

Foundations for Studying Creative Design Practices

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ABSTRACT

We argue that empirical research on creativity in design is detached from the realities of the design profession and therefore unable to contribute much to the development of the discipline. We believe that by taking an industry needs-centered approach to research and starting by understanding design practices we can find better and more fruitful research questions. This theoretical paper presents an overview of the empirical approaches to studying creativity in design, specifically in the front end of the design process. We define a practice-based approach for design research and review some studies pertinent to this approach. We discuss the theoretical foundations of the practice-based approach and propose it can yield several insights into professional designers' productivity. We expect that this style of inquiry can advance design tools for both practitioners and students in the future.

Keywords

Design, creativity, practice, organizations, cognition

INTRODUCTION

Design work is strongly dependent on creativity. Professional designers are engaged in a creative profession and are required to produce new and useful ideas constantly as part of their routine work. In contrast to the old views of mythical and insightful creativity, designers cannot wait for inspiration and creativity is on constant demand. Designers themselves can view their creative profession as "routine" work, even if it involves high-levels of creativity (e.g. Lempiälä & Tuominen, 2009).

Unsurprisingly, topics of innovation through design and creativity in design have drawn tremendous attention in the recent years. Much of the research on creativity in design has focused on detailed questions, such as on the influence of ideation techniques, or functions of sketching (Shah, Smith and Vargas Hernandez, 2006; Goldschmidt, 1991). We argue that this research has not addressed issues of practical value, or the needs of the design practice. The connections between academic research and reality seem to

be thin at best, and as a consequence, various creativity techniques and research findings have had a diminishing effect on professional design.

A conflict seems to exist between design as a professional discipline and a topic of academic research (e.g. Schön, 1984; Lawson, 1990; Cross, 2001). Design investigations have typically focused on specific social or cognitive aspects of designing, and have been based on very small sample sizes. Studies often either use individual professional designers (Cross, 2004b), or ignore the influence of expertise, conducting research on small groups of design students (Defazio, 2008; Lawson, 2004). Furthermore, the design tasks often reflect simplified and reduced conditions (Lawson, 2004), rather than the type of complex situations designers encounter in their profession (Schön, 1983). Finally, the focus tends to be on individuals (Cross, 2004b), even though professional design is typically and ever increasingly conducted in groups.

One reason for the present problem might be that the academic understanding of the reality in design companies is insufficient. It is inadequate to inform scientific work on studying and developing fuzzy front-end practices. As an example, Jung, Sonal kar, Mabogunje, Banerjee, Lande, Han and Leifer (2010) propose that design research has often failed to be relevant for design practice and been unsuccessful in establishing a sustainable discourse between research and practice. The current state is understandable because the world of design practice is presumably heterogeneous, secretive, and poorly documented, rendering it a difficult catch for rigorous research. But understanding is not justifying. Jung and associates (*ibid.*) comment on the need not to study just the existing skills of designers, but to improve the *practice of designing* by creating new tools and techniques for practitioners. A strong incentive exists for studying and developing the real-life creative practices within front-end professional design.

Plenty of people seem to share our interest in understanding successful, creative design practice. There are several examples of non-academic texts documenting methods and processes underlying successful design projects in organizations, such as the design consultancy IDEO (Kelley & Littman, 2001; Brown 2009). However, these are typically not "objective" or scholarly studies, but descriptions of company "best practices" and they most

likely present an idealized or selected view of design activities and their outcomes.

We claim that an important level of scientific interest is largely absent in research on creativity in design. That is the level of practice, where the unit of analysis is set in what happens in-between the individuals and the organization, placing the focus on concrete activities that advance the design (e.g. Reckwitz, 2002). This includes, for example, how the tools and methods such as idea generation techniques are used as parts of meaningful practices in designers' daily work.

In the field of social studies, the practice perspective is well established (e.g. Bordieu, 1977; Reckwitz, 2002; Schatzki, 1996). However, relatively few studies (with the exceptions of e.g. Hargadon & Beachky, 2006) have thoroughly described shared practices in collective professional creative work, and even fewer have explicitly approached the issue from the perspective of social practices. We expect further studies adopting this approach to reveal several aspects of creative practices that are shared between successful creative professionals, but which may still be less than optimal for their present environment.

In this paper we present an overview of the established approaches to the study of creativity and design, with the focus on creativity in design, specifically the front end of the innovation process. We discuss the practice-based approach and how it is expected to complement the conventional approaches. We believe that this approach can yield insights into both how professional designers maintain their high level of creative productivity, and how practitioners and students can be provided with improved tools for conducting creative work.

ESTABLISHED PERSPECTIVES IN STUDYING CREATIVITY IN DESIGN WORK

The best term to describe the approaches to creativity in design is diversity. There are numerous studies, and since 2010 even a conference¹, dedicated to "creativity in design." Studies that are relevant to creativity in design are obviously not limited to those on design creativity *per se*. Although design eludes reduction and no single definition adequately captures the diversity of topics studied in the field (Buchanan, 1992), the field of research can be referred to as the *science of design* (Cross, 2001). The uniting element for the different approaches is the process of creating something new, or *changing existing situations into preferred ones* (cf. Simon, 1969). Thus creativity is integral to the entire field of study. From our point of view, most of research about thinking and behavior in design is relevant to understanding *creativity in design*. This is based

on a view of a creative process in which creativity cannot be traced back to any magical technique or moment in the design process, but falls back to complex interactions between the individual, the design team, the design organization, and the rest of the world throughout the time span of the design process.

Research Questions

Much of the research on design creativity centers on either individuals or whole organizations. We see this as a direct consequence in following development in the psychological study of creativity. The individual perspective involves issues such as the behavioral correlates of creativity, cognitive processes and skills, metacognition, general intelligence, and the effects of experience on creativity (e.g. Mumford, 2003; Sternberg, 1999). The organizational perspective, in turn, considers the impact of the work environment on creativity and the study of the organization itself as an entity producing creativity (e.g. Amabile et al. 1996; Woodman, Sawyer & Griffin 1993). The group or team-level approach lying "in between" these two perspectives includes issues such as the effects of team diversity and specific team processes on creativity (e.g. Kress & Schar, 2011; Milliken, Bartel & Kurtzberg 2003; West 2002), but has received less empirical attention than the other two perspectives.

In design research, the focus has largely been on *design thinking*, describing design-specific cognitive activities that designers apply during the process of designing (Badke-Schaub, Roozenburg & Cardoso, 2010). Multiple models of design thinking have emerged over twenty years of research, based on widely different approaches and using models from various branches of science (Dorst, 2010), but essentially, design thinking research focuses on the exploration of design cognition, or the cognitive aspects of designing (Goldschmidt & Badke-Schaub, 2010). The body of knowledge within the field has been developed through seminal works such as Archer (1965), Simon (1969), Lawson (1980), Rowe (1987), and Cross (1982, 2001). Schön (1983) should also be mentioned as an important deviation from the mainstream, with the focus outside the exploration of mental processes. There also exists a more recent version of design thinking, which concerns utilizing designerly skill and attitudes in various contexts such as management and social problems (Johansson & Woodilla, 2010). Here the focus has been more on the organizational level. However, this recent work has not been grounded on empirical studies nor does it refer to the established discussion (Badke-Schaub, Roozenburg & Cardoso, 2010).

The literature on design thinking divides into two theoretical streams. Schön (1983) advocates an analytic tradition in which the understanding and the skill of design are developed with the help of reflection. This presents a counterpart for the main stream of design research, which we call design psychology or *design cognition* (cf. Akin, 1986; Thomas & Carroll, 1979). This implies a heavy

¹ The First International Conference on Design Creativity (ICDC2010) endorsed by the Design Society was organized between Nov 29 and Dec 1 in Kobe, Japan.

dependence on cognitive psychology, particularly on the problem-solving tradition advocated by Newell and Simon (1972), as a theoretical framework. The cognitive approach has often meant investigating the cognition of an individual, as it has done in creativity research more generally. Studies have explored issues such as how the problem is framed or structured by the designer (Cross, 2004b), or the prevalence and effects of different design strategies, such as solution versus problem driven approaches (Kruger & Cross, 2006), problem solving strategies or guiding principles (Cross, 2003; Lawson, 1994; Liikkanen & Perttula, 2009).

Finally, a significant amount empirically founded literature has discussed the methods and tools aimed to support creativity within the design process. These include the engineering-focused systematic problem-solving and conceptual design, foremost idea generation methods (e.g. Pahl & Beitz 1984; Cross, 2008).

Types of Inquiry and Methods of Data Collection

Much of research in design cognition has been conducted using verbal protocol analysis (VPA; Ericsson & Simon 1993). In this method, individual designers think aloud while addressing a design challenge. VPA has been used with video protocols, with different experimental setups, and to address variable research questions. For instance, designers with different amounts of experience have been studied (Cross, 2004b) and the cognitive strategies in early concept design process have been explored (Liikkanen & Perttula, 2009). However, much of this work has been based on students rather than professional designers (Lawson, 2004, utilized in e.g. Popovic, 2004; McDonnell, Loyd & Valkenburg, 2004). Sample sizes are often small (Eteläpelto, 2000), with some studies being based on even individual designers (Lawson, 2004). In addition to VPA, behavior and output based studies (e.g. Liikkanen & Perttula, 2010), questionnaires (e.g. Römer *et al.* 2001), and even electroencephalography studies (Göker, 1997) have been conducted. There have been some ethnographic (Bucciarelli, 1994) and observational (Visser, 1990) studies in design as well, but protocol analysis on design cognition seems to be the dominant research approach.

Limitations of Current Research Approaches

Studies that focus on individual elements of creativity or adopt a specific angle to the design issue at hand can easily leave the overall picture unclear. They can also end up with findings that contradict the experiential views of practitioners. For example, in social psychology, brainstorming (Osborn, 1957) has been repeatedly widely found to be less efficient in producing ideas than if the individuals were working separately (e.g. Mullen, Johnson & Salas, 1991). However, in spite of this knowledge, brainstorming along with its variations is a widely used method today. Apparently there are benefits experienced by practitioners that go beyond the creative output in terms of the quantity and quality of generated ideas. These benefits

are however only acknowledged in a few studies, one example being ethnographical studies conducted within the design firm IDEO by Sutton and Hargadon (1996), who found that besides just producing ideas, the brainstorming sessions served purposes such as to communicate and reinforce organizational norms for collaboration and constant experimentation. In this example, the controlled experiments by psychologists provided a very limited view on the issue by disregarding a variety of factors, such as the effect of future task-interdependence of the participants that takes place within a real organizational setting.

It seems that studying design methods, e.g. ideation, in isolation from their real-life context does little to provide understanding about how these methods are manifested as components of meaningful, shared practices and not just as isolated entities. Also, the focus on individuals, while providing valuable insights, similarly provides an incomplete view of the reality by leaving out important factors affecting creative work, such as the formal and informal structures existing in real organizational settings.

TOWARD THE SCIENCE OF CREATIVE DESIGN PRACTICES

We propose 'creative practices' as an object of interest when studying the professional design work. The term 'practice' does not currently have a defined meaning within design research. It has been used by some authors, such as Haseman (2005), who quite rightly concludes that the term "*encompasses a wide range of activities that are encountered in a host of settings and for many different purposes.*" (*ibid.*, p. 158) Haseman, however does not provide a definition for what type of activities the term is actually used to denote to. We propose the term to refer to shared approaches for conducting design work. More specifically, we adopt the view presented by social scientist Andreas Reckwitz (2002) in which practices are described as routinized behavior consisting of several interconnected elements, including bodily activities, mental activities, use of artefacts (tools, methods), and related know-how (*ibid.* p. 249). Practices are temporally sustained, recurrent, inherently social, and are carried out by individuals.

Philosopher Theodore Schatzki (1996) makes a division between **dispersed** and **integrative** practices, which we find useful for further outlining our topic. According to him, dispersed practices are a more simple form of practices that primarily require the understanding on 'how to do something', such as explaining something to another person (Warde, 2005), which presupposes a shared and collective practice. Integrative practices are more complex. They are found in and constitutive of particular domains of social life (Schatzki, 1996). They typically include dispersed practices in specialized forms. In our view, creative practices in design fall under the category of integrative practices, in which formal processes, guidelines and methods influence this activity. Dispersed practices in this context are parts of the components of sayings and

doings (Warde, 2005) allowing the understanding of the given design practices along with the ability to follow the rules governing these practices.

Thus, in the context of creative practices in design work, within an organizational setting, the focus of research should be on dispersed practices. These are formed from the interplay between the formal rules, processes and instructions, the informal procedures of the organization, understandings, know-how and emotional and motivational states of the employees involved in design, and the tools and methods utilized. The established perspectives on design creativity have adopted an individual, a group, or an organizational perspective. The practice-approach, however, eliminates the need for this choice by placing the unit of analysis in between the individual and the organization, consequently providing a more holistic view about the fuzzy reality of design work.

Relevant Recent Studies of Design Practices

In the following we will describe some relevant and recent studies of practices in creative work in order to further illustrate the value of pursuing this line of research. The overview presented here is not meant to be conclusive or exhaustive, but rather underline some of the gaps in the current literature and illustrate what type of insights this particular field can yield to creativity in design. Most of the studies presented here have not explicitly adopted a practice approach in their theorizing or in the analysis of the findings, but describe activities that fall in the category of practices.

Hinds & Lyon (2011) have recently documented their first steps in studying cross-cultural differences in design practices. Concentrating on the methodology, their report describes the different challenges of carrying out research in Asia, Europe and North America. Above all, they emphasize how the qualitative research requires a combination of elicitation methods and observation, with the emphasis on the latter. So far they have discovered that design practices are influenced by different regional client expectations. For example, in the US, the relations are seen as more collaborative, whereas in Europe and particularly in Asia, the professional designers' sole responsibility in design decisions and deliverables is emphasized. This reflects a difference that re-emerges with prototype presentations. European and Asian designers prefer to display polished and detailed prototypes whereas the American clients were seemingly satisfied with rougher sketches of the design.

Sutton and Hargadon (1997) used an ethnographical approach to study brainstorming in the design consulting agency IDEO. Their study shed light on how componential elements of design practices, namely ideation techniques, present themselves as a part of the larger scale operation in design. Their approach provided insights into the factors that make brainstorming popular among practitioners that the traditional ways of studying brainstorming and ideation

techniques, such as controlled experiments, have disregarded. They found that designers were highly motivated in team work; teams allowed effective utilization of knowledge and dissemination of ideas, and working in teams supported social bonding.

A study by Nov and Jones (2006) investigated the creative practices in an advertising agency by means of interviews and observations. The investigation yielded a model of the organizational roles contributing to ad design. They also mapped the creative influences into a circular model of creative practice. They identified six "inner circle" organizational principles and activities contributing crucially to overall creativity. These included knowledge distillation, task focus, feedback functions, accountability, recognition, and career development. The outer circle of the model included less central, but influential factors that aim to maintain the creative atmosphere of the work place. They concluded that creativity in the studied advertising agency hinged upon a delicate balance of formal processes and informal practices, which together feed the progress.

Petre (2004) documented a field study which described full two years in twelve engineering consultancies. Although not presented in full detail, she identified 14 practices, aimed mainly at knowledge gathering and expanding the search space by either considering more potential solutions or broadening the definition of the problem or potential solution. Petre notes, that although seemingly almost contradictory, deliberate and systematic practices do foster inspiration and innovation in the studied firms. She concludes by giving an account of why exceptional performance in design and development is rare by highlighting the complex balance among contributing factors. Specifically she draws attention to the reliance of the identified practices on expertise (particularly expert skills) and a reflective, supportive, and collaborative culture and communication. However, even though discussing several elements of social practices she does not utilize any structured approach to what she describes as practices.

Another field study of six professional service firms by Hargadon and Beachky (2006) identified interactions that precipitate moments of collective creativity in organizations. Their evidence, collected through ethnographic methods, suggests that while some creative solutions can be viewed as the products of individual insight, others are clearly the products of a momentary collective process. In essence, their study illuminated how the locus of creative problem solving shifts between individuals and the interactions of a collective. As a central outcome of the study, Hargadon and Beachky present and discuss four sets of interrelating activities that play a role in triggering moments of collective creativity; *help seeking*, *help giving*, *reflective reframing*, and *reinforcing*. Although their results do not address the issue from a social practices perspective, describe social interactions in the workplace,

which shape new perspectives on problematic situations and help uncover relevant organizational knowledge.

Finally, Lempiälä (2010) adopted a practice approach in studying barriers and obstructions in group idea generation. This work also relied on qualitative methods, namely observation and interviews. Lempiälä's study provided interesting insight into the practices manifesting within the specific activity of idea generation. She describes four antecedents *vision, culture for questioning and tolerance, balanced risk-taking, and priority and demand for radical innovation* and how they antecedents are concretized in group practices with specific attention on practices detrimental to what she calls "out-of-the-box creativity." The paper notes that the intention is merely to present examples of these specific group practices.

These six studies offer a glimpse into a scope of results that can be achieved by studying practices in "creative" professions. The research discussed above offers many important insights and views, but lacks a unified rigorous approach that would allow systematic comparison, combination and evaluation of the findings. Without a few exceptions, the existing studies have not utilized the practice approach as a structured way to analyze the observed practices. The writings related to design that have adopted the approach of social practices have mostly been concerned with products and artifacts considered as elements or carriers of social practices that cross the boundaries of design, production and consumption. In their take on the potential for theoretical exchange between design research, science and technology studies, and social theories of practice and consumption, Ingram, Shove and Watson (2007) highlight the potential fruitfulness of attention being "*paid to the continually coevolving relation between human and nonhuman actors (objects) jointly implicated in the process of 'doing'*" (*ibid.*, p. 16). This brings the discussion closer to the proposals of applying activity theory to design sciences (see e.g., Kuutti, 1996).

In our opinion, the practice-based design research requires the "right amount" of theory to be meaningful. Theory is necessary to aim our analytic focus, but should not eventually depart too far off to become indistinguishable from the practitioners themselves.

CONCLUSIONS

This paper has discussed a practice approach to studying creativity in design work as a needed complementary view to the established traditional approaches. Where previous studies on creativity have focused exclusively on either individual, organizational, or group levels and have been lacking in understanding the interactions between these levels, the practice-based approach to studying design aims at placing the unit of analysis between the individual and the organization (Schatzki, 1996). Practices can be used as a framework for describing activities at several levels providing structure to the studies of complex dynamics of the reality of design work where interconnected factors are

found on various levels. Thus, to advance our understanding on creative practices in design work taking place within an organizational setting; we propose focusing on studying dispersed practices that address both formal and informal organizational influences, expertise, emotional and motivational states of the employees, and the tools and methods utilized by designers.

The main idea of this paper is to fill the gap in design research literature by pointing out that while several studies have discussed 'practices' in design work, very few of them have explicitly defined what it is. Nor have they explicitly adopted an approach rooted in the social practices –research. This is illustrated by the six relevant recent studies discussed in the paper. A rigorous practice-based approach is proposed as a step towards making design research more meaningful for design practice, a shortcoming highlighted recently by e.g. Jung et al. (2010).

Expected benefits of the practice-based approach to creativity in design

We propose that the practice-based approach offer benefits and structure to ethnographic and observatory research in terms of research design, gathering data and analyzing the findings. In addition, in many qualitative studies of design practices, the data analysis is not presented in a clear or repeatable fashion. This leaves the reader with no way to assess the validity of the findings but to trust the authors' interpretation of the data (cf. Petre, 2004). A rigorous approach rooted in the theories of practice would make the analysis more systematic and transparent, providing a more solid basis for the evaluation of the validity of both the results and analysis.

We hope that future work on creative design practices could pinpoint areas of research and development which currently lack scientific support the most. This would allow us to develop evidence-based practices for (creative) design, following the examples set by medicine. As an example, by adopting the "components" of social practices described by Reckvitz (2002) (including bodily and mental activities, use of artefacts, i.e. tools and methods, and related know-how) as elements of analysis for the data gathered through observational and complementing methods, a more solid and structured approach to often hazily described analysis would be achieved. Our ongoing research aims to address these gaps in research on creative design work by conducting field studies in selected organizations utilizing the practice-approach for structuring the studies and analysis. The gained knowledge will be disseminated in the first phase by developing the education of future designers in our home university, and through interventions in the industry.

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REFERENCES

1. Amabile, T.M., Conti, R., Coon, H., Lazenby, J. and Michael Herron, M. (1996) Assessing the Work Environment for Creativity. *The Academy of Management Journal*, Vol. 39, No. 5, 1154-1184.
2. Akin, Ö. (1986). *Psychology of architectural design*. London: Pion.
3. Ball, L., Evans, J. et al. (1994). Cognitive processes in engineering design: a longitudinal study. *Ergonomics*, 37, 1753-1786.
4. Badke-Schaub, P.G., Roozenburg, N.F.M. & Cardoso, C. (2010) Design thinking: a paradigm on its way from dilution to meaninglessness? In: K. Dorst, S. Stewart, I. Staudinger, B. Paton & A. Dong (Eds.), *Proceedings of the 8th Design Thinking Research Symposium (DTRS8)*, 39-49.
5. Brown, T. (2009) *Change by Design*. New York, NY: HarperCollins.
6. Bourdieu, P. (1977) *Outline of a Theory of Practice*. New York, NY: Cambridge University Press.
7. Bucciarelli, L.L. (1994) *Designing engineers*. MIT Press, Cambridge, MA.
8. Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues*, 8(2), 5-21.
9. Cross, N. (1982) Designerly ways of knowing. *Design Studies*, Vol. 4, 221-227.
10. Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science. *Design Issues*, 17(3), 49-55.
11. Cross, N. (2003). The expertise of exceptional designers. In N. Cross and E. Edmonds (Eds.), *Expertise in Design* (pp.23-35). Sydney, Australia: Creativity and Cognition Press, University of Technology, Sydney.
12. Cross, N. (2004a). Creative thinking by expert designers. *Journal of Design Research*, 4. DOI: 10.1504/JDR.2004.009839
13. Cross, N. (2004b). Expertise in design: an overview. *Design Studies*, 25, 427-441.
14. Cross, N. (2008) *Engineering design methods. Strategies for product design*. Fourth edition. Chichester: John Wiley & Sons Ltd.
15. Defazio, J. (2008). The identification of design experts. *Journal of Design Research*, 1, 84-96.
16. Dorst, K. & Cross, N. (2001). Creativity in the design process: co-evolution of problem-solution. *Design Studies*, 22, 425-437.
17. Ericsson, K.A. and Simon, H.A. (1993). *Protocol analysis: verbal reports as data*. The MIT Press, Cambridge, Massachusetts
18. Getzels, J.W. (1975). Problem-finding and inventiveness of solutions. *Journal of Creative Behavior*, 9, 12-18.
19. Getzels, J.W. (1979). Problem finding: A theoretical note. *Cognitive Science*, 3(2), 167-172.
20. Goldschmidt, G. (1991). The dialectics of sketching. *Creativity Research Journal*, 4(2), 123-143.
21. Goldschmidt & Badke-Schaub (2010) The Design Psychology Indispensable Research Partnership. In: K. Dorst, S. Stewart, I. Staudinger, B. Paton & A. Dong (Eds.), *Proceedings of the 8th Design Thinking Research Symposium (DTRS8)*, 199-209.
22. Guindon, R. (1990). Knowledge exploited by experts during software system design, *International Journal of Man-Machine Studies*, 33, 279-304.
23. Göker, M.H. (1997). The effects of experience during design problem solving. *Design Studies*, 18(4), 405-426
24. Hargadon, A.B. & Beach, B.A. (2006) When collections of creatives become creative collectives: a field study of problem solving at work. *Organization Science*, Vol. 17, No. 4, 484-525.
25. Hinds, P., & Lyon, J. B. (2011). Innovation and culture: Exploring the work of designers across the globe. In C. Meinel, L. Leifer & H. Platner (Eds.), *Design thinking* (pp. 101-110). Berlin: Springer.
26. Hülsheger, U.R., Anderson, N. & Salgado, J.F. (2009) Team-level predictors of innovation at work: A comprehensive meta-analysis spanning three decades of research. *Journal of Applied Psychology*, Vol. 94, No. 5, 1128-1145.
27. Johansson, U. & Woodilla, J. (2010) How to avoid throwing the baby out with the bath water: An ironic perspective on design thinking. *EGOS Colloquium 2010: June 30 - July 3, Lisbon, Portugal*.
28. Jung, M., Sonalkar, N., Mabogunje, A., Banerjee, B., Lande, M., Han, C., Leifer, L. (2010) Designing Perception-Action Theories: Theory-Building for Design Practice. In: K. Dorst, S. Stewart, I. Staudinger, B. Paton & A. Dong (Eds.), *Proceedings of the 8th Design Thinking Research Symposium (DTRS8)*, 233-242.
29. Kelley, T. & Littman, J. (2001) *The Art of Innovation: Lessons in creativity from IDEO, America's leading design firm*. New York: Doubleday.
30. Kolodner, J.L. & Willis, L.M. (1996). Powers of observation in creative design. *Design Studies*, 17, 385-416.
31. Kress, G., & Schar, M. (2011). Initial conditions: The structure and composition of effective design teams. Paper presented at the *International Conference on Engineering Design, ICED11, Copenhagen, Denmark*.

32. Kruger, C., & Cross, N. (2006). Solution driven versus problem driven design: strategies and outcomes. *Design Studies*, 27, 527-548.
33. Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In B. E. Nardi (Ed.), *Context and consciousness: Activity theory and human-computer interaction* (pp. 17-44). Cambridge, MA: MIT Press.
34. Lawson, B. (1990). *How designers think. The design process demystified*. Oxford: Butterworth-Architecture.
35. Lawson, B. (1994). *Design in mind*. Oxford, UK: Butterworth-Heinemann.
36. Lawson, B. (2004). Schemata, gambits and precedent: Some factors in design expertise. *Design Studies*, 25(5), 443-457.
37. Lempiälä, T. (2010) Barriers and obstructive practices for out-of-the-box creativity in groups. *International Journal of Product Development*, Vol. 11, No. 3, 220-240.
38. Liikkanen, L. A., & Perttula, M. (2009). Exploring problem decomposition among novice designers. *Design Studies*, 30(1), 38-59.
39. Liikkanen, L. A., & Perttula, M. (2010). Inspiring design idea generation: Insights from a memory-search perspective. *Journal of Engineering Design*, 21(5), 545 - 560.
40. McDonnell, J., Lloyd, P., & Valkenburg, R.C. (2004). Developing design expertise through the construction of video stories. *Design Studies*, 25(5), 509-525.
41. Milliken, F. J., Bartel, C.A. & Kurtzberg, T.R. (2003) Diversity and Creativity in Work Groups: A dynamic perspective on the affective and cognitive processes that link diversity and performance. In: Paulus, B., Nijstadt, B. Arjan & B. A. Nijstadt (Eds). *Group Creativity: Innovation through collaboration*. Cary, NC: Oxford University Press.
42. Mullen, B., Johnson, C. & Salas, E. (1991) Productivity loss in brainstorming groups: A meta-analytic integration. *Basic and Applied Psychology*, Vol. 12, 2-23.
43. Mumford, M. D. (2003) Where have we been, where are we going? Taking stock in creativity research. *Creativity Research Journal*, Vol. 15, No. 2-3, 107-120.
44. Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.
45. Nov, O., & Jones, M. (2006). Ordering creativity: Knowledge, creativity, and idea generation in the advertising industry. *International Journal of Product Development*, 3(2), 252-262.
46. Pahl, G. and Beitz, W. (1984) *Engineering design*. London: Design Council.
47. Petre, M. (2004). How expert engineering teams use disciplines of innovation. *Design Studies*, 25(5), 477-493.
48. Popovic, V. (2004). Expertise development in product design—strategic and domain-specific knowledge connections. *Design Studies*, 25, 527–545
49. Reckwitz, A. (2002) Toward a theory of social practices: A development in culturalist theorizing. *European Journal of Social Theory*, Vol. 5, No. 2, 243-263.
50. Rowe, P. (1987). *Design thinking*. Cambridge, MA: MIT Press.
51. Römer, A, Weissahn, G, Hacker, W, Pache, M and Lindemann, U (2001). Effort-saving product representations in design - results of a questionnaire survey. *Design Studies*, 22(6), 473-491
52. Schatzki, T. (1996) *Social Practices: A Wittgensteinian Approach to Human Activity and the Social*. Cambridge: Cambridge University Press.
53. Schön, D. (1983). *The Reflective Practitioner: How Professionals Think in Action*. London: Basic Books Inc.
54. Shah, J. J., Smith, S. M., & Vargas Hernandez, N. (2006). Multilevel aligned empirical studies of ideation: Final results. Paper presented at the *International Design Engineering Technical Conference (ASME IDETC 2006)*, Philadelphia, PA.
55. Simon, H.A. (1969). *The Sciences of the Artificial*. Cambridge, MA: MIT Press.
56. Sternberg, R. J. (Ed.) (1999) *Handbook of creativity*. Cambridge: Cambridge University Press.
57. Sutton, R.I. & Hargadon, A. (1996) Brainstorming Groups in Context: Effectiveness in a Product Design Firm. *Administrative Science Quarterly*, Vol. 41, No. 4, 685-718
58. Thomas, J C and Carrol, J M (1979) The psychological study of design. *Design Studies*, 1(1), 5-11
59. Ullman, D.G., Dieterich, T.G. et al. (1988). A model of the mechanical design process based on empirical data. *AI in Engineering Design and Manufacturing*, 2, 33-52.
60. West, M.A. (2002) Sparkling fountains or stagnant ponds: An integrative model of creativity and innovation implementation in work groups. *Applied Psychology*, Vol. 51, No. 3, 355–387.
61. Woodman, R. W., Sawyer, J. E, Griffin, R. W. (1993) Toward a theory of organizational creativity. *Academy of Management Review* Vol. 18, No. 2, 293-321
62. Visser, W (1990) More or less following a plan during design: opportunistic deviations in specification. *International Journal of Man-Machine Studies*, 33, 247-278