INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'07
28 - 31 AUGUST 2007, CITÉ DES SCIENCES ET DE L'INDUSTRIE, PARIS, FRANCE

COGNITIVE CONFLICT IN DESIGN TEAMS: COMPETING OR COLLABORATING?

Petra Badke-Schaub[1], Gabriela Goldschmidt[2], Martijn Meijer[1]
[1]TU Delft, Faculty of Industrial Design Engineering, Product Innovation Management
[2]Technion – Israel Institute of Technology, Haifa, Israel

ABSTRACT

Is cognitive conflict detrimental to innovation in design teams, or is it a precondition for innovative performance? Assuming that there is a relationship between cognitive conflict and innovation, what kind of strategies do teams use in situations of cognitive conflict and what are the consequences?
This paper provides insights into design teams' behaviours and how cognitive conflict could be used while performing a design task. The way design teams deal with cognitive conflicts was captured in protocols which were generated from video recordings in an experiment. In this paper we report the results of the analysis of the verbal protocols according to the five styles of (cognitive) conflict behaviour by Thomas & Kilmann [1]: *competing*, *collaborating*, *compromising*, *avoiding* and *accommodating*. In addition, the evolution of ideas has been categorised and analysed.
Out of all six teams, the results of the best two and worst two teams from innovation and functionality respectively are compared. We show that design teams, even in a laboratory environment, encounter a considerable amount of cognitive conflicts. A statistical comparison between the groups with the most innovative resp. functional design concept with those with the least innovative resp. functional design concept reveals significant differences related to their conflict behaviour styles.
The high innovation groups used a more competing and a more compromising style whereas groups rated low on innovativeness used a more collaborating style. The groups rated high on functionality used a more rejecting, collaborating and more compromising conflict behaviour style than the groups rated low on functionality.

Keywords: Cognitive conflict, conflict style, innovation, creativity, collaboration

1 INTRODUCTION

Design is a complex activity involving different people with different backgrounds and different experience, who pursue different aims, possess different skills and capabilities and use different working styles. According to the common definition of conflict as a consequence of perceived incompatibilities among individuals [2], each design process by a team is likely to be prone to innumerable conflicts. Multidisciplinary groups in particular often experience a clash of views, interests, goals and values. However, it is also known that diverse views lead to a broader access to information and thus introduce a knowledge space with more and different insights into the current problem field. At the same time there is the recommendation that groups should establish a positive group climate to ensure information exchange in the group, which enhances creative insights; thus, conflicts have to be avoided [3].
Assuming that cognitive conflicts in groups are unavoidable it is still unclear how teams, and more specifically design teams, cope with that problem and to what extent the output is influenced by different styles of conflict behaviour.
This paper aims to contribute to a better understanding of the relationship between conflict and innovation in design teams. The emphasis lies on the question: in situations of cognitive conflict which behaviour leads to a more innovative outcome in design teams?

2 THEORETICAL BACKGROUND

2.1 Types of conflicts

A common assumption is that the occurrence of conflict in groups is destructive in terms of group dynamics and group performance; thus, ideally conflicts should be avoided or reduced to a minimum. This point is supported by a meta-analysis which revealed a negative correlation between task conflict and overall team effectiveness [4]. Studies showed that even the anticipation alone of low conflict with other individuals leads to more flexible thinking and more creative problem solutions [5].

However, there are also suggestions that conflicts can be used in a productive and contributory way, even as an asset [6,7,8]. This line of argumentation is based on a distinction between different types of conflict. According to literature [9] we can distinguish between three main types of conflict: cognitive, affective (socio-emotional), and process conflicts.

Cognitive conflicts can be defined as differences between task-related issues, which in the team context are expressed as disagreements. *Affective conflicts* relate to differences in emotions and unsatisfactory relationships among team members. *Process conflicts* are conflicts which, similar to cognitive conflicts, are linked to the task but involve issues related to the mode of accomplishing the task [10], e.g., disagreements about timing, planning and scheduling of tasks and related activities. Taking into account the different types of conflicts it becomes obvious that the correlation between conflict and performance depends on the conflict type.

Research suggests that affective conflicts usually have a negative impact on team performance in terms of reduced motivation, openness and communication [11]. Process conflicts were also found to be responsible for decreased productivity and low task content quality [12]. Cognitive conflicts, on the other hand, may have a contributory potential [6]. Managed adequately, they allow for a larger number of ideas and perspectives to be brought to discussion, which is especially important for developing new and innovative solutions.

This view on cognitive conflict is particularly relevant to design, which can be described as a creative problem solving process [13]. Through the creation of knowledge based on diverse skills, experience and information exchange, the quality of design processes and the creative performance of design teams improve. In this view creativity is determining the strategy of the process whereas the innovative product is the result of a creative process including the application component [27]. West & Farr define innovation as "the intentional introduction and application within a role, group or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, the organization or wider society." [28] (p.9).

Although there are several studies illustrating the different effects of conflict on team output, it is still unclear in which way cognitive conflict influences the conflict behaviour of teams, and how this affects the output. In this study we focus on cognitive conflicts, because we are interested in the manner in which groups use cognitive conflicts to achieve a successful design result in terms of innovation, but also in terms of functionality.

2.2 Conflict behaviour

People respond differently to a conflict situation. It is widely assumed that each person has a preferred way of dealing with a conflict, a so called conflict style [14]. Researchers such as Putnam [15], Rahim [16,17] and Thomas & Kilmann [1] developed a typology of five conflict styles based on the two dimensions 'assertiveness' and 'cooperativeness' (see Figure 1). Assertiveness is the extent to which a person attempts to satisfy his or her own concern, cooperativeness the extent to which she or he aims to satisfy another's concerns.

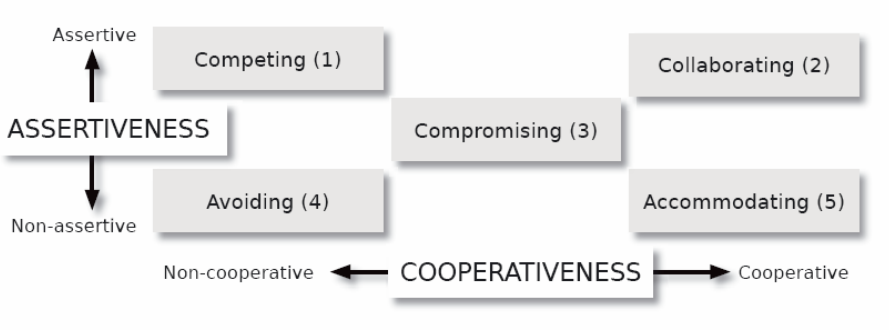

Figure 1. The five conflict styles [1]

A person's conflict style incorporates both assertiveness and cooperativeness in varying degrees. The five conflict styles are described as following:

1. Competing (1) is assertive and non-cooperative, a more power-oriented style. Own concerns are set above the concerns of other parties in order to attain (and keep) a higher position. This style is regarded as less effective as it provokes a win-loose-situation.
2. Collaborating (2) is assertive and cooperative. When collaborating, a person tries to work together with other persons to find a solution that satisfies the needs of everyone concerned. This style is associated with problem solving situations (such as design) and is effective in exploring and finding different (design) solutions.
3. Compromising (3) is located between assertiveness and cooperativeness. The objective of this conflict style is to find a suitable, mutually acceptable solution that partially satisfies all parties. This style seems to be appropriate in situations where different goals are equally important to all concerned parties, but a solution still needs to be reached.
4. Avoiding (4) is non-assertive and non-cooperative, with low concern for self and low concern for other parties, thus not addressing the conflict. This style is effective in conflict situations where issues other than the best solution are more urgent, or when confronting the conflict is more damaging than non-acting.
5. Accommodating (5) is non-assertive and cooperative, with low concern for self and high concern for other parties. This conflict style supports a positive climate and is useful when keeping harmony is a high priority.

Research indicates that using the collaborative conflict style is the most successful strategy to arrive at a positive outcome. For example, Weingart & Jehn [18] state that the use of the collaborative conflict style is the key to team-effectiveness; open-minded debates as part of the collaborative conflict style are particularly useful in situations aiming at creativity and innovative solutions.

There are also studies which show a negative effect of cognitive conflict on team performance in multi-disciplinary design teams, although teams using a collaborative style did not suffer from this detrimental effect [19,20].

3 RESEARCH APPROACH: EMPIRICAL STUDY

3.1 Research questions

According to the findings reported in section 2.2 the most promising way to deal with cognitive conflicts in design teams is the collaborative style. However, as the design process requires different cognitive processes during the development of a design solution, it comes as no surprise that there is some evidence [21] that in different phases of the design process different conflict behaviour is needed for good results. Therefore we assume that a 'pure' collaborative style is not very fruitful in terms of generating new ideas and coming up with an innovative solution. A team also needs to establish a competitive style, which will raise more discussion and thus may lead to more innovative solutions.

Furthermore, we assume that a mostly collaborative style will increase the functionality of the product but not necessarily its innovativeness; the reason behind this assumption is, that it seems difficult to come up with common decisions related to the implementation of new ideas when there is more competition than collaboration. Once ideas have been selected, the working out of functionality is a collaborative task in its nature and competition seems less likely to surface.

In this study we try to answer the following three questions:

1. How do design teams deal with cognitive conflict?
2. What kind of conflict behaviour in a group is best suited to enhance the quality of design in terms of innovativeness?
3. What kind of conflict behaviour in a group is best suited to enhance the quality of design in terms of functionality?

3.2 Set-up of the experiment

Six groups[1] of three design students each, acting as teams, were asked to design a concept proposal of a new tent for Nomad's "Global Family Gear". The participants were Industrial Design Engineering students who either just started a six months design project, or were working on their graduation projects, or had recently graduated. Eleven participants were female, ten were male.

The assignment was to design a flexible-size tent for hiking and climbing that could be used by a single adult, a couple, and a couple with two small children. The main requirements were named as follows:

- lightweight and compact enough for hiking and climbing
- usable by a variable number of users: one to two adults + one to two children up to the age of 5
- practical and easy to put up, pack and transport
- extremely durable.

The experiment, which was conducted with each group separately, was divided into three main phases following an introduction: an individual session, a group session and a debriefing session including a questionnaire (see Table 1). First, the participants were informed about the procedure and the design task. After this introduction the three participants were taken to separate rooms to individually generate design ideas which were later used as input in the group session. In the individual session the participants were asked to think aloud. After 25 minutes of individual designing the group was reconvened for a session in which a final concept of a tent was to be completed. After 40-50 minutes, at the end of the group session, the participants had to fill in a questionnaire which took about 10-15 minutes to complete. During this time one of the participants was interviewed separately (debriefing) for about 5-10 minutes (recorded on audio tape); interviews with the two other participants followed suit. The individual sessions were audio taped, the group sessions video taped. Later all final designs were rated by independent judges (see section 3.4).

Table 1. Time-schedule of the experiment

Phase	Time (min.)	Session task description
0	0:00 – 0:05	Introduction: assignment and procedure
1	0:05 – 0:30	Individual session: individual design ideas of tents
2	0:30 - 1:20	Group session: designing a (group) concept of a tent
3	1:20 - 1:35	Debriefing: individual debriefing and questionnaire

Four types of data were gathered:

- observational data of the complete design process on audio and video tapes
- drawings of the individual sessions and group sessions, which are not included here
- questionnaires and debriefings, which are not included here (except Figure 4)
- rating of the final design concepts.

3.3 Analysis of the behavioural data

The group video-tapes were first all transcribed and segmented into units, each being one utterance by a participant, and then coded according to four distinct categorization systems which will be explained in the following: conflict type, styles of conflict behaviour, idea type and idea evolution.

[1] Initially seven groups were invited to participate in the experiment, and all of them undertook the task and reached a solution. Due to a technical problem with sound recording we have no documentation of the verbalizations in one of the groups. Therefore the analysis pertains to only six groups while ratings of the resultant designs are reported for all seven groups (see Table 7).

For coding, the software program Mangold InterAct (www.mangold.de) was used. The program is able to code many types of behavioural data per time unit and the data can be easily transferred into statistical programs.

Conflict type

Besides the evidence that there is no conflict during the communication in the group according to literature (see section 2.1) three types of conflicts have been distinguished:

Table 2. Types of conflicts

Cognitive conflict	affective conflict	process conflict	no conflict

Conflict behaviour

The actual conflict behaviour was gathered from the observational data of the group sessions. The subcategories were developed according to the conflict behaviour style [1] (see section 2.2):

Table 3. Styles of conflict behaviour

Competing	collaborating	compromising	avoiding	accommodating	none

Idea type

As we assume that the conflict behaviour style will influence creativity in the group and thus the innovativeness of the outcome, we categorized how ideas were generated during the experiment. A distinction was made between individual and group ideas, and the resolution level with a distinction between overall solution ideas and sub-solutions (as part of the overall idea).

Table 4. Types of ideas

individual overall solution	individual sub-solution	group overall solution	group sub-solution	no idea generation

Idea evolution

This categorization system pertains to the way the groups generated, and reacted to solution ideas. Ideas may be repeated, associated (an idea is generated based on another idea), a completely new idea can be generated, or there is no idea evolution, which means that participants do not react on an idea. And ideas may also be rejected (discarded).

Table 5. Idea evolution

new ideas	Associating	repeating	rejecting	none

The following Table is an example of three lines from a coded protocol. On average a group session's protocol in this experiment holds 680 lines.

Table 6. Example of three lines of coded behavioural data

Start time	**End time**	**Parti-cipant**	**Transcription**	**Idea type**	**Idea evo-lution**	**Conflict type**	**Conflict behaviour**
07:47	07:47	Lucille	I think we can agree that it should be separate parts.	Group+ sub	Asso-ciate	Cognitive	Collaborate
07:50	07:52	Lucas	I also think that all three of us have thought of approximately the same concept, they are very similar.	Group	Repeat	Cognitive	Collaborate
07:52	07:53	Lucille	Just a little different, …	Group	Repeat	Cognitive	Compromise

3.4 Ratings of the final group designs

In order to evaluate the groups' performance in terms of innovativeness and functionality the final concept designs were rated by three judges. The judges were design tutors in the Faculty of Industrial Design Engineering and had experience in judging designs.

The final designs were rated on the criteria innovation and functionality on a scale of 0 (lowest) to 7 (highest) [22]. The criteria were set beforehand and discussed by the judges before the rating of the group designs. This procedure reduces differences in the interpretation of the criteria between the judges.

As Table 7 shows, group 2 and group 4 scored highest on both innovation and functionality, whereas group 0 and group 5 scored lowest on innovation, group 3 and group 5 scored lowest on functionality. Obviously in two design teams (group 2 and group 4) high innovativeness goes along with high functionality, an in one design team (group 5) low innovativeness goes with low functionality, two groups rank moderate in functionality and low on innovation (group 0 and group 1) and two groups rank moderately high on innovation but low on functionality (group 6 and group 3).

Table 7. Ratings of the final designs

	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Innovation average	**2,0**	3,0	**6,0**	4,5	**6,5**	**2,0**	5,0
Functionality average	4,0	4,5	**5,0**	**3,5**	**4,8**	**2,2**	3,5

4 RESULTS

In the following the results of this experiment are presented. In the first part the results of all six groups are presented together, so as to answer our first question: How do design teams deal with cognitive conflict? In the second part the two groups with the most innovative outcomes are compared with the two groups with the least innovative outcomes. In the third part the two groups with the highest ranking on functionality are compared with the two groups rated lowest on functionality. This analysis will help us answer the remaining two questions: What kind of conflict behaviour in a group is best suited to enhance innovativeness, and what kind of conflict behaviour is best matched to enhance functionality.

4.1 Results of all groups (n=6)

Type of conflicts

The results indicate that process and affective conflicts occurred in all six groups very seldom (3,3% and 0,8% of all utterances) whereas the number of cognitive conflicts varied across the six groups: in five of six groups between 43,2% and 53,7% of all utterances bear evidence of cognitive conflict, and only one group showed a very low amount of cognitive conflicts with 16,4% of all utterances. This group agreed right from the beginning to adopt the idea of one team member and therefore there was hardly any need to engage in cognitive conflicts further on, as no other ideas needed to be considered.

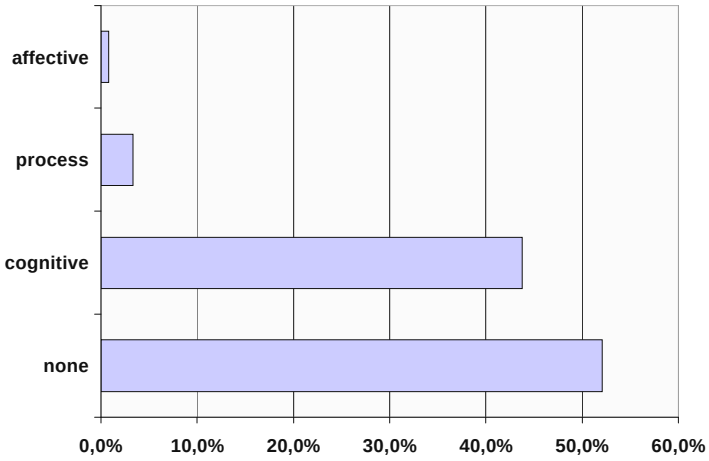

Figure 2. Average percentage of different types of conflicts during the design process (n=6)

The following analysis takes into account only the situations of cognitive conflict; situations categorized as demonstrating affective, process, or no conflict are not part of the analysed data below.

Conflict behaviour

A view of the assessment of the observed conflict style behaviour of all six groups (see Figure 3) reveals that in situations of cognitive conflict the design teams used mainly a collaborative style (59%). Competing (12%), accommodating (9%), and even compromising (12%) occurred significantly less often, each of these styles hold around 10%. The avoiding style was hardly be observed (1%), what might be an effect of the experiment what gave the group only 45 minutes time to come up with a common concept.

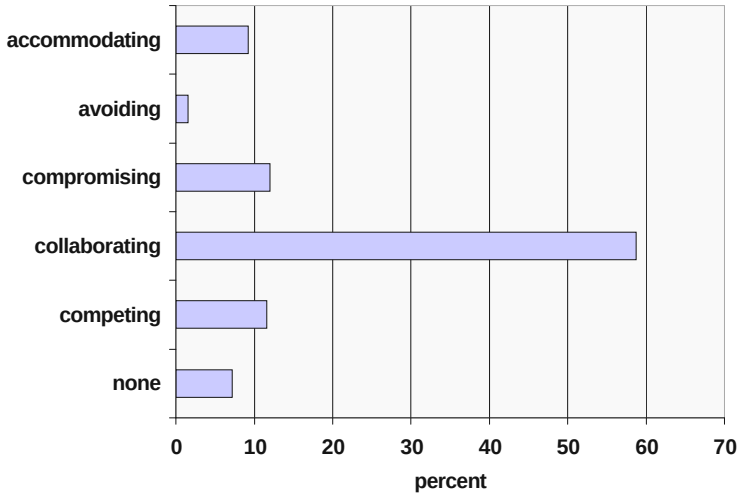

Figure 3: Average percentage of observed conflict styles (n=6)

Idea generation

Collaboration seems to be a fruitful behavioural strategy in the sense that by building on each other's ideas and input, various aspects of the design problem can be explored and discussed.

According to Table 8, most solution ideas by far were generated by the groups rather than by the individual designers, and they pertain mostly to sub-solutions. Furthermore, most often ideas were generated by association, however repetition of ideas was also very often observed. Thus, idea generation in most of the groups can be described as a process of developing sub-solutions building on the ideas brought into the group from the individual session, which then were enriched by associations and these were often repeated.

Table 8. Idea type and idea evolution

idea type	Frequency	%	idea evolution	Frequency	%
none[2]	123	6,9	new	51	2,8
individual	73	4,1	**associate**	568	**31,7**
group	194	**10,8**	**repeat**	510	**28,5**
individual sub	153	8,5	reject	327	18,3
group sub	1247	**69,7**	none	334	18,7

Based on the data of the six groups we can state that on the average the design teams were involved in cognitive conflicts in nearly 50% of their activities during the design process. They predominantly used collaborative strategies in these situations, with a mainly group-oriented idea generation procedure and a low share of new ideas. The solution search process was wavering between associating ideas to previous ideas, and repeating ideas.
The reason may be twofold: first, due to the outline of the experiment each group member had developed his or her own solution ideas in the individual session, before he or she joined the group. Therefore not many new ideas were left to be added in the group session. Second, people develop a certain commitment to their own ideas, which means that each group member was to a certain extent inclined to adhere to what he or she had done earlier and not very motivated to introduce new ideas in the group session.

4.2 High innovation groups vs. low innovation groups

As each of the groups show a different pattern related to the rated outcomes we followed a comparison between the extreme groups: The two groups with the highest ratings for innovative design concepts (groups 2 and 4) were compared with the two groups with the lowest ratings for innovative design concept (group 5 and 0).

Conflict behaviour

Table 9 presents the differences between the groups (low – high innovation) related to their conflict behaviour styles. The high innovation groups used a competing style significantly more often, whereas the low innovation groups were much more collaborative.
Taking into account that a competing style surfaces different viewpoints before a solution is decided on, it is not surprising that the high innovation group also showed a more compromising style than the low innovation groups. There is no significant difference between both groups in relation to the avoiding or accommodating style.

Table 9. Comparing styles of conflict behaviour between high and low innovation groups

	innovation		Chi[2] significance
	low	high	
competing		more	.05
collaborating	more		.000
compromising		more	.000
avoiding			n.s.
accommodating			n.s.

Idea evolution

According to our data (Table 9) collaboration is clearly a less useful behaviour on the road to an innovative outcome; conversely, the combination of a competing and a compromising style proves to be successful. How does this mixed pattern of competing and compromising behaviour relate to idea evolution?

[2] None means that the utterances do not relate to idea generation but to other aspects of the design process.

Whereas the groups rated low on innovativeness showed more repeating of ideas, the groups rated high on innovativeness produced more new ideas, associated more, and also rejected more ideas (see Table 10).

Table 10. Comparing idea evolution between groups' concept rated high and low on innovativeness

	innovativeness		Chi^2 significance
	low	high	
new ideas		more	.042
associating		more	.001
repeat	more		.000
reject		more	.032

4.3 High functionality groups vs. low functionality groups

Similar to the comparison between the high and low innovation groups, we chose the two groups with the highest functionality ratings and compared their conflict behaviour and idea evolution with the two groups with the lowest ratings on functionality. Interestingly the two groups which scored high on innovation were the same groups scoring high on functionality.

Conflict behaviour

We expected a more collaborative and a less competing style of the high functionality groups compared to the low functionality groups. One reason for this assumption was that the functionality of a concept is seen as high if it is worked out to greater detail, whereas it is difficult to get a clear idea about functionality when there is only a rough and vague sketch (see for example the differences between the concept of a high functionality group and a low functionality group in Figure 4).

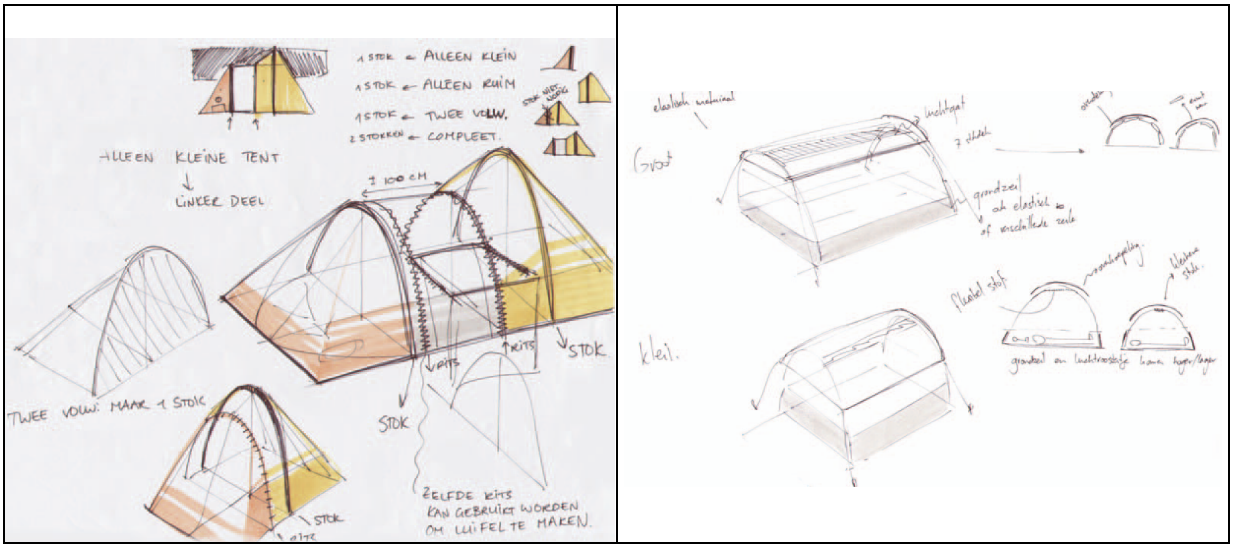

Figure 4. A more detailed final design concept and a less detailed final design concept

As Table 11 shows – contrary to our expectations – groups rated high on functionality used a more rejecting, collaborating and more compromising conflict behaviour style than the groups rated low on functionality. Now, taking into account that the two groups which scored high on innovation were the same groups scoring high on functionality, this result is not surprising any more.

Table 11. Comparing styles of conflict behaviour between high and low functionality groups

	functionality		Chi^2 significance
	low	high	
competing		more	.009
collaborating		more	.000
compromising		more	.006
avoiding			n.s.
accommodating			n.s.

Idea evolution

When compared to groups rated low on functionality, the idea evolution in groups rated high on functionality were more associating, repeating and rejecting, thus building on each other's ideas but also criticising and rejecting ideas.

Table 12. Comparing ways of idea evolution between groups' concept rated high and low on functionality

	functionality		Chi^2 significance
	low	high	
new ideas			n.s.
Associating		more	.003
Repeat		more	.006
Reject		more	.053

5 DISCUSSION AND CONCLUSION

This study provides insights into ways in which design teams use cognitive conflict while performing a design task.

It has been shown that design teams, even in a laboratory environment, encounter a considerable amount of cognitive conflict. The style of conflict behaviour most frequently used by all six analysed groups is by far the collaborating style. However, there are considerable differences among extreme groups, rated on innovativeness and functionality of their final design concepts. A statistical comparison between the extreme groups, those with the most innovative design concepts compared with those with the least innovative design concepts, revealed significant differences related to conflict behaviour styles. High innovative groups used a more competing and a more compromising style, whereas groups rated low on innovativeness used a more collaborating style. This result was supported by the analysis of the evolution of ideas in the same groups: Groups with low innovative design concepts were inclined to repeat already existing ideas while the groups rated high on innovativeness produced more new ideas, associated more but also rejected more ideas. Thus, teams with low innovative outcomes used a mainly collaborative style and spent too much time on discussing and working out the same ideas.

As a conclusion we can state that important components of creativity are diverse views which are discussed openly, linked to each other, while less promising ideas are consciously allowed to drop out along the way. Furthermore, the data revealed that those groups rated high on innovation were also rated high on functionality. Compared with groups rated low on functionality they had significantly more utterances coded as competing, collaborating and compromising behaviour. Obviously, the mixed pattern of all three conflict behaviour styles – competing, collaborating and compromising – is important to arrive at the production of an innovative and functional design. This result is in contradiction with the explanations of De Dreu [26] who sees the collaboration as the most important contribution of the group to arrive at an innovative product in situations of cognitive task conflict.

Although these results are very convincing there are also some limitations:

- Time: The groups worked together only 50 minutes to come up with a final design concept. Therefore lengthy discussions, when they took place, left the team with no time to work out valuable solution ideas. On the other hand too little discussion resulted in a loss of the opportunity to gather, integrate and assess information from different perspectives.
- Task: the type of task also plays a role in the extent to which cognitive conflict leads to an innovative result [23]. Probably tasks with a high degree of uncertainty would create a high amount of cognitive conflict, which could provoke affective conflicts and thus might impede innovation. Holahan [24] and Jehn [25] found that cognitive conflict could easily end up in an affective conflict depending on determinants such as open mindedness and trust.
  The task is also related to the level of conflict and there is some evidence for a curvilinear relationship between cognitive conflict and innovation, what means that both high and low levels of cognitive conflict lead to less innovation [26].
- Context: The experiment took place in a laboratory context and with groups which had the same background and for the time being also the same goal. In an organisational context with different roles and responsibilities the same behaviour could lead to different results.

The potential benefits and limitations of cognitive conflicts during the design process should, with no doubt, be further explored.

REFERENCES

[1] Thomas K.W. and Kilmann R.H. The Thomas-Kilmann conflict mode instrument. 1974 (Xicom Tuxedo).

[2] Deutsch M. The resolution of conflict: constructive and destructive processes. 1973 (Yale University Press, New Haven, Conn).

[3] Badke-Schaub P. and Buerschaper C. Creativity and Complex Problem Solving in the Social Context. In C.M. Allwood & M. Selart (eds.), *Decision Making: Social and Creative Dimensions*, 2001, p.p.177-196 (Kluwer, Dordrecht).

[4] De Dreu C. K.W. and Weingart L. R. Task versus relationship conflict, team effectiveness, and team member satisfaction: A meta-analysis. *Journal of Applied Psychology*, 2003, Vol. 88, p.p.741-749.

[5] Carnevale P.J. and Probst T.M. Social values and social conflict in creative problem solving and categorization. *Journal of Personality and Social Psychology*, 1998 Vol. 74, p.p.1300–9.

[6] Tjosvold D. The Conflict-Positive Organization, stimulate diversity and create unity. 1991 (Addison-Wesley Series).

[7] Stempfle J. and Badke-Schaub P. Thinking in design teams – an analysis of team communication. *Design Studies*, 2002, Vol. 23, 5, p.p.473-496.

[8] Meijer M. Using cognitive conflict in design teams as an asset. 2006 (Graduation Report, TU Delft).

[9] Jehn K.A. A multimethod examination of the benefits and detriments on intragroup conflict. *Administrative Science Quarterly*, 1995, Vol. 40, p.p.256-282.

[10] Jehn K.A. and Nortcraft G. and Neale M. Why differences make a difference: a field study of diversity, conflict and performance in workgroups. *Administrative Science Quarterly*, 1999, Vol. 44, p.p.741-763.

[11] Amason A.C and Sapienza H.J. The effects of top-management team size and interaction norms on cognitive conflict and affective conflict. *Journal of Management*, 1997, Vol. 23, 4, p.p.495-516.

[12] Jehn K.A. and Mannix E. The dynamic nature of conflict: a longitudinal study of intragroup conflict and group performance. *Academy of Management Journal*, 2001, Vol. 44, p.p.238-251.

[13] Roozenburg N.F.M. and Eekels J. Productontwerpen: structuur en methoden. 2nd edition, 1995 (Uitgeverij Lemma B.V., Utrecht).

[14] Friedman R.A. and Tidd T.S. and Currall S.C. and Tsai J.C. What goes around comes around: the impact of personal conflict style on work conflict and stress. *The International Journal of Conflict Management*, 2000, Vol. 1, 1, p.p.32-55.

[15] Putnam L. Communication and interpersonal conflict in organizations. *Management Communication Quarterly*, 1988, Vol 1, p.p.293-301.

[16] Rahim M.A. Rahim organizational conflict inventories: Professional manual. 1983, (Consulting Psychologist Press, Palo Alto, CA).

[17] Rahim M.A. and Magner N.R. Confirmatory factor analysis of the styles of handling interpersonal conflict: First-order factor model and its invariance across groups. *Journal of Applied Psychology*, 1995, Vol. 80, p.p.122-132.

[18] Weingart L.R. and Jehn K.A. Manage intra-team conflict through collaboration. In E.A Locke (eds.), *The Blackwell Handbook of Principles of Organizational Behavior*, 2000, p.p.226-238 (Blackwell Publishers, Oxford UK).

[19] Lovelace K. and Shapiro D.L. and Weingart L.R. Maximizing crossfunctional new product teams'

innovativeness and constraint adherence: A conflict communications perspective. *The Academy of Management Journal*, 2001, Vol. 44. 4, p.p.479-493.
[20] De Dreu C.K.W. and West M.A. Minority dissent and team innovation: the importance of participating in decision making. *Journal of Applied Psychology*, 2001, Vol. 86, p.p.1191-1201.
[21] Badke-Schaub P. and Frankenberger, E. Design Representation in Critical Situations of Product Development. In G.Goldschmidt and W.Porter (eds.) *Design Representation*, 2003, p.p.105-126 (Springer, London).
[22] Besemer S. and O'Quinn K. Analyzing creative products: Refinement and test of a judgement instrument. *Journal of Creative Behavior*, 1986, Vol. 20, 2, p,p.115-126.
[23] Chen M.H. Understanding the Benefits and Detriments of Conflict on Team Creativity Process. *Journal of Creativity and Innovation management*, 2006, Vol. 15, 1, p.p.105-116.
[24] Holahan P.J. and Mooney A.C. Understanding conflict in project teams: an investigation of organizational, task, and team-level determinants. *PICMET 2003 Conference*, 2003 (Wesley J. Howe School of Technology Management, Portland, OR.).
[25] Jehn K.A. A qualitative analysis of conflict types and dimensions in organizational groups. *Administrative Science Quarterly,* 1997, Vol. 42, p.p.530-557.
[26] De Dreu C.K.W. When Too Little or Too Much Hurts: Evidence for a Curvilinear Relationship Between Task Conflict and Innovation in Teams. *Journal of Management,* 2006, Vol. 32, 1, p.p.83-107.
[27] Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M.. Assessing the work environment for creativity. *Academy of Management Journal,* 1996, Vol. 39, p:p. 1154-1184.

Contact: Petra Badke-Schaub
Professor of Design Theory and Methodology
Faculty of Industrial Design Engineering
Dept. Product Innovation Management
Landbergstraat 15
TU Delft
2628 CE Delft
The Netherlands
phone: ++31 -15 -2781403
email: p.badke-schaub@io.tudelft.nl