Talking about team framing: using argumentation to analyse and support experiential learning in early design episodes

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To address the problem framing which takes place during the conceptual stages of design notions about individual reflective practice need to be extended to account for team designing. Our research is concerned with formulating an argumentative approach to understanding the process of frame negotiation among the team. Hence we pay attention to designers' interactions, in particular how frame shifts are effected, in the hope of clarifying the phenomenon of frames and their establishment in design teams. This approach is explained on a theoretical level and illustrated with examples drawn from design transcripts. Frame shifts are detected by focusing on rhetorical schemes as markers of reality construction. Transcripts are structured into episodes that show the negotiation of terms. Finally, we discuss support for reflection on the design process. © 2001 Elsevier Science Ltd. All rights reserved.

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Our understanding of designing and the design process has undergone a number of radical and more subtle shifts over the past 30 years. The postmodernist turn of events has resulted in the realisation that there is no intrinsically 'true' way of seeing designing, only a collection of alternative paradigms, each of which capture certain aspects of designing to a better or worse degree. As design researchers we analyse design episodes for different purposes. Our findings form an important part in the way we see design, sometimes contributing to fuller theoretical pictures of designing as an end in itself, or sometimes more pragmatically to suggest better practical ways of doing design. Whatever the goal, we need to be aware that each analysis is embedded within a paradigm, which determines, amongst other things, how the analyses are carried out and which features are noted or disregarded. We have moved beyond a reductive argu-

ment that some ways are better than others; we see instead that it is a question of the emphasis that is placed on different aspects. Dorst[1] has provided an example of how the different paradigms of what he terms rational problem-solving and reflective practice influence the analysis of a design episode. Each paradigm gives us a language to talk about specific aspects of designing, coloured by underlying assumptions about the characteristics and actions of the designer. Furthermore, it is instructive to compare how the same design episode can be analysed in a variety of ways[2]. What is important to be aware of is one's research orientation, and the limitations of a paradigm.

1 Current design paradigms

Recent contributions to the design literature can be structured around four design paradigms: rational problem-solving[3]; social process[4]; hypothesis testing[5]; and experiential learning[6]. These genera all encapsulate assumptions about designing that constitute models of the designer, the design task and the design process at the macro-level and micro-level. The model of the designer makes assumptions about what he does and how he behaves. Similarly, a model of the design task makes assumptions about what is going on. The model of design process dynamics describes the activities that a designer carries out during designing and this process can be sub-divided into micro-level processes and macro-level processes. In this respect, a macro-level process takes place over the whole course of the design, whilst a micro-level process is formed from the smallest units of design activities that the model recognises. Such models selectively highlight limitations and problems that can occur during the design process. Consequently, prescriptive methods and techniques seek to address the issues inherent in the way that design paradigms view designers and designing. We can also identify physical outputs that result from applying the methods and techniques. Lastly, we can try to understand the attitude that an individual paradigm displays towards learning, that is, what is to be learned by a designer and how learning is thought to be effected. Table 1 gives a brief outline of the key positions underlying each identified paradigm. Without going into further details for each paradigm, we would like to concentrate in this paper on Experiential Learning and, particularly, its extension to a team setting.

1.1 The experiential learning paradigm

The experiential learning model of designing—sometimes also called 'Reflective Practice' [6,7]—stresses a dynamic, cyclic and unfolding nature of design. Its model of designer and designing places emphasis on an individual practitioner who needs to deal with a unique, value-laden and uncer-

1 Dorst, K 'Describing design—a comparison of paradigms' PhD Thesis, TU Delft, Netherlands (1997)

2 Cross, N, Christiaans, H and Dorst, K (eds) *Analysing Design Activity*, Wiley, Chichester, UK (1996)

3 Simon, H A 'The structure of ill-structured problems' in **N Cross** (ed) *Developments in Design Methodology*, Wiley, Chichester, UK (1984)

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

5 Broadbent, G 'The developments of design methods' in **N Cross** (ed) *Developments in Design Methodology*, Wiley, Chichester, UK (1984)

6 Schön, D A *The Reflective Practitioner—How Professionals Think in Action* Avebury, Aldershot, UK (1991)

7 Schön, D A *Educating the Reflective Practitioner* Jossey–Bass, San Francisco, CA (1987)

Table 1 Overview of current design paradigms and their underlying assumptions

	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
Prescription				
Design methods and techniques	Formalisation of individual sub-processes and control mechanisms between them e.g. formalisation of analysis and life cycle models	Negotiation, voting, conflict resolution	Design from precedents and mistakes	'Learn by doing' and openness to backtalk
Outputs	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

tain situation out of which a design problem is shaped. On the micro-level the designer approaches the solution by a construction cycle: she interactively frames the problem and names the things she attends to within this frame, generates moves towards a solution and reflects on the outcomes of these moves. Surprise at the outcome of these experiments allows the designer to surface her understanding of the situation and develop a new framing of the situation or new moves. In this paradigm, designers use frames as 'structures of belief, perception and appreciation'[8], within which they construct a view of the problem and attempt to solve it. Emphasis is placed on a constructed, hermeneutical basis to design problem framing, taking place in a 'conversation with the situation'. The action of designing is always in a particular situation, whereas reflection can be either situated in or abstracted from this situation.

This paradigm has gained popularity since it accounts for the difficult nature of designing, especially in early design episodes where the emphasis is on what to design rather than on design detail. Experienced designers respond well to this paradigm, feeling that it intuitively strikes the right chord. Moreover, since it is based on a learning cycle[9] it finds resonance with design educators who have moved towards establishing 'learning by doing', for example, by linking into practical design studios.

The problems that experiential learning per se pose to researchers have been pointed out in the past[1,10]. One of these issues concerns a lack of formality and reliability of its vocabulary. For example, although the notion of a frame seems intuitively appealing, its definition is not at all formally presented[11]. At the moment, no consensus exists amongst researchers on the term, and questions remain about what a frame is, how it is to be applied and at what level of scale. This lack of formality and consensus in the definitions makes replicable analyses very difficult, especially if we are looking to gain a useful description of progression in a design process.

In addition, only recently has attention been directed at the extension of the experiential learning paradigm to a team setting[12–15]. Particularly, an account of how the micro-level process is brought about when designers work together is actively investigated, since it is felt that the study of team designing within the experiential learning paradigm brings several benefits. Firstly, it offers a different perspective of what activities a team needs to perform by providing a basis for analysis of early design phases where other paradigms do not focus. It thus forces us to consider how individual frames are shared within a team for moves to be carried out, and how reflecting is integrated within the team design process. Secondly, the notion that individuals may hold conflicting frames neatly explains problematic

8 Schön, D A and Rein, M *Frame Reflection: Toward the Resolution of Intractable Policy Controversies* Basic Books, New York (1994)

9 Kolb, D A *Experiential Learning* Prentice Hall, Englewood Cliffs, NJ (1984)

10 Roozenburg, N F M and Dorst, K in H Birkhofer (ed) *Describing Design as Reflective Practice: Observations on Schön's Theory of Practice Designers—the Key to Successful Product Development*, Springer Verlag, Berlin (1998)

11 Valkenburg R 'The reflective practice in product design teams' PhD Thesis, TU Delft, Netherlands (2000)

12 Valkenburg, R and Dorst, K 'The reflective practice of design teams' *Design Studies* Vol 19 (1998) 249–271

13 Valkenburg R and Dorst K 'Frame cognition' *Proceedings 4th Design Thinking Research Symposium (DTRS99)*, MIT, Cambridge, MA, 2–25 April (1999)

14 Stumpf SC and McDonnell JT 'Relating argument to design problem framing' *Proceedings 4th Design Thinking Research Symposium (DTRS99)*, MIT, Cambridge, MA, 2–25 April (1999)

15 Stumpf SC and McDonnell JT 'A representation of rhetorical construction of understanding in teams during early design episodes' *Adjunct Proceedings CoDesigning 2000* Coventry, UK, 11–13 September (1999)

team designing. It can hence be used as a normative measure to talk about when designing goes right and when it goes wrong. Lastly, results from analysing experiential learning could be used as a diagnostic tool to examine how design teams operate, and indeed provide meta-information for a team's learning and reflection. To achieve these benefits, we require a coherent and consistent way of analysing how a team 'does' experiential learning, we need to be able to tell a good instance of experiential learning from a bad one and aim to strive to develop supporting tools for team experiential learning.

Our research addresses the problem of applying an argumentative approach to understand the process of experiential learning in design teams during the early episodes of designing. As part of this approach we emphasise that designers make use of persuasion as a linguistic skill connecting them to their community and culture as they design in a team[16]. We are using a background of argumentation theory, specifically rhetoric, to construct a bottom–up approach to find reliable markers that allow us to tell when a frame starts or shifts, and how teams move the concept along a focus of attention. Underlying this is our treatment of the design process and rhetoric as reality construction. Additionally, we are interested in whether this analysis of persuasive schemes will help teams to reflect on the processes and products with respect to concept development. In the remainder of this paper we provide in the first instance a brief orientation of our research within argumentation theory. We then outline concepts of importance within team experiential learning, introduce a new approach for a bottom–up analysis of experiential learning using rhetoric and finally provide an overview of support of experiential learning in design teams.

2 *A brief argumentation theory primer*

For the purposes of our approach we have turned to a background of argumentation. In this respect, argumentation should not be understood in its narrow 'everyday' usage of a heated debate, instead argumentation in our sense bears close links to a cognitive interpretation as a 'methodical reasoning' process[17]. Narrowly conceived notions of argumentation are not recognisable as descriptions of what is going on during design conversations. However, we suggest that a theory of argumentation that accounts for its everyday use (just as Wittgenstein's work accounts for language in its everyday use) can provide us with a fuller understanding of how teams' experiential learning proceeds. We have chosen to concentrate on rhetoric in preference to analytic logic or dialectic because we believe it allows focus on the role that argumentation plays to construct persuasive concepts within the communication process of two or more persons.

It should be remembered that in a traditional view analytic argumentation

16 **Fleming, D** 'Design talk: constructing the object in studio conversations' *Design Issues* Vol 14 No 2 (1998) 41–62
17 **Sykes, J B** (ed) *Concise Oxford Dictionary*, Oxford University Press, Oxford (1982)

centres on knowledge guaranteed to be absolutely certain and reliable through the modes of formal logic. Generally accepted opinions are covered under dialectic argumentation which describes the 'moves' (*topoi*) and the conduct of debates to argue for and against a standpoint by a proponent and opponent (recently taken up by the pragma-dialecticians). Finally in this traditional view, rhetoric is used by an orator to persuade an audience.

Newer conceptions of rhetoric are much more inclusive than this traditional view[18]. Current rhetorical studies are usually concerned with the importance of reasonableness and issues of power, as well as the use of rhetorical figures and how they receive their persuasiveness. This recent surge of interest in rhetoric is mainly due to work by Perelman and Olbrechts-Tyteca[19], who endeavoured to carry out an investigation, which was not normative but instead provided 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 to be understood in terms of value judgements, rather than being reduced to 'rational' evaluation in the narrowly defined sense. By their shared background of opinions, beliefs and the values underlying them, an audience creates a context in which certain premises, also called points of departure, and argumentation schemes are considered acceptable. Perelman and Olbrechts-Tyteca provide a classification of argumentation schemes based on their observations. These argumentation schemes are used to persuade the audience to accept other items in addition to the points of departure.

However, concerning the recognition of argumentation theory outside the field itself, Toulmin[20] has without a doubt been most influential because his easily understood account of dialectical argumentation is immediately appealing. His main work was conceived to be a challenge to the dominance, 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, he maintains, validity depends on the soundness criteria applied within a certain *field of argument,* such as jurisdiction, medicine, arts and—something that we would like to add—design. However, when his proposed structure of arguments is applied to design discourse, argumentation can be reconstructed as products but this does not capture the process of arguing. Toulmin has been also criticised for introducing structural categories when they are not really necessary[21], for failing to go far enough and only replacing formal

18 **Tindale, C W** *Acts of Arguing—A Rhetorical Model of Argument* State University of New York Press, Albany, NY (1999)
19 **Perelman, C and Olbrechts-Tyteca, L** *The New Rhetoric: a Treatise on Argumentation* University of Notre Dame Press, Notre Dame, IN (1971)
20 **Toulmin, S** *The Uses of Argument* Cambridge University Press, Cambridge, UK (1958)
21 **Freeman, J B** *Dialectics and the Macrostructure of Arguments: A Theory of Argument Structure* Foris Publications, New York (1991)

logic rules with informal logic procedures[18], or indeed not capturing all possible ways of reasoning[22].

Since argumentation has this relation to reasoning, it has been used as a window to look onto the design process in the past. Trousse and Christiaans[23] have suggested that design proceeds in a series of argumentative moves between designers sharing a discursive space. Brereton et al.[24] and Cross and Clayton Cross[25] have also commented on the persuasion that can be observed throughout design team practice. Furthermore, Fleming[26], observing student designers working together, noted that arguments were used to explain, predict, justify and warrant their artifacts. In an extension of this observation[16], he highlighted the use of language in object-laden versus language-laden talk. Object-laden talk often 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 evidence of the use of, amongst others, argument, indicating language's independence from the object and dependence on values, community, etc. Further points to note are that talk is used to create, manipulate and revise an object throughout a conversation. An active role is taken by the project supervisor to train students in the use of argumentation. The focus of these approaches has been to investigate the nature of problem-solving or social processes in a design team. In our case the focus is to investigate the role that rhetoric plays in experiential learning. In particular, we are interested in the role that argumentation plays in problem-framing in small design teams and how problem-framing informs the way designers justify their actions and use argument. The benefits that rhetoric brings are that it already focuses its attention onto processes amongst a group of people, and an epistemic outlook onto the nature of reasoning[27].

3 The experiential learning paradigm in teams

After priming the reader to our orientation within argumentation theory we will now outline a framework of important concepts within team experiential learning. As a structuring device we will use the models, methods, techniques and attitude to learning identified in Table 1. These are then concretised for team experiential learning, summarised in Table 2.

With respect to the model of the designer, it is important to note that there are various levels of interaction. Firstly there is the individual interaction between designer and the object to be designed, the original focus of Schön's attention. The process that sustains the communication with others adds yet another level. There is, in a sense, a design context and a social negotiation context[28]. In a team situation, a distinction needs to be made between individual team members' conversations with the situation and

22 Crosswhite, J *The Rhetoric of Reason* University of Wisconsin Press, Madison, WI (1996)
23 Trousse, B and Christiaans, H 'Design as a Topos-based Argumentative Activity: a Protocol Analysis Study' in **N Cross, H Christiaans and K Dorst** (eds) *Analysing Design Activity*, Wiley, Chichester, UK (1996)
24 Brereton, M F, Cannon, D M, Mabogunje, A and Leifer, L J 'Collaboration in Design Teams: How Social Interaction Shapes the Product' in *Analysing Design Activity*, Wiley, Chichester, UK (1996)
25 Cross, N and Clayburn Cross, A 'Observations of teamwork and social processes in design' *Design Studies* Vol 16 No 2 (1995) 143–170
26 Fleming, D 'Learning to link artifact and value: the arguments of student designers' *Language and Learning across the Disciplines* Vol 2 No 1 (1997) 58–84
27 Dearin, R D 'The philosophical basis of Chaim Perelman's theory of rhetoric' in **R D Dearin** (ed) *The New Rhetoric of Chaim Perelman—Statement and Response*, University Press of America, Lanham (1989)
28 Strauss, A *Negotiations* Jossey–Bass, San Francisco, CA (1978)

Table 2 Overview of team experiential learning and its underlying assumptions

	Team Experiential Learning
Description	
Model of designer	Practitioner engaged in rhetorical construction with team
Model of design task	Unique, uncertain, value-laden problem which the designers construct individually and share with other team members
Model of macro-level design process dynamics	Move towards synergy in frames/converge on one frame
	If this process goes OK, team has one 'team' frame
	If this process goes wrong, team exhibits frame conflict
	By-product: appreciative system for team
Model of micro-level design process dynamics	Framing–naming–moving–reflecting is effected by verbal means at the social level
Prescription	
Design methods and techniques	Increase awareness with relation to frames, reflection on team perspectives
Outputs	'Frame' rationales
Attitude to learning	Reflective abstraction based on concrete experiences

conversation within a 'designing system', the first resulting through frames and the latter through social communication which enables the use of frames. However, individual designers need to align the focus of team attention towards their own, and engage in a construction of the design problem, underlined by their use of rhetoric to persuade the team to adopt a point of view. The design task is hence constructed individually out of a problematic situation and comes to be shared among team members.

With respect to the design process dynamics, team experiential learning places emphasis on this sharing of frames. On a macro-level, we will need to pay attention to how individual frames converge towards a team frame. Some work on this process has been conducted[8], in which particular attention is paid to a team process failure within the experiential learning paradigm when conflict between individual frames is evident. In 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. Even within shared frames, interpretations might differ; these are termed frame disputes. According to the investigation, this can only be resolved through a frame shift by all or one party to the team. On the other hand, if the macro-level process goes well, the team should work within a common frame and have the same appreciation of the design

problem and how to solve it. Within the micro-level process we should still find evidence of a construction cycle of framing, naming, moving and reflecting. However, these individual processes need to be externalised and communicated to the team, and the team may need to be persuaded—meant in the nicest possible way—to adopt this way of seeing. The rationale for looking at the conversational level of team interaction is that team members need to externalise in some way what they are thinking or doing to be able to design with others. It is hence suggested that traces of this construction cycle should be found in the verbal utterances of individual team participants. Clearly much of design is a visual activity, which cannot be captured by relying on utterances 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[29].

These descriptive models of the design team and team designing lead to prescriptive methods and techniques proposed on a team basis. To overcome failure of the design process, such as when frame conflict is evident, the team's awareness of the dominant frames will need to be strengthened in the first instance. This can then be used as a mode to reflect on team perspectives. Even when the team does not exhibit frame conflict it may be of benefit to highlight how the design proceeded[30]. In particular, frames form the context of what is considered and form a 'rationale' detailing why an artefact was designed the way it was. Techniques are grounded in a learning attitude that situates action in concrete experiences of design but allows reflection to be abstracted away from them, leading towards an analytical learning exercise which is temporally removed from the throws of in-the-moment designing.

Recent work in analysing design behaviour, using a notation based on Schön's model of design as 'reflective practice', has indicated that such a representation can be successfully applied to gain new insights into the design process of design teams and that the action of framing and exploring the situation within the frame appears to be a powerful indicator of successful designing[12]. A coding scheme and notation has been developed by Valkenburg and Dorst[12,13], based on the notion that individual designers selectively attend to the design environment in order to form a problem situation (naming and framing), develop a solution out of local experiments (moving) and evaluate the outcome of these local experiments (reflecting). This coding scheme is applied to the analysis of design teams with an aim to support the synchronisation of the team's thoughts and activities. Coded episodes are shown in a notation and arranged in a temporal sequence. The notation developed by these researchers allows the high-level coding and

29 **Mazijoglou, M and Scrivener, S A R** 'The rich picture of design' *Activity Automation in Construction* Vol 7 (1998) 157–175

30 **Glock F** 'A sociological interpretative approach to design research' in *Proceedings International Conference on Engineering Design (ICED '99)* Munich, Germany, 24–26 August (1999)

analysis of design transcripts with respect to their activities in reflective practice at relative speed and with little training. However, although it provides an account of the design process in terms of reflective practice, it does not answer any questions about how this is effected through team communication. In contrast to this top–down approach, Trousse and Christiaans[23] describe a bottom–up coding scheme based on semio-linguistic and argumentative theory. It investigates individual and shared discursive spaces of designers which were developed using *topoi* and posits that the interaction of designers is dependent on the intersection of topical and discursive spaces. In effect, a graphical representation of the individual designer's semantic network gives an indication of their appreciation of the design task. However, it stops short of explaining any unfolding[31] and the combined team effect of these appreciations as an explicit instance of experiential learning.

4 A new approach for analysis—the rhetorical construction of understanding

As a new bottom–up approach for analysing experiential learning in teams, we are using a background of argumentation theory to find reliable markers that allow us to tell when a frame starts or shifts, and how teams move the concept along a focus of attention. As a tool to illuminate the design process we are studying the interplay of reality construction and persuasive figures to analyse and model design discourse, allowing to express what steps are taken on a communicative level. We refer to this as the rhetorical construction of understanding. In the following section we will concentrate on individual terms on the micro-level process within team experiential learning, that is, framing, naming, moving and reflecting.

Firstly, we will try to elucidate framing and naming in rhetorical terms. The New Rhetoric[19], which provided the basis for our coding scheme, distinguishes between premises that are considered real and those considered preferable by the audience. Real premises are defined as facts, truths or presumptions. Preferable premises are values, value hierarchies and loci—that is, preferences of one abstraction over another that form the basis of value hierarchies. These preferable premises are used as guidelines to make choices. In effect, what the audience and the arguer accept as valid defines the boundary of their attention and what they select as important. By placing importance on the facts that are accepted as valid we can gain access to the way reality is perceived. The inclusion of preferable premises gives us the ability to consider the role of values and the shaping of them in the design process. Each utterance by a participant in team designing acts as an invitation to see the situation in the way of the speaker[22], narrows the focus of attention and sets up an accepted premise.

31 **McDonnell, J T** 'Descriptive models for interpreting design' *Design Studies* Vol 18 No 4 (1997) 457–473

Contrary to dialectical theories of argumentation which are based on a two-person game between a proponent and opponent, the New Rhetoric allows us to view the design process as a social interaction of persuasion between an arguer and an audience. It should be noted that the role of arguer and audience switches between the individual members of the team at different times. In the New Rhetoric, the argument that is employed is critically dependent on 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 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'[8]. Furthermore, the inclusion of values, value hierarchies and loci gives us the ability to consider the role of an appreciative system[32] in the definition of a frame.

Frames impose an order on a situation, allowing us to explore and solve a problem by constructing moves. Translated into the notions of the New Rhetoric, this means that starting from the shared premises that the audience accepts as a frame, the arguer can construct links to other concepts that she would like to have accepted by the audience. Rhetorical argumentation schemes provide links between statements, called associations. By using this argumentation scheme, a chain of arguments can be constructed to persuade the audience towards the adoption of a solution. The connection of an already accepted concept to a concept that the arguer wishes to be accepted can occur by various means. Leaving aside the quasi-logical argument schemes which are concerned with form, we attach most emphasis to those concerned with content. These are associations based on the structure of reality and associations to establish the structure of reality (Table 3). Association based on the structure of reality tries to exploit the reality as constructed by the audience. This can occur, for example, by providing a causal or coexistential association between two already accepted facts, or by drawing an association between two concepts in a value hierarchy. Association to establish the structure of reality tries to draw a new link to a new claim. This is achieved by way of examples,

Table 3 Examples of the 'association' argumentation scheme

Association based on the structure of reality	'We are designing for an off-road bike so you'd need a real rugged attachment or a rigid attachment for a backpack'
Association establishing the structure of reality	'Maybe the rack is a little bucket that the backpack sits in'

32 **Vickers, G** *Value Systems and Social Process* Penguin Books, Harmondsworth, UK (1968)

analogy, metaphor or illustration, allowing the new claim to be established by drawing on accepted facts.

Another important notion in Schön's work is that of frame conflict and shift. 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. Similarly, Crawshay-Williams[33] 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, resulting in individual members interpreting statements in these different contexts. The dilemma of incompatible or inconsistent demands or where there is a perceived misfit[34] brings new dimensions to the problem situation and it triggers surprise in the designer. Surprise provides an opportunity to reflect and allows the designer's understanding to be examined, leading potentially to a shift of frame to resolve the incompatibilities. In the New Rhetoric coding scheme, the argumentation scheme that fits this characteristic is a dissociation, which is introduced to overcome an incompatibility by separating an established concept into new concepts (Table 4). Dissociation is not decomposition; rather, a 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 notion of dissociation can also be understood in terms of the suggestion that generative metaphors, involving 'normative dualisms', are underlying frames[35]. The definition of a 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 relation to 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.

The argumentation schemes of association and dissociation work in tandem. By introducing a dissociation, we have created a new conception of reality and what we see as facts or values. 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 process terms, further arguments are only required when a

33 Crawshay-Williams, R *Methods and Criteria of Reasoning* Routledge and Kegan Paul, London, UK (1957)
34 Alexander, C *Notes on the Synthesis of Form* Harvard University Press, Cambridge, MA (1964)
35 Schön, D A in **A Ortony** (ed) *Generative Metaphor: A Perspective on Problem-setting in Social Policy Metaphor and Thought*, Cambridge University Press, Cambridge (1993)

Table 4 Examples of the 'dissociation' argumentation scheme

Dissociation	'What if your backpack were big? What if this tray were not plastic but like a big net you just pulled it around and zipped it up'

gap of connection is perceived and added reasons to support a new concept are needed[21].

It appears that definitions of frames in the sense of Schön and the concepts in the New Rhetoric are sufficiently similar to allow us to use rhetorical structures as markers for *potential* frame shifts. We now provide a worked example to show the application of the coding scheme.

4.1 Application of the coding scheme to a case study

The coding scheme identifies associations based on the structure of reality (ABS), associations establishing the structure of reality (AES) and dissociations (D) during team work. We are suggesting that an incompatibility sets up a potential for a frame shift, which is indicated in the transcript by the use of a dissociation. The dissociation is then developed and negotiated by associations, the team working with the new concept and the norms established through the separation of concepts.

The transcript is drawn from a design exercise of three industrial designers working on a conceptual design for a backpack rack to be used with a bicycle, which was part of a workshop investigating the use of protocol analysis in design research[2]. In Figure 1, we present an excerpt of this 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. But although they have worked for almost 40 min 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 rain water 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 observed that the proposer of the idea puts forward further

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 kkkkk, 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	
	Kerry	you pull down, it retracts in	
AES	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 1 Use of argumentation schemes in example design team transcript

grounds to strengthen his suggestion and a negotiation ensues which defines the sense the team will associate with the term 'tray' (annotation 6).

In Figure 1, we have shaded the areas between dissociations in differing

shades 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.

This illustration shows 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 by association, working with the newly established concept and norms.

4.2 Coding scheme reliability

In the complete transcript of the team design session by Ivan, John and Kerry lasting 2 h, we can discern 294 associations and 19 dissociations. Out of the associations, 121 establish the structure of reality and 17 are associations based on the structure of reality. The reliability of the coding scheme was tested by calculating the Kappa coefficient for inter-rater reliability. A section of the raw transcript was presented to four coders who were asked to use the coding scheme to categorise the utterances. Two of the coders were considered 'naïve', but no special training was given. The two remaining coders had experience of the coding scheme and applying it to transcripts. Kappa calculated for the 'expert' coders was 0.67, which indicates a moderate to high inter-coder reliability. The coefficients when 'naïve' coders are included are 0.65 and 0.54, respectively, for three-coder and four-coder reliability. It should be noted that 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 also be the case that coders are more familiar with the rhetorical figures 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 the new concept is not settled yet, that is, 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 from edited statements. There is some evidence that higher Kappa ratings can be achieved by some form

Figure 2 Use of argumen-tation schemes in example design session
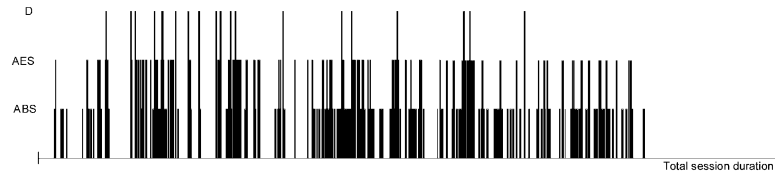
of pre-processing[36]. Overall, we are satisfied by the reliability of codings, especially since disagreements seem to stem from the novelty of use, rather than some intrinsic shortcoming of the coding scheme.

4.3 A representation of design process

Figure 2 shows us the designers' use of persuasive schemes over the course of the transcript and allows us to note various characteristics of this design session. This representation shows us that persuasive 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 session. We can also observe 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 persuasive activity settles down.

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 handled acceptably later on, whereas dissociations that require radical reframing of fundamental design concepts at a very late stage may have very serious consequences.

The analysis of the transcript offers some useful insights into team processes, for example, we see a pattern of association clusters—especially associations extending what is attended to—surrounding dissociations. In these instances, team participants appear to use the persuasive figures to develop and negotiate a newly introduced dissociation. We observe that where dissociations are introduced but not strengthened by associations, a shift in the team's understanding does not take place.

A representation at this level clearly cannot stand alone since we cannot detect any occurrences of frame conflict, when individual participants have different understandings of the design problem and solution. As a remedy some additional representation of the lower-level content is needed. This would allow access into the semantics of the dissociations. To put it another

36 **Warnick, B and Kline, S L** 'The New Rhetoric's argument schemes: a rhetorical view of practical reasoning' *Argumentation and Advocacy* Vol 29 (1992) 1–15

way, we need to supplement this representation to allow us to tell the impact of a dissociation during the design session. Linkography[37] is one such approach, which has taken steps to show the importance that individual strands of concept developments play in design reasoning.

5 Discussion

Learning is important for both design researchers and design practitioners. For the design researcher, learning involves finding out more both about the design process and the paradigm through which it is viewed. A good paradigm provides a way of structuring our observations, explaining phenomena of designing and suggesting useful techniques and methods. Simultaneously, by applying a paradigm to investigate team design processes we clarify our understanding of the meaning of a paradigm's terms and concepts themselves. Studies of the design process through a paradigm should contribute to our knowledge of what designers do. These studies should allow us to say something about the design process in a new way.

Research from within the experiential learning paradigm in the past few years has tried to make sense of the use of frames within a design team setting, firstly by trying to identify them in some way and secondly to explore their role in the design process. The lack of formal definition of what constitutes a frame has exacerbated the difficulty of conducting reliable and replicable analyses. Our approach has been to focus on the interaction among team members to see what this can tell us about how frames get established and how they shift as design progresses. To detect frame shifts we have used a bottom–up approach which relies on the identification of the rhetorical schemes used by the team in reality construction. By coding transcripts with these schemes we have been able to see in the design process the episodes in which terms are suggested, negotiated and developed. We believe that attempts like ours at describing design teams' framing give us a better understanding of the design process per se. Our approach in particular highlights the persuasive nature of frame establishment that occurs in the team design process.

Descriptions of the design process based on coding schemes like ours can begin to serve as diagnostic tools. This raises the question of which indicators count in terms of good or bad designing within the experiential learning paradigm. An obvious link has not been established between the products of designing, that is, the artifacts, and the process of establishing *shared* frames; we accept, however, that the quality of frames can impinge on the quality of the products. We can be more confident, however, that the team's interaction to share frames provides a legitimate indication of the quality of team processes.

37 **Goldschmidt, G** 'The designer as a team of one' *Design Studies* Vol 16 No 2 (1995) 189–209

We are also concerned with how the view of the design process that our coding scheme reveals can be used by design teams to learn about the way they work together. We are interested in supporting the reflection-on-action that is an integral part of experiential learning by providing useful representations of what goes on during designing. Some descriptions are better than others; for a start, the design team needs to recognise their designing in the description presented to them. Some researchers have claimed that this recognition is actually a test of research validity. 'It is a criterion for the validity of research results—the researchers' reconstructive interpretation—that the designers 'can find themselves' in the provided descriptions'[38]. To make a connection between designers' experiences of designing and our encodings of framing and frame shifting, we have to make a number of decisions. One of these concerns the granularity of the description. Our experiments with showing micro-level detail (like that shown in Figure 1, but displayed through a visualisation tool) and macro-level detail (at the level of detail shown in Figure 2) suggests that there is no single appropriate level of detail that is useful for team or individual reflection. Rather, we need to provide ways of moving between levels of description to support a team's learning needs. There are also choices about whose learning is supported, and upon what the learning is focused. When we are focusing on designing in teams we need to be clear about whether we want to help the team to learn to work better as a whole, whether we are helping individuals to develop themselves or whether we want to inform the approach taken to one-to-one interaction between team members.

Thirty years ago Kunz and Rittel[39] proposed an issue-based network of nodes and links to represent the deliberation of participants working together to solve 'wicked' problems[40]. This has formed the basis of a number of design rationale notations. Currently, we are working with design teams to see how we can increase their reflection-in-action and reflection-on-action by providing them with a representation of 'frame rationale' which is based on the coding scheme we have described. This representation captures design argumentation by emphasising temporal progression; statements (nodes) are labelled according to type (e.g. fact, value), the speaker identified and negotiated terms are highlighted from the statements. Facts and values tend to be linked in an argumentation network forming argument chains, broken down into frames. In a graphical layout this representation enables a micro-level and overview inspection, showing the overall process, the local argument chain and the current negotiated terms in use in the argument chain. This allows the designer—or researcher—to switch between the appropriate level of granularity as required.

We have found that talking about team framing opens up a discussion on

38 **Glock F** 'Design tools and framing practices workshop on the role of objects in design communication: communication through physical or virtual objects' *Fourth International Conference on the Design of Cooperative Systems (COOP '2000)*, Sophia-Antipolis, France, 2 May (2000)

39 **Kunz, W and Rittel, H W J** *Issues as Elements of Information Systems, Working Paper 11* University of California, Berkeley, CA (1970)

40 **Rittel, H W** 'Second-generation design methods' in **N Cross** (ed) *Developments in Design Methodology*, Wiley, Chichester, UK (1984)

learning, on paradigms and on design processes. This is a good start as a dialogue can only be sustained by giving a common language to both design researchers and practitioners.

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