Using Visualization to Support Idea Generation in Context

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ABSTRACT
Idea Generation has been a topic of creativity research for centuries. A wealth of creative processes has been devised to overcome difficulties at the perceptual, emotional, and cultural levels. Brainstorming in particular has grown to become synonymous with idea generation. This paper discusses our preliminary study on current conception of brainstorming and calls for future studies that help understand brainstorming as a set of guidelines rather than strict rules that creative teams follow. We also propose using mind-map as an effective visualization aid for creative processes.

Keywords
Creativity, Idea Generation, Brainstorming, Thinking Aid, Visualization, Mind-map

INTRODUCTION
Idea Generation has been a topic of creativity research for centuries. A wealth of creative processes have been devised to overcome difficulties at the perceptual, emotional, and cultural levels. Brainstorming in particular has grown to become synonymous with idea generation. Brainstorming was first coined by Osborn in 1953, and the brainstorming process strictly adheres to the following four rules [11]:

- Focus on quantity
- Withhold criticism
- Welcome unusual ideas
- Combine and improve ideas

Osborn claimed that by reducing the amount of self-criticism and criticism from others during this creative process, a group of individuals can produce better results in terms of both quantity and quality.

Most studies of the brainstorming process focus on detailing either the creative outcomes produced in controlled laboratory settings that required participants to follow seemingly idealistic rules, or success stories at well established design organizations filled with trained creative professionals. However, little is known about how brainstorming is appropriated and adapted to fit a variety of different contexts. Such information could shed light on brainstorming criteria that are essential to making idea generation effective in context rich settings such as the domain of engineering design.

In a prior brainstorming study, we observed 16 groups of four participants as well as 16 individual participants (80 participants total) brainstorming about specific set topics [12]. The individuals were formed into groups of four based on the Nominal Group Technique [4]. This design is standard across previous brainstorming studies and was adopted in our study so we could more easily compare our results. Demographic surveys and post-task questionnaires were collected and semi-structured interviews were conducted throughout the study. This paper will discuss some findings from our study and how they relate to current brainstorming research. We also provide directions of future work.

BRAINSTORMING CRITERIA
Two of the foremost measured brainstorming criteria are fluency, the number of ideas one generates in a given period of time, and flexibility, the diversity of the ideas generated. While Osborn's view of brainstorming typically assumes that quantity breeds quality, creativity experts have shown that fluency does not always equate to flexibility as a large body of ideas could turn out to represent only a very shallow spectrum of the problem space. Therefore, brainstorming research is often criticized for focusing too narrowly on quantity without regard of the consistency of idea quality.

The ideal of being able to rely on quality as a standard measurement has its drawback as well, because no definition of creativity tasks can be truly objective and context free. In an earlier study, Amabile reported that brainstorming outcomes can be manipulated by providing a very specific conceptual definition of creativity and instructions on striving for flexibility as a goal [1]. Specific definition of what constitutes creativity in the given task rendered the task algorithmic. As a result, brainstorming outcomes are seen as more creative merely by task instruction. This goes against the very definition of creativity itself, because conceptually, the task must be

undefined in order for the product of task engagement to be considered creative.

In general, the past brainstorming literature suggests that neither quantity nor quality is entirely adequate as a determinant of brainstorming successes. Sutton and Hargadon published an influential study on the brainstorming practices at IDEO [1], an internationally renowned design firm based in Palo Alto, CA [14]. Deviating from the quantity- and quality-centric views, they found that brainstorming satisfies other practical needs when it is practiced within the organizational context. Within the scope of creativity, context is relevant such that participants strive for "creative" outcomes as is required by the experimental conditions. It is not surprising that just as idea quality depends largely on the definition of creativity provided to the groups, Isaksen and Gaulin also confirmed that idea quantity depends heavily on task instruction [7]. Participants from our study reported that the traditional notion of brainstorming is not what they typically experience in their daily settings. An important reason is that it is virtually impossible for them not to judge ideas provided by others when they are surrounded with different organizational contexts, objectives, and goals. Therefore, carefully balancing brainstorming criteria and external context is essential for allowing brainstorming to meet its purpose.

Litchfield further examined the effect of instructions on brainstorming outcomes by treating brainstorming rules as goals that could be prioritized and modified [8]. The results of his study confirmed that brainstorming outcomes depend largely on the specific instructions. Because surrounding context and goal requirements vary greatly among organizations across different domains, future studies focusing on brainstorming in context within organizations can help establish brainstorming as a set of guidelines rather than strict rules that creative teams follow.

VISUALIZATION AS THINKING AID

In addition to contextual influences, researchers attempt to uncover triggers to effective idea generation from a more cognitive perspective by proposing an associative memory model. An associative memory model assumes that idea generation is a repeated search for ideas in associative memory. In their study, Dugosh and Paulus experimented with group outcomes induced by being exposed to other ideas [5]. They concluded that exposure to a high number of ideas and to common ideas enhanced the generation of additional ideas. In another study, Nijstad and Strobe showed that ideas suggested by others aid the activation of problem-relevant knowledge [10].

Interestingly, both studies found that the ability to recall ideas from memory strongly correlated with groups' brainstorming productivity. In our study, we found that a mind-map is particularly effective for assisting memory recall. The use of mind-maps as an effective method for brainstorming evolved from generating ideas by associations using semantic networks [3]. Participants in our study commented that by having ideas visualized in a mind-map layout, they were able to associate and synthesize ideas based on spatiality and color representations. We showed that although traditional brainstorming typically involves generating ideas verbally or in list or outline, brainstorming can be improved by evoking the mind's cognitive ability with visual aids.

McKim categorized the brain's visual imagery ability into three stages: (1) perceptual imagery, the ability to see and record information, (2) mental imagery, the ability to recall and manipulate visual images, and (3) graphic imagery, the ability to express thoughts in drawings and sketches [9]. Therefore, the ability to perceive a problem statement from different angles and further represent and manipulate them is pertinent to creative thinking. Other alternatives of visualization techniques that could enhance any of the three stages of imagery should be explored.

BRAINSTORMING ADAPTED

Alternative approaches to enhancing brainstorming are also currently being researched. Gerber and Bao developed a technique called Brainstorm Bounce that aims to improve in-session brainstorming experiences by better preparing participants before the meeting takes place [6]. Participants are prompted with questions relevant to the meeting at regular intervals, and participant responses are visualized at the start of the meeting. Visualization is used as an effective aid to facilitate conversations and trigger new responses.

At the organizational level, Aranda and Venolia identified a potential area for brainstorming research in the domain of software testing and bug finding [2]. Developers and testers at Microsoft often have difficulty isolating bugs in complex software systems that span multiple modules and geographical locations. Developers rely on emails to communicate ideas and contribute to the bug finding process; however, the email threads can easily grow very large, and many useful resources are often lost in the mist of all the emails. The problem could be more manageable if different leads to the bug under focus are represented visually in a mind-map. We think that visualization techniques in general could be especially effective for large scale problems of this kind.

On the other hand, Stenmark proposed an asynchronous brainstorming system called Mindpool that is suitable for assisting brainstorming at the organizational level. Mindpool allows participants from different parts of an organization to contribute to an idea generation session via the email protocol [13]. Participant contributions are anonymized in a generated webpage and responses to an idea proposal are for exclusive viewing of the original

[1] http://www.ideo.com/

proposer. Variations of such a system could allow idea pooling from experts company-wide and not restricted to resources assigned at the project or the team level.

CONCLUSION

We have identified several areas worthy of exploration in the realm of idea generation. Current research calls for a more flexible view on brainstorming criteria, and future research is necessary for understanding how brainstorming techniques could be better applied and adapted to different contextual and organizational needs. Additionally, because creativity is inspired, triggered, and bounded by various cognitive and social constraints, visualization could serve as an effective alternative to the traditional list or outline layout used in most prior brainstorming research. Traditional research focuses on face-to-face brainstorming meetings in small groups; however, remote and large scale brainstorming at the organizational level has been left largely underexplored. Systems and processes that use design experts with different backgrounds could be explored as a way to improve brainstorming in an organizational setting.

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