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CONTEXT INDICATORS FOR DETERMINING LINKS BETWEEN DESIGN IDEAS

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1. Introduction

The majority of studies into the effectiveness of idea generation meetings use outcome measures as dependent variables. Few tools are available that directly address the process [Puccio & Murdock 1999]. In our research of the functioning of sketching in design idea generation meetings, we required a method that focused on the differences in structure of the processes, rather than their outcomes [Van der Lugt 2001]. From the existing body of methods for describing the design process, linkography [e.g. Goldschmidt 1995] was identified as a promising method for analyzing the idea generation process. In contrast to other available methods, such as Newell & Simon's [1972] Problem Behavior Graphs and Dwarakanath & Blessing's [1996] use of the decision tree, linkography does not require the researcher to backtrack the process of the designers as if it were a rational reasoning or decision making process. This is especially important when analyzing idea generation meetings, as the processes of association taking place in such meetings are quite distant from such rational processes. Instead, in linkography, the researcher limits him- or herself to assessing whether there is sufficient evidence for a link between each possible combination of ideas to be present (or not).

Goldschmidt uses 'common sense' as the determining factor for determining links which, according to her, means that links are primarily determined by similarities in subject matter. We attempted to strengthen the linkography approach by investigating the potential for using more objective means for determining whether or not a link is present.

One way to deal with this issue is to take situational evidence into account, in addition to similarities in subject matter. Such situational evidence may consist of, among other things, gestures or remarks made by the designers when they explain their ideas, physical action when conceiving of the idea, or connecting symbols on the flipcharts. Instances of situational evidence for links are referred to as 'context indicators'. Instances of evidence found within the subject matter of the ideas are referred to as 'content indicators'.

During linkography, for each idea, links with earlier ideas are determined by means of gathering and evaluating evidence of connections. Making explicit use of the context indicators in addition to the content indicators, while constructing link systems could enhance the reliability of linkography as a method for data analysis. The first objective of this paper is to understand the nature of these context indicators for links. The second is to understand the relative importance of context indicators for determining links between ideas. Perhaps, links could be determined solely by means of context indicators, which would provide a more objective method for data analysis.

2. Method

This research is based on three experimental meetings, originally designed to explore the differences in process structure between techniques that use sketching or written language as a primary working medium. In each meeting two idea generation techniques were applied. Brainstorming with post-its [Isaksen et al, 1994] was used as a representative of techniques that use written language as the primary working medium. Brainstorming with post-its is similar to brainstorming, with the exception that the participants write down their ideas on post-its and then give them to the facilitator. As a representative of techniques that use sketching as the primary working medium, 'brainsketching' [VanGundy 1988] was applied. Brainsketching is a variation to the better known 'brainwriting technique [Geschka, Schaude & Schlikksupp 1973]. Participants generate ideas individually in short rounds. After each round, they briefly share their ideas and switch papers. In the following round they use the ideas on the paper as a source of inspiration for new ideas.

The task consisted of generating ideas for making traveling by car fun for children. The car involved a family car with a flexible interior. Each meeting consisted of five advance product design students. Experienced professional facilitator moderated the meetings.

This resulted in six segments of about fifteen minutes that were used for this analysis of context indicators. For each of these segments, linkographs were constructed [see Van der Lugt 2000 for a description of the adaptations made to the linkography research approach in order to make it applicable for analyzing idea generation meetings] by two independent judges. To make sure that only links with a high level of confidence were used for assessing the context indicators, we limited the analysis to links that were recognized by both judges. For each of these links, the videotape was scrutinized to uncover context indicators. Both context- and content evidence was collected in a 'script'. See table 1 for an example of such a script for the link between two brainstorming ideas (translated from Dutch):

Table 1. example of the 'script' of the link between two brainstorming ideas.

ID 68/F Toy car that can be disassembled	While designer F explains his idea, designer G reads along on the post-it. Then he looks to the right while he tilts his head in a pensive manner. Around him there is some commotion. To re-focus the group, the facilitator paraphrases: "Okay, a car that can be dismounted" (This is the first time that the term 'mini' is left out). At this moment G abruptly turns his head to look at the post-it again. Then he starts to write. As he explains his idea, he mentions: "Why not disassemble the car itself?" (Both choice of wording and intonation suggest that G refers to idea F68).
ID 71/G Car can be disassembled	
Context indicators:	Inspection, Time, Physical reaction, Explanation.
Content indicators:	Car that can be disassembled

For each link, the decisive value of the body of evidence was weighed by a set of three criteria: 1) The participant needed to show a clear shift in attention around the time of the noted link. 2) The movements connected to the context indicator needed to be clearly visible and unambiguous. 3) Combinations of different indicators strengthen the evidence. This inspection determined which links could have been identified solely based on the available context evidence.

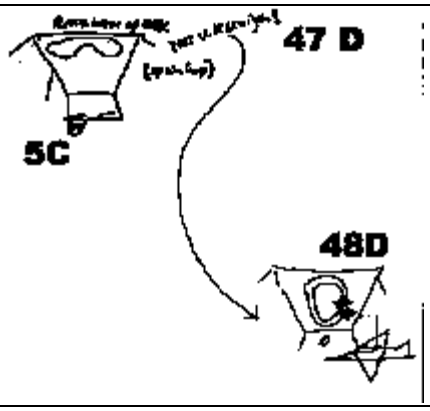
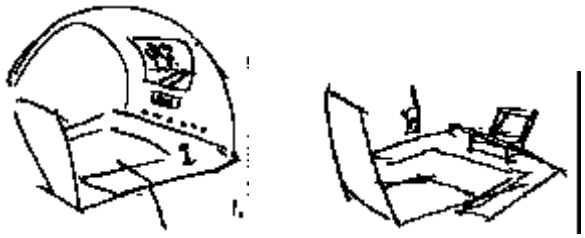
3. Results

3.1 Types of context indicators

The context indicators found in the segments of the first two meetings were clustered. The context indicators from the segments of the third meeting were then used to test the resulting categorization. The constructed categorization was satisfactory, all indicators in the segments of the third meeting could be covered by the existing categories; no new categories were uncovered. This resulted in the following nine context indicator types (Table 2):

Table 2. Categories of context indicators.

Indicator	Description	*Example*
1 Time	This relates to the time span between the sharing of the prior idea and starting the notation of the new idea. A short time span can provide an indication for linking.	*Five minutes into the brainstorming with post-its segment of meeting 1, designers A and B both want to explain an idea. Designer A first explains her idea, 'communicating through a head-set' (idea 19). As designer B hears the word 'communicating', she becomes visibly anxious to express of her idea. She quickly hands her idea to the facilitator and then starts writing. Before any other group member provides an idea she shares her next idea, 'cellular phone' (idea 21). This whole episode takes less than thirty seconds.*
2 Inspection	Designers seek inspiration by inspecting previous ideas on the posted flipcharts.	*In the brainstorming with post-its segment of meeting 2, designer F inspects the flip chart with post-its for ten seconds. One of the ideas on the flipchart is designer K's idea 'a street plan on the floor' (idea 20). After inspecting, designer F directly starts writing down his idea: 'making a route map for your father' (idea 25).*
3 Physical reaction	Frequently there is a physical reaction when an idea mentions triggers a new idea, such as moving from a reclined position into a more active position.	*In the brainstorming with post-its segment of meeting one, designer C just sits back after explaining an idea. When designer A explains her next idea, 'spinning on your chair' (idea 55), C turns his head abruptly. He looks at A and then moves his body up and forward before starting to write down his idea: 'rocking chair' (idea 58).*
4 Verbal reaction	These are spontaneous statements that happen right before the designer makes a notation of the new idea. Common are verbal reactions like "oh.. yes".	*When, in the brainstorming with post-its segment of meeting 2, designer F shares his idea: 'making a route map for your father' (idea 25), designer G reacts immediately: 'a treasure map or something'. After this impulsive reaction, he actually writes down the idea (27), and explains it upon finishing writing.*
5 With-drawal	The designer may withdraw, or 'freeze' after an idea is mentioned and then come up with a related idea some time after. It appears that the designer takes in the information, withdraws to process it, and then generate a new idea that builds on the earlier one.	*During the brainstorming with post-its segment in meeting 1, designer A explains his idea 'animal parts on the ceiling'. Then he is lost in thoughts, moving his hands in support of his thoughts. He then starts inspecting one of the flip charts with earlier ideas on the wall. He ignores designer E explaining an idea, then he springs up, being triggered by an idea on the flipchart (likely to be idea 24, 'tossing a ball back and forth'). He stares at his book of post-its for a few seconds, ignoring designer B explaining her idea (47). Then he starts writing. After explaining his idea (50), 'ball sticks to the ceiling when thrown', he sits back, and examines the present flipchart to catch up on ideas that, apparently, he missed while developing his own idea.*
6 Explana-tion	In explaining their ideas the designers use words that connect their idea to earlier ideas. Utterances like "This idea builds on that one" or "I liked that idea, so I came up with this one" make up this category of indicators.	*In meeting 1 at the end of the brainsketching segment, designer D explains his idea (47), 'racetrack for planes on the ceiling'. He says: "I also really liked that one, that idea for a racetrack on the roof. You could do that with airplanes, because they are in the air anyhow". From his explanation it becomes pretty clear that D's idea 47 builds on idea 5, 'racetrack upside down on roof' that designer C sketched earlier)*

		
7 Addition	Designers draw arrows or lines to indicate connection of ideas.	*See figure above. Designer D develops his previous idea of the racetrack with airplanes. By means of an added arrow, he points out the connection between the two ideas.*
8 Location	The target idea is positioned very closely to the source idea, even when the usual order of idea production would suggest a different position on the flipchart.	*Designer D writes down his idea 47 very closely to idea 5, providing an annotation to the 'racetrack on the roof' idea. See figure above.*
9 Scheme resem-blance	These indicators consist of a resemblance in the notations on the paper, instead of the content or the meaning that these notations carry.	*For instance, in the brainsketching segment of meeting 1, designer E sketches 'a car cockpit surrounding the child' (idea 9). In the next round of generating ideas, designer D comes up with an idea for a' real mini-office' (idea 21). The characteristics of the sketch of idea 9 are likely to have triggered the sketchpad idea. There is a resemblance in the characteristics of the sketch, while there is hardly any resemblance in the ideas themselves* 

The occurrence of these context indicators was calculated for each of the brainstorming with post-its and brainsketching segments. The results are presented in figure 1:

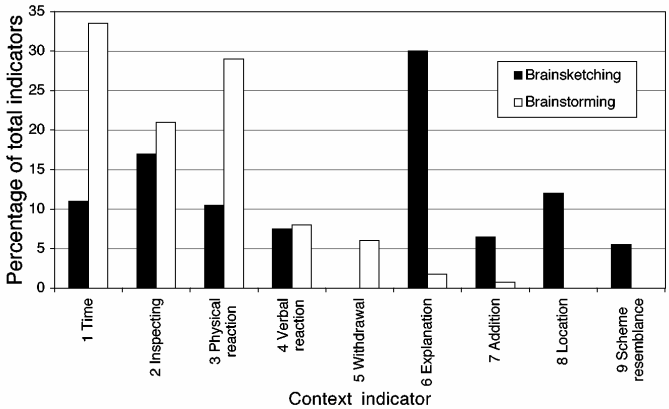


Figure 1. Occurrence of the various link indicators for the brainsketching and the brainstorming segments

For brainsketching, the three most frequently recognized indicators are ‘explanation’ (30%), ‘inspecting’ (17%) and ‘physical reaction’ (16%). For brainstorming with post-its, the two most frequently recognized indicators are ‘time’ (34%) and ‘physical reaction’ (29%). The ‘addition’, ‘location’, and ‘scheme resemblance’ indicators almost exclusively occur in the brainsketching segments. This is not surprising, as they relate to clues for links that are situated on the flip charts. Also indicator 6, ‘explanation’, is mostly noticed during brainsketching segments. As the explanation of ideas is separated from the idea generation in brainsketching, designers tend to describe where their ideas originated. Because of the high speed of idea generation during the brainstorming with post-its segments, the designers tend to solely mention the idea without references to the way in which the idea originated, which results in a less frequent occurrence of the explanation indicator in the brainstorming with post-its segments.
Indicator 5, ‘withdrawal’, is found exclusively in the brainstorming with post-its segments. ‘Withdrawal’ is an indication that a designer retreats from the group process into his or her individual idea generation process. During the rounds of generating ideas during brainsketching, the designers generate ideas by themselves. As the designers are already involved in an individual process, the ‘withdrawal’ indicator is not likely to be encountered during brainsketching. To a lesser extent, the same is valid for the ‘time’ and ‘physical reaction’ indicators, which refer to direct reactions to ideas generated in the group as well. As the explanation of the ideas and the generation of ideas are separated in brainsketching, these indicators are less relevant.

3.2 Ratio of links supported by context indicators

For the three meetings, the strength of the context evidence was determined for the links that were recognized by both the researcher and the observer. A link was considered to have strong context evidence when there was more than one context indicator present, or when a single context indicator provided very strong evidence.
An example of such a link with a strong single context indicator is designer C’s idea ‘swing on the ceiling’ (idea 60) in the brainstorming with post-its segment of meeting 1. This idea builds on designer D’s idea ‘spinning in a chair’ (idea 55). The link has a single strong ‘physical reaction’ context indicator: When designer C explains his idea, designer D makes a sharp turn with his head. He is absolutely motionless for a brief moment and then moves forward and up before he starts writing down his idea.
The results of this investigation into the ratio of links that were supported by strong context indicators are shown in table 3:

Table 3. Ratio of clear links supported by strong context indicators

	Brainstorming	brainsketching
Meeting 1	0.70	0.59
Meeting 2	0.72	0.51
Meeting 3	0.78	0.58
Average	0.73	0.56

These results suggest that agreed links are frequently founded by strong context evidence. For the six segments, between 59% and 78% percent of the clear links were founded by strong context indicators. This appears to be especially relevant for the brainstorming segments, where on average 73% of the clear links were supported by strong context indicators. The brainsketching process has a more individual character, which resulted in a lesser level of strong context indicators (average 56%).
Only links noted by both the researcher and the independent judge were inspected for the presence of context indicators. A substantial portion of these links would remain unnoticed if the linking were only decided on by means of the presence of clear context indicators. This means that determining links in a link matrix solely based on context indicators would disregard too many links to provide an informative system of connections made in the idea generation process. However, the nine types of context indicators identified can provide valuable additional information that can strengthen the confidence in the links found.

4. Conclusion

As generating ideas is a process that, at least partly, occurs within the minds of the designers, there are bound to be occasions where no context evidence for linking can be found, while the content of the ideas strongly points towards a connection between the two. This means that subjective judgement, based on Goldschmidt's [1995] notion of 'common sense', will remain to play a role in linkography, albeit a smaller one. However, the nine types of context indicators identified can assist judges involved in linkography by giving them directions what to look for while examining videotapes of meetings. This may strengthen the confidence in the links found.

References

Dwarakanath, S. & Blessing, L., "Ingredients of the design process: A comparison between group and individual work", Analysing design activity, Cross, N., Christiaans, H., and Dorst, K. (Eds.), Wiley, Chichester, U.K, 1996, pp. 65-91.

Geschka, H., Schaude, G. R., & Schlicksupp, H. "Modern techniques for solving problems", Chemical Engineering, August 1973, pp. 91-97.

Goldschmidt, G. "The designer as a team of one", Design Studies, Vol 16, No. 2, 1995, pp. 189-210.

Isaksen, S. G., Dorval, K. B., & Treffinger, D. J. "Creative approaches to problem solving", Kendall & Hunt, Dubuque, IA, 1994.

Newell, A. & Simon, H. A. "Human problem solving", Prentice-Hall, Englewood Cliffs, NJ, 1972

Puccio, G. J. & Murdock, M. C. (Eds.) ,"Creativity assessment: Readings and resources", Creative Education Foundation Press, Buffalo, NY, 1999.

Van der Lugt, R., "Developing a graphic tool for creative problem solving in design groups", Design Studies, Vol. 21 No. 5, 2000, pp. 505-522.

Van der Lugt, R., "Sketching in design idea generation meetings", Doctoral dissertation, Delft University of Technology, 2001.

VanGundy, A. B., "Techniques of structured problem solving (second edition)", Van Nostrand Reinhold, New York, 1988.

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