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IMPROVING CREATIVITY TRAINING: A STUDY OF DESIGNER SKILLS

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1. Introduction

Creativity is widely accepted to be a crucial element in design, and design has traditionally been a popular domain for creativity studies. Moreover, creativity has repeatedly been shown to be an important element for design and innovation e. g. [Christiaans 1992], [Amabile et al. 1996], [Dorst and Cross 2001]. Establishing that creativity is important for design and innovation implies that identifying ways of improving creativity is a relevant research area within design studies. Creativity is a basic human skill and multiple studies have been published showing that creativity is a skill that can be trained (see e.g. [Scott et al. 2004] for a review of these). Despite establishing that creativity training works, it is though not yet clear how individual creativity skills can influence the creative process, although many studies have been published on different types of creativity training formats e.g. [Scott et al. 2004], [Robbins and Kegley 2010]. The aim of this study was therefore to investigate *how individual creativity skills influence the creative process of design teams* working within the fuzzy front end (as defined in [Koen et al. 2002]) of innovation; an important first step in identifying which individual creativity skills should be trained in designers. An exploratory study was designed, using participatory observation of two design teams in a six-month case study in two major organizations, with individual skills being the unit of analysis. The focus of the study was to observe the process the teams operated within and its progress when individuals applied their creativity skills to advance its progress, while the intent was not to assess the creative product or output as such.

Design is a collaborative effort and creativity has to be understood both on an individual and on a team level. In creativity research, the 'standard definition of creativity' [Runco and Jaeger 2012] defines creativity as the production of something *new and appropriate* for a specific context, thus bringing value to its prospective users [Stein 1953]. Onarheim and Friis-Olivarius [2013] suggest that 'new' is related to divergent thinking, the process of coming up with multiple solutions, while 'appropriate' coincides with convergent thinking, the process of taking those multiple ideas and converging them into an appropriate solution. Divergent thinking is here considered somewhat a 'solo sport', as producing ideas is often considered as a cognitive individual task [Onarheim 2011], whereas convergent thinking could be thought of as a 'team sport' – teams are good at selecting ideas and are likelier to successfully complete the task [Singh and Fleming 2010]. Thus, creativity training for designers should not only be directed at the individual level by enhancing individual creativity skills, but also improvement at the team level, rendering it important to first improve the understanding of both these levels of creativity in the design process.

There are multiple ways to train creativity, although currently most creativity training is directed at enhancing individual creativity skills, usually measured through the ability to generate ideas, i.e. divergent thinking [Guilford 1959]. However, as individually focused as creativity training might seem,

Scott et al. [2004] concluded that the most optimal way of training creativity is through a combination of (1) educating individuals about creativity, thereby building a solid theoretical understanding, and (2) providing them with a real world case where they are trained in the use of creative tools and processes [Scott et al. 2004]. The latter point has great implications for creativity training for designers, as in the real world designers rarely work in a void but in teams and thus the team interactions should be taken into account in creativity training for designers. Here we understand the team as an entity, independent from, yet influenced by the organization, however largely dependent on individuals; the individuals that make up the team (following [Woodman et al. 1993]). With that in mind the current study was designed to investigate individuals and how they operate in teams, thus focusing both on the individual level as well as the team level and their respective importance and contribution to the creative process of design teams.
In the following chapters a theoretical overview is first provided about the individual- and team level in regards to creativity literature. Next, a description of the case study and the methods deployed in the context of the case study is given. Chapter four contains the findings of the study and chapter five provides a discussion and subsequent conclusions drawn from the findings.

2. Theoretical background

In the previous decades the study of creativity has expanded from the traditional psychological standpoint of individual creativity (e.g. [Guilford 1959]) to different aspects ranging from creativity and the social environment (e.g. [Amabile 1988]), neuroscience [Dietrich and Kanso 2010] to organizational creativity (e.g. [Woodman et al. 1993]). Moreover, as emphasized above, its importance to design and innovation has been argued for in an extensive amount of creativity-, design- and, innovation literature e.g. [Christiaans 1992], [Amabile et al. 1996], [Dorst and Cross 2001]. Taking departure from these views on the importance of creativity it becomes relevant to discuss ways to enhance it. At the individual level creativity training focuses on 'creative potential' or 'trait creativity': A person's biological ability to produce creative thoughts, i.e. it is a pre-wired human basic function [Friis-Olivarius 2015]. Pre-wired means that it can be manipulated, it is an individual's creative potential that can either be suppressed or nurtured, i.e. you can train yourself to reach your full creative potential. It can be thought of in a way that your genes create the first draft and experience later edits it [ibid]. It is important to note, that even though creativity training works, little has been shown about which parts make it effective. Scott et al. [2004] reported that 25% of companies with over 100 employees deploy some sort of creativity training for their employees, a finding emphasizing the importance of making the right deployment of creativity training. The following sections take a closer look at creativity at the individual level where cognitive skills and -processes belong, and the team level where group characteristics and team interactions reside.

2.1 Individual level

The formation of creativity as a research field is usually assigned to J. P. Guilford and his presidential speech at the American Psychological Association in 1950. In addition to formalizing the field of creativity, another important contribution from Guilford was the emphasis on the value of divergent thinking [Guilford 1959]. His consequent research into the subject in the 1950's and 1960's lead to a comprehensive framework of divergent thinking (see [Runco 2011]). Divergent thinking is the process of generating multiple ideas or solutions to a given task and divergent thinking tests score the ideas or solutions on three different indexes; fluency, originality and flexibility. Fluency refers to the number of ideas, originality refers to how different the idea is from the others and flexibility means the number of categories under which the ideas fall [Guilford 1967]. Divergent thinking is thought of as the best measure of creative potential [Runco 2011] and the cognitive key to creativity [Woodman et al. 1993]. Furthermore, divergent thinking tests are still the most widely used creativity tests [Davis 1997], [Cropley 2000] amongst them the Alternative Uses Test (AUT) developed by Guilford [1967] himself.
Divergent thinking is usually described as the opposite cognitive process of convergent thinking, and Guilford is usually accredited for being the first to distinguish between the two [Runco 2011]. Convergent thinking is the process of combining multiple ideas into one solution, thus producing a useful or appropriate solution to the task at hand [Guilford 1959]. An approach to creativity is a sequential application of divergent- and convergent thinking as e.g. proposed by Basadur et al. [1982],

where the two are applied one after another through stages of the operational creative process. This application has, amongst other, famously been adopted by the UK Design Council and operationalized in the Double Diamond model [Design Council 2005].
Another take on individual creativity is the neuroscience of creativity e.g. [Dietrich 2004], [Onarheim and Friis-Olivarius 2013], [Fink et al. 2015] where scientists have been exploring regions of the brain in relation to creative tasks. Onarheim and Friis-Olivarius [2013] propose a model based on neurological processes they argue will enhance creative abilities and -processes consisting of five key concepts; (1) remote associations, (2) priming, (3) fixation, (4) incubation and (5) cognitive inhibition. The five key concepts are based on known brain processes but in the unique constellation proposed significantly enhanced trait creativity when recognized and manipulated with the right creativity tools [Onarheim and Friis-Olivarius 2013].
Other theories on individual creativity have been put forth, where not only the cognitive skills are taken into account but other factors such as domain relevant skills, intrinsic motivation [Amabile 1988], and personality traits such as self-confidence, persistence, attraction to complexity and curiosity to name a few [Woodman et al. 1993]. Amabile [1988, 1996a,b, 2012] developed the 'Componential Theory of Creativity' which states that creativity is comprised of four components; three of them intrinsic to the individual (1) creative thinking skills such as divergent thinking and the ability to make remote associations (2) domain relevant skills or expertise and (3) intrinsic task motivation. The fourth component is (4) work environment recognizing that creativity happens in a certain context and is affected by other components than only those residing within the person. Certainly the first three components are all intrinsic to a person, but task motivation is especially prone to being affected by outside factors such as the work environment. The theory describes the intrinsic motivation being the personal interest and involvement in the work, which can be substantially affected by factors such as perceived autonomy, role of managers etc. [Amabile 1988]. The importance of motivation proposed by Amabile compliments Hackman's and Morris' [1975] proposal that improvements in motivation can be accomplished through social facilitation in teams and when team members press each other for results.

2.2 Team level

Knowledge of the individual aspects reviewed above is necessary for identifying useful ways to produce individual creativity. However, individuals usually work in teams, or are at least influenced by informal groups [Woodman et al. 1993], when turning a creative idea into innovation and it has been shown that the likelihood of success rises when individuals work as part of a team [Singh and Fleming 2010]. Limiting the scope of creativity research to the individual level ignores important factors, which are e.g. the social interactions and dynamics that take place within teams [Amabile 1996a]. Thus, taking social aspects into account, here limited to the team level, is deemed necessary in the context of enhancing creativity through creativity training.
Woodman et al. [1993] provide a review of the conditions proposed to increase the probability of creativity in teams. Amongst what they summarize as overarching categories to consider are team composition, team characteristics and team process factors. Characteristics identified as influencing team creativity are amongst other norms, enacted roles, degree of cohesiveness, and task assignments [Amabile 1983], [King and Anderson 1990]. Other characteristics were additionally identified by King and Anderson [1990] such as size, leadership, group longevity and diversity. In sum, the conditions that are predicted to heighten the chance of creativity in teams are e.g. when the structure of the team is organic, when the team is composed of members with diverse backgrounds and experiences, and when leadership is collaborative [Woodman et al. 1993]. Workplace democracy is a known concept from participatory design, which originates in Scandinavia [Bjerknes and Bratteteig 1995] where it is both politically and culturally based into the societal setting. Implementing workplace democracy, or having a flat hierarchical structure, is furthermore proposed to increase intrinsic motivation of employees [Gregory 2003].
Group problem-solving tools such as brainstorming were developed with the belief that groups would benefit from building on each other's ideas and produce a greater number of solutions or ideas. However, research has repeatedly generated evidence on the contrary, i.e. individuals produce fewer ideas in groups [Stein 1974]. Brown and Paulus [2002] found that alternate rounds of individual- and group

brainstorming proves to have an advantage and possibly increase overall creative output. This links back to the discussion about the inter relatedness of divergent thinking and convergent thinking, and the proposal that divergent thinking is a 'solo sport' while convergent thinking is a 'team sport'. Woodman et al. [1993] propose that the team provides the social context needed for creative behaviour to thrive in, allowing for convergent thinking to happen.
To conclude this section, the importance of the team level will be highlighted, as it does provide a venue for the individual team members to augment each other's knowledge through their diverse backgrounds [Brown and Paulus 2002]. Some aspects are better done individually, such as divergent thinking, and individuals are indeed the building-blocks, but in the end, creative production occurs through the social context that emerges when those individual building-blocks form a team [Woodman et al. 1993].

3. Case study

This case study is part of a larger research design with the overall aim of identifying ways to improve creativity of designers through creativity training and is the first step of several in achieving that overall aim. As introduced shortly earlier participatory observations were conducted over a six-month period with two teams, each situated within major domestic organizations with the purpose of gaining an in-depth view of how design teams work within front-end innovation. The study was conducted with an inductive approach and thus started out in an exploratory manner; open-ended and with no more direct research focus other than that provided by the research question (in line with [Eisenhardt 1989]), which was: *How do individual creativity skills influence the creative process of design teams?*
The observations were meant to reveal patterns and develop explanations for answering the research question. Throughout the study there were several observations that stood out, however, the most prominent ones were related to team interactions in team meeting and how the individuals deployed knowledge of tools and cognitive processes to advance their work. This deep understanding of the teams was gained through the means of spending large amounts of time with the two teams, not only as an observer during team meetings but, over time, rather as part of the work environment. Only through this deep understanding is an adequate level of familiarity obtained, allowing for analysis of longitudinal development in addition to providing snapshots of events of particular interest.

3.1 Method

The method deployed in this study was, as mentioned earlier, participatory observation, involving the participation and somewhat integration of the researcher into the teams. The main source of empirical material gathered was in the form of field notes, which were diligently made and enriched after each day as recommended by Woodsong et al. [2005]. It will be argued that the field notes revealed interactions in greater depth due to team integration, by minimizing the distance between researcher and her subjects, as Hong and Duff [2002] describe in their work. Photographs were additionally taken to provide visual evidence in some instances, and 'snapshots' of situations were acquired when the researcher encountered interactions of special interest and recorded more detailed field notes in the form of short narratives.
Total duration of the case study was six months where majority of time was spent as participation in daily activities in the form of presence, participation in team meetings, team work, workshops, personal interactions and educational activities. In addition to the empirical material gathered through these activities the researcher had access to internal documentation, presentations and other material used for internal communication between the teams and other units within each respective company.
Two major approaches were adopted for data collection and analysis. First Eisenhardt's [1989] framework to building theories from case studies was used as an overall frame, providing guidance from the very beginning to end, allowing for both a rigor design of the case study as well as providing guidance in manoeuvring from one step to another when analysing the data. Second, thematic analysis (see e.g. in [Boyatzis 1998]) was deployed in the 'Analyse within-case data' step [Eisenhardt 1989], which is a commonly used approach to coding practice where codes are generated, which are in turn developed into themes with comprehensive descriptions. The approach taken when analysing consisted of the researcher applying codes to the data, which developed and changed throughout each round of iteration. The data was next grouped as deemed fitting when the codes had been finalized and finally

rearranged where patterns started to emerge and themes came about. This was accomplished through numerous iterative rounds and contemplation on the natural arrangement of codes and themes, which will be elaborated on in the upcoming chapter containing the findings of the study. It will be argued here that an appropriate analysis of the findings was optimized based on the thorough iterative analysis of observational data, researcher's theoretical knowledge and intuition, and deep understanding of the context in which the observations took place.

3.2 Context

The two teams were selected using theoretical sampling [Eisenhardt 1989] and were chosen on the grounds of their innovative nature and expressed interest in innovation. From distinctively different industries, both teams shared the common characteristic of specifically working within the fuzzy front end. Additionally there was a shared progressiveness in methodology being deployed in their work as well as a general openness portrayed by their willingness to allow the researcher access to the teams.
The first case company operates in the IT market, developing software and programs for municipalities and other organizations in Denmark. At the time of initiating the study the design team (Team 1) to be studied was operating as a separate entity within the whole organization and their identity was highly related to that. Their offices were markedly different from those in other departments and their ways of working differentiated too, according to them resembling those of design thinking. Thus, although belonging to a large and established IT organization, the team had the characteristics appropriate for the research focus of this study. Their whole innovation process had just undergone a reconstruction and more focus was being put on radical innovation with shorter iterative processes and a more rigid handover framework, providing this study with a highly interesting subject.
The second case company belongs to the automotive market, designing and producing quality vehicles being sold globally to users. The design team (Team 2) that provided access to their work was about to initiate a new process, starting with a new subject, which fit well with the time frame of this study. Their work belongs in the very front end, where scoping, problem identification and problem defining took place, ending with a handover of opportunity areas. Their methodology originated from design, but was, however, focused on user experience thus proving to be more exploratory. This difference, although not substantial, proved to be an interesting viewpoint adding to the richness of the empirical material for this study.

4. Findings

In the following sections the findings of the study will be listed, first (1) similarities and differences will be discussed as general findings, second (2) the codes and themes will be presented as more specific findings and finally (3) a theory will be introduced which emerged from the case study.

4.1 Similarities and differences

As could be expected of teams working within design and innovation processes, both used tools and exercises in their work such as facilitation, brainstorming etc., and their general ways of working had a lot in common. Both companies were aware of the different stages of their development process and had each stage well outlined and planned. Interestingly, it was observed that both teams had difficulties when intending to 'stay' in the diverging and converging stages in their design processes. A number of differences were also observed which were mainly to be found in relation to the structure of process flow and the active management of different stages of the process. The following Table 1 summarizes the similarities and differences that were observed.

Table 1. Overview of similarities and differences

Similarities	Differences
- Challenging to converge - Difficult to 'stay' in divergent stages - Hard to maintain time facilitation - Lack of individual diverging	- Structure in process flow clearer in Team 2 - Verbalized individual awareness of cognitive proc esses (priming, incubation, parking lot etc.) was more apparent in Team 2

- Hands-on approaches and visualization - Hand-over fears - Critisism in divergent stages - Detailed discussion when not intending to - Long discussions frequent in meetings - Encouraged participation and openness to suggestions in meetings	- Management of the different planned stages of the process was more visible in Team 2 - Timing of data collection in development process was different (start versus mid-process) - Team 2 had a more structured approach when converging after diverging - Trust in team managers was greater in Team 1 - Attitude toward surprising elements was more positive in Team 1

4.2 Codes and themes

When going through the collected field notes seven relevant codes emerged after several iterative rounds of coding the data, and became apparent throughout each data set as described earlier. After further analysing the observational data three general themes were identified under which the observations were categorized, each relating to different aspects of the research question. And finally the three themes and their respective codes contributed to the forming of a theory built on the overall case study, which will be described and discussed in the following section 4.3. An overview of codes and themes and the emerging theory can be seen in Table 2.

Table 2. Overview of codes and themes

Theory	Theme	Code	Description of code
Process awareness	Individual	Individual style	Individual display of creativity characteristics or personality trait
		Awareness	Where individual members displayed awareness of own and/or others cognitive effects
	Team	Team activity	Where team members engage in activities
		Team interactions	Where team members interact in some way
		Team atmosphere	Atmosphere that arises as a result of incidents/activities/interactions in the process
	Strategies	Planned	Exercises, facilitation, material and tools are used (or not) in the process
		Not planned	Exercises, facilitation, material and tools are used in the process

The first theme was concerning the (1) *individual* skills, or individual creativity skills, of team members. This theme can be described as one containing observations that were related to incidences when individuals displayed either an act of creativity skills, such as when one team member clearly was different from others in the team in terms of forming remote associations, or a specific personality trait, such as self-confidence and a sense of autonomy, related to those described in the section regarding the individual level of creativity. Additionally it encompasses observations of individuals displaying awareness of cognitive effects on either their own process or the team process at that point in time. Second was the (2) *team*, where all team interactions and team activities could be categorized under. More specifically it contains observations where team members engaged in activities such as group brainstorming or discussions, or interactions in team meetings such as increased active focus when appearing to be in a state of flow [Csikszentmihalyi 1991] and the general atmosphere, such as when encountering uncertainty, or frustration e.g. when experiencing a mismatch of skills. The third theme to be identified was concerning (3) *strategies* the teams deployed in their creative work, such as facilitation, the use of creative exercises or tools and other supporting material such as post its, whiteboards for

sketching, templates etc. where the observations were divided based on whether the observed use of strategies was planned or not. All of these three themes are related to aspects of the design process the teams worked under and thus relevant for answering the research question.
When merging the three themes into a theory it was compelling to realize that 'awareness' was an interesting mix of *individual* and *team*, whereas the individuals strategically used their knowledge of underlying cognitive processes steering the creative process, to manage project development and facilitate the process appropriately. Thus the concluding theory derived from the data was '*process awareness*', which contributes to answering the research question. The next section will discuss the theory and its corresponding findings.

4.3 Process awareness

From the rigour and iterative data analysis a theory emerged, relating to both the individual- and team level of creativity in the context of the design process. Several observations were made supporting the theory which will now be elaborated on in more depth. Team interactions and activities were influenced by this particular tendency of individuals showing awareness of the process flow and the underlying cognitive processes accompanying it. It was especially intriguing to recognize how individuals indeed managed to control the team process with their knowledge about cognitive processes. By verbalizing their knowledge they were able to facilitate the team process more efficiently and thereby advance their project work in an appropriate way. It is therefore proposed that learning about how creativity actually works and being aware of the pitfalls one can fall into while solving problems or working on projects gives the opportunity of actually avoiding them, which is in line with the suggestions of Onarheim and Friis-Olivarius [2013]. The supporting observations can be divided into four main concepts, which will be indicated throughout this section.
One of the most reoccurring observations relating to 'process awareness' was (1) when individuals in the teams displayed awareness of the different stages of divergence and convergence, and the importance of staying in the diverging phase when opening up in the process. This is in line with Basadur's et al. [1982] aforementioned proposition of the importance of a sequential application of divergent and convergent thinking through the operational design process. Furthermore, as mentioned in the theoretical part of this paper, it has been practically adapted in prescriptive models such as the Double Diamond model [Design Council 2005]. Therefore it was of great interest to observe individuals verbalizing this knowledge to properly facilitate their current processes to make sure that proper divergence took place before closing down again through the converging phase. This was especially apparent when external members joined the core teams; people less accustomed to working within the design process were very prone to falling into solution mode, when supposed to be opening up as became apparent in this exchange "[…] *your biggest restriction is your specificity, you have a tendency to fall into solution mode. At this stage we should want to elevate our focus from the specific product areas [and open up]*". This exemplifies the importance of the others being vigilant about being aware of and managing the process, so as to not fall into solution mode when supposed to be in a diverging phase. This was furthermore exemplified in verbal exchanges such as "[…] *it is important to keep in mind that we are still opening up. Very important that we don't fall into solution mode*" and "[…] *we aren't thinking in solutions yet, so please put it in the 'parking lot' until later in the process*".
Another reoccurring observation, related to the previous one, was (2) the awareness of priming. Priming can have a double purpose in design processes; sometimes teams want inspiration and thus seek priming through mental stimuli in different forms. However, in many cases it is regarded important to avoid priming to avoid design fixation [Agogué et al. 2011], e.g. when the purpose is to get pure reflections from individuals, without them being influenced by the opinions or observations of others. An example of an individual being aware of priming is e.g. "[…] *we're not priming ourselves with this now, we don't want to start looking for specific things, because when you do you always find that thing*". Therefore it is regarded important for the process to be aware of priming when appropriate, e.g. when collecting insights from team members one might miss his or hers own intuitive observations if primed by others contributions, however it can prove challenging to control this. In a situation where a team had been in the field collecting user insights and had a formalized sharing workshop planned later (no sharing was supposed to take place prior to that) an excerpt from the field notes states: "*People are eager to start*

talking about the insights they collected, and it is challenging to stop that from happening". This is another example of why divergent and convergent thinking should take place sequentially [Basadur et al. 1982], preferably alternating rounds of individual and group thinking [Brown and Paulus 2002], starting with an individual diverging round, as to avoid being primed by other team members before sharing. Priming can though be used to strategically manoeuvre the process as well, as became apparent, especially when it came to decision time concerning strategical moves throughout the process.
A situation where (3) an individual round of diverging proved useful was described in a detailed narrative in the field notes, where a team was working in a part of the process where diverging should have been taking place, however, it was chosen to conduct the session in a group, i.e. no individual diverging. This brought no new insights and some time was spent being fixated on the same things without being able to break loose from that track and diverge to more remote associations [Friis-Olivarius 2015]. A while into the team session an individual suggested that due to this fixation the team would take a step back, take a few minutes to think individually and write down individual thoughts on post-it's and subsequently enter a group round of sharing. This proved to be successful at relieving the fixation and alternative solutions were produced to the problem at hand. This leads to another act individuals strategically deployed when entering either a stage of fatigue or fixedness; (4) the use of breaks. The gains of this method are furthermore discussed by e.g. Ellwood et al. [2009] and Onarheim and Friis-Olivarius [2013]. A quote exampling this was e.g. "[…] *keep thinking about it during lunch while taking a break, keep in mind, and write down if you come up with anything*". Furthermore a descriptive narrative from the field notes describes an instance when a team was hitting a rut in teamwork due to fatigue, resulting in fixation. In that instance an individual suggested taking a break to "relieve the fixation" and to be able to incubate while taking a short walk (Oppezzo and Schwartz [2014] have e.g. reported the gains of walking on divergent thinking). This can furthermore be related to what Brown [2009] discusses in terms of a mood curve within the design process; i.e. when frustration and fatigue is at a high point, and hope is almost lost, one should anticipate an insight impending, and knowledge of this was also observed in this study. An example is e.g. this statement following a question of whether an outcome should always be expected from the process: "*Yes, sometimes you get super frustrated, but then it [an outcome] always comes in the end.*"

5. Discussion and conclusion

Opposed to design research many of the studies and theories about individual and team creativity have been conducted either in a laboratory setting or proposed as a theoretical framework based on gathered knowledge on different traits and processes considered important. Here, however, the intent was to gain real world insights and collect empirical material on what actually happens in teams of individuals working within design and innovation. However, it should be emphasised that the intent was not to identify which individual creativity skills are important, but how observed skills were influential and further emphasize the importance of those.
As was argued in the introduction to this paper, the importance of creativity to design and innovation is undeniable, thus it is reasonable to consider ways to enhance the creativity of individuals and teams working within those domains. 'Process awareness' is an aspect that was observed as having an influence on the progress of the design process. It materialized when individuals were aware of the different stages of the process and the underlying cognitive processes that could influence their own creative abilities. Throughout the study, this ability proved to be beneficial at advancing and enhancing the team process, thus it is fair to conclude that it is something that should be emphasized in creativity training. Substantial knowledge of this can be gained when advancing through design school; however, emphasizing the importance of it and of training the active use of the knowledge is something that should be applied in creativity training for professionals. This is in line with Scott et al. [2004], who in their impressive meta-analysis of 70 creativity training studies argue the most effective way to structure such a program: (1) the focus should be put on developing cognitive skills, by providing a theoretical understanding of creativity before moving the focus towards (2) skill application by using real world exercises that are domain appropriate [ibid]. Two famous examples of creativity-training programs structured in that way are the 'Creative Problem-Solving Program' [Parnes and Noller 1972] and the 'Purdue Creative Training Program' [Feldhusen et al. 1970], both proven successful at increasing trait

creativity when measured on a divergent thinking test. A more recent program, 'Applied NeuroCreativity' is a creativity-training program offered at universities at a graduate level where this structure is deployed, with the added novelty of applying the neuroscience of creativity as the theoretical foundation, based on the five key concepts [Onarheim and Friis-Olivarius 2013]. Furthermore it can be said that it is especially important for creativity that individuals recognise the diverging and converging phases, and the importance of going through both stages consecutively throughout the process. For instance, if the diverging stage is not deployed efficiently it could influence the design process and the originality of its output. Thus, the findings here provide implications toward appropriate material to use and develop in the first part of creativity training.

The main focus of the findings here was on observable aspects such as when team members verbalized their processual knowledge and interacted with each other to manage the process. As individual creativity skills, such as divergent thinking and the ability to make remote associations, are not easily observable, additional research needs to be conducted, as that will provide deeper insights. As introduced, this paper is only a first step of many to gain these valuable insights into the minds and ways-of working of individuals working within design- and innovation processes on which the authors are currently working. How does creativity happen in design teams and how is it best enhanced? That is an important question with a pending answer.

References

Agogué, M., Kazakçi, A., Weil, B., Cassotti, M., "The impact of examples on creative design: explaining fixation and stimulation effects", 18th International Conference on Engineering Design (ICED11), Vol.2: Design Theory and Research Methodology, Lyngby/Copenhagen, Denmark, 2011, pp. 266-274.

Amabile, T. M., "A model of creativity and innovation in organizations", Research in organizational behavior, Vol.10, No.1, 1988, pp. 123-167.

Amabile, T. M., "Componential Theory of Creativity", Boston, Harvard Business School, 2012.

Amabile, T. M., "Creativity and innovation in organizations", Boston, Harvard Business School, 1996a.

Amabile, T. M., "Creativity in Context", Boulder, Colorado, Westview Press, 1996b.

Amabile, T. M., "The social psychology of creativity", New York: Springer-Verlag, 1983.

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., Herron, M., "Assessing the work environment for creativity", Academy of Management Journal, Vol.39, No.5, 1996, pp. 1154-1184.

Basadur, M., Graen, G. B., Green, S. G., "Training in creative problem-solving: Effects on ideation and problem finding and solving in an industrial research organization", Organizational Behavior and Human Performance, Vol.30, 1982, pp. 41-70.

Bjerknes, G., Bratteteig, T., "User participation and democracy: A discussion of Scandinavian research on system development", Scandinavian Journal of Information Systems, Vol.7, No.1, 1995, p. 1.

Boyatzis, R. E., "Transforming qualitative information: Thematic analysis and code development", Sage, 1998.

Brown, T., "Change by design: How Design Thinking Transforms Organizations and Inspires Innovation", New York, Harper Collins, 2009.

Brown, V. R., Paulus, P. B., "Making group brainstorming more effective: Recommendations from an associative memory perspective", Current Directions in Psychological Science, Vol.11, No.6, 2002, pp. 208-212.

Christiaans, H. H., "Creativity in design: the role of domain knowledge in designing", TU Delft: Delft University of Technology, 1992.

Cropley, A. J., "Defining and measuring creativity: are creativity tests worth using?", Roeper Rev., Vol.23, No.2, 2000, pp. 72-79.

Csikszentmihalyi, M., "Flow: The psychology of optimal experience", New York, HarperPerennial, 1991.

Davis, G. A., "Identifying creative students and measuring creativity", In: Colangelo, N., Davis, G. A. (Eds.), Handbook of Gifted Education, 1997, pp. 269-281.

Design Council, "A Study of the Design Process - The Double Diamond", Available at: <www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20(2).pdf>, 2005, [Accessed 09.07.2015].

Dietrich, A., "The cognitive neuroscience of creativity", Psychonomic Bulletin & Review, Vol.11, No.6, 2004, pp. 1011-1026.

Dietrich, A., Kanso, R., "A review of EEG, ERP, and neuroimaging studies of creativity and insight", Psychological Bulletin, Vol.136, No.5, 2010, pp. 822-848.

Dorst, K., Cross, N., "Creativity in the design process: co-evolution of problem–solution", Design studies, Vol.22, No.5, 2001, pp. 425-437.
Eisenhardt, K. M., "Building theories from case study research", Academy of Management Review, Vol.14, No.4, 1989, pp. 532-550.
Ellwood, S., Pallier, G., Snyder, A., Gallate, J., "The incubation effect: Hatching a solution?", Creativity Research Journal, Vol.21, No.1, 2009, pp. 6-14.
Feldhusen, J. F., Treffinger, D. J., Bahlke, S., "Developing creative thinking: The Purdue Creative Thinking program", Journal of Creative Behavior, Vol.4, No.2, 1970, pp. 85-90.
Fink, A., Benedek, M., Koschutnig, K., Pirker, E., Berger, E., Meister, S., et al., "Training of verbal creativity modulates brain activity in regions associated with language-and memory-related demands", Human brain mapping, Vol.36, No.10, 2015, pp. 4104-4115.
Friis-Olivarius, M., "The Associative Nature of Creativity", CINC Press, Copenhagen, 2015.
Gregory, J., "Scandinavian approaches to participatory design", International Journal of Engineering Education, Vol.19, No.1, 2003, pp. 62-74.
Guilford, J. P., "The Nature of Human Intelligence", New York, McGraw-Hill, 1967.
Guilford, J. P., "Traits of creativity", In: Anderson, H. H., Anderson, M. S. (Eds.), Creativity and its Cultivation, Addresses Presented at the Interdiscplinary Symposia on Creativity, New York, Michigan State University, 1959, pp. 142-161.
Hackman, R. J., Morris, C. G., "Group tasks, group interaction processes, and group performance effectiveness: A review and proposed integration", In: Berkowitz, L. (Ed.), Advances in Experimental Psychology, New York, Academic Press, Vol.8, 1975, pp. 47-99.
Hong, L. K., Duff, R. W., "Modulated participant-observation: Managing the dilemma of distance in field research", Field Methods, Vol.14, No.2, 2002, pp. 190-196.
King, N., Anderson, N., "Innovation in working groups", In: West, M. A., Farr, J. L. (Eds.), Innovation and Creativity at Work, Chichester, England: Wiley, 1990, pp. 81-100.
Koen, P. A., Ajamian, G. M., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S., Johnson, A., et al., "Fuzzy front end: effective methods, tools, and techniques", Wiley, New York, NY, 2002.
Onarheim, B., "Using a company Brainstorm for employee-driven innovation: a case study", Design Principles and Practices: An International Journal, Vol.4, No.6, 2011, pp. 347-354.
Onarheim, B., Friis-Olivarius, M., "Applying the neuroscience of creativity to creativity training", Frontiers in Human Neuroscience, 7, 2013, p. 656.
Oppezzo, M., Schwartz, D. L., "Give your ideas some legs: The positive effect of walking on creative thinking", Journal of Experimental Psychology: Learning, Memory, and Cognition, Vol.40, No.4, 2014, pp. 1142–1152.
Parnes, S. J., Noller, R. B., "Applied creativity: The creative studies project: Part results of the two year program", Journal of Creative Behavior, Vol.6, No.4, 1972, pp. 164-186.
Robbins, T. L., Kegley, K., "Playing with Thinkertoys to build creative abilities through online instruction", Thinking Skills and Creativity, Vol.5, No.1, 2010, pp. 40-48.
Runco, M. A., "Divergent Thinking", In: Runco, M., Pritzker, S. R. (Eds.), Encyclopedia of Creativity, Boston: Academic Press, 2011, pp. 400-403.
Runco, M. A., Jaeger, G. J., "The standard definition of creativity", Creativity Research Journal, Vol.24, No.1, 2012, pp. 92-96.
Scott, G., Leritz, L. E., Mumford, M. D., "The effectiveness of creativity training: A quantitative review", Creativity Research Journal, Vol.16, No.4, 2004, pp. 361-388.
Singh, J., Fleming, L., "Lone inventors as sources of breakthroughs: Myth or reality?", Management Science, Vol.56, No.1, 2010, pp. 41-56.
Stein, M. I., "Creativity and culture", Journal of Psychology, Vol.36, No.2, 1953, pp. 31-322.
Stein, M. K., "Stimulating Creativity", New York: Academic Press, Vol.1, 1974.
Woodman, R. W., Sawyer, J. E., Griffin, R. W., "Toward a Theory of Organizational Creativity", Academy of Management Review, Vol.18, No.2, 1993, pp. 293-321.
Woodsong, C., Mack, N., MacQueen, K. M., Guest, G., Namey, E., "Qualitative research methods: a data collectors field guide", 2005.

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