential

learning in learning situations. Design team experiments, functioning as learning situations, are discussed which show how team experiential learning can be represented using frame rationale, learning styles and perceptions, and how teams and individuals reflect-on-action using these representations.

Chapter 7 Learning about team learning: Representations and their use for reflection

7.1 Introduction

Representations are selections of data arranged in a meaningful way for some purpose. Design paradigms influence what is considered data by the fact that they highlight certain aspects whilst suppressing others; they attribute meaning. Therefore, descriptive representations can only be developed within a certain design paradigm. In chapter 5, characteristics that representations of team experiential learning should capture were outlined. For ease of reference, a summary of these characteristics is restated here in Figure 7.1.

	Characteristics to represent
Model of Designer	Designer as learner Designer as participant in the rhetorical construction of understanding
Model of Design Task	Perception whether team-frame has been established: Framing
Model of Design Process Dynamics	Micro-level construction cycle effected through verbal means Perception how team-frame was constructed: Team Agreement Appreciations Frame conflict

Table 7.1 – Characteristics of team experiential learning for representations

Representations can be used for description and support. In experiential learning in particular, description and support go hand in hand; a 'reflective turn' in design research suggests that descriptive representations of designing are used to encourage reflection by design practitioners and to function as support for learning.

Frame rationale is a representation of design discourse that is sensitive to the qualities of team experiential learning. Whilst design researchers may use it as an analytical tool, its use as a reflective tool by designers is also addressed in this chapter. This chapter investigates in part how designers use design discourse representations in learning situations. Design researchers, particularly those interested in design education, can also make use of frame rationales to develop more directed learning situations, which focus on encouraging designers to reflect on their design activity and develop abstract conceptualisations. In supporting reflection-on-action, representations of the design process only form one aspect of designing; representations of other dimensions of designing can also be developed. In this chapter, complementary representations are constructed based on the analysis of characteristics in chapter 5 and put to use to encourage learning.

Firstly, then, there is the question what it means to encourage learning. To answer this question, experiential learning in design is revisited in section 7.2 to examine the role of reflection-in-action and reflection-on-action in team experiential learning situations. In particular, section 7.2.1 will address the issue of measuring experiential learning.

The representations that are developed in this chapter describe teams in learning situations. Design team experiments, that function as learning situations, are used to draw out a rich account of how representations are used to reflect-on-action. The set-up of the teams and the learning situations are explained in section 7.3. In the remaining sections, representations are developed for these specific learning situations. In section 7.4, the use of design discourse representations, in particular frame rationale and IBIS, by teams is discussed. It is claimed that frame rationale can be used by a researcher to

put together ‘critical instances’. The use of these critical instances to stimulate reflection-on-action is demonstrated in section 7.5. In section 7.6, representations of designers and designing are profiled. In particular, section 7.6.1 discusses learning styles, whereas section 7.6.2 focuses on representations of designers’ perceptions. Using learning styles in the description of design teams and support for reflection-on-action is discussed in section 7.7. Designers’ perceptions in design teams and their use in learning will be described in section 7.8. Connections between learning styles and perceptions are made in section 7.9.

7.2 Experiential learning in design revisited

In section 3.2, experiential learning in design was examined. A link was made between learning and the learning cycle (Kolb, 1984), which proceeds through concrete experience, reflective observation, abstract conceptualisation and active experimentation. Experiential learning is a process of change that is grounded in an individual’s experience. As such, experiential learning cannot be measured in terms of outcomes because new knowledge is integrated or substituted rather than added. Experiential learning can be summarised as “the process whereby knowledge is created through the transformation of experience. (*ibid.*, p.38).” In this respect, two modes through which experiential learning in design is achieved were distinguished. Reflection-in-action are the designers’ ‘on the spot’ reflective activities linked to concurrent action. Reflection-on-action on the other hand concerns the designers’ reflection on their subjective practices as a whole.

Descriptions of reflection-in-action can be made available to designers to use in reflection-on-action as part of a reflective turn in design research. Glock (2000) suggests the appropriateness of descriptions rests on designers ‘finding themselves’ in these representations. However, this does not touch on the usefulness of these

descriptions for reflection-on-action. The question then presents itself how it can be known whether learning has occurred during a learning situation.

7.2.1 Measuring Experiential Learning

Experiential learning cannot be measured through an additive body of knowledge; instead, learning depends on a process of *transformation*, linked to a learning cycle (Figure 7.2). Experiences can be known through apprehension (A) or comprehension (C) and transformed through intension (I) or extension (E).

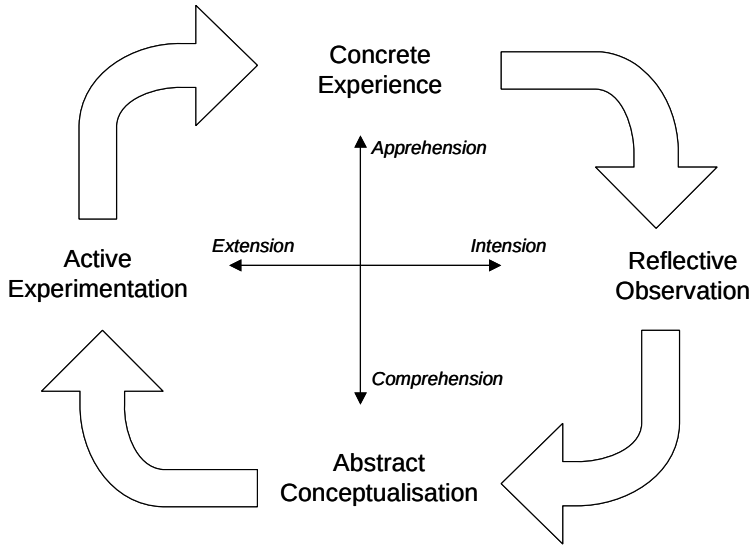


Figure 7.2 – The learning cycle's dialectics of grasping and transformation

The forms of learning can be thus described with the building blocks A, C, E and I whilst the transformation of knowledge is shown through a combination of these building blocks (indicated by Δ): A Δ I, A Δ E, C Δ I, C Δ E. The chaining of these elemental building blocks, e.g. A Δ I Δ C, form more powerful learning, i.e. the more elements are involved in a learning exercise, the higher the level of learning (Kolb, 1984). Hence concrete experience is transformed through reflection into abstraction, abstractions are transformed through experimentation into experiences. Hence, it is

proposed that the amount of chaining of elemental building blocks can be used as a measure of team experiential learning.

In this respect, it is important to notice that experiences and what is learned are connected to specific dimensions of designing. In a design team, we can therefore learn about other designers, the design team, the design task, design process etc. Individually, these dimensions are subject to the forms of learning above, and learning may be measured for each dimension. Therefore, it may be found that learning is not evenly distributed over the dimensions, i.e. that more powerful learning takes place in one dimension rather than another.

7.3 Learning situations and experimental set-up

Descriptions of designers, design task and design process were made in the course of design team experiments that comprised learning situations. Learning situations in the context of this thesis are situations in which designers are directed towards an engagement with design practice.

The experiments comprised a series of separate learning situations that involved either an individual from a team or an entire team. Initially, an entire team took part in a design exercise spanning three design sessions that engaged them in concrete experience. A detailed description of the design exercise set-up is given in section 7.3.1. Furthermore, the design exercise allowed the use of design discourse representations to be investigated, which is detailed in section 7.4. Once the design exercise had been completed, the design researcher interacted with the design teams in a learning tutorial where complementary descriptions were presented. These abstract conceptualisations were discussed with the design teams. An account of the descriptions and their use in reflection-on-action is provided in section 7.7 and 7.8. Finally, the design researcher

conducted directed learning situations using 'critical instances' that involved reflective observation by individual designers. This step is discussed in more detail in section 7.5. A depiction of these learning situations is shown in Figure 7.3.

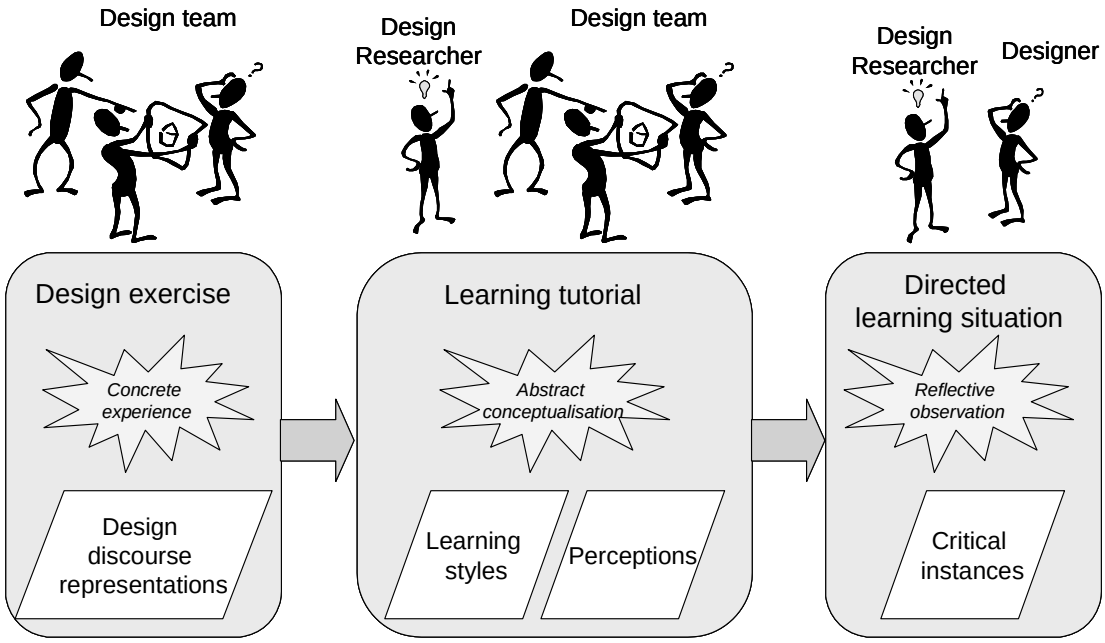


Figure 7.3 – Learning situation steps

7.3.1 Design exercise set-up

Three teams – Team 1, Team 2 and Team 3 – consisting of up to four student designers were asked to carry out a co-operative design exercise and develop prototypes with a user. Each design exercise per team spanned over three sessions. The designers were drawn from final year undergraduates studying User Centred Design as part of a BSc in Information Management, who volunteered to conduct their design sessions under observation. The design task concerned a scenario in which they were to design an order-delivery system for a pizza company, choosing either an external or an internal focus (Figure 7.4).

The Bespoke Pizza Company is a new venture for an existing pizza restaurant chain. The existing business operates along the same lines as, say, Pizza Express, offering set-menu style pizzas for an eat-in or take-away service. Now, they would like to expand their business to give their customers a more flexible menu choice via ordering over the Internet.

You will be part of a group to prototype some aspect of this new system which is expected to take orders and respond to them. As a group, you can focus on the customer side and/or the in-house order management and dispatch operation.

Your group will need to develop this prototype co-operatively with a user who has some experience in either ordering fast food or the running of a fast food establishment (depending on whether you choose to focus on customer or in-house side of the pizza delivery company), and some experience of using the Internet. You should arrange to see this user for 45 minutes on three separate occasions.

You can use paper, PowerPoint, HTML, Internet Assistant or any other suitable medium for building your prototype.

Figure 7.4 – Prototyping scenario used in experiment

If the team chose an external focus, the team was asked to concentrate on a web-based interface for pizza ordering. The user[14] (U) provided had experience in ordering via the Internet and other pizza-delivery options. Teams choosing an internal focus were free to concentrate on a specific sub-system of the pizza company order provision process. They were helped in their design task by a user that had experience as an employee of a pizza restaurant.

Each team held three design sessions, each lasting 45 minutes, which were spaced over three weeks with a gap of at least six days between each design session. It was left up to

[14] Due to the significant time commitment that would have had to be made by a real user, an actor played the user's role in the experiments. We thank Kathleen Kiirik Bryson for her very convincing performance as both customer and employee of the pizza company. The experiment participants were not aware that the user was an actor.

the teams to structure and plan their activities over the three sessions. Before each session, 15 minutes were spent to brief the team. Participants were given instructions concerning the task and shown representations of their design discourse. The sessions concluded with a 15-minute slot during which the teams were asked to fill in a feedback questionnaire. The questionnaire aimed to elicit an evaluation of the use and usefulness of design process representations presented and individual perceptions about designers' interaction and design activities during the design session. More detailed discussions about the use and usefulness of design process representations is provided in section 7.4. The analysis of the questionnaire feedback was used to construct descriptions of team experiential learning based on the perceptions gathered. The development of the feedback questionnaire in terms of eliciting perceptions is presented in section 7.6.2.

The team and user met in a room set up by the experimenter (Figure 7.5 and 7.6). A video camera was set up which allowed the design sessions to be recorded. The designing was observed by the experimenter who could take down additional notes and deal with any technical problems that arose. The experimenter did not participate in any team design activities.

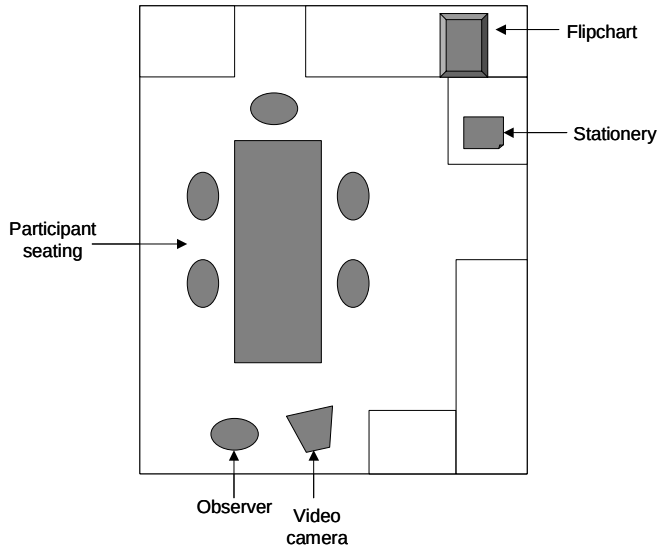


Figure 7.5 – Experiment room set-up

Figure 7.6 – Team 3 in action

Each team was provided with different support for reflection-on-action during the time slot reserved for briefing before session two and three. Team 1 and 3 were given a representation of their previous sessions' design discourse whilst Team 2 was not given a design discourse representation. Team 1 was presented with a representation of their previous argumentation and decision-making in the form of an IBIS map (see section 5.5.1), whereas Team 3 was provided with a frame rationale representation. The teams were free to discuss and make use of this representation throughout the ensuing design session. Table 7.7 shows a matrix of design discourse representations provided against teams and team participants.

Team	Design Discourse Representation	Team participants (without user)
1	IBIS	H
		K
		S
2	N/A	C
		E
		J
		S
3	Frame Rationale	B
		L
		T

Table 7.7 – Design discourse representations provided to teams

7.4 Design discourse representations

Team 1 was presented with an IBIS map and Team 3 with a frame rationale to examine the impact that different design discourse representations may have on reflection-on-action by design teams. These representations were not constructed by the teams; instead, the representations were presented to them by the experimenter, who had created them from the session tapes.

Feedback was sought on the use and usefulness of representations presented at two design sessions as part of the feedback questionnaire. The analysis of measures of the use and usefulness of the representations did not differ to a statistically significant degree across teams or individuals. Therefore, conclusions cannot be drawn with respect of the usefulness of a frame rationale representation as opposed to an IBIS representation in this particular instance of application.

In general, however, it was observed that detailed design discourse representations were not used by the designers as a resource *during* the design sessions. The teams focussed more attention on 'getting the job done', rather than on reflecting on how they were operating. Expressed in experiential learning terms, the designers had the tendency not to transform their apprehension through intension. When presented with the design discourse representations, the teams agreed the representations provided a fair picture of what happened but they had the tendency not to transform what was shown in the representations, comprehension, through reflection (intension). In either case, the concrete experience of designing and the abstract conceptualisation that the representations provided were not connected. This, then, indicates a lower-level learning process.

It is interesting to speculate why the relation between design discourse representations and designers' concrete experiences should be so weak. Firstly, the designers may not place great value on reflecting on and learning about the way they design. Secondly, it may be that these representations fail to connect designers' ways of knowing. However, this would mean that the dual-knowledge structure of designers becomes more important. On one hand, representations that function as abstract conceptualisations may fail to link to designers' apprehension, i.e. representations do not connect because designers do not experience designing as that process described. Obviously, if this is the case, designers cannot 'find themselves' in the representation and the representation does not fulfil its role in supporting reflection-on-action. On the other hand, representations may fail to connect to designer's comprehensions, i.e. representations do not connect because designers do not conceptualise designing as that process described. In this case, some preparatory learning would tackle this problem to sensitise designers to the conceptualisation described by the representation.

7.5 Critical instances

In fact, frame rationale can be used to construct directed learning situations, which draw designers' attention to 'critical instances'. These 'critical instances' stimulate designers, firstly, to reflect in their experience and, secondly, to build abstract conceptualisations. Furthermore, frame rationale can be supplemented by other representations, described in section 7.6, that allow designers to transform their experience (Figure 7.8).

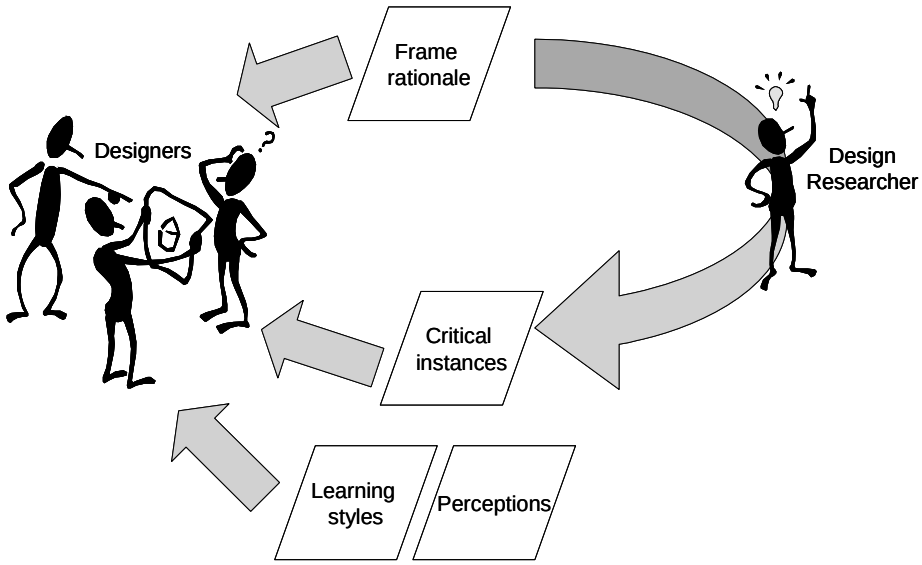


Figure 7.8 – Representations used to encourage learning

Critical instances in the context of this thesis are segments of design sessions when participants enact a shift in perspective through the rhetorical construction of understanding that has ramifications on the design concept. Critical instances are presented as edited video sequences to the participants in a follow-up session, where the design researcher acts as a facilitator. This facilitator or educator poses a set of questions to sensitise designers to the rhetorical construction of understanding. The aim of these more directed learning situations is to encourage reflection-on-action by getting designers to reflect on their concrete experiences (A Δ I) and develop abstract conceptualisations (A Δ I Δ C).

The notion of critical instances bears similarities to Frankenberger and Badke-Schaub's (1996) definition of 'critical situations'. As they point out, not every decision carries equal importance for the solution development; there is a certain amount of routine work. Critical situations determine the ensuing course of designing and its results by introducing new directions for design concepts. In their work, critical situations are identified according to their role in the problem-solving process, such as determining

new requirements, clarifying the task and developing or evaluating new solution concepts or embodiments. Critical instances, in contrast, are identified by paying heed to how teams reflect-in-action and participate in the rhetorical construction of understanding to achieve a team-frame. Not all activities that form part of design sessions have important ramifications on the design concept; there is an element of hindsight and attention is narrowed down to smaller units, hence the name ‘instances’. The identification of critical instances and critical situations can be further distinguished from ‘critical incidents’ known from Critical Incident Technique (Flanagan, 1954). Whereas critical incidents are provided by designers, critical instances and critical situations are identified by design researchers.

Frame rationale provides support as an analytical tool for researchers to prepare a shortlist of salient points that may be used as critical instances. As demonstrated in section 6.4, attempts at framing, contributions that do not fit in or that jump around, in addition to chunks and critical moves, form salient points in argument chains. Furthermore, using strength of agreement as discussed in section 6.5 can identify contributions with low or high strength, and, in particular, attempts at framing that receive high or low agreement. Coupled with the knowledge of the importance to the design concepts of these salient points, a shortlist of time spans can be prepared that allows suitable critical instances for a design session to be picked.

Whilst frame rationale allows the investigation of salient points and hence the identification of critical instances, video evidence is used to present experience back to designers. Since edited extracts are used in the directed learning situation, the video excerpts have to evoke the critical instance(s). Consequently, some skill is involved in editing the video evidence to evoke the essence of a critical instance: for example, a

video extract that covers a critical instance where a change of perspective is displayed could include an individual 'withdrawing' into reflection, prompted by something that is puzzling them, to set the scene. Therefore, whilst the identification of critical instances relies on salient points from design discourse, the final edited video extract covering critical instances additionally relies on an intuitive interpretation of body language such as frowning, 'pulling of hair', shifting in seats, etc.

7.5.1 Example of using critical instances in directed learning situations

The use of critical instances in reflection-on-action by individuals is now illustrated. Follow-up sessions were conducted with participants of Team 2 and 3[15]. The participants are shown in Table 7.9.

Team	Team participants	Directed learning situation participant
1	H	✗
	K	✗
	S	✗
2	C	✓
	E	✗
	J	✓
	S	✓
3	B	✓
	L	✗
	T	✗

Table 7.9 – Participants in directed learning situations

The critical instances centre on the divergent perspectives of team participants and the user that is expressed through a lack of distinction of terms. The user uses several terms from the application domain, which are erroneously conflated by the team participants[16]. In argumentative terms, this can be seen as a fallacy of equivocation between the user and the team. As Deppermann (2000) has pointed out these equivocations have their origin in semantic shifts and function as 'keywords'

[15] Whilst follow-up sessions were offered to all individuals, participation was optional and self-selected.
[16] The particular conflation observed in the design sessions centres on the distinction between tables, orders and pizzas.

(Nothdurft, 1996) that encapsulate understandings and positions unfolded over the course of a discussion.

Team 2 and 3 have constructed their understanding on the assumption that an order consisted of one pizza only and that each order has a table associated with it. This is incongruent with the way that the user sees orders. Orders are items from a 'paying group' and several paying groups might share a table. Each order is then made up of individual pizzas, side orders and drinks. The way that the problem was perceived manifested itself through the equivocation of these terms and obviously, this had important effects on the way that any solution system handled orders.

The difference of perspective between the user and the rest of the team was not discovered by Team 2 until the end of the last design session. This meant that substantial parts of their design needed to be revised, however due to time constraints further team work with the user was not possible. Team 3 spotted the distinction early in the second design session, resolved it and carried this new understanding successfully forward through their design.

During follow-up sessions, an edited videotape that covered the relevant critical instance within Team 3 was replayed to individual B. Similarly, C, J and S were shown, one at a time, an edited video covering the critical instance within Team 2. Each agreed that the relevant video clip captured the first instance when this difference of perspective became apparent to them. During the directed learning situation, each was asked initially by the design researcher to summarise what was going on the video clip (Figure 7.10) to prompt them to reflect on their experience (A Δ I).

B:	I think we had already elicited the information we needed, we had lots of ideas and we wanted to put them forward to U to see what she thought of them - get ideas from her, to improve our ideas and to see what we thought was really applicable and workable.
C:	That's the final final meeting so we have our prototype done like ninety percent and we are telling U what's going on and like she was (.) telling us what she thought (.) like running through the whole system (.) and we changed things during that meeting
J:	The final realisation about something about the orders (.) we assumed all along that an order was slightly different to what she meant it was we suddenly went [higher voice] oh my God hang on we better ask about this [returns to normal voice] and then I asked her and then it was all clear and it was a shame it was in the last one (.) that we got it
S:	[…] just finalising the last points cos (.) like you said it was our last meeting (.) so basically we were trying (.) to get the fine detail (.) about how the interface was going to be in the kitchen and then for the waiters and waitresses

Figure 7.10 – Recounting experience

In their reflection-on-action, each individual focussed on the notion that there was a change in their understanding in terms of the design problem and its effect on the design concept. However, the implications of this change were perceived differently: the change can be perceived as an instance in a process that tries to fit the design concept to the requirements of the user or, more importantly, as a way of aligning the perspective of the team with the user. In expressing their view of the concrete experience, individuals B, C and S described this shift of perspective in terms of the general design process. The change in perspective was submerged into 'finding out fine detail' and evaluation of whether the prototype worked successfully. This contrasted with individual J who focussed on the realisation that the term 'order' had different meanings for the team and the user.

Attention was then turned towards how understanding was constructed verbally by each individual to concentrate on their interaction with the user as a first step to build abstract conceptualisations (A Δ I Δ C). Whilst each individual formed some understanding of the interaction, it is striking that abstract conceptualisations of the interaction were related at different levels of design activity (Figure 7.11). Individual C viewed the

team's interaction with the user across the whole of the design process. She did not reflect on the construction of understanding; instead, in her view, the interaction with the user only takes place to get the design concept right and the team takes reactive action once the user has pointed out faults. In contrast, B and S focussed on the user's clarification of things in relation to the team's understanding of the problem. They were surprised that the user has different meanings; it struck them that designing is concerned with a common understanding. In section 3.2.3, it was pointed out that the notion of surprise plays an important role in triggering reflection-in-action; it appears that this is echoed here by the individuals concerned when they reflect-on-action. Similarly, individual J used her observation of the interaction between the user and another team member to identify the difference of perspectives and mentions the element of surprise. At the same time, she reflected on the way she had spotted the difference of perspectives: she extended her conceptualisation of the way that she used reflective observation in the particular design session to a general approach of reflective observation that could be used in other instances.

B:	OK, I was a bit concerned because at the time we had only talked about how she would prepare one pizza and she was saying how (.) and then it suddenly occurred to me that there may be more than one pizza on an order and we hadn't accommodated for that fact (.) and that struck me probably just as you came in and so I was thinking inside how we could go about incorporating that into our system.
C:	How she thought the system should be? What she thought would be best as a prototype? so we changed it afterwards
J:	I think there was something going on between her and E (.) and E's perception of it I kinda observed that and then I looked at hers and I thought hang on a minute they are talking different languages (.) so when you see it in other people then you kinda think hang on I'll ask about this
S:	Her clarification of things (.) making sure we understood what she was talking about (.) sort of sometimes a confusion about when she was talking about being a waitress and when she was being a chef sort of qualifying those areas and I had to pay attention to that.

Figure 7.11 – Reflection on construction of understanding

Focus was then directed by the design researcher onto the existence of a team-frame. In particular, emphasis was placed on how perspectives could differ within the team and

their strategies for managing to reduce the difference of perspectives. Individual J was keenly aware that individuals in the team might have different perspectives, however B and S did not make that distinction as forcefully (Figure 7.12). Whilst they were aware of the difference in perspectives between the user and the rest of the team, they did not perceive that their own perspective could be different from the rest of the team. In fact, individual C was still not aware of the implications, even when presented with video evidence: the meaning of table and order did not reflect the user's.

B:	Perhaps not (.) because they didn't show it but once I mentioned it I'm sure it clicked
C:	[…] (.) but she is saying it as order per person on that table
J:	E definitely knew, C […] I don't know if she did, but I don't think S did either
S:	[…] (.) we maybe I didn't realise that other people didn't know what that was

Figure 7.12 – Reflection on team-frame

When attention was drawn to strategies that could be adopted for construction of a team-frame, individual S did not think that the team paid any heed to this particular aspect during the design sessions. They had talked within the team before and after every meeting, and used sketches to work through their understandings, however they did not attempt to use any techniques to develop a team-frame during the meetings with the user (Figure 7.13).

S:	No not there in the meetings on our own (.) no I think in those meetings it was more just trying to get as much information as possible rather than (.) trying to make sure that everyone else like we all understood what we were talking about I suppose

Figure 7.13 – Reflection on strategies for managing a team-frame

Individuals B and J expressed that there was no concern about taking the team along to actively construct a team-frame. It appears that individuals assume that although their

understanding might differ from others, once they have resolved some difference of perspective, everybody else should be able to follow suit (Figure 7.14).

B:	[…] I hoped that just by saying it in front of everyone (.) everyone was able to understand the same
J:	[…] we kinda said everybody knows this is it (.) if you didn't get it in the meeting (.) I think it was pretty obvious in the meeting

Figure 7.14 – Reflection on strategies for managing a team-frame

J insisted that her individual approach to handle the construction of a team-frame was not a strategy at all, it was an attitude to be open to surprise (Figure 7.15).

J:	[…] I don't think I did any strategy at all it was just pure natural kinda question things and just go hang on a minute what's going on

Figure 7.15 – Reflection on being open to surprise

Similarly, B concentrated on the moments of surprise and reflection, surfacing what this means in terms of her own understanding (Figure 7.16).

B:	I was thinking hard. Maybe sometimes she'd mentioned something, I pick up on it and I'm trying to (.) create something from what she said. I'm still listening to her but I'm focussing more on something I'm trying to build up.

Figure 7.16 – Reflection on being open to surprise and reflection

To summarise, follow-up sessions in which critical instances are presented as video extracts coupled with sensitising questions can be used to encourage designers to reflect on their experience. However, in the process of reflection and building abstract conceptualisations about aspects of team experiential learning, individuals may be unsure how to make sense of the situation. For example, individuals may be uncertain about the way that perspectives may differ between team participants or which

strategies could be adopted to ensure the construction of a team-frame. Individuals may even resist building appropriate conceptualisations. Nonetheless, it is encouraging that designers can be supported to reflect-on-action and to build abstract conceptualisations concerning the individual experiential learning design process. In particular, the notion of surprise as an important part of the design process can be crystallised.

7.6 Complementary representations of team experiential learning – designers, design task and design process

Characteristics of team experiential learning were proposed in chapter 5 as the basis for representations that can be used by designers to reflect on their practices. These characteristics were developed from the models of designers, design task and design process. In section 7.6.1, learning styles as a characteristic of the designer as learner is discussed. In section 7.6.2, it is shown how perceptions given by designers about participation in the rhetorical construction of understanding, the establishment and construction of a team-frame – as proposed in section 5.3 – can be elicited.

7.6.1 Designers and Learning styles

Learning Styles have been proposed by Kolb (1984), based on the learning cycle. Learners, it is argued, need different kinds of abilities to make use of different learning modes. Learning styles can also have an impact on team composition. Firstly, Kolb *et al.* (1991) report that communication difficulties arise in association with differing learning styles. This, on a superficial inspection, might lead one to think that a team where individuals display similar learning styles might be preferable. However, learning is dependent on the transformation of experience through a learning cycle and hence a team that displays a balance of learning styles is actually the best for learning – but not communication within the team.

According to Kolb (1984), personality types impinge on the learning process and inhibit or strengthen certain dispositions to particular learning modes:

> "This self-programming conditioned by experience determines the extent to which the person emphasizes the four modes of the learning process […]" (*ibid.*, p.64)

Learning styles are related through the modes of learning of concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC) and active experimentation (AE) with notions of feeling, watching, thinking and doing respectively. Hence, an orientation towards CE engenders a personality that values people and an intuitive, open-minded approach to life. A person disposed to RO learning places emphasis on meanings of situations and ideas, values different perspectives and considered judgements. Learners who prefer the AC mode like systematic planning and symbol manipulation within logic, ideas and concepts. They value precision and rigour. Finally, a person oriented towards the AE mode favours a pragmatic approach to applications and the value of seeing results.

The idea that people have different learning styles has been used by Honey and Mumford (1992) to develop a learning style questionnaire that classifies people according to their learning styles (Appendix 5). They maintain that their approach enjoys greater 'face validity' with learners, since they "refrain from asking direct questions about how people learn" and base it instead "on what managers and professional people do" (*ibid.*, p.4). They structure learning styles around four archetypes: activists, reflectors, theorists and pragmatics (see Appendix 6 for brief descriptions of these archetypes). These, as Honey and Mumford maintain, correspond to an orientation to CE, RO, AC and AE respectively. Categorisation of individual learning styles is based on responses to eighty statements, giving normed scores between zero and twenty against the different learning styles, resulting in a

classification of very low to very strong preference. Individuals incur scores for all learning styles. Combinations of different learning styles can occur, as well as a domination of a particular learning style.

The role of learning styles is to firstly bring to designers' attention their preferred disposition to learning based on experience and accords with characteristics of designers as learners identified in chapter 5. This then helps to prime designers to pay attention to the way that they approach learning situations and the limitations of their predispositions.

Representations of learning styles were developed for the teams and individuals participating in the design exercise. These representations were presented to the teams by the design researcher in a learning tutorial and enabled the designers to reflect on their learning style predispositions. The results of the learning styles analysis will be discussed in more detail in section 7.7.

7.6.2 Designers and their perceptions of designing

The design task cannot be objectively described; it is always bound up in individual's apprehension. However, representations can be developed based on perceptions reported by designers. Characteristics of designers and the design process based on the perceptions of designers can also be elicited and represented. Representations of these perceptions can then be made available for reflection-on-action. In section 5.3, specific perceptions by designers were identified that relate to characteristics of team experiential learning. These perceptions were termed *persuasion*, *framing*, *perspective*, *appreciation*, *progress* and *team process*. For ease of reference, Table 7.17 shows the relation of these perceptions to the characteristics of team experiential learning.

For the purposes of the learning situations described in this chapter, a feedback questionnaire was constructed that elicited the perceptions of individual designers through questions pertaining to each perception. This is described in section 7.6.2.1. A copy of the feedback questionnaire as used in the design exercise can be found in Appendix 7.

These perceptions were presented to the teams by the design researcher in a learning tutorial and enabled the designers to reflect on designing. The results of the analysis of perceptions will be discussed in more detail in section 7.8.

	Characteristics to represent	**Indicators**	**Perceptions**
Model of Designer	Designer as participant in the rhetorical construction of understanding	Over a normal discourse: - roles of arguer and audience perceived as equally shared Over abnormal discourse: - feelings of illegitimate persuasion pervade	Persuasion
Model of Design Task	Perception whether team-frame has been established	If team-frame established: - team agree about the design concept to be developed as a solution - perspectives are aligned - terms used by team members perceived to be readily understandable to other group members If team-frame not established: - multiplicity of perspectives are in operation at the same time	Framing
Model of Design Process Dynamics	Perception how team-frame was constructed	During successful construction: - individuals have communicated their own perspective to the team openly and co-operatively - feeling that they 'work as one' and have made good progress designing the solution - awareness of differing issues, proposals for solution and justification for design alternatives should be clear During unsuccessful construction: - the team talks past each other and they may exhibit frame conflict - agreement cannot be reached on terms, the importance of values and the reasons why solutions were developed the way they were. - there may then be various solution proposals within the team, but the team cannot agree on one of them. -feelings of tension within the team may appear.	Perspective Appreciation Progress Team Process

Table 7.17 – Relation of perceptions to team experiential learning

7.6.2.1 Perception Questionnaire

After each design session, participants were asked to fill in questionnaires to elicit their perceptions related to the week's design session. To describe what was going on in a team, a set of statements for each perception was developed. Table 7.18 shows the statements in the questionnaire against each perception.

Perceptions	Statements
Persuasion	At times I felt I was being railroaded. Sometimes I had the feeling that one of us persuaded us that we should adopt his/her particular solution for the design.
Framing	When other people in the group talk about the way the design should be, I understand what they mean immediately. The group has changed their minds radically about what the design should be like during this session. I don't understand what other people in the group mean when they talk about the design. We all have the same view of what the design should be. As a group we don't agree on what design to develop. Some individuals in the group seem to have their own design ideas. As a group we don't agree about what we need to do to accomplish the design I think other people in the group have a different perspective of what the design is.
Perspective Appreciation Progress Team Process	We discussed our design as a team extensively. We all worked co-operatively on the coursework. I try to tell the group how I see the design from my perspective. I could justify how to design our prototype in different ways. I could explain how we came up with the current idea of the design I can explain how the design ideas evolved. I could give reasons why we are implementing the design the way we are. I don't know what problems the design is supposed to address. I can't explain why we are developing the design the way we are doing. I feel that the group has made more progress in the current design session than in previous design sessions[17] I understand better than when we started the session what the problems are that the design is supposed to solve. I think the direction we are taking with the design is the right one. I feel that the group has made substantial progress in the current design session. I think we work well together as a group. I feel there is tension within the group.

Table 7.18 – Statements developed to elicit perceptions

Each statement allowed a designer to express his or her degree of agreement on a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Statements related to particular perceptions were distributed over the questionnaire, so that no obvious clustering of the same perception occurred. To detect inconsistencies, negative pairs of statements were introduced. Ratings of agreement to statements were aggregated

[17] This statement was only included in the questionnaire presented after the second and third design session.

according to each perception. A score for each perception was calculated for each individual and team for each design session and represented graphically.

7.7 Representations of designers' learning styles

Learning styles questionnaires were completed by participants before the start of the first design session. Additionally, team averages for learning styles were calculated. To this end, each designer was analysed in terms of individual learning style and the scores used to compute a team learning style average. Across all teams, the learning style average appeared balanced, with a strong preference for the Activist and moderate preferences for the remaining learning styles.

7.7.1 Team 1 learning styles

Team 1 consisted of four individuals (H, K, S and U), including the user. Three out of the four team members were very strong Activists and scored low or moderately on the other learning modes (Table 7.19). One of the team, participant K, formed a counterpoint to the rest of the team by being a strong Reflector and Theorist.

	Activist	Reflector	Theorist	Pragmatist
U	Very Strong	Low	Low	Low
H	Very Strong	Moderate	Low	Moderate
K	Moderate	Strong	Strong	Moderate
S	Very Strong	Low	Very Low	Low
Team Average	Very Strong	Moderate	Low	Moderate

Table 7.19 – Summary of Team 1 learning styles

The team average for the learning styles indicators was hence strongly biased towards the activist learning style (Figure 7.20).

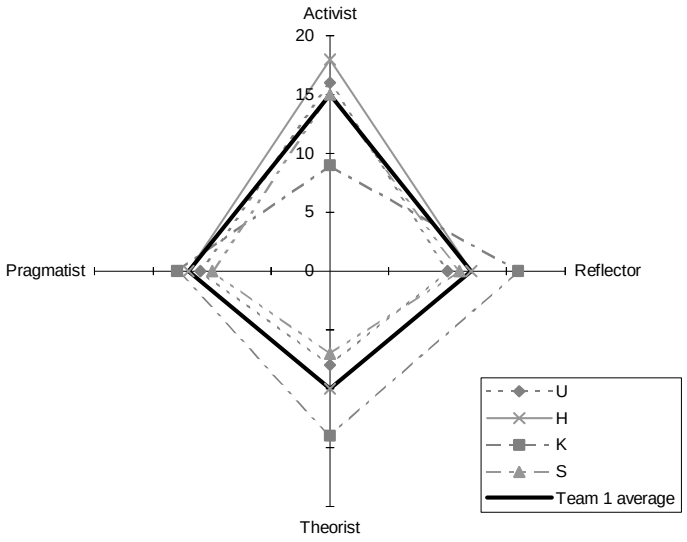


Figure 7.20 – Individual and team average learning styles for Team 1

In designing the visual characteristics of their design concept, Team 1 relished the chance to come up with lots of ideas, making for lively design sessions. It was evident that the group as a whole enjoyed being involved in new experiences, as pointed to in the Activist learning style.

However, Activists, as Honey and Mumford (1995) warn, may find it difficult to 'assimilate, analyse and interpret lots of 'messy' data' and fail to work through a problem and solution in detail. A negative effect can also be caused through their tendency to claim the centre of discussions. A bias to this style of working in the team was observable. Additionally, team member K, the Reflector and Theorist of the group, was pushed to the background.

7.7.2 Team 2 learning styles

Members of Team 2 consisted of five individuals in total (C, E , J, S and U). In contrast to Team 1, the majority of the team members had strong preferences for a Reflector learning style and only moderate preferences for the Activist learning style (Table 7.21).

	Activist	Reflector	Theorist	Pragmatist
U	Very Strong	Low	Low	Low
C	Moderate	Strong	Moderate	Strong
E	Moderate	Strong	Strong	Strong
J	Moderate	Strong	Low	Low
S	Strong	Strong	Strong	Strong
Team Average	Strong	Strong	Moderate	Moderate

Table 7.21 – Summary of Team 2 learning styles

The user (U) was the only one in the team with a very strong preference for the Activist learning style (Figure 7.22), whereas team member S was an 'all-rounder', being strong on all learning styles.

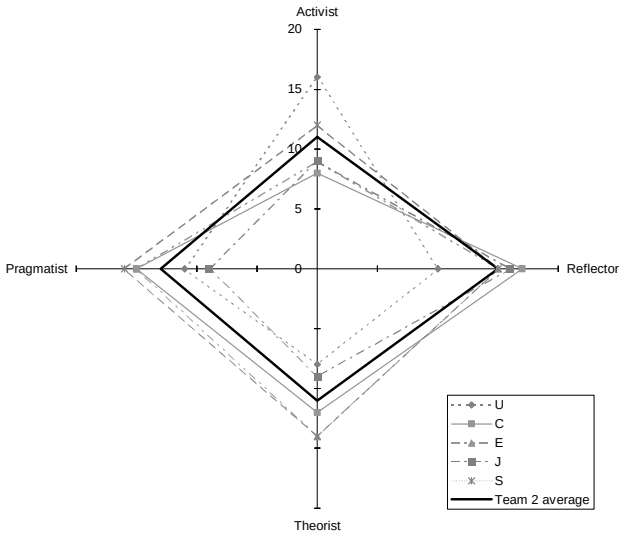


Figure 7.22 – Individual and team average learning styles for Team 2

The way that Team 2 approached the design sessions was markedly more restrained than other teams. The team tended to prefer to question the user and absorb information, rather than committing to and working through a hypothetical solution. They tried to understand the interrelationships of the situation, but action was mostly absent.

This seemed to be very frustrating for the user, who adopted a much more low-key behaviour with this team. Her feedback after the design sessions also indicated that she felt that the sessions with this team were 'hard-going'. This difficulty in communication may be related back to differences in learning styles (Kolb *et al.*, 1991).

7.7.3 Team 3 learning styles

Team 3 was composed of four individuals (U, B, L and T). In terms of learning style preferences, the team tended towards a very strong Activist mode (Table 7.23), however this is balanced out by having members that show strong or very strong preferences for Reflector and Theorist learning styles (Figure 7.24).

	Activist	Reflector	Theorist	Pragmatist
U	Very Strong	Low	Low	Low
B	Moderate	Very Strong	Strong	Strong
L	Strong	Strong	Strong	Low
T	Very Strong	Low	Moderate	Very Low
Team Average	Very Strong	Moderate	Moderate	Moderate

Table 7.23 – Summary of Team 3 learning styles

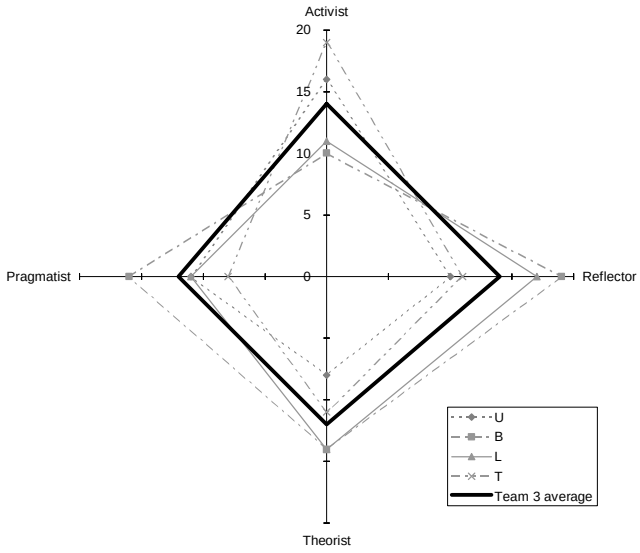


Figure 7.24 – Individual and team average learning styles for Team 3

The team worked very actively on the design concept, at the same time engaging the user in trying to understand what was going on. In total, individuals appeared to complement each other well.

7.7.4 Learning styles discussion

During the discussion in the learning tutorial where the learning styles analysis were presented, the designers were able to 'find themselves' in the representation. The learning styles were seen as useful by individuals and teams to explain their attitude and behaviour in the design process as a learning situation. In this respect, learning style analysis and its subsequent use in discussions with designers can encourage reflection about the way that designers approach learning. Learning styles is an abstract conceptualisation and yet designers were able to relate this conceptualisation to the concrete experiences of the design sessions. In other words, designers' comprehension was applied via intension to apprehension (C Δ I Δ A). Learning styles as a description of designers therefore has the potential to encourage designers' reflection-on-action about how they engage in designing.

7.8 Representation of designers' perceptions

After each design session, participants were asked to fill in questionnaires to elicit their perceptions related to the week's design session. A score for each perception was calculated for each individual and team for each design session and represented graphically as a resource for reflection. These graphical representations were shown to and discussed with participants during a learning tutorial.

7.8.1 Team 1 perceptions

Team 1's individual scores were analysed and shown as a team average over the three design sessions (Figure 7.25).

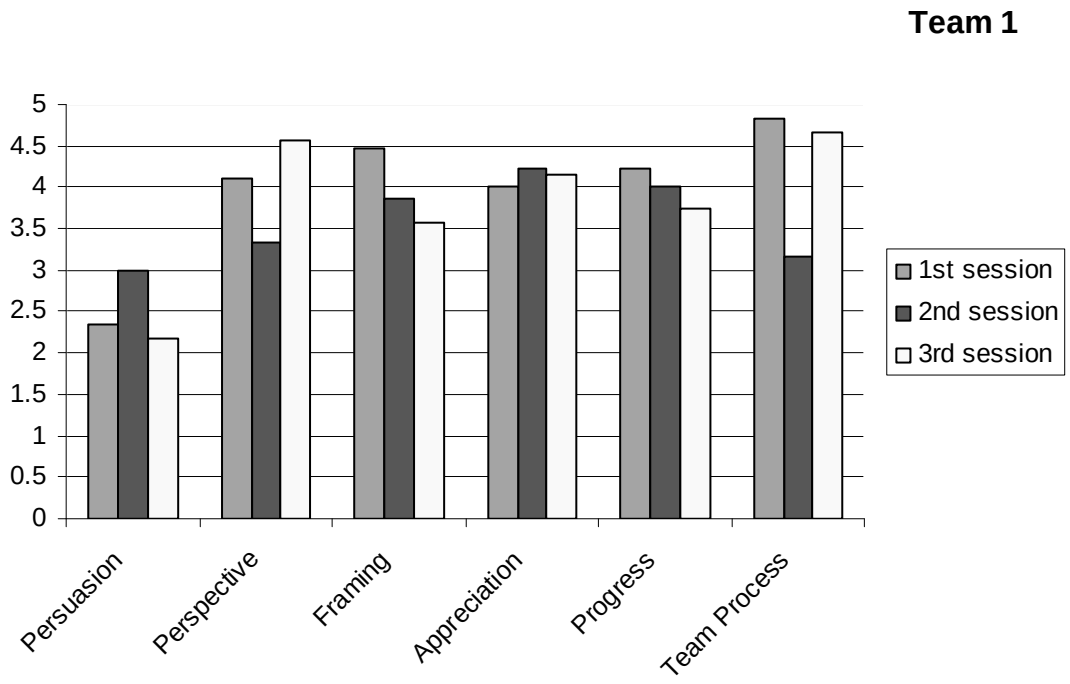


Figure 7.25 - Team 1 averages over perceptions

It can be observed that there is a marked drop in the perception of good *team process* and *perspective* sharing in the second design session, together with an increase in the feeling of *persuasion*. This can be related to problems experienced in the second design

session in the way that two participants interacted with each other. All three team members give lower ratings for the *team process* perception, indicating that the result of their problem is group tension. However, looking at individual ratings, the nature of the problem becomes clearer when perceptions of *persuasion* during the second design session is further investigated. The team is split: some members feel railroaded by another, since the feeling of persuasion is higher in participants K and S, whereas team member H rates persuasion low (Figure 7.26). The pattern in this case might lead particpants to reflect on the level of illegitimate persuasion that team members perceived.

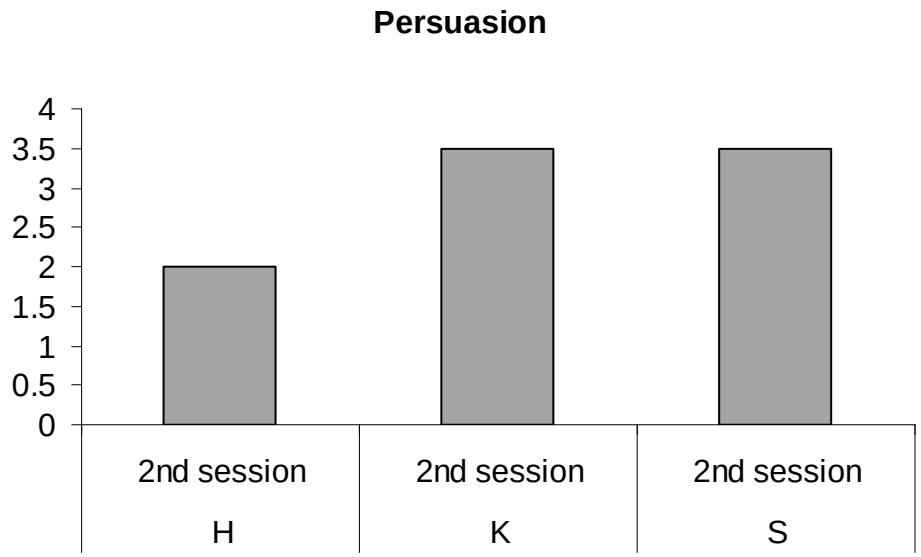


Figure 7.26 – Team 1 individual perception of persuasion in second design session

7.8.2 Team 2 perceptions

Team 2's individual perception scores were analysed similarly and shown as a team average over the three design sessions (Figure 7.27). The graph for team 2 shows perceived *persuasion* increasing in the third session, whilst all other measures decrease.

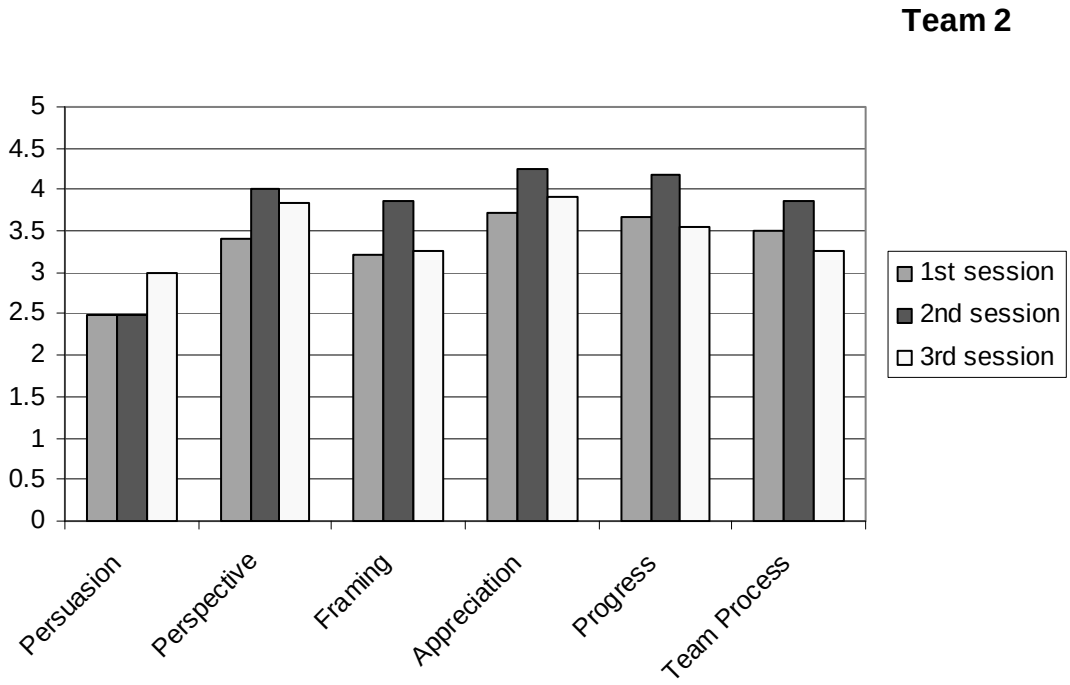


Figure 7.27 –Team 2 averages over perceptions

The team was able to connect this to the experience in the third session where it became obvious rather late in the design session that the user had a different meaning for a crucial term compared to the rest of the team. Consequently, the team had the perception that their designing went awry, indicated by a decrease in team process and progress. Furthermore, they were unsure of the construction of a team-frame and of their understanding of why they were designing the design concept the way they did, indicated by lower scores in framing and appreciation. Furthermore, perceptions of *persuasion* went up since the team felt that in this case the view of the user was imposed.

7.8.3 Perception discussion

During a learning tutorial, the graphs served as devices to probe and explore aspects of team designing. In particular, the graphical representations of perceptions were used to relate to concrete experiences in the design sessions by concentrating on patterns of

perceptions over the three design sessions. By presenting this representation, abstract conceptualisations are reflected on and linked to concrete experience. Comprehension is applied via intension to apprehension (C Δ I Δ A).

7.8.4 Correlations over all perceptions

During the analysis of perceptions, the patterns of perceptions observed lead to the supposition that there are links between the scores across perceptions i.e. there might be a correlation between the scores for perception. Furthermore, in section 5.3.4.1 it was noted that perceptions of the design process might also have a bearing on the perception of the designer as a participant in the rhetorical construction of understanding. A study of correlation between categories was carried out and tested for statistical significance; a summary of correlation is shown in table 7.28.

	Persuasion	Perspective	Framing	Appreciation	Progress	Team Process
Persuasion			-0.43	-0.35		-0.55
Perspective				0.45		0.67
Framing	-0.43			0.55	0.55	0.47
Appreciation	-0.35	0.45	0.55			
Progress			0.55			0.46
Team Process	-0.55	0.67	0.47		0.46	

Table 7.28 – Significant correlations between categories

It was found that *persuasion* is significantly negatively correlated to *framing*, *appreciation* and *team process*. This means that if the feeling that one is being (illegitimately) persuaded is high in the team, then the feeling of good *framing*, *appreciation* and *team processes* will decline. Obviously, it cannot be stated which categories are dependent ones and which are controlling, however it appears from the example of Team 1 that feelings of *persuasion* has a resulting effect on the evaluation of *team process*.

Furthermore, one should be aware that feelings of *perspective* and *appreciation* have an impact on each other, and especially the feeling of *perspective* and *team process*. More obviously, *progress* and *team process* are also correlated. Furthermore, the correlation indicates that low scores in *framing* (i.e. the perception that a team-frame has been established) will find resonance in decreased scores in *appreciation*, *progress* and *team process*. This link is supported by the work of Mitchell and Sackney (1998) who point out that framing and naming activities in organisational learning are linked to developing common understandings, engaging in co-operative processes and building trust amongst a team.

7.9 Connections between designers and their perceptions

During the analysis of perceptions and learning styles, patterns in the data suggested that there exists a link between learning styles and individual's perceptions. Initially, this was based on observations that individuals scoring high as reflectors seemed to be more sensitive to feelings of persuasion than other learning styles. A study of correlation was conducted between learning styles and related scores of perceptions. A summary of correlations with statistical significance is shown in Table 7.29.

	Persuasion	Perspective	Framing	Appreciation	Progress	Team Process
Activist		0.61			0.55	0.68
Reflector		-0.35		0.33		-0.32
Theorist	-0.37		0.39	0.51		
Pragmatist	-0.31		0.42	0.38		

Table 7.29 – Correlations between perceptions and learning styles with statistical significance

It shows that there is no link between the Reflector learning style and perceptions of persuasion. Instead, there is a significant correlation between feeling persuaded and scoring high on the Theorist and Pragmatist learning styles. At the same time, these learning styles also showed a correlation concerning their perceptions on *framing* and *appreciation*. Reflectors are more susceptible to lower scores in rating *perspective* and

team process, but have greater feeling of understanding the design. Activists are sensitive to *perspective*, *progress* and *team process*.

7.10 Conclusion

In this chapter, representations of team experiential learning were developed and made available to designers for use in reflection-on-action and learning. Experiential learning – a process of knowledge transformation – can only be measured by the way that knowing – comprehension or apprehension – is transformed through intention or extension. Chaining of transformations are therefore higher-order learning.

The representations developed in this chapter were put to use in the context of learning situations: design exercise, learning tutorial and directed learning situation. These specific learning situations make use of pre-dominant learning modes that correspond to the learning cycle (Figure 7.30).

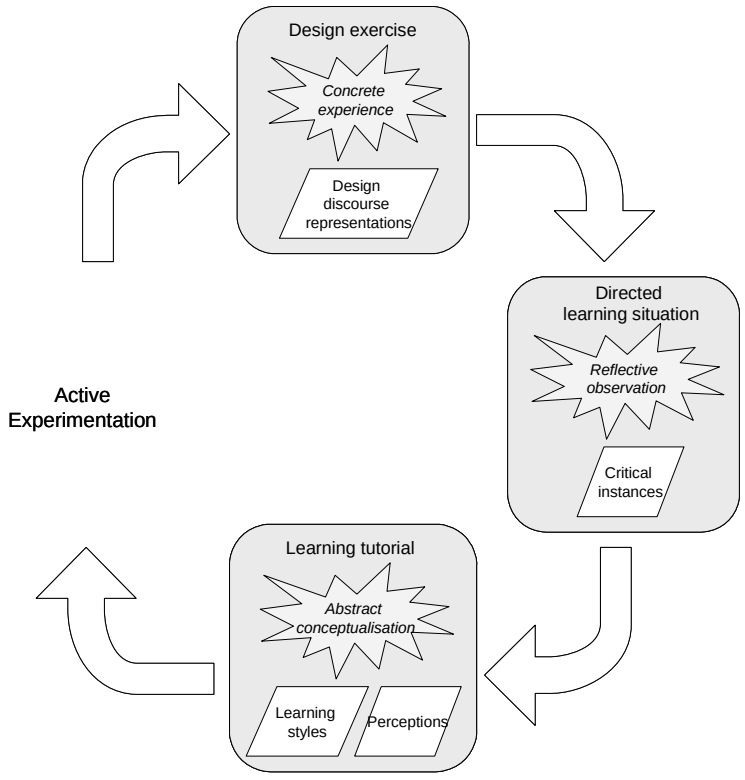


Figure 7.30 – Learning situations corresponding to modes in learning cycle

Designers did not use design discourse representations during design exercises; their concrete experiences and the abstract conceptualisations were not connected. Ways have to found to circumvent these problems; sensitising designers to certain conceptions of designing is one way forward. This can be achieved through directed learning situations based on critical instances or complementary representations that appear more accessible to designers. Whilst frame rationale may not be readily useful as a reflective tool for designers, it may nonetheless be used as an analytical tool by design researchers.

Critical instances, used in directed learning situations, encourage designers to reflect on their concrete design experiences. Furthermore, designers can be guided to develop abstract conceptualisations of designing. In particular, designers can build conceptualisations of the design process that centre on the importance of surprise as a trigger for reflection.

During a learning tutorial, learning styles and perceptions were used to encourage designers to reflect-on-action. Representations that make use of learning styles describe designers and allow them to reflect on their predisposition to approach designing, learning and interaction with other team members. Representations that describe designing can also be based on perceptions of designers; a way of eliciting perceptions of persuasion, framing, perspective, appreciation, progress and team process through a feedback questionnaire was described in this chapter. Correlations were explored between perceptions, which suggest connections between some categories of perceptions. Graphical representations of these perceptions can be made available to designers for reflection. These abstract conceptualisations can be used by designers to

make a link to what went on in designing. However, no description is value-free: personality types show sensitivity to certain perceptions, as evidenced by correlations between learning styles and perceptions scores.

Chapter 8 Conclusion

In this thesis, designing was investigated to shed light on elemental ways of designing in a team. To this end, description and support of team designing was conducted against the background of the *experiential learning* design paradigm. In this concluding chapter, the thesis is summarised in section 8.1. In section 8.2, a review of key claims and contributions is presented. Suggestions for further work are outlined in section 8.3.

8.1 Thesis summary

Chapter 1 provided an introduction to this thesis. The scope of the thesis was set to include the design paradigm of experiential learning in its application to design teams.

In chapter 2, design paradigms and their relation to design practice were discussed. A design paradigm consists of archetypal descriptive models which influence how designers, design tasks and design process are seen and which aspects are highlighted or neglected. These descriptive models also form an idealised view, which gives rise to a normative slant: deviances and dysfunctions can be identified. From design paradigms follow corollary dimensions, such as methods and techniques, representations and attitudes to learning.

Four design paradigms were identified from a literature review and structured around descriptive models; these design paradigms were termed rational problem-solving, social process, hypothesis testing and experiential learning. The remainder of this thesis examined team designing within the experiential learning paradigm.

Learning in general and experiential learning in particular were defined in chapter 3. To summarise, experiential learning is the process whereby knowledge is created through the transformation of experience. Experiential learning in design is carried out through the modes of reflection-in-action and reflection-on-action.

Following this definition, the individual experiential learning paradigm was examined in detail. The model of the designer was considered: an individual expert practitioner engages in continuous learning to make sense of unique, complex and value-laden design situations and improve design practice in the long run. The design task is constructed out of a problematic situation and is made and remade during the course of designing. This is achieved through a construction cycle of framing, naming, moving and reflecting, which forms the micro-level process of individual designing. To facilitate the understanding of the micro-level process, different conceptions of framing in the literature were contrasted. To summarise, frames have been used to explain individual sense-making and world-making, to understand social behaviour and the organisation of experience. Framing in individual experiential learning is an activity that constructs meaning out of a problematic situation. Frames in this sense are structures of belief, perception and appreciation, which impose order on the situation and set a boundary for a situation within which certain solutions can be explored. Frames are based on stereotypical abstractions and generative metaphors that suggest certain paths to be investigated and provide a judgement of fit or misfit. A designer is never objective; a designer is always caught up in frame. It was stressed that although a frame cannot be exhaustively specified, evidence of markers nonetheless gives an indication of the activity of framing.

Naming highlights aspects of a situation and provides a label for things that are focussed on. Moves are made in accordance with frames to develop a design option, whilst at the same time testing the frame itself. Surprise at the outcome of moves can turn to reflection that surfaces the designer's understanding, leading to new moves or reframing. The macro-level design process of the individual designer moves towards fitness of the solution against the problematic situation. With respect to techniques and methods that support designers' activities, an orientation to reflection-in-action and reflection-on-action was emphasised. Reflection permeates: Openness to backtalk and awareness of framing is encouraged.

The implications of this view with respect to team designing were discussed. The nature of the designer in a designing system, which adds a social layer on top of an individual perspective, was highlighted. In this social layer, designers need to externalise their reasoning processes and therefore a background of argumentation theory was proposed as a window to examine the reasoning and the interactional processes that operate in team designing. The interaction between participants in an argumentative process – incorporating a rhetorical stance – that is used to drive the construction of the design task and the micro-level design process forward was termed the rhetorical construction of understanding. The way that the team's perspective towards the design task is co-ordinated is by way of a newly constructed team-frame or by adopting an individual's frame. The macro-level process, although still based on the notion of fitness, is reoriented towards the achievement of this team-frame. Macro-level process failures are likely to be due to frame conflict.

A team-frame is not an independent object; it is achieved through and contained in the interaction between team members. Chapter 4 examined how designers establish a team

frame in early design episodes through verbal means and the role of argumentation in this process. A coding scheme based on rhetoric was developed that was used to analyse design discourse. The coding scheme distinguishes between real and preferable premises and between the argumentation schemes of association based on the structure of reality, association establishing the structure of reality and dissociation.

The background method of discourse analysis was introduced and illustrated by reference to a specific example of design discourse, the Delft protocol. To summarise the detailed analysis of design discourse, it was shown that designers use argumentation to bring premises into presence and highlight premises from the background frame of reference. Concentrating on this aspect allows focus of attention to be detected, and what 'names' are applied to things in the situation. Associations based on the structure of reality introduce organisation and evaluation into the design discourse. Such associations are used by designers to justify or evaluate certain solution developments in relation to their current understanding of the problem. Furthermore, association based on the structure of reality allows us to draw on the background frame of reference by looking at the way that designers organise the premises. In our discussion of associations establishing the structure of reality, we asserted that these enable designers to establish new premises by either generalisation or similarity. It was particularly highlighted how this argumentation scheme makes use of the plasticity of notions to drive the solution development forward. These notions function as keywords that encapsulate understandings and positions in the design discourse. Finally, dissociation can be used as a marker for potential reframing. The notions of reframing and dissociation were compared with respect to their triggers, worlds and bases, and commonalities identified. Attention was drawn to the fact that while a dissociation is

introduced by an individual to affect the team-frame; further agreement is needed for this reframing to actually occur.

It was concluded that dissociations and ensuing associations can be used as rhetorical identifiers of potential frame shifts. A misfit sets up a potential for a frame shift, which is resolved by the introduction of a dissociation. At the same time, the dissociation introduces a new way of 'seeing', which is then developed and negotiated within the team if assent has been given explicitly or implicitly. However, there are instances when attempts at reframing are rejected, either explicitly or implicitly. It was highlighted that implicit disagreement with dissociation may set teams on the road for frame conflict.

The validity of discourse analysis as an investigative method was discussed. To gain a measure of validity, the coding of the Delft protocols was submitted to a test of inter-coder reliability. The level of inter-coder agreement proved to be satisfactory; closer inspection showed that disagreements were due to novelty of use rather than serious shortcomings of the coding scheme.

Whilst discourse analysis provides a powerful and detailed description of the verbal reasoning footprints that underlie the design process at the micro-level, the form it takes does not allow structuring and presentation of the description across specific instances of designing. Instead of prose, description can take in the form of a representation. Moreover, description of the micro-level design process is only one facet of designing.

Chapter 5 investigated the characteristics of descriptive representations in experiential learning. Representations are selections of data arranged in a meaningful way for some purpose. Design paradigms influence what is considered data by the fact that they

highlight certain aspects whilst suppressing others; they attribute meaning. Therefore, descriptive representations can only be developed within a certain design paradigm.

Representations can be used to describe experiential learning or support experiential learning. Descriptive representations model how knowledge is created, whereas representations used in support enable the creation of knowledge. However, it was noted that this distinction is not strictly delineated: descriptive representations are made available to designers to provide the basis for reflection-on-action.

Team experiential learning was revisited to propose a set of characteristics that representations ought to capture, since these have to be developed in tune with a particular design paradigm. These characteristics followed from the models of designers, design task and design process. The model of designers highlights designers as learners and participants in the rhetorical construction of understanding, hence characteristics of learning styles and argument roles should be captured in representations. Whilst certain aspects of models of design task and design process are inaccessible as they are based on personal knowledge, comprehensions of designers can be captured in the form of their perceptions. The model of the design task focuses attention on the perception of whether a team-frame was established, whereas the model of the macro-level design process attends to how a team-frame was constructed. The findings of the micro-level design process contained in design discourse were used to motivate characteristics for descriptive representations.

With this in mind, characteristics of design discourse representations were further investigated to develop requirements that capture aspects of team experiential learning. These requirements dealt specifically with showing individual contributions, the

boundary of attention, the organisation of premises, the establishment of new and flexible notions, attempts at framing and the strength of agreement.

Two candidate design discourse representations, design rationale and linkography, were analysed and compared to these requirements. It was found that they do not capture all requirements: design rationale does not show individual contributions, boundary of attention, new and flexible notions and attempts at framing, whereas linkography cannot show attempts at framing and strength of agreement. Both design rationale approaches and linkography as they stand were shown to be unsuitable for representing the design process as understood within team experiential learning.

In chapter 6, a new representation of the design process – termed frame rationale – was discussed and defined. The frame rationale representation was proposed to structure design discourse through a basic formal abstraction, which records contributions and their attributes, links between contributions and their type and units of attention. It was shown how this abstraction fulfils the requirements of highlighting the boundaries of attention, and the strength of agreement, the organisation of premises, the introduction of new notions, attempts at reframing and unfolding through *units of attention*, *names*, *argument chains* and *dissociations*; these elements of frame rationale lock together to allow salient points in a design discourse to be investigated. Examples for frame rationale were given, using an illustration based on a Delft protocol excerpt.

Descriptive representations such as frame rationale can be made available to designers to enable reflection-on-action. However, frame rationale only forms one part of the arsenal that describes team experiential learning. In chapter 7, the use of a comprehensive collection of representations of team designing was investigated and

illustrated through examples from learning situations. The specific learning situations – design exercise, learning tutorial and directed learning situation – made use of predominant learning modes that correspond to the learning cycle.

Experiential learning in design – in terms of reflection-on-action – is measured through a process of transformation of experience. In this respect, experiences can be known through apprehension or comprehension and transformed through intention or extension. Therefore, higher-level learning is indicated by the length of chaining of these elemental building blocks of learning.

Designers did not use design discourse representations during design exercises; their concrete experiences and the abstract conceptualisations were not connected. Sensitising designers to certain conceptions of designing was achieved through directed learning situations based on critical instances or complementary representations that appear more accessible to designers. Whilst frame rationale may not be readily useful as a reflective tool for designers, it may nonetheless be used as an analytical tool by design researchers.

Critical instances, used in directed learning situations, encouraged designers to reflect on their concrete design experiences. Furthermore, designers were guided to develop abstract conceptualisations of designing. In particular, designers built conceptualisations of the design process that centre on the importance of surprise as a trigger for reflection.

During a learning tutorial, learning styles and perceptions were used to encourage designers to reflect-on-action. Representations that make use of learning styles described designers and allowed them to reflect on their predisposition to approach

designing, learning and interaction with other team members. Representations that describe designing can also be based on perceptions of designers; a way of eliciting perceptions of persuasion, framing, perspective, appreciation, progress and team process through a feedback questionnaire was described in chapter 7. Correlations were explored between perceptions, which suggest connections between some categories of perceptions. Graphical representations of these perceptions were made available to designers for reflection. These abstract conceptualisations were used by designers to make a link to what went on in designing. However, no description is value-free: personality types show sensitivity to certain perceptions, as evidenced by correlations between learning styles and perceptions scores.

8.2 Review of key claims and contributions

Design methodology as a field aims not only to provide better support for designers, but also to gain a better understanding as to what designing actually is. However, analyses of design activities are carried out within the bounds of certain design paradigms, which influence the view taken by design researchers. This thesis examined design paradigms that frame the way designing is seen and supported. One of the contributions of this thesis consists of the identification, structuring and comparison of four design paradigms in chapter 2. These were termed rational problem-solving, social process, hypothesis testing and experiential learning and were structured along dimensions of models of designer, design task and design process, along with corollaries such as notions underlying techniques and methods, representations and learning.

Experiential learning as a design paradigm is propounded through ‘reflective practice’ (Schön, 1991; 1987). Whilst intuitively appealing, design researchers still struggle to make sense of this paradigm, exacerbated by the vagueness of definitions (Dorst, 1997; Valkenburg, 2000). This thesis contributes in chapter 3 by clarifying the experiential

learning design paradigm and by extending its notions to teams. Experiential learning was examined by reference to its models of designer, design task and design process: an individual expert practitioner engages in continuous learning to make sense of unique, complex and value-laden design situations, out of which she constructs a design task that is made and remade during the course of designing through a construction cycle of framing, naming, moving and reflecting. A design team adds a social layer on top of an individual perspective. In this social layer, designers need to externalise their reasoning processes to co-ordinate their perspectives and to achieve a shared team-frame. A team-frame is not an independent object; it is achieved through and contained in the interaction between team members. A rhetorical stance, in particular, takes account of social and epistemological facets of designing and was hence proposed to investigate the footprints these reasoning processes leave in design discourse. In a design team, the interaction between participants in an argumentative process – incorporating a rhetorical stance – that is used to drive the construction of the design task and the micro-level design process forward was termed the rhetorical construction of understanding. The macro-level design process of the individual designer moves towards fitness of the solution against the problematic situation. The macro-level process in a design team, although still based on the notion of fitness, was reoriented towards the achievement of a team-frame. Macro-level process failures are likely to be due to frame conflict. With respect to techniques and methods that support designers' activities, an orientation to reflection-in-action and reflection-on-action was emphasised.

Applying a coding scheme to identify reflective practice elements is difficult and criteria for good reflective practice are absent (Dorst, 1997). It is claimed that whilst a frame cannot be exhaustively specified, evidence of markers nonetheless gives an indication of the activity of framing. This thesis contributes in chapter 4 to the

understanding of the experiential learning design paradigm by the development and application of a coding scheme to investigate design discourse. By performing discourse analysis using appropriate markers, team designing can be illuminated. By developing and applying the coding scheme, the thesis further contributes by identifying elements of the coding scheme that correspond to experiential learning. In particular, it is claimed that designers bring certain facts into presence; these facts form the boundary of attention and count as things that are attended to. Association argumentation schemes either have an organisational function or develop new understandings. Dissociation argumentation schemes are used as attempts at reframing. However, agreement to these attempts is crucial to influence the team-frame.

Certain demands are made of representations in the way that they correspond to a design paradigm. Representations highlight certain features; in chapter 5, this thesis identified and proposed a set of characteristics of team experiential learning to be captured. These characteristics concerned the designer as learner and participant in the rhetorical construction of understanding, establishment of a team-frame and the construction of a team-frame. Characteristics of the designer as a learner can be captured through an analysis of learning styles, whereas the remaining characteristics can be elicited through perceptions by designers. Furthermore, requirements for representations of the design process as contained in design discourse were suggested. These concerned showing individual contributions, boundary of attention, organisation of premises, new and flexible notions, attempts at framing, unfolding and strength of agreement.

A comparison of design discourse representations with these requirements showed that a new representation was needed. A contribution of this thesis is the development of frame rationale as a way of representing team experiential design process in chapter 6.

Frame rationale fulfils the requirements made in terms of a representation of team experiential learning by structuring design discourse into contributions, units of attention, names, argument chains, argumentation schemes – in particular, dissociation – and contribution strength.

Descriptions of designing can be made available to designers as a basis for reflection-on-action (Glock, 2000). Descriptive representations function as abstract conceptualisations and their use can be illuminated through measuring the experiential learning that occurs. The final contribution of this thesis, in chapter 7, demonstrates team experiential learning representations in learning situations. In particular, it is shown how critical instances, learning styles and perceptions can form the basis of designers' reflections and lead them to make connections to their concrete experiences or to develop abstract conceptualisations.

8.3 Further work

Whilst this thesis provides an important step towards the understanding of team experiential learning in early design episodes, nonetheless there are some limitations of investigation.

There are limitations to the representation of design process, termed frame rationale. Frame rationale captures information about design discourse; the amount of information and its differing types pose a challenge of information visualisation (Card et al, 1999). The best way to visualise a frame rationale, particularly for the purpose of reflection-on-action by designers, has yet to be investigated. Furthermore, whilst contribution strength has been defined and can be implemented in a simple fashion, the complexity of agreement is an area that merits further investigation. In particular, issues remain in the

calculation of contribution strength based on subsequent strengthening by the original owner or other team members.

Secondly, frames play an important role in the design process; it is hence crucial to distinguish between good and bad frames. Frames are better if they direct “inquiry toward progressively greater inclusion of features of the problematic situation and values for its transformation” (Schön, 1990). Whilst it was investigated how the interaction of the team participants is focussed on the establishment of a team-frame, the question of what constitutes a good team-frame remains unanswered. An associated point has to be made: currently the impact of a change in the team-frame can only be known with the benefit of hindsight. This suggests further work is needed to investigate the features of a perspective shift that determine the scale of impact.

Finally, limitations have also been highlighted in designers’ reflection-on-action. Some representations can provide a useful basis in encouraging designers to reflect on designing; designers can also be sensitised towards taking a certain view of designing by descriptions. Designers do not think about designing in a vacuum: they are influenced by design paradigms just as much as design researchers are. Currently, design education places emphasis on design as rational problem-solving. Integrating experiential learning as an abstract conceptualisation of designing into design education is to be encouraged to result in a richer social knowledge.

References

Alexander C (1964) *Notes on the Synthesis of Form.* Harvard University Press, Cambridge, MA, US

Atkinson RL, Atkinson RC, Smith EE, Bem DJ (1993) *Introduction to Psychology (11th edition).* Harcourt Brace and Company, Orlando, FL, US

Bardwell LV (1991) Problem-Framing: A Perspective on Environmental Problem-Solving. *Environmental Management* 15(5) : 603-612

Bateson G (1972) *Steps to an Ecology of Mind*. Intertext Books, London, UK

Blandford A (1993) Applying the WOM to WOMBAT: evaluation of a tool to support learning about design evaluation. *Design Studies* 14(3): 228-246

Blyth A, Worthington J (2001) Managing the brief for better design. Spon Press, London, UK

Brereton M, Cannon DM, Mabogunje A, Leifer LJ (1996) Collaboration in Design Teams: How Social Interaction Shapes the Product. In *Analysing Design Activity*, Cross N, Christiaans H, Dorst K (eds.), John Wiley & Sons, Chichester, UK

Broadbent G (1984) The Development of Design Methods. In: *Developments in Design Methodology* Cross N (ed), John Wiley & Sons, Chichester, UK

Brooks L, Jones M (1996) CSCW and Requirements Analysis: Requirements as Cooperation/ Requirements for Cooperation. In: *CSCW Requirements and Evaluation*, Thomas P (ed), Springer, London, UK

Bucciarelli L (1994) *Designing Engineers.* MIT Press, Cambridge, MA, US

Buckingham Shum S (1996) Design Argumentation as Design Rationale. In *The Encyclopedia of Computer Science and Technology* 35(20) : 95-128

Buckingham Shum S (1999) *Computer-Supported Collaborative Argumentation for Learning Communities.* Workshop Report http://kmi.open.ac.uk/sbs/csca/csc199/

Buckingham Shum S, Hammond N (1994) Argumentation-based Design Rationale: What use at what cost?. *International Journal of Human-Computer Studies* 40(4) : 603-652

Card SK, Mackinlay JD, Shneiderman B (eds.) (1999) *Readings in Information Visualization – Using Vision to think.* Morgan Kaufmann Publishers, San Francisco, CA, US

Carletta J (1996) Assessing agreement on classification tasks: the kappa statistic. *Computational Linguistics* 22(2) : 249-254

Concise Oxford Dictionary (1982) 7th edition Sykes JB (ed.), Oxford University Press, UK

Conklin J, Begeman ML (1988) gIBIS: A Hypertext Tool for Exploratory Policy Discussion. *ACM Transactions on Office Information Systems,* 6(4) : 303-331

Conklin J, Burgess-Yakemovic KC (1996) A Process-Oriented Approach to Design Rationale. In: *Design Rationale: Concepts, Techniques and Use* Moran TP, Carroll JM (eds.), Lawrence Erlbaum Press, Hillsdale, NJ, US

Coyne R, Snodgrass A (1995) Problem Setting within Prevalent Metaphors of Design. *Design Issues,* 11(2) : 31-61

Crawshay-Williams R (1957) *Methods and Criteria of Reasoning.* Routledge and Kegan Paul, London, UK

Cross N (1984) *Developments in Design Methodology*. John Wiley and Sons, Chichester, UK

Cross N (1997) Descriptive models of creative design: application to an example. *Design Studies* 18(4) : 427-455

Cross N, Clayburn Cross A (1996) Observations of Teamwork and Social Processes in Design. *Analysing Design Activity*, Cross N, Christiaans H, Dorst K (eds.), John Wiley & Sons, Chichester, UK

Cross N, Christiaans H, Dorst K (1996) *Analysing Design Activity.* John Wiley & Sons, Chichester, UK

Crosswhite J (1997) *The Rhetoric of Reason.* University of Wisconsin Press, Madison, WI, US

Cuff D (1991) *Architecture: The Story of Practice.* MIT Press, Cambridge, MA, US

Darke J (1984) The Primary Generator and the Design process. In: *Developments in Design Methodology*, Cross N (ed.), John Wiley and Sons, Chichester, UK

Dennett DC (1990) Cognitive Wheels: The Frame Problem of AI. In: *The Philosophy of Artificial Intelligence*, Boden MA (ed.), Oxford Readings in Philosophy :147--170

Deppermann A (2000) Semantic Shifts in Argumentative Processes: A Step Beyond the 'Fallacy of Equivocation'. *Argumentation* 14 : 17-30

Dewey J (1997) *How we think.* Dover Publications, Toronto, Canada

Dorst K (1997) *Describing Design – A comparison of paradigms*. PhD Thesis, Industrial Design Department, TU Delft, The Netherlands

Dunbar K (1997) How scientists think: On-line creativity and conceptual change in science. *Conceptual structures and processes: Emergence, discovery, and change*, Ward TB, Smith SM, Vaid J (eds.), American Psychological Association Press, Washington DC, US

Edmondson W (1982) *Spoken Discourse: A model for analysis.* Longman, New York, NY, US

Eemeren van F, Grootendorst R (1992) *Argumentation, Communication and Fallacies - a pragma-dialectical approach.* Lawrence Erlbaum Press, Hillsdale, New Jersey, US

Erickson T (1995) Notes on Design Practice: Stories and Prototypes as Catalysts for Communication. *Scenario-based design*. Carroll JM (ed.), John Wiley & Sons, Chichester, UK

Finkelstein A, Sommerville I (1996) The Viewpoints FAQ. Software Engineering Journal, 11 (1): 2-4

Fisher K (1997) Locating Frames in the Discursive Universe. *Sociological Research Online* 2(3) http://www.socresonline.org.uk/socresonline/2/3/4.html

Flanagan JC (1954) The critical incident technique. *Psychological Bulletin* 51(4) : 327-358

Fleming D (1997) Learning to Link Artifact and Value: The Arguments of Student Designers. *Language and learning across the disciplines* 2(1) : 58-84

Fleming D (1998) Design Talk: Constructing the Object in Studio Conversations. *Design Issues* 14(2) : 41-62

Fox J, Parsons S (1997) On using arguments for reasoning about actions and values. *Proc AAAI Spring Symposium on Qualitative Preferences in Deliberation and Practical Reasoning*, Stanford, CA, US

Fox J, Parsons S (1998) Arguing about beliefs and actions. In: *Applications of Uncertainty Formalisms, Lecture Notes in Artificial Intelligence*, Hunter A, Parsons S (eds.), Springer

Frankenberger E, Badke-Schaub P (1996) Modelling Design Processes in Industry – Empirical Investigations of Design Work in Practice. In: *Proceedings of The first international symposium on descriptive models of design*, Akin O, Saglamer G (ed), Istanbul.

Freeman JB (1991) *Dialectics and the Macrostructure of Arguments.* Foris, Dordrecht, The Netherlands

Gee JP (1999) An introduction to Discourse Analysis. Routledge, London, UK

Georgakopolou A, Goutsos D (1997) *Discourse Analysis – An Introduction.* Edinburgh University Press, Edinburgh, UK

Gilhooly KJ (1996) *Thinking: Directed, undirected and creative.* Academic Press, London, UK

Glock F (2000) Design tools and framing practices. In: *Workshop 2: The role of objects in Design Co-operation: Communication through Physical or Virtual Objects. COOP2000 Workshop Proceedings*, Sophia Antipolis, France, 23 May 2000

Goffman E. (1974) *Frame Analysis.* Penguin Books, Harmondsworth, UK

Goldschmidt G (1995) The designer as a team of one. *Design Studies* 16(2) : 189-209

Goldschmidt G (1996) Design Problem Solving: The Effect of Problem Formulation on the Construction of Solution Spaces. *Proc Cybernetics and Systems 96*, Vienna, Austrian Society for Cybernetic Studies 1 : 388-393

Goldschmidt G (1997) Capturing indeterminism: representation in the design problem space. *Design Studies* 18(4) : 441-445

Goldschmidt G, Weil M (1998) Contents and Structure in Design Reasoning. *Design Issues* 14(3) : 85-100

Goodman N (1978) *Ways of Worldmaking.* Hackett Publishing, Indianapolis, IN, US

Goodwin D (1991) Distinction, Argumentation, and the rhetorical construction of the real. *Argumentation and Advocacy*, 27 : 141-158

Gordon WJJ (1961) *Synectics.* Harper & Row, New York, NY, US

Gotel O, Finkelstein A (1995) Contribution Structures. *Proc 2nd International Symposium on Requirements Engineering RE95*, IEEE CS Press: 100-107.

Green DW (1995) The abstract selection task: thesis, antithesis and synthesis. In: *Perspectives on thinking and reasoning*, Newstead S, Evans J (eds.), Lawrence Erlbaum Associates, London, UK

Gross A (1990) *The Rhetoric of Science.* Harvard University Press, Cambridge, MA, US

Grosz BJ (1977) *The Representation and Use of Focus in Dialogue Understanding.* Technical Note 151, Artificial Intelligence Center, SRI International, CA, US

Grosz BJ (1978) Focusing in Dialog. In: *Proceedings of the Workshop on Theoretical Issues in Natural Language Processing – 2*, University of Illinois at Urbana-Champaign, Champaign, IL : 96-103

Hillier B, Musgrove J, O'Sullivan P (1984) Knowldege and Design. In: *Developments in Design Methodology* Cross N (ed.), John Wiley and Sons, Chichester, UK

Honey P , Mumford A (1995) *Using your Learning Styles.* Peter Honey, Maidenhead, UK

Honey P, Mumford A (1992) *The Manual of Learning Styles.* Peter Honey, Maidenhead, UK

Isenberg DJ (1987) Inside the Mind of the Senior Manager. In: *Thinking: The Second International Conference*, Perkins DN, Lochhead J, Bishop J (eds.), Lawrence Erlbaum Associates, Hillsdale, NJ, US

Kallmeyer W (1996) Gesprächsrhetorik – Rhetorische Verfahren im Gesprächsprozess. Gunter Narr Verlag, Tübingen, Germany

Kaufer DS, Butler BS (1996) *Rhetoric and the Arts of Design.* Lawrence Erlbaum Associates, Mahwah, NJ, US

Kolb DA (1984) *Experiential Learning.* Prentice Hall

Kolb DA, Rubin IM, Osland J (1991) *Organisational Behaviour.* Prentice Hall

Krause P, Ambler S, Elvang-Goransson M, Fox J (1995) A Logic of Argumentation for Reasoning under Uncertainty. *Computational Intelligence* 11 : 113-131

Kuhn D (1991) *The Skills of Argument.* Cambridge University Press, Cambridge, UK

Kuhn T (1962) *The Structure of Scientific Revolutions*. University of Chicago Press, US

Kunz W, Rittel HWJ (1970) *Issues as Elements of Information Systems*, Working Paper 131, Institute of Urban and Regional Development, University of California Berkeley, CA, US

Lawson B (1997) How Designers think: The design process demystified. Architectural Press, Oxford, UK

Lee J (1990) SYBIL: A Tool for Managing Group Decision Rationale. *Proc CSCW 90*, Los Angeles, CA, US

Lee J, Lai KY (1992) *A Comparative Analysis of Design Rationale Representations.* Working Paper WP84-92, Sloan School of Management, MIT, Cambridge, MA, USA

Lee J, Lai KY (1996) What's in Design Rationale?. In: *Design Rationale: Concepts, Techniques, and Use*, Moran TP, Carroll JM (eds.), Lawrence Erlbaum Press, Mahwah, NJ, US

Levi M, Salvadori M (1992) *Why buildings fall down.* WW Norton and Co., New York, US

Locke J (1964) An Essay concerning Human Understanding. Fontana, London, UK

MacLean A, Young RM, Moran TP (1989) Design Rationale: The Argument behind the artifact. *Proceedings of CHI'89 - Human Factors in Computing Systems,* 30 April – 4 May, Austin, TX : 247-252

MacLean A, Bellotti V, Shum S (1993) Developing the Design Space with Design Space Analysis. In: *Computers, Communication and Usability: Design Issues, Research and Methods for Integrated Services*, Bryerley, Barnard, May (eds.), Elsevier Science Publishers, Amsterdam, 1993

MacLean A, Young RM, Bellotti V, Moran TP (1996) Questions, Options, and Criteria: Elements of Design Space Analysis. In: *Design Rationale: Concepts, Techniques and Use*, Moran TP, Carroll JM (eds.), Lawrence Erlbaum Press, Mahwah, NJ, US

Mann WC, Thompson SA (1988) Rhetorical Structure Theory: Toward a functional theory of text organization. *Text* 8(3) : 243-281

Mazijoglou M, Scrivener SAR (1998) The Rich picture of design activity. *Automation in Constrcution*, 7 : 157-175

Mazijoglou M, Scrivener SAR, Valkenburg RC (2000) Matching Descriptions of Team Design. In *Proc CoDesigning2000*, Coventry, 11-13 September

McCall R (1991) PHI: a conceptual foundation for design hypermedia. *Design Studies* 12(1) : 30-41

McFadzean J, Cross N, Johnson J (1999) Drawing and soliloquising of design suppositions. *Proc 4th Design Thinking Research Symposium (DTRS99)* Cambridge, 23-25 April

McKerlie D, MacLean A (1994) Reasoning with Design Rationale: practical experience with Design Space Analysis. *Design Studies*, 15(2): 214-226

Merriam-Webster's Collegiate Dictionary Online, http://www.m-w.com/netdict.htm

Milne AJ (2000) Analysing the Activity of Multidisciplinary Teams in the Early Stages of Conceptual Design: Method and Measures. *Proc CoDesigning2000*, Coventry, 11-13 September : 289-297

Minneman S, Leifer L (1993) Group Engineering Design Practice: The Social Construction of a Technical Reality. *Proceedings of ICED'93*, 17-19 August, The Hague, The Netherlands : 301-310

Minsky M (1975) A Framework for Representing Knowledge. In *The Psychology of Computer Vision*, Winston PH (ed.), McGraw-Hill

Minsky M (1987) *The Society of Mind.* Heinemann, London, UK

Mitchell C, Sackney L (1998) Learning about Organizational Learning. *Organizational Learning in Schools*, Leithwood K, Seashore Louis K (eds.) Swets & Zeitlinger, Lisse, The Netherlands

Newman SE, Marshall CC (1991) Pushing Toulmin Too Far: Learning From an Argument Representation Scheme. Xerox PARC Technical Report, SSL-92-45

Nothdurft W (1996) Schlüsselwörter. Zur rhetorischen Konstruktion von Wirklichkeit. In: *Gesprächsrhetorik – Rhetorische Verfahren im Gesprächsprozess*, Kallmeyer W (ed.), Gunter Narr Verlag, Tübingen, Germany

Olson GM, Olson JS, Carter MR, Storrøsten (1992) Small Group Design Meetings: An Analysis of Collaboration. *Human-Computer Interaction* 7 : 347-374

Perelman C, Olbrechts-Tyteca L (1971) *The New Rhetoric: a treatise on Argumentation.* University of Notre Dame Press, Notre Dame, IN, US

Perkins DN, Allen R, Hafner J (1983) Difficulties in Everyday Reasoning. In: *Thinking – The Expanding Frontier*, Maxwell W, Bruner J (eds), Franklin Institute Press, Philadelphia, PA, US

Perkins DN, Farady M, Bushey B (1991) Everyday Reasoning and the Roots of Intelligence. In: *Informal Reasoning and Education*, Voss, Perkins, Seagal (eds.) Lawrence Erlbaum Press, Hillsdale, NJ, US

Potts C, Bruns G (1988) Recording the Reasons for Design Decisions. *Proceedings of the 10th International Conference on Software Engineering*, Singapore, IEEE Comp. Soc. Press: 418-427

Pugh S (1991) Total Design – Integrated Methods for Successful Product Engineering. Addison-Wesley Publishing, Wokingham, UK

Reichman R (1978) Conversational Coherency. *Cognitive Science* 2 : 283-327

Rein M, Schön D (1993) Reframing Policy Discourse. In *The Argumentative Turn in Policy Analysis and Planning*, Fischer F, Forester J (eds.), Duke University Press, London, UK

Rescher N (1977) Dialectics – A Controversy-Oriented Approach to the Theory of Knowledge. SUNY Press, Albany, NJ, US

Rittel HW (1984) Second-generation Design Methods. In *Developments in Design Methodologies*, Cross N (ed), John Wiley & Sons, Chichester, UK

Rittel HW, Webber MM (1984) Planning Problems are wicked problems. In: *Developments in Design Methodologies*, Cross N (ed.), John Wiley & Sons, Chichester, UK

Schön DA (1963) *Displacement of Concepts.* Tavistock Publications, London, UK

Schön D (1984) Problems, frames and perspectives on designing. *Design Studies* 5(3) : 132-136

Schön DA (1987) Educating the Reflective Practitioner – Towards a New design for Teaching and Learning in the Professions. Jossey-Bass Publishers, San Francisco, CA, US

Schön DA (1988) Designing: Rules, types and worlds. *Design Studies* 9(3) : 181-190

Schön DA(1990) The design process. In: *Varieties of Thinking – Essays from Harvard's Philosophy of Education Research Center*, Howard VA (ed.), Routledge, London, UK

Schön D (1991) *The Reflective Practitioner - How professionals think in action.* Avebury, Academic Publishing Group, Aldershot, UK

Schön D (1993) Generative metaphor: A perspective on problem-setting in social policy. In *Metaphor and Thought*, Ortony A (ed.), Cambridge University Press, Cambridge, UK

Schön D (1996) Reflective Conversation with Materials. In: *Bringing Design to Software*, Winograd T (ed.), ACM Press

Schön D, Wiggins G (1992) Kinds of seeing and their functions in designing. *Design Studies* 13(2) : 135-156

Schön DA, Rein M (1994) *Frame Reflection: Toward the Resolution of Intractable Policy Controversies.* Basic Books, New York, NY, US

Shipman FM, McCall R (1997) Integrating Different Perspectives on Design Rationale: Supporting the emergence of Design Rationale from Design Communication. *Artificial Intelligence in Engineering Design, Analysis and Manufacturing (AIEDAM)* 11(2): 141-154

Siegel S, Castellan NJ Jr (1988) *Nonparametric Statistics for the Behavioural Sciences*. MacGraw-Hill, New York, US

Sillince JAA (1994) Multi-agent conflict resolution: a computational framework for an intelligent argumentation program. *Knowledge-Based Systems* 7(2) : 75-90

Simon HA (1969) The Sciences of the Artificial, MIT Press, Cambridge, MA, US

Simon HA (1984) The structure of ill-structured problems. In: *Developments in Design Methodology*, Cross N (ed), John Wiley and Sons, Chichester, UK

Slade C (1995) Reflective Reasoning in Groups. *Informal Logic* 17(2) : 223-234

Smith GF (1998) Idea-generation Techniques: A Formulary of Active Ingredients. *Journal of Creative Behavior* 32(2)

Snodgrass A, Coyne R (1992) Models, Metaphors and the Hermeneutics of Designing. *Design Issues* 9(1) : 56-74

Stahl G (1993) Supporting Situated Interpretation. Proceedings of the Cognitive Science Society - A Multi-disciplinary Conference on Cognition, Boulder, CO : 965-970

Stahl G (1998) Collaborative Information Environments for Innovative Communities of Practice. *Proceedings of D-CSCW'98*, 28-30 September, Dortmund, Germany

Stahl G (2000) Collaborative Information Environments to Support Knowledge Construction by Communities. *AI & Society* 14 : 1-27

Strauss A (1978) Negotiations: Varieties, Contexts, Processes and Social Order. Jossey-Bass Publishers, London, UK

Strauss A, Corbin J (1998) *Basics of Qualitative Research.* Sage, London, UK

Stumpf S (1998) *Argumentation-based Design Rationale – The sharpest tools in the box.* Research Note 98/103, Computer Science, UCL

Suthers D (1999) Effects of alternate representations of evidential relations on collaborative learning discourse. *Proc 3rd Conference on CSCL*, Stanford, 11-15 December

Toulmin S (1958) *The Uses of Argument.* Cambridge University Press, Cambridge, UK

Toulmin S, Rieke R, Janik A (1984) *An Introduction to Reasoning.* Macmillan Publishing, New York, NY, US

Trousse B, Christiaans H (1996) Design as a Topos-based Argumentative Activity: a Protocol Analysis Study. In *Analysing Design Activity*, Cross N, Christiaans H, Dorst K (eds.), John Wiley & Sons, Chichester, UK

Valkenburg RC (1996) Shared understanding as a condition for design team decision making. In: *Proceedings of The first international symposium on descriptive models of design*, Akin O, Saglamer G (ed), Istanbul.

Valkenburg R (2000) *The Reflective Practice in product design teams.* PhD Thesis, TU Delft, Netherlands

Valkenburg R, Dorst K (1998) The reflective practice of design teams. *Design Studies* 19(3) : 249-271

Valkenburg R, Dorst K (1999) Frame Cognition. *Proc 4th Design Thinking Research Symposium (DTRS99)* Cambridge, 23-25 April

Van der Lugt R (1999) Developing a graphic tool for creative problem solving in design groups. *Proc 4th Design Thinking Research Symposium (DTRS99)* Cambridge, 23-25 April

Van der Lugt R (2000) Comparing the Process Characteristics of Graphic and Sentential Idea-Generation Techniques for Design Groups. *Proc CoDesigning2000*, Coventry, 11-13 September : 261-268

Vickers G (1968) *Value Systems and Social Process.* Penguin Books, Harmondsworth, UK

Voss J (1991) Informal Reasoning and International Relations. In: *Informal Reasoning and Education*, Voss, Perkins, Segal (eds.) Lawrence Erlbaum Press, Hillsdale, NJ, US

Voss J, Means ML (1991) Learning to reason via instruction in argumentation. *Learning and Instruction* 1 : 337-350

Walton DN (1989) *Informal Logic - A Handbook for Critical Argumentation.* Cambridge University Press, Cambridge

Warnick B, Kline SL (1992) The New Rhetoric's argument schemes: A Rhetorical View of Practical Reasoning. *Argumentation and Advocacy* 29 : 1-15

Watzlawick P, Weakland J, Fisch R (1974) *Change: Principles of Problem Formation and Problem Resolution.* Norton, New York, NY, US

Wheelwright SC, Clark KB (1992) Revolutionizing Product Development – Quantum leaps in Speed, Efficiency and Quality. Free Press, New York, NY, US

Whorf B (1942) Language, Mind and Reality. *Theosophist*, Madras, January/ April issues

Witte EH, Lecher S (1998) Beurteilungskriterien für aufgabenorientierte Gruppen. *Gruppendynamik* 29(3) : 313-325

Wooffitt R (1990) On the Analysis of Interaction – An Introduction to Conversation Analysis. In: *Computers and Conversation*, Luff P, Gilbert N, Frohlich D (eds.), Academic Press Ltd, London, UK

Appendix 1 An argumentation primer

Argumentation in its role in decision-making as opposed to traditional utility theory offers plasticity in an uncertain world where an objective reality is not available to a subjective individual. The rationalistic approach to utility theory, which stresses the search through a fleshed-out space of options and their attached utility represented as an accurate model of how the world is, appears incongruous to how people actually behave. Are we really objective when we make decisions? It appears from some landmark results (Kahnemann and Tversky, 1979, Shafir et al, 1993) that most of the time we are not. What we appear to do is justify our actions on the basis of reasons that feed into what we find convincing.

However, some cautionary voices have been raised. Argumentation is sometimes assumed to underlie decisions as a cognitive process. In this case people make use of and display argumentative behaviour. On the other hand, argumentation is claimed as a model of knowledge which structures what people do. The latter then makes no connection to whether people themselves use argumentation or not; the only determining factor is whether an outsider can recognise behaviour as argumentative. We remain unconvinced by this distinction: people can make use of certain behaviour without being explicitly aware of them. Argumentation allows us to name certain features and investigate people's behaviour further.

What we like to concentrate on in this primer is the historical development of argumentation theory and the impact of the rejection of positivist thought. This will not be a complete and comprehensive account of the history, however we aim to take in some major landmarks on the way.

Argumentation Theory, like the natural sciences, has been based on a positivist understanding of the world and how we use argument within it. However, the turmoil started by *Being and Time* has been also reflected in argumentation theory, leading to heated discussions about the implications for argumentation and the focus that it needs to take (see, for example, Argumentation, 1995, 9, 1, for a discussion of the impact of postmodernism on argumentation theory). The options range from a complete rejection of argumentation as no longer relevant in an age of relativism to favouring a return to formal logic as a prescriptive basis of argumentation. In between these two extremes, there is a wealth of alternatives. Some advocate concentration on rhetoric and understanding the value systems that underlie social communication, whereas others prefer to focus on descriptive/normative rules of conduct or the attempt to make argumentation more 'rational' by introducing critical thinking. In this paper I would like to introduce the main alternatives in a more or less chronological fashion, placing emphasis on their place within the positivist and relativistic extremes. This will also highlight a departure on how knowledge has been viewed: positivist knowledge places emphasis on facts about objects and generally applicable rules, whereas a relativistic standpoint stresses the subjective experience of situated actions, a knowing-how rather than a knowing-that.

Aristotle and the way to formal logic

The cradle of argumentation theory was built by Aristotle, with his treatises on *analytic*, *dialectic* and *rhetoric*. These are infused by his view that knowledge is only gained from existing knowledge and arguments facilitate the inference of new knowledge from that which already exists. Exemplary in this is the use of syllogisms, which allows the combination of premises, i.e. what is already known, to deduce a new piece of

knowledge. Good argumentation in this respect signifies the production of certain and reliable knowledge.

Analytic argumentation concerns knowledge guaranteed to be absolutely certain and reliable. This is achieved through the use of syllogisms and the modes of formal logic. Generally, accepted opinions are covered under *dialectic*, which describes the 'moves' (*topoi*) and the conduct of debates to argue for and against a standpoint. Finally, *rhetoric* is used to convince a particular audience as part of judicial, political or festive proceedings. The persuasion is carried out by either 'inartificial' means, i.e. by reference to laws, documents, etc., or by reference to 'artificial' bases, be they emotions, authority or conclusions through syllogisms founded on premises that are accepted by the audience.

According to Aristotlean understanding, premises are the foundation from which to gain new knowledge. Premises in turn are based on access to the objective reality. To get to new pieces of knowledge we make use of rules, which are applied to the facts, certain from the contemplation of reality, to give us new, equally certain facts. This is also reflected in the rationalistic view of how we function in the world. In our behaviour, we model the world and form intentions. By making use of rules between the facts and our intentions, we express our behaviour. Consequently, taking a rationalistic viewpoint, all that we need to know to function in the world is the facts of the situation, the rules that we (should) operate by.

Subsequently, rationalistic thinking shaped much of argumentation theory, brought to a head with Descartes who insisted that the only way to the truth is rational reflection and, in particular, mathematical proof. Dialectic and Rhetoric were more and more pushed to

the background and taught in separation to the ‘superior’ art of Analytic. Furthermore, formal logic was used prescriptively in relation to argumentation as the way a rational argument was to be conducted.

Crawshay-Williams: Loosening the noose of truth

Starting from the early part of this century, the dominance of formal logic as a normative representation of argument was to be challenged. Having developed his outlook on argumentation throughout the 1930s and 1940s, Rupert Crawshay-Williams addressed the problem of why so many problems remain controversial and unsolved in *Methods and Criteria of Reasoning, An Inquiry into the Structure of Controversy*, published in 1957. In exploring this, Crawshay-Williams adopts a standpoint to argumentation that introduces an intersubjective notion of argument on top of an already existing objective approach. Some of these thoughts are mirrored in the independent work of Toulmin and later contributors to argumentation theory (notably Olbrechts-Tyteca) admitted his influence on their thinking.

Harking back to my interest in argumentation’s role in decision making, it struck a cord in me that Crawshay-Williams reflects an emphasis on actions rather than objects and the plasticity of argument in giving us reasons to make decisions, not only on objective facts but also on subjective considerations:

> "This leads directly to the conclusion that it is not correct for all purposes to describe the functions of language – in the traditionally accepted manner – as to tell us simply 'what things are'. It also leads somewhat indirectly […] to the conclusion that for most theoretical purposes we need to think of the function of language *qua* instrument of reason as being to give us in compendious and communicable form correct directions as to what sorts of behaviour or responses are appropriate for dealing with a situation in accordance with our varying needs. And the way in which language carries out this function – the way in which it directs present behaviour – is by using words which assimilate present behaviour to past behaviour and which in consequence classify primarily in terms of behaviour rather than in terms of things." (*ibid.*, p.168/169)

Crawshay-Williams' starting point to his discussions was the question why it was so difficult to resolve some arguments. He notes that controversy should not arise if the evaluation of an argument was based purely on objective facts. Following this, he then concentrates on the criteria that allow a proposition to be evaluated as to its truth. Not only are we evaluating arguments on objective facts, further than that we are adding an intersubjective angle to the evaluation. To form agreement intersubjectively, criteria are accepted by the group of people taking part in the argument, which he terms the company. Hence, the criteria that underlie any evaluation need to be made explicit to clear up the controversy and resolve the dispute. He puts forward that this intersubjective agreement hinges on the contextual aspect of a statement, the purpose for which the statement is put forward: "S is P with a view to purpose M". This is turned into a "methodological" statement of the form: "In connection to purpose M it is a good method to regard S as something which is commonly known as P."

However, he goes on, this context is not often expressed explicitly and thus makes statements *indeterminate*. The context of a statement is often determined implicitly by the company, the force of the determination being such that it is *axiomatically understood* i.e. we usually do not question what context is assumed.

Non-empirical statements obviously cannot be tested by reference to facts; instead, we use conventional or logical criteria to evaluate them. Conventional criteria, and indeed logical criteria, are reached intersubjectively by consensus within the company on the meaning of terms and turned into analytic statements, the truth of which is accepted by the company. Crawshay-Williams commented that "the only rules of logical deduction which are formally valid are those which are accepted as formally valid." (*ibid.*, p.175).

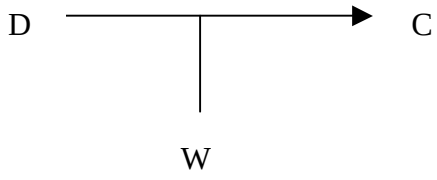
The next few years proved to be the most revolutionary in terms of argumentation theory. Although one can see the challenge to objective formal logic in Crawshay-Williams' work, formal logic was overtly rejected by Toulmin as an apt description of argumentation.

Toulmin and rejection of formal logic

Toulmin has without a doubt been the most influential of the argumentation theorists, especially outside the narrow field of argumentation theory itself. His main work *The Uses of Argument*, first published in 1958, was conceived and indeed perceived to be a challenge to the rule, until then, of formal logic. Rather than prescribing a formal logic form as the basis of our rationality, Toulmin draws our attention to the issue that rationality can be claimed for arguments sustained by reasons, which do not follow rigid and context-free rules. Instead, as he argues, validity depends on the soundness criteria applied within a certain *field of argument* (such as jurisdiction, medicine, arts, etc.). He rejects that formal logic holds the norms to evaluating the validity of an argument – rather, he proposes a new argumentation scheme. In it, he combines the notion that valid argument draws upon a procedure with criteria, which allow this procedure to become valid within a context.

But this validity is, as Toulmin views it, both field-invariant and field-dependent. It is field-dependent in that the evaluation criteria, which allow this procedure to become valid, are dependent on the norms of the field of application. For example, in a discussion about whether a summer is going to be hot and dry, meteorological criteria need to be applied[18].

However, it is with the field-invariant procedure that Toulmin concerns himself most. The simplest argument procedure in Toulmin's mind starts with a standpoint or claim (C) which rests on facts or data (D). The use of the data in support of a claim is justified by an *implicit* inference step called a warrant (W). An argument is said to be valid if the argument follows the procedure and if the warrant for the step from data to claim is adequate.



Simplified argumentation scheme according to Toulmin, 1958

Backing can be given, should the warrant itself be challenged, and takes usually the form of reference to laws, statutes, etc. In later works, Toulmin makes the point of stressing that this could also be statistics or other means which establish an authority. The claim can also be qualified if it has been challenged, and so the truth of it is in doubt.

With publication of Toulmin the claim of formal logic to being the only rational way of sustaining the truth of a claim was undermined. Instead it marked the birth of informal

[18] Example drawn from Van Eemeren et al 1996

logic as a field of study, which again has developed, in my opinion, into a normative approach not based on how people actually argue. But there have been alternatives: rather than concentrating on analytic argumentation, theorists have turned increasingly towards a resurrection of rhetoric and dialectic.

Perelman and Olbrechts-Tyteca – the New Rhetoric

In 1958, Chaim Perelman and Lucie Olbrechts-Tyteca (who was influenced by Crawshay-Williams) published their work *La Nouvelle Rhétorique: Traité de l'Argumentation*, which was translated into English in 1969. It is probably due to this delay in making their thoughts available to the English-speaking world that their work has not received the attention it deserves. Perelman and Olbrechts-Tyteca's aim was to develop a new theory of argumentation, combining the tenets of rhetoric and dialectic to investigate 'nonanalytic' thought, i.e. everything that formal logic had set aside:

> "The very nature of deliberation and argumentation is opposed to necessity and self-evidence, since noone deliberates where the solution is necessary or argues against what is self-evident. The domain of argumentation is that of the credible, the plausible, the probable, to the degree that the latter eludes the certainty of calculations." (*ibid.*, p.1)

It was to be an investigation which was not normative but instead provides a description of ordinary use of argumentation. Central to their work is Perelman's interest in values and value judgements around which social groups form. Criteria to evaluate arguments are therefore always reducible to value judgements and do not form a 'rational' evaluation in the narrowly defined sense. But nonetheless argumentation must be described as rational by the way it seeks to make decisions and justify choices:

> "Dialogue, as we consider it, is not supposed to be a debate, in which the partisans of opposed settled convictions defend their respective views, but rather a discussion, in which the interlocutors search honestly and without bias for the best solution to a controversial problem." (*ibid.*, p.37)

The New Rhetoric: A treatise on Argumentation has at its core rhetoric as a theory of how dialectical argumentation techniques can be used to persuade by increasing the "intensity of adherence among those who hear it in such a way as to set in motion the intended action" (*ibid.*, p.45). Indeed, the audience was elevated to a new height – argumentation develops in terms of an audience and soundness of the argumentation depends crucially on how well it does its job with an audience. What is more, "[i]t is indeed the audience which has the major role in determining the quality of argument and the behaviour of orators" (*ibid.*, p.24). Consequently, by their opinions and beliefs (and the values underlying them) the audience creates a context in which certain premises hold. Soundness of an argument is therefore not given by reference to independent rules but is fully dependent on the reaction of the audience. This means that the techniques used by the arguer must also correspond to the audience "frame of reference" (van Eemeren et al, 1996, p.96). To decide on the best course of argumentation, the arguer has to put herself into the audience's shoes and consider the audience's existing structures of values and knowledge. As van Eemeren et al (1996) remark in a review of Perelman and Olbrechts-Tyteca' work: "The arguer's train of thought must in some way accord with the audience's way of thinking" (Perelman and Olbrechts-Tyteca, 1969, p.98/99). This notion of values underlying a social group is further highlighted by their insistence that there are implicit agreements within certain audiences, expressed by their shared language (e.g. jargon, professional practices) and the initiation required to join such a group.

The arguer needs to take into account their audience when developing an argument. Perelman and Olbrechts-Tyteca distinguish between a “universal audience” which they define as the group of all people considered by the arguer as reasonable as opposed to a “particular audience”. Of course, the particular audience that the arguer addresses might correspond to his universal audience, but more importantly is the implicit notion that the universal audience can shift depending on author, time and space.

As mentioned before, the audience judges soundness of argumentation and it behoves the arguer to build up an understanding of the background of the addressed audience. As “points of departure” the arguer needs to be aware of the premises that the evaluating audience holds. Perelman and Olbrechts-Tyteca distinguish these premises into real and preferable. Real premises count as facts or truths within the audience and are not subject to discussions (although presumptions are also included). Preferable premises consist of values, value hierarchies and *loci* (preference of one abstraction over another, forming the basis of value hierarchies), which are used as guidelines to make choices and form opinions by both the audience and the arguer.

With the points of departure out of the way, the arguer then makes use of argumentation schemes, which are divided into two types: argumentation by association and argumentation by dissociation. Argumentation by association brings together elements into a whole, which were seen as separate before. A term which is already accepted by the audience as part of the points of departure is associated with a new term which the arguer is hoping to make acceptable to the audience. This can occur by making use of quasi-logical arguments, arguments based on the structure of reality or arguments to establish the structure of reality. Quasi-logical arguments try to cast arguments into a mould that resembles formal logic (although the way that language is permeated by

meaning and interpretation makes this only possible to a limited degree hence, quasi-logical). Arguments based on the structure of reality try to exploit the reality as constructed by the audience, for example, "She must be very right wing: You can see it in that pearl necklace.[19]" Arguments to establish the structure of reality try to draw a link that is new to the audience by way of a concept that is taken to imply a general relation in reality, for example, "Men are more aggressive interviewers. Just look at Jeremy Paxman." Viewed in this way, analogy and metaphor are also classified as association to establish the structure of reality. Argumentation by dissociation in contrast separates wholes into separate elements by differentiating concepts from something that they were part of before, e.g. "Adam and Eve were our ancestors, one needs to distinguish religious truth from scientific truth." In effect, Perelman and Olbrechts-Tyteca argue, this is necessitated by a need to introduce a distinction between appearance and reality, a basically creative process. Although association and dissociation are presented as distinct argumentation techniques, in practice they work in tandem as the bringing together of elements by way of association means that they are separated from the previous neutral background.

Viewing argument from a rhetorical approach allows us to illuminate the influence of an audience and their conventions that form the backdrop to argument. However, a non-analytic approach to argumentation was also reflected in the rise of attention to a 'new dialectic'.

The 'New' Dialectic?

Austin's theory of speech acts provided a new impetus to a view of argumentation based on social interaction and the importance of commitment to a statement which when

[19] Example taken from van Eemeren et al, 1996, p.112

challenged needs to be grounded. This allowed a shift of focus onto the rules of conduct that this social interaction necessitates (see also Habermas' notion of ideal speech situation [Habermas 1984]).

An example of this 'new dialectic' is the work by van Eemeren and Grootendorst (van Eemeren et al, 1996). Their field of pragma-dialectics is concerned with the conditions that allow the resolution of a dispute. By establishing rules, it is seen as a combination of the descriptive and the normative "based on the assumption that a philosophical ideal of critical rationality must be developed" (*ibid.*, p.275) to strive towards "a theoretical model for argumentative discourse in critical discussion" (*ibid.*, p.275). Van Eemeren et al thus see argumentation employing a procedure of regulated disputation, aimed at convincing another person. This provides an interactional aspect to argumentation, following a staged progression of confrontation, opening the argument, supplying justifications and conclusion of the argument. Fallacies in argumentation are seen as the inadherence to rules governing the discourse within and throughout the stages, and therefore constitute an "unacceptable move". Some of these rules, for example, deal with the obligation of defending a standpoint once put forward, to make implicit arguments explicit and to use appropriate argumentation schemes (such as causality, analogy etc). Failure to adhere to these rules might generate fallacies in the opening stage as declaring standpoint sacrosanct or evading the burden of proof. What this brings to advance argumentation theory is that it allows us to discuss discourse in terms of formal rules of conduct that need to be met for successful social argument (i.e. one in which differences are resolved). It thus establishes a kind of 'logic of argument' based on illocutionary components, cutting out reference to an 'objective' access to reality.

Freeman (1991) adds a further dimension to a descriptive approach to dialectic. His work is based on trying to find a representation of the interaction of a proponent and opponent during the course of argument. To get to his theory of the structure of arguments through a critique of Toulmin's argumentation scheme, he highlights a point that is salient to our understanding of the semantic content of arguments. Making use of the contrast between traditional diagrammatic elements of premises and conclusion and Toulmin's argument elements, Freeman motivates the notion of 'gappiness'. This comes about in his comparison of warrant and data. Warrants, as he points out, are understood to be inference rules that allow us to move from data to the claim. But why would we need to treat warrants differently to data? He draws attention to the view of warrants as inference from one fact to another by way of using a rule where variables are substituted in the application of that rule. However, this inference step is only needed because the challenger senses a gap of connection between data and claim and needs an added reason to support the claim. Normally, the move from premise to conclusion involves a reasoning 'habit' of which we are not conscious, as he quotes Peirce who called it a 'leading principle':

> "When the inference is first drawn, the leading principle is not present in the mind, but the habit it formulates is active in such a way that, upon contemplating the believed premiss, by sort of perception the conclusion is judged to be true."(*ibid.*, p.83)

Instead, what was previously called a warrant is yet another premise put forward which when we asked why we should believe going from premise to conclusion. This implies that grounds are only needed when what we could call the intersubjective agreement of what constitutes the situation has not been reached. An argument's function is to establish agreement between proponent and opponent to establish a 'leading principle'.

Conclusion

In this research note it was shown how the history of argumentation proceeded and, by the way it has been understood from a rationalistic perspectives, led to the domination of Analytic in the field of argumentation history. It took a shift in this perspective earlier this century to break out of this domination and, with the rejection of formal logic by Toulmin, to initiate a search for other possible interpretations of argumentation other than as a reflection of objective truth. It was with the emergence of emphasis on the neglected fields of argumentation, dialectic and rhetoric, that we gained further understanding on the intersubjectivity, and indeed subjectivity, of argumentation. This resulted in a re-focussing onto the fields of dialectic and rhetoric. Recognising the importance of social aspects within argumentation and the resulting experience of the world is crucial to build a relativist account of argumentation.

A further point that we should consider is the levels of argument that are integrated in an account of argumentation. Habermas (1984), for example, argues that for rational discourse to occur there is a need for three levels in which arguments can be looked at: the process, the procedure and the product. He argues that we cannot abstract in only one of these levels but need to take a view in their combinatorial effect. A good argument, he proposes, is one which follows a process of convincing a universal audience and intention to gain agreement, and which applies a procedure to end the dispute with a rationally motivated agreement and a product which grounds a claim with arguments. The new rhetoric of Perelman and Olbrechts-Tyteca is a good basis for a launch into combining the three levels.

Austin JL (1975) *How to do things with words.* 2nd edition, Oxford University Press, Oxford

Crawshay-Williams R (1957) *Methods and Criteria of Reasoning.* Routledge and Kegan Paul, London

Freeman JB (1991) *Dialectics and the Macrostructure of Arguments*. Foris, Dordrecht, Netherlands

Habermas J (1984) *The Theory of Communicative Action, Volume 1, Reason and the Rationalization of Society*. translated by Thomas McCarthy, Heinemann, London

Kahneman D, Tversky A (1979) Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47 : 263-291

Perelman Ch, Olbrechts-Tyteca L (1971) *The New Rhetoric: a treatise on Argumentation*. University of Notre Dame Press, Notre Dame, Indiana

Shafir E, Simonson I, Tversky A, (1993) Reason-based Choice. *Cognition*, 49 :11-36

van Eemeren F, Grootendorst R, Snoeck Henkemans F (1996), *Fundamentals of Argumentation Theory*. Lawrence Erlbaum, Mahwah, New Jersey, US

Appendix 2 Coding Scheme

Version 3

Coding procedure

The following are the codes that are to be applied to the transcript:

Fact (F)

Truth (T)

Presumption (P)

Value (V)

Value Hierarchy (VH)

Loci (L)

Association based on structure of reality (ABS)

Association establishing the structure of reality (AES)

Dissociations (D)

Use the descriptions/criteria below to apply the codes to the transcript.

Code the transcript in 'blocks', i.e. try and identify the utterance when code was used first, but if that is not possible indicate the block of utterances where the code is developed.

Dissociations need to specify which concept is broken apart and which elements are introduced

e.g. D (rack - rack used for something else as well). If it is not possible to state the previous concept broken apart or the new concept introduced, code it as a presumption.

Points of Departures

Fact, truths, presumptions refer to what is real: ‘what is’

Values, Hierarchies, loci refer to what is preferable: ‘what should be’

Facts

- Refer to ‘objective reality’ and follow from observation
- Require no justification
- Have conditions of verification

Truths

- Form connections between facts
- Result from a system of thought e.g. scientific theories, religious experience etc.
- Often based on probabilities

Presumptions

- Are expected to be reinforced at a later point
- Cannot be gained by calculation but based on factual data
- Are attached with what is normal and likely
- Form an expectation

Values

- Influence action
- Condone particular ways of acting
- Fall usually into two groups: abstract (e.g. equality, truth, etc.) or concrete (e.g. obligation, fidelity, solidarity i.e person-oriented) values

Value Hierarchies

- Are often implicit
- Depend on reference group

Loci

- Also called ‘commonplaces’
- Are general justifications (e.g. whole preferable to part)
- There are loci of quantity, quality, order, existing, essence, and person
- Value hierarchies are often justified by refernce to loci
- Implicit

Argumentation Schemes

Association

Based on the structure of reality

Establishes link between already accepted concepts and others that one wishes to promote

Causal (sequential)

- On same phenomenal level
- Link event – event
- Link a cause to a known effect
- Link an effect to a known cause
- Link means to ends and vice versa
- Argument of waste
- Argument of direction

- Argument of unlimited development

Coexistence

- Transfer of qualities from fact to consequences, essence to its manifestations
- One term more explanatory than the other
- One term more structured than the other
- Argues from observable to unobservable
- Persons – acts
- Argument by authority
- Argument by sacrifice
- Group – person
- Groups of events etc – characteristics

Symbols

- Signify particular relationship for particular group
- Connect symbol and thing symbolised

Double Hierarchy

- Argue from one accepted value hierarchy to another contested one
- Often backed up by proportionality, statistical correlation
- Can also be term-to-term (from one term in a value hierarchy to another)

Establishing the structure of reality

Establish reality by referring to a particular case

Example

- Establishes a rule/generalisation
- Exhibit some similarity to other examples given
- Enjoys the status of fact
- Is actual, concrete

Illustration

- Strengthens adherence to known and accepted rule by providing instances for clarification i.e. concrete
- Can be hypothetical, fabricated

Model/Anti-model

- Inspire action by reference to a person's behaviour as model, works by prestige

Analogy

- Semblance of relationship is used to transfer knowledge (instead of relationship of semblance)
- A is to B as C is to D (from theme (A is to B) to phoros (C is to D); phoros is usually better known) e.g. "as the eyes of bats are to the blaze of day *(phoros)*, so is the reason in our soul to the things which are by nature most evident of all *(theme)*"
- Goes from concrete to abstract

Metaphor

- Condensed analogy (A is C), fusion of phoros and theme
- Alteration of word or phrase from its proper meaning

Dissociations

Break apart a previous unity of concepts to remove an incompatibility arising out of confrontation of one proposition to another (suggested compromise?), introduces an implicit pair Term1/Term2 where Term1 refers to the appearance (i.e. previous unity of concept) and Term2 provides a constructed ‘rule’, resulting from the dissociation, which is both normative and explanatory, Term2 allows a ordering of concepts by devaluing Term1

- Break connected links
- Reorganise conception of reality
- Objection to existing link by reference to experience, conditions governing situation, drawbacks
- Change in conceptual data
- Establish distinction between appearance and reality, reality as a norm, rule, and higher value
- Watch out for definitions and the following keywords:
  - “really”
  - “apparently”/”really”
  - “either…or”
  - “one of…, another is…”
  - “part of…”
  - “another..”
- Watch out in general for:
  - Objections
  - Distinctions (“yes, but…”)
  - Introduction of new names and terms
  - Introduction of alternatives

Appendix 3 Transcription Convention

Where necessary in this thesis, narrow transcription is used to convey further details. The following convention is used to capture linguistic detail.

<u>emphasis</u>	spoken emphasis on word
(.)	short audible pause in speaking
(...)	long audible pause in speaking
[comments]	comments and actions
[...]	break in narrow transcription
?	rising intonation indicating a question
.	falling intonation indicating end of sentence

Appendix 4 Frame Rationale

cont(‘we ll just call it that for now er bag put it in a bag’,1,ivan,f).
cont(‘we re gonna need some sort of thing to do something with those straps’,2,ivan,f).
cont(‘to get this out of the way’,3,kerry,f).
cont(‘yeah’,4,john,o).
cont(‘yeah either the’,5,ivan,o).
cont(‘so it s either a bag’,6,john,f).
cont(‘or maybe it s like a little vacuum formed tray kinda for it to sit in’,7,john,f).
cont(‘yeah a tray that s right OK’,8,ivan,o).
cont(‘cos it would be nice I think I mean just from a positioning standpoint if
we ve got this frame outline and we know that they re gonna stick with that you
can vacuum form a a tray or a inaudible’,9,john,f).
cont(‘right or even just a small part of the tray or I guess they have these’,10,ivan,f).
cont(‘inaudible so something to dress this in’,11,kerry,o).
cont(‘yeah’,12,john,o).
cont(‘or even just em’,13,ivan,o).
cont(‘maybe the tray could have plastic snap features in it so you just like
kkkkkk snap your backpack down in it’,14,john,f).
cont(‘mmmm I was thinking of er’,15,ivan,o).
cont(‘snap in these rails’,16,kerry,f).
cont(‘it s a multifunction part huh’,17,john,f).
cont(‘you just snap in these rails’,18,kerry,f).
cont(‘yeah snap the rails into the tray there’,19,john,f).
cont(‘mm mm’,20,kerry,o).
cont(‘OK’,21,ivan,o).
cont(‘it takes care of the easy it takes care of the rooster tail problem on
your pack’,22,john,f).
cont(‘uh uh what if your bag were big er what if you re you re on’,23,ivan,f).
cont(‘er in this tray were not plastic but like a big net’,24,ivan,f).
cont(‘you just sorta like pulled it around and zipped there I dunno’,25,ivan,f).
cont(‘maybe it could be part maybe it could be a tray with a with a net and a
drawstring on the top of it’,26,john,f).
cont(‘I like that’,27,john,v).
cont(‘that s a cool idea’,28,john,v).
cont(‘yeah I mean em a tray with sort of just hanging down net’,29,ivan,f).
cont(‘you can pull it around and and zip it closed’,30,ivan,f).
cont(‘it could be like a a a window shade so you can kinda it sinks back in so
it just’,31,kerry,f).
cont(‘oh yeah’,32,john,o).
cont(‘it retracts yeah’,33,ivan,f).
cont(‘you pull down it retracts in’,34,kerry,f).
cont(‘a retracting shade’,35,john,f).
cont(‘right right’,36,ivan,o).
cont(‘so that that s not dragging in the spokes if you don t have anything
attached’,37,kerry,f).

```
%units of attention and namesunit([1],'bag').
unit([2,3,37],straps).
unit([7,8,9,10,14,19,24,26,29],'vacuumformed tray').
unit([14,16,18,19],'snap in rails').
unit([24,26,29],'net').
unit([26,29],'tray with net').
unit([31,33,34,35],'retracting windowshade').

%argument scheme structure: link(previousCont,thisCont,linktype).
link(1,7,d).
link(7,9,abs).
link(7,14,aes).
link(7,16,aes).
link(9,16,abs).
link(7,17,aes).
link(7,18,aes).
link(7,22,abs).
link(7,24,d).
link(24,25,aes).
link(24,26,aes).
link(26,27,abs).
link(26,28,abs).
link(29,30,aes).
link(26,31,aes).
link(31,33,aes).
link(31,34,aes).
link(31,35,aes).
link(31,37,abs).

%explicit agreement: agree(Value,prevCont, thisCont)
agree(1,1,6).
agree(1,2,3).
agree(1,2,4).
agree(1,7,8).
agree(1,7,10).
agree(1,7,11).
agree(1,7,12).
agree(1,7,14).
agree(1,14,20).
agree(1,14,21).
agree(-1,14,23).
agree(1,16,19).
agree(-1,26,29).
agree(1,31,32).
agree(1,31,36).

%implict agreement through associationagree(X,Y,Z):-
      link(Y,Z,Link),
      scale(Link,Value),
      X is Value.

scale(aes,1).
scale(abs,1).
scale(d,-1).

%Give a list of contributions and their strengths

strengths:-
      contstrengths(1,37).

contstrengths(X,Y):-
      X>Y,!,      fail.
```

```
contstrengths(X,Y):-
      X=<Y,
      strength(X,Z,Owner,Strength),
      write(X), write(‘,’), write(Strength), write(‘,’), write(Z), nl,

      X1 is X+1,
      contstrengths(X1,Y).

%Calculate individual contribution strength
      strength(ContA, GetCont, Owner, Strength):-
      cont(GetCont,ContA,Owner,_),
      findall(Value,agree(Value,ContA,ContB),List),
      sumlist(List,Strength).


%who gives strength to a certain contribution


whostrength(X):-
      findall(Cont,agree(Value,X,Cont),List),
      helplist(X,List).


helplist(X,[]).


helplist(X, [Head|Tail]):-
      cont(_,Head,Owner,_),
      agree(Value,X,Head),
      write(Head), write(‘,’), write(Owner), write(‘,’), write(Value),
nl,
      helplist(X,Tail).



%Sum a list of strengths

sumlist([],0).
sumlist([Head|Tail],X):-
      sumlist(Tail,X1),
      X is Head+X1.
      writeStrength([]).

writeStrength([Head|Tail]):-
      write(Head),nl,   writeStrength(Tail).

%show D


diss(List):-
      findall(Links,link(_,Links,d),List).



% Show argument chains

quicklist(X,X,[X]).


quicklist(X,Y,[X|List]):-
      X<Y,
      X1 is X+1,
      quicklist(X1,Y,List).
      findchains:-
```

```
      quicklist(1,37,List),
      getlinks(List).


getlinks([]).


getLinks([X]):-
      findall(Links,link(X,Links,aes),List1),
      write(X),tab(2),write('AES links'),tab(2),write(List1),nl,
      findall(Links,link(X,Links,abs),List2),
      write(X),tab(2),write('ABS links'),tab(2),write(List2),nl.


getlinks([X|Tail]):-
      findall(Links,link(X,Links,aes),List1),
      write(X),tab(2),write('AES links'),tab(2),write(List1),nl,
      findall(Links,link(X,Links,abs),List2),
      write(X),tab(2),write('ABS links'),tab(2),write(List2),nl,
      getlinks(Tail),
      getlinks(List1),
      getlinks(List2).
```

Appendix 5 Learning styles questionnaire

LEARNING STYLES QUESTIONNAIRE revised 1986

This questionnaire is designed to find out your preferred learning style(s). Over the years you have probably developed learning 'habits' that help you benefit more from some experiences than from others. Since you are probably unaware of this, this questionnaire will help you pinpoint your learning preferences so that you are in a better position to select learning experiences that suit your style.

There is no time limit to this questionnaire. It will probably take you 10-15 minutes. The accuracy of the results depends on how honest you can be. There are no right or wrong answers. If you agree more than you disagree with a statement put a tick by it (✓). If you disagree more than you agree put a cross by it (x). Be sure to mark each item with either a tick or cross.

☐ 1. I have strong beliefs about what is right and wrong, good and bad.

☐ 2. I often act without considering the possible consequences.

☐ 3. I tend to solve problems using a step-by-step approach.

☐ 4. I believe that formal procedures and policies restrict people.

☐ 5. I have a reputation for saying what I think, simply and directly.

☐ 6. I often find that actions based on feelings are as sound as those based on careful thought and analysis.

☐ 7. I like the sort of work where I have time for thorough preparation and implementation.

☐ 8. I regularly question people about their basic assumptions.

☐ 9. What matters most is whether something works in practice.

☐ 10. I actively seek out new experiences.

☐ 11. When I hear about a new idea or approach I immediately start working out how to apply it in practice.

☐ 12. I am keen on self discipline such as watching my diet, taking regular exercise, sticking to a fixed routine, etc.

☐ 13. I take pride in doing a thorough job.

☐ 14. I get on best with logical, analytical people and less well with spontaneous, 'irrational' people.

☐ 15. I take care over the interpretation of data available to me and avoid jumping to conclusions.

☐ 16. I like to reach a decision carefully after weighing up many alternatives.

☐ 17. I'm attracted more to novel, unusual ideas than to practical ones.

☐ 18. I don't like disorganised things and prefer to fit things into a coherent pattern.

☐ 19. I accept and stick to laid down procedures and policies so long as I regard them as an efficient way of getting the job done.

☐ 20. I like to relate my actions to a general principle.

☐ 21. In discussions I like to get straight to the point

☐ 22. I tend to have distant, rather formal relationships with people at work.

☐ 23. I thrive on the challenge of tackling something new and different.

☐ 24. I enjoy fun-loving, spontaneous people.

☐ 25. I pay meticulous attention to detail before coming to a conclusion.

☐ 26. I find it difficult to produce ideas on impulse.

☐ 27. I believe in coming to the point immediately.

☐ 28. I am careful not to jump to conclusions too quickly.

☐ 29. I prefer to have as many sources of information as possible - the more data to think over the better.

☐ 30. Flippant people who don't take things seriously enough usually irritate me.

☐ 31. I listen to other people's points of view before putting my own forward.

☐ 32. I tend to be open about how I'm feeling.

☐ 33. In discussions I enjoy watching the manoeuvrings of the other participants.

☐ 34. I prefer to respond to events on a spontaneous, flexible basis rather than plan things out in advance.

☐ 35. I tend to be attracted to techniques such as network analysis, flow charts, branching programmes, contingency planning, etc.

☐ 36. It worries me if I have to rush out a piece of work to meet a tight deadline.

☐ 37. I tend to judge people's ideas on their practical merits.

☐ 38. Quiet, thoughtful people tend to make me feel uneasy.

☐ 39. I often get irritated by people who want to rush things.

☐ 40. It is more important to enjoy the present moment than to think about the past or future.

☐ 41. I think that decisions based on a thorough analysis of all the information are sounder than those based on intuition.

☐ 42. I tend to be a perfectionist.

☐ 43. In discussions I usually produce lots of spontaneous ideas.

☐ 44. In meetings I put forward practical, realistic ideas.

☐ 45. More often than not, rules are there to be broken.

☐ 46. I prefer to stand back from a situation and consider all the perspectives.

☐ 47. I can often see inconsistencies and weaknesses in other people's arguments.

☐ 48. On balance I talk more than I listen.

☐ 49. I can often see better, more practical ways to get things done.

☐ 50. I think written reports should be short and to the point.

☐ 51. I believe that rational, logical thinking should win the day.

☐ 52. I tend to discuss specific things with people rather than engaging in social discussion.

☐ 53. I like people who approach things realistically rather than theoretically.

☐ 54. In discussions I get impatient with irrelevancies and digressions.

☐ 55. If I have a report to write I tend to produce lots of drafts before settling on the final version.

☐ 56. I am keen to try things out to see if they work in practice.

☐ 57. I am keen to reach answers via a logical approach.

☐ 58. I enjoy being the one that talks a lot.

☐ 59. In discussions I often find I am the realist, keeping people to the point and avoiding wild speculations.

☐ 60. I like to ponder many alternatives before making up my mind.

☐ 61. In discussions with people I often find I am the most dispassionate and objective.

☐ 62. In discussions I'm more likely to adopt a 'low profile' than to take the lead and do most of the talking.

☐ 63. I like to be able to relate current actions to a longer term bigger picture.

☐ 64. When things go wrong I am happy to shrug it off and 'put it down to experience'.

☐ 65. I tend to reject wild, spontaneous ideas as being impractical.

☐ 66. It's best to think carefully before taking action.

☐ 67. On balance I do the listening rather than the talking.

☐ 68. I tend to be tough on people who find it difficult to adopt a logical approach.

☐ 69. Most times I believe the end justifies the means.

☐ 70. I don't mind hurting people's feelings so long as the job gets done.

☐ 71. I find the formality of having specific objectives and plans stifling.

☐ 72. I'm usually one of the people who puts life into a party.

☐ 73. I do whatever is expedient to get the job done.

☐ 74. I quickly get bored with methodical, detailed work.

☐ 75. I am keen on exploring the basic assumptions, principles and theories underpinning things and events.

☐ 76. I'm always interested to find out what people think.

☐ 77. I like meetings to be run on methodical lines, sticking to laid down agenda, etc.

☐ 78. I steer clear of subjective or ambiguous topics.

☐ 79. I enjoy the drama and excitement of a crisis situation.

☐ 80. People often find me insensitive to their feelings.

® Honey and Mumford 1986

Appendix 6 Learning styles archetypes

LEARNING STYLES - GENERAL DESCRIPTIONS

Activists

Activists involve themselves fully and without bias in new experiences. They enjoy the here and now and are happy to be dominated by immediate experiences. They are open-minded, not sceptical, and this tends to make them enthusiastic about anything new. Their philosophy is: 'I'll try anything once'. They tend to act first and consider the consequences afterwards. Their days are filled with activity. They tackle problems by brainstorming. As soon as the excitement from one activity has died down they are busy looking for the next. They tend to thrive on the challenge of new experiences but are bored with implementation and longer term consolidation. They are gregarious people constantly involving themselves with others but, in doing so, they seek to centre all activities around themselves.

Reflectors

Reflectors like to stand back to ponder experiences and observe them from many different perspectives. They collect data, both first hand and from others, and prefer to think about it thoroughly before coming to any conclusion. The thorough collection and analysis of data about experiences and events is what counts so they tend to postpone reaching definitive conclusions for as long as possible. Their philosophy is to be cautious. They are thoughtful people who like to consider all possible angles and implications before making a move. They prefer to take a back seat in meetings and discussions. They enjoy observing other people in action. They listen to others and get the drift of the discussion before making their own points. They tend to adopt a low profile and have a slightly distant, tolerant unruffled air about them. When they act it is part of a wide picture which includes the past as well as the present and others' observations as well as their own.

Theorists

Theorists adapt and integrate observations into complex but logically sound theories. They think problems through in a vertical, step-by-step logical way. They assimilate disparate facts into coherent theories. They tend to be perfectionists who won't rest easy until things are tidy and fit into a rational scheme. They like to analyze and synthesize. They are keen on basic assumptions, principles, theories models and systems thinking. Their philosophy prizes rationality and logic. 'If it's logical it's good'. Questions they frequently ask are: 'Does it make sense?' 'How does this fit with that?' 'What are the basic assumptions?' They tend to be detached, analytical and dedicated to rational objectivity rather than anything subjective or ambiguous. Their approach to problems is consistently logical. This is their 'mental set' and they rigidly reject anything that doesn't fit with it. They prefer to maximize certainty and feel uncomfortable with subjective judgements, lateral thinking and anything flippant.

Pragmatists

Pragmatists are keen on trying out ideas, theories and techniques to see if they work in practice. They positively search out new ideas and take the first opportunity to experiment with applications. They are the sort of people who return from management courses brimming with new ideas that they want to try out in practice. They like to get on with things and act quickly and confidently on ideas that attract them. They tend to be impatient with ruminating and open-ended discussions. They are essentially practical, down to earth people who like making practical decisions and solving problems. They respond to problems and opportunities 'as a challenge'. Their philosophy is: 'There is always a better way' and 'If it *works* it's good'.

Appendix 7 Feedback Questionnaire

Name

To what extent do you agree with the following statements? Please circle the number which you think most closely shows what you feel.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
We discussed our design as a team extensively.	1	2	3	4	5
As a group we don't agree about what we need to do to accomplish the design	1	2	3	4	5
I try to tell the group how I see the design from my perspective.	1	2	3	4	5
I feel that the group has made substantial progress in the current design session.	1	2	3	4	5
We all worked co-operatively on the coursework.	1	2	3	4	5
I don't understand what other people in the group mean when they talk about the design.	1	2	3	4	5
Some individuals in the group seem to have their own design ideas.	1	2	3	4	5
I feel there is tension within the group.	1	2	3	4	5
I could give reasons why we are implementing the design the way we are.	1	2	3	4	5
We all have the same view of what the design should be.	1	2	3	4	5
I think the direction we are taking with the design is the right one.	1	2	3	4	5
Sometimes I had the feeling that one of us persuaded us that we should adopt his/her particular solution for the design.	1	2	3	4	5
I think we work well together as a group.	1	2	3	4	5

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
I could explain how we came up with the current idea of the design	1	2	3	4	5
I think other people in the group have a different perspective of what the design is.	1	2	3	4	5
I don't know what problems the design is supposed to address.	1	2	3	4	5
I could justify how to design our prototype in different ways.	1	2	3	4	5
At times I felt I was being railroaded.	1	2	3	4	5
I can explain how the design ideas evolved.	1	2	3	4	5
When other people in the group talk about the way the design should be, I understand what they mean immediately.	1	2	3	4	5
I understand better than when we started the session what the problems are that the design is supposed to solve.	1	2	3	4	5
As a group we don't agree on what design to develop.	1	2	3	4	5
The group has changed their minds radically about what the design should be like during this session.	1	2	3	4	5
I can't explain why we are developing the design the way we are doing.	1	2	3	4	5

Would you like to add any other comments?

Publications and research notes by the thesis author

Stumpf S, McDonnell J (forthcoming) Talking About Team Framing: Using Argumentation to Analyse and Support Experiential Learning in Early Design Episodes. *Design Studies*

Stumpf SC, McDonnell JT (2000) A Representation of Rhetorical Construction of Understanding in Teams During Early Design Episodes. *Adjunct Proc CoDesigning 2000*, Coventry, 11-13 September 2000

Stumpf S, McDonnell JT (1999) Relating Argument to Design Problem Framing. *Proc 4th International Design Thinking Research Symposium (DTRS99)*, MIT, 23-25 April 1999

Stumpf S (1998) *Between a rock and a hard place: Argumentation Theory between rationalistic and interpretivist standpoints.* Research Note RN/98/51, Computer Science Department, University College London

Stumpf S (1998) *Argumentation-based Design Rationale - The sharpest Tools in the box.* Research Note RN/98/103, Computer Science Department, University College London