Understanding Creativity Methods in Design

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ABSTRACT
This paper contributes an analytical framework to improve understanding of the composition of recognized creativity methods used in design. Based on an extensive literature review, our framework synthesizes key concepts from design and particularly creativity research, and is further supported by significant experience with creativity methods in design. We propose that nine concepts are relevant for analyzing creativity methods in design: process structure, materials, tools, combination, metaphor, analogy, framing, divergence, and convergence. To test their relevance as components of an analytical framework, we use these key concepts to analyze three recognized creativity methods that we have often used ourselves: Inspiration Card Workshops, Fictional Inquiry, and Extreme Characters. Our analytical framework expands current categorizations of methods and offers new insight into how creativity methods are composed, how and why they work, and how they potentially may be tweaked or refined for enhanced deployment in design.

Author Keywords
Creativity; ideation; design methods; creativity methods; analytical framework.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION
Design is inherently a creative activity. Be it in incremental or disruptive ways, design aims at reshaping and improving the existing through the introduction of something novel. Consequently, literature and practice in the DIS community abound with creativity methods to be utilized either by individuals or, as is often the case, by design teams. Design research offers a number of phase-based categorizations of creativity methods to help designers select a suitable method for a particular juncture in the process, e.g., the transition from concept generation to concept evaluation. Such overviews are valuable when the designers engaged in the process have a clear understanding of where they are or want to proceed to in the process. But if no such clear point or position can be established, or if the design process features fluent phases that are hard to compartmentalize (which is typically the case), phase-based categorizations become more difficult to apply directly to design practice.

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To supplement this body of work, the present paper takes one step back in order to examine the creative basis of such methods. We explore how these methods can be understood through the lens of *creativity research*, which tends to be a 'silent partner' in many of the methods, i.e., an implicit and critical, yet rarely articulated, premise for the composition of the methods, especially when ideation is the objective. Based on a comprehensive literature review of design and creativity research, we propose that *nine key concepts* from this body of work are central and productive for analyzing creativity methods for deployment in design. To test how well these proposed key concepts can serve as components of an *analytical framework* to pry open creativity methods in design and provide an improved understanding of how and why these methods work, we use the nine key concepts to analyze three recognized creativity methods in design: Inspiration Card Workshops [41], Fictional Inquiry [24], and Extreme Characters [27].

Our *main contribution* is the analytical framework proper comprised of the proposed nine components from design and creativity research. The framework is relevant to design researchers since it lends itself to *analytical inquiries* into design activities by, compared to the current phase-based categorizations, providing even richer insight into the inner workings of creativity methods that are often integral to design. Also, our framework enables *practical application* by aiding professional designers in making informed decisions when they orchestrate design processes, e.g., when they are asked to devise and tweak creativity methods to best match the creative challenge at hand.

The paper is structured thus. First, we give an overview of key contributions to creativity methods pertaining to design. On this basis, we offer a literature review of design and creativity research, which leads to the formulation of nine key concepts. We treat these as *propositions* that in sum comprise an analytical framework in which the nine concepts are components. We test the framework's relevance and explanatory power by analyzing the above three creativity methods. Finally, we discuss the potentials and limitations of the analytical framework.

CLARIFICATION OF CREATIVITY METHODS IN DESIGN

When looking at the entire design community very broadly, many creativity methods are on offer; however, it would seem that some of them might be based more on anecdotes than on evidence. It is well established that creativity is integral to design [18], and it has been argued that design is marked by (at least) two main views on creativity [2], and that even experienced design educators find it difficult to define creativity [46]. Runco and Jaeger [69,p92] note that the standard definition of *creativity* is dual: creativity needs *originality* (novelty, surprise) and *effectiveness* (usefulness, appropriateness). Our use of the term 'creativity' is informed by this consensual standard definition, but we subscribe to the more elaborate definition offered by Plucker, Beghetto, and Dow [63]: "Creativity is the interaction among *aptitude, process, and environment* by which an individual or group produces a *perceptible product* that is both *novel and useful* as defined within a *social context*" (p90, orig. emphasis).

A similar clarification is needed with regard to *methods*. We have noted that the terms 'method' and 'technique' are often used interchangeably. This is somewhat unfortunate since distinguishing between the two in terms of complexity and richness enables a more nuanced view. On a domain-general level, 'method' can be seen as: "[a] well-specified repeatable procedure for doing something: an ordered sequence of goal-directed operations" [15,p180]. This deliberately generic expounding is a relevant terminological basis; however, echoing [80], we consider it important that the development of new creativity methods in design be grounded in a thorough understanding of design practice. Also, we appreciate the need for a 'common language' for problem framing in design [53]. We therefore subscribe to Löwgren and Stolterman's [55] domain-specific distinction between design methods and techniques:

"Simply put, a *method* refers to a description of a way of working or a recipe for action. A *method* is always based on a specific purpose and specific values, and it translates them into an actable procedure. A *technique* is smaller in scope and ambition than a *method* and is frequently related to a particular form of expression or execution, as in the visual arts where pencil and charcoal can be categorized as *techniques*. A *method* may comprise several steps to be carried out in different *techniques*, or allow for the choice of different *techniques* in accomplishing a certain outcome" (p63, emphasis added).

This type of proposed hierarchical itemization of method vs. technique is even more pronounced by [70] who within Participatory Design in an ascending order of complexity distinguish between *tools* (material components used), *toolkit* (a combination of tools used for a specific purpose), *technique* (a description of how tools and toolkits are put into action), *method* (defined as "a combination of tools, toolkits, techniques and/or games that are strategically put together to address defined goals within the research plan" (p196), and finally *approach* (the overall mindset dictating how the research plan should be conducted) (op.cit.). For studies on designers' use of methods 'in the wild', other researchers have argued for sustaining an inclusive and less hierarchical understanding of methods in general, thereby pooling together design methods, tools, techniques, i.e., basically any resource that might support a design process [38,81]. We appreciate this particular approach for studying design practitioners' in-situ use of such methods, but we argue that a proposed theoretical contribution such as this may benefit from a more critical filtering of some of the above design process components.

In order to specifically explore creativity methods used in design, we find it fruitful to begin by bringing together the above views on creativity and method in order to build a terminological foundation before we examine in more detail the array of creativity methods for use in design. Our proposed working definition is the following: a creativity method in design is *a well-specified repeatable procedure that through the combination of relevant tools, toolkits, and techniques aims to bring about a perceptible product that is novel and useful as defined within a specific design context.*

This working definition means that we do not single out any design methods as being completely *non-creative*. On the contrary, the argument we wish to make is that all methods in design contain an element of creativity since creativity is integral to design proper. This is the reason why we refer to the methods as 'creativity methods in design.'

Categorizations of Creativity Methods in Design

As shown by Dubberly's [29] extensive compilation, any designer today literally has hundreds of different design process models to choose from, including specific methods integral to them. This means than any attempt to classify methods in design is a challenge. The fact that recent years have seen a plethora of more business-oriented books trying to mass-market design thinking by improvised (and at times seemingly purely anecdotal) methods have not made it any easier to get an overview of all methods available [38].

One of the first and most extensive collections of methods to support creative design practice (35 in total) is Jones' (1970/1992) *Design Methods* [45]. Jones takes a pragmatic approach by defining a design method as: "any action one may take while designing," thereby stressing that there is only: "one principle involved: choose whatever method will tell you what you don't know, but need to know, in order to proceed" (pxxv). Jones does underline the importance of a designer's ability to assess his/her creative process, thereby enabling a more insightful selection of the proper method. Jones' attempt to expose the inner workings of design soon waned and was replaced by Rittel's [65] so-called 'second generation' of design methods in which negotiation and argumentation in the design activity are critical [38].

Later works have built on Rittel's ideas and have evolved to focus mainly on classifications of *domain-general* creative

problem-solving methods (CPS) [21,22,58], or *domain-specific* methods [19,23,60,71]. Since the domain-general methods by definition aim to leverage and help hone a user's ability to tackle creative problems regardless of context, these are not of primary interest in design. Conversely, as for the domain-specific methods, [23] has advised a set of engineering design methods ('tactics') as strategies for product design. Others have developed an arsenal of creativity methods for general use, particularly ideation [60], e.g., card-based [36], or focused on in-depth development of one method for a particular domain, e.g., BadIdeas 3.0 [75] for design. Other studies have analyzed (often comparatively) the efficiency of creativity methods [19,71,74], examined a possible cross-domain transfer of creativity methods [57], or compiled creativity methods to help the creative agent (often a designer) choose the best method for a given situation. The method compilation that may be among the most used in academic education is the *Delft Design Guide* [8]. Other related works tend to adopt a more tool box-like perspective, e.g., within Participatory Design (PD) [49,61], Interaction Design (IxD) [5], Human-Centered Design (HCD) [56], and organizational innovation [51]. Some tool box-like contributions have even been popularized with success, e.g., IDEO's 51 *Method Cards*, each containing one method and the story behind it (https://www.ideo.com/post/method-cards).

Within this body of work, [56] have deliberately taken a phase-based approach to help practitioners choose the most suitable design method at any point in the process. They formulate a five-phase division of the design process with specific methods for each design phase. Similarly, [51] has proposed a four-step model of the design innovation process (which seems related to the model by [3]). Phase-based categorizations like these are valuable for gaining a guiding overview of many design methods (here 100 and 101 methods, respectively) to help designers choose which method to apply at any point in a design process. Even so, such overviews cannot by definition go into more detail about the most (or least) relevant aspects of each method. Therefore, phase-based groupings cannot render analyses of these creativity methods' componential features the very basis for selecting one creativity method over another.

Following [42], we believe it is crucial for designers, and especially design students, to have analytical tools at their disposal to guide them in making informed decisions about which creativity method(s) to select, and why and how one creativity method may be more suitable than another for a specific design purpose. This is particularly important when orchestrating design workshops that often feature several participants from various (often non-design) domains. Our contribution complements the phase-based categorizations by offering theoretical support for an improved analytical understanding of how creativity methods in design are constructed, and how their (often rarely articulated) reliance on well-established creativity concepts can be discerned.

THE ANALYTICAL FRAMEWORK'S COMPONENTS: NINE KEY CONCEPTS FROM DESIGN AND CREATIVITY RESEARCH

Guided by our working definition of creativity methods in design and the above presentation of main contributions and categorizations of these methods, we now explore the *basis* of many of these methods—key concepts from design and particularly creativity research. Our aim is to examine to what extent a selection of these concepts can pry open and explain how creativity methods in design work so that the *proposed concepts* can serve as *components of an analytical framework*. This means that we present and examine the selected key concepts as *propositions* in the terminology of Whetten's classic work on what constitutes a theoretical contribution [86,p491], which has been applied widely in fields such as business and management research [9,p36,]. According to Whetten, a theoretical contribution based on propositions is built from concepts (here, key concepts from design and creativity studies), and should be evaluated on their *conceptual coherence* and *explanatory power*. This is in contrast to scientific hypotheses that require measurable empirical testing, although the two may be combined. Here, we examine the explanatory power of our propositions by applying the framework to three dissimilar, recognized creativity methods in design, and discuss the framework's potentials and limitations on this basis.

Method

Many factors influence the understanding of creativity in design [2,11,17]. Given this complexity, we decided to conduct a *narrative literature review* as detailed by [62]: "A narrative review is a written report that summarizes—and optimally critiques—the literature on a particular topic, without providing any integration of either quantitative or qualitative findings" (p23). A narrative review "provide[s] a broad overview of a topic, rather than addressing a specific question," so "readers typically are not made privy to the literature reviewer's decision-making" (p24). We chose the (conventional) interpretive and reflective, *general* literature review that expounds "the salient and critical aspects of the most current knowledge" such as "substantive findings, as well as conceptual, theoretical, and/or methodological contributions" (ibid.). Therefore, our "research strategy is based on an interpretative epistemology" [14,p111].

Critical to this type of literature review is the reviewers' prior knowledge of the domain and the main themes before conducting the review. Based on our prior knowledge and domain experience (in sum, more than sixty years of both theoretical and practical work), we conducted the literature review in accord with [62]—a seven-step process in three phases: a) an Exploration phase, b) an Interpretation phase, and, c) a Communication phase (which is this paper).

While there have been works on creativity in the first half of the 20th century, e.g., Wallas' (1926) *The Art of Thought* [83], we confined our search to works from 1950 and onward since 1950 is generally accepted as the start date of modern creativity research as an academic field, initiated by

J.P. Guilford's influential APA presidential address (the American Psychological Association) that year [39]. First, we conducted an a) Exploration phase individually and then compared findings. In sum, we reviewed 85 pivotal primary works of which 39 were deemed relevant enough to be included [1,4,6,7,10,12,13,16,20,25,26,28,30,31,33,34,40, 43,44,47,48,50,52,54,55,59,64,66,68,69,70,72,73,78,79,82, 84,85,87]. This was supported by including two of the most recognized secondary sources in creativity research [67,72]. Our b) Interpretation phase was informed by taxonomic analysis [77] according to which a domain is mapped out using visual representations (tables, mind maps, etc.) to identify and cluster predominant subsets of key concepts and their interrelatedness. To further qualify this iterative analytic-synthetic process, we continually sought peer feedback [35] by presenting our results in order to ensure intermediate checks of validity against domain experts' understanding of suitable criteria for selecting key concepts.

These informed validity checks led us to eventually ignore additional creativity concepts, e.g., expertise, motivation, sources of inspiration, and combinational creativity. Doing this was in compliance with this type of literature review; however, this necessary simplification and condensation did mean that some nuances were lost at the expense of internal coherence of the concepts. Even so, some of the ignored concepts have remained on the list albeit indirectly, e.g., the role of sources of inspiration as a trigger for creativity is relevant across several of the key concepts. With the aim of respecting theoretical adequacy and analytical applicability, we arrived at *three overarching categories* each containing *three key concepts*. We argue that these *nine proposed key concepts* in sum address the tangible and material aspects of using creativity methods in practice, the mechanisms by which creativity unfolds, as the methods are employed, and the ways in which creativity methods relate to the overarching project and design space they occur in.

We stress that our general, narrative literature review—given its interpretive and reflective nature—per definition is *non-exhaustive* and that it should only be interpreted in the context of the individual information sources in the specific domain of creativity and design [62,pp29-31]. It is based on this methodological premise that we now present our results as propositions, which we subsequently test by analyzing three dissimilar, recognized creativity methods in design.

Concrete Aspects

The concrete aspects of design and creativity pertain to the *structural and tangible procedures for organizing and using a creativity method*. This includes guidelines and sequences of steps to undertake during a method, as well as the ways in which specific materials and tools are used.

Process Structure

We define process structure as the *formal procedure and sequence of a creativity method*. In addition to Product, Person, and Press (from the milieu), a focus on Process has been integral to creativity research at least since Rhodes' (1961) [64] 4P model representing a quadrisection of main areas of study. The Process view often involves analyses of creative courses in various settings, and studies range from micro time spans to longitudinal studies, from real-world observations (in vivo) to controlled lab experiments (in vitro). Our interest is not process analysis in this sense, but rather process structure as the guiding process principle.

Studying a design process structure may profitably be based on the role of creativity constraints defined as all "explicit or tacit factors governing what the creative agent/s must, should, can, and cannot do; and what the creative output must, should, can, and cannot be" [7,p37]. Creativity methods seen through the lens of a creativity constraint-based process structure entails that our interest is how each method is devised in terms of what can and cannot be done in the method. This includes the extent to which a creativity method relies on rigidity of guidelines, formal requirements on participants in terms of numbers and roles, sectionalized phases, explicit rules, etc.; all of which govern the design activity. The process structure view lets us examine each creativity method's formal construction on a concrete level.

Materials

We define materials as *physical artifacts that are employed and consumed as part of the creativity method*. This can be plain materials such as paper, cardboard, and sticky notes, or materials made specifically for a particular method, e.g., props, game boards, or cards. Although materials are not brought into play in all creativity methods, they often play a critical role by enabling externalization of concepts and structures [25]. In creativity methods, this is relevant for the setup and execution. In the setup phases, method organizers can shape and organize materials to frame and guide events by preparing specific props and pieces of scenography, etc. When the methods unfold, participants can use materials to externalize, explore, and refine concepts. Materials thus support creative design processes in several ways [1].

The role of materials of relevance to creativity and design include, but is certainly not exhausted with, the following characteristics: Materials can *capture* fleeting concepts and represent them in a stable form so that participants can return to them during or after the use of the method. They can contain *content*, e.g., images as sources of inspiration, to support creativity and ideation. Materials can serve as *boundary objects* [26,79] concrete enough to be a shared point of reference for participants with unalike backgrounds and agendas, yet open enough to hold different meanings depending on participants' objectives for initiating the method. Also, materials can serve as *props* [13] to help participants enact scenarios, and offer *cognitive offloading* [28] for participants as an external memory deposit of ideas and concepts created, and by enabling ways of combining and rearranging the concepts by manipulating the physical materials. Finally, materials can serve to structure and build *momentum* in a process, e.g., via cues or affordances that indicate potential next steps in the creativity method.

Tools

We define tools as the *physical artifacts that are used in a creativity method in the creation and transformation of materials*. In contrast to materials, tools are not consumed in the process. Tools can be generic artifacts such as pens, markers, video cameras, still cameras, smartphones, flatbed scanners, etc., but tools may also be developed specifically for a particular creativity method, e.g., a digital web-based tool for organizing images and video.

Tools used in human practice date back millions of years and are extensively applied in crafts like carpentry, pottery, and engraving. In the context of digital artifacts, the tool perspective is used to characterize use of computer artifacts, emphasizing the user in complete, continuous control of the manipulation and transformation of digital materials into more refined products [47]. In Interaction Design, not least in Participatory Design, the proliferation of design tools is profound [70]. As opposed to this paper, however, [70] do not distinguish between tool and material, but define materials as: "the material components that are used in PD [Participatory Design] activities" (p196). Occasionally, you hear the term 'creativity tools', but often interchangeably with 'creativity methods' or 'creativity techniques.'

Conceptual Aspects

The conceptual aspects of creativity methods pertain to *how ideas and concepts emerge and transform*. Within design, creativity methods are concerned with the development of novel and useful concepts, so conceptual aspects refer to the creation of original ideas, spur-of-the-moment insights, and the refinement of ideas and concepts in the design domain. Creativity research accentuates three primary types [84].

Combination

We define combination as *bringing two or more concepts together to create a novel concept* [20,85]. While this is central to many aspects of creative processes, e.g., as *conceptual combination* (see [66, p191]), we use it to show how some methods rely on combination in their procedure. An early articulation of the importance of combination in creativity is Beveridge (1951) [4]: "Originality often consists in linking up ideas whose connection was not previously suspected" (p21). Koestler [50] has argued that combination is a key pattern in creativity, and that creativity lies in: "the perceiving of a situation or idea […] in two self-consistent but habitually incompatible frames of reference" (p33). He calls this 'bisociation.'

Boden [10] has stressed *combinatorial creativity* as a vital form of creativity. Turner and Fauconnier [30,82] consider *conceptual blending* a 'mechanism of creativity' and have studied how new concepts and insights emerge through combination of existing ones. Louridas [54] has argued that much design is *bricolage* and the designer a bricoleur who combines existing elements to form a new, meaningful whole. Given this accent on combination, we identify and compare ways in which creativity methods frame and incite combination as a way to bring about novel design concepts.

Metaphor

We define metaphor as: *"conceptual combinations that involve mapping a vehicle concept onto a topic concept"* [72,p119, orig. emphasis, 33]). Some researchers argue that original ideas are often found via associative processes, and Mednick's [59] work on the associative basis for creative processes has been influential. Others argue that analogical thinking (using metaphors and analogies) is the crux of the creative process. Lakoff and Johnson [52] have proposed that: *"[t]he essence of metaphor is understanding and experiencing one kind of thing in terms of another"* (p5). In this sense, metaphors are familiar in design [16] and in everyday life. Indeed, [34] has argued that people use about four conventional ('frozen') and two novel metaphors in every minute of ordinary discourse. Metaphors tend to take a quite colloquial form (with connotations to literature) by referring to just one or very few properties mapped onto a topic concept. Examples could be iron curtain, the man who sold the world, heart of glass, paranoid android, etc.

Analogy

We define use of analogy as a *conceptual transfer through which knowledge from one particular field (base domain) is mapped to an objective from another (target domain)* [33]. This echoes Welling's [85] definition of analogical thinking by which the *abstract relationship* between the elements of the first situation must be similar to the one found in the new context (p168). Analogy differs from combination, as combination requires: "the creation of a new conceptual structure" (p169). Also, analogy differs from metaphor since analogy refers to: "a transfer of whole structures and relations" [72,p120], not just one or a few properties. In creativity research, analogy is considered vital in human creative practice. This is clear in ideation although analogy is often construed as *analogical thinking*—the cognitive process of interdomain knowledge transfer. Analogical thinking is familiar not only in design [12], but in creative thought in general. It has been studied in depth by Holyoak and Thagard [43] who have built a so-called multiconstraint theory. The theory conceptualizes analogical thinking via three distinct types of *guiding constraints*—direct similarity between the elements involved, shared structure between roles in the base end target domain, and purpose, which means the person engaged in analogical thinking must have a reason for doing it, e.g., improving understanding of a situation. These three types of guiding constraints appear in all four steps of the process, i.e., selection of relevant information from memory, mapping of source onto target domain, evaluation to realize unique features of the target domain, and learning of success or failure of the application of the analogy. Our use of analogy is based on the selection and mapping steps and the three guiding constraints therein.

Design Space Aspects

We subscribe to the definition of a design space as: "*a conceptual space, which encompasses the creativity constraints that govern what the outcome of the design process might (and might not) be*" [6,p456, orig. emphasis].

Creative problem solving (CPS) is an area of study in creativity research and is often articulated via a distinction between a problem space and a solution space. Using the above definition of a design space enables a distinction between the problem and solution space and then the design space insofar as the latter is based on the creativity constraints that set the boundaries for an evolving creative activity and is co-constituted, explored, and developed by the designer. This builds on Zwicky's [87] morphological analysis of complex problem configurations according to which key parameters of a problem and their underlying conditions can be identified as a way to grasp the problem. Zwicky suggests that parameters and their (sub)conditions can be represented in a matrix. Since Zwicky has not applied this analysis to design, a further development of his two concepts has been proposed as a *design space schema*.

A design space schema is a notational tool for mapping critical aspects and their underlying options, which in sum make up a design space at any time. These aspects and the options associated with them can be seen as creativity constraints. Since some constraints in a creative process are manipulable [7], a designer can (to some extent) shape, explore, define, and delimit his/her particular design space by adjusting its aspects and options. A design space is a construct that a designer forms and bounds based on his/her knowledge and experience and in response to external conditions. By realizing the aspects and options, which as creativity constraints constitute the design space, a designer can define, develop, and delimit his/her design space to make it auspicious for creative performance—neither too wide (underconstrained), nor too narrow (overconstrained) [78]. This is vital in a creativity method's ideation part, as this is where the designer explores the creative problem and the pressure from its creativity constraints. Here, we focus on the extent to which a creativity method lets the designer explore, define, and delimit his/her design space to optimize potential for creative performance. This creative latitude can be construed via three key design space aspects.

Framing

The framing aspect of a creativity method in design pertains to the *mindset and perspective that a method strives to establish*. Many creativity methods in design seek to create a special mindset or disrupt participants' preconceptions of their design space in order to foster creativity [70,p196]. Design problems are rarely clear-cut from the outset, and Schön [73] has argued that a crucial aspect of design is framing and naming the design problem before the work to form a solution ensues. Therefore, some creativity methods seek to foster a change of perspective or mindset in order for designers to frame and name the design problem (or part of it) in another way to attain process progression. Such methods often support divergent parts of the process [55] where ways to address a design problem are explored and developed. Design fixation [44], i.e., becoming so fixated upon a specific way of seeing a problem or solution that it stops progress and the emergence of new solutions in the design process, can be a grave challenge for designers, and some creativity methods are well suited for avoiding and overcoming fixation. Framing aspects concern how specific creativity methods fit into the overall design process they are a part of, as well as the ways in which they transform or create momentum in the process.

Divergence

We define divergence as the *process of expanding the design space in order to enable and identify new options and alternatives beyond the immediate design space*. Guilford [40] has established divergent thinking as a key strategy in creative processes. Divergent thinking: "allows one to explore in different directions from the initial problem state, in order to discover many possible ideas and idea combinations that may serve as solutions" [31,p183]. In design, the goal of divergent thinking is to expand and explore the design space while avoiding criticism and evaluation. Runco and Acar [68] have shown how tests of divergent thinking for years have been the main measure of creativity. Divergent thinking may lead to originality, but not always to creativity in the sense of being both original (novel) and effective (useful) [69]. Despite this inherent conceptual indistinctness, tests of divergent thinking remain a relevant estimate of the potential for creative thinking (see [48] for an overview of creativity tests).

Convergence

As the polar opposite of divergence, we define convergence as the *process of contracting the design space in the form of fusing and/or discarding ideas in order to create a more focused understanding of the immediate design problem*. In convergent thinking: "one goes from an initial problem state through a series of prescribed operations in order to converge upon a single correct solution" [31,p183]. In design, convergence refers to the process of reducing the list of potential creative options by zooming in on salient aspects of the design process [55]. A phase of convergence (also called selection, reduction, elimination, evaluation, etc.) is analytical by decimating alternatives to a few or just one and is—regardless of denotation—integral to all models of creative processes (for an overview, see [72]).

Having introduced the nine key concepts from design and particularly creativity research, we now propose these as *potential components of an analytical framework* to help unpack creativity methods in design in order to improve understanding. To examine this, we apply the framework to three recognized creativity methods in design in order to probe the analytical framework's explanatory power.

ANALYZING THREE CREATIVITY METHODS IN DESIGN

Although there are several creativity methods available for different phases of a design process, we wish to probe the proposed analytical framework's potential in as much depth as the scope of this paper permits. We have thus confined ourselves to the following three creativity methods because they are significantly *dissimilar* and all prioritize *ideation*, which is integral to all creativity and design activities.

Smith [76] has shown that at least 172 distinct methods for ideation exist. Recently, Gonçalves, Cardoso, and Badke-Schaub [37] have studied the importance of design ideation among student and professional designers and noticed that both parties use ideation, but exhibit dissimilar inspirational approaches. Since most of our work is within Interaction Design, we focus on creativity methods in this discipline. We build on extensive first-hand experience with the three creativity methods both in design practice and in research.

Although we delimit our focus in this way, we argue that our analytical framework may well extend beyond methods specifically for ideation and specifically within Interaction Design. The motivation for prioritizing creativity methods for ideation does not reflect a return to a phase-based model approach. Ideation will often be featured most prominently in the beginning of a design process; however, ideation understood broadly as forming and relating ideas is critical throughout the duration of the design process. Our aim is to complement the phase-based categorizations, so our choice of ideation is for illustrative purposes only. In consideration of the paper's scope, we deliberately ignore more practical concerns, e.g., instructions and recommendations regarding preparation and execution time, required skills, experience, costs, etc. for each of the three creativity methods. Instead, we take the liberty of referring to the primary source stated in each of the methods for a detailed outline of these topics.

Table 1 below provides an overview of the three selected ideation-focused creativity methods in design as analyzed using the framework's nine components subsumed under the three overall categories. We return to Table 1 in the Discussion below.

Inspiration Card Workshops (ICW)

An *Inspiration Card Workshop* (ICW) [41] is devised as a collaborative design event involving professional designers and participants with knowledge of the design domain in which domain and technology insights are combined to create new design concepts.

The *process structure* of an ICW is built on three main phases: a) Introduction, b) Combination and co-creation, and c) Presentation of concepts. Also, there is an initial preparation phase and a subsequent processing phase. For the preparation phase, two sets of *materials* are created, Domain Cards and Technology Cards, which are index card-sized cards with an image and an optional brief text. Domain Cards represent knowledge about the context being designed for, and are commonly created based on field studies or other ways of gaining knowledge about the domain. Technology Cards represent generic technologies or a specific application of technologies. A web-based *tool* is available for browsing and selecting Technology Cards. Domain Cards and Technology Cards serve as sources of inspiration (which as an ignored concept is thus featured indirectly, see Method section) for the pivotal Combination and co-creation phase, and the selection of the cards helps define and delimit the *design space*. Selecting inspiration cards kindles *divergence* in the next part of the workshop. In preparing and setting up the workshop, organizers can work with *framing* to decide how much they should disrupt preconceptions among participants. Selecting familiar technologies for the Technology Cards is less disruptive than choosing new or even provocative technologies. This may be preferable in some situations, e.g., if participants are not accustomed to using creativity methods, but it might also lead to more conservative concepts.

The literature on ICW does not state how *metaphors* or *analogies* can affect the development of concepts. Still, it is clear that concepts emerging from these design workshops will often be creative *combinations* of ideas, concepts, and sources of inspiration in which aspects from one domain (e.g., qualities of a technological installation depicted on a Technology Card) are transferred to another (e.g., a new system for a part of the use domain on a Domain Card). The use of metaphor and analogy can be discerned based on the complexity of this cross-domain transferal.

The cards are presented in the Introduction phase, at times supported by video material to explain the Technology Cards. The cards are *combined* to form design concepts, and using *tools* such as pens and markers, the concepts are captured on sticky notes and similar design *materials* before being collected on poster-sized sheets of paper. While there is a defined *process structure* for the workshop, there are no mandatory process rules for the main creative phase—Combination and co-creation. The design concepts generated are then discussed and evaluated, but no distinct *convergence* in the form of reduction of options occurs. For the processing phase, the design concept posters are often transformed from physical to digital material, typically by using a flatbed scanner as a *tool* to create PDF files, which enables storing and digital distribution among participants.

Fictional Inquiry (FI)

Created by Dindler and Iversen [24], *Fictional Inquiry* (FI) is a collaborative creativity method for design that builds a narrative *framing* to transgress participants' preconceptions of a design situation.

The creativity method is often used to spur *divergence* in a process when designers either notice design fixation, need radically new creative input, or experience that their role as designers impact the ability of other project participants to offer original contributions. The creativity method works by "bypassing existing socio-cultural structures by creating partially fictional situations, artifacts, and narratives that mediate collaborative design activities" (p207). The method sets a novel *design space* through a fictional *framing* in which participants take on predefined roles. As an example, the authors describe how FI was used to develop concepts for digitally enhanced school bags in a project with primary school students. The fictional frame was that of Martians visiting Earth. The designers took on the role of Martians,

Framework		*Three Selected Creativity Methods in Design*		
Components		**Inspiration Card Workshops (ICW)**	**Fictional Inquiry (FI)**	**Extreme Characters (EC)**
Concrete Aspects	**Process Structure**	Three main phases, two additional phases. No specific process rules	Ad-hoc approach	Ad-hoc approach
	Materials	Blank paper, sticky notes, Domain and Technology cards	Visuals. Narrative-specific props	Visuals (collages). Character-specific props
	Tools	Pens, markers. Web-tool for selecting Technology cards. Scanner for sharing PDFs	Rarely relevant. Only if chosen materials require it	Rarely relevant. Only if chosen materials require it
Conceptual Aspects	**Combination**	Contents on cards are combined to form design concepts put on posters	Real-world and fictional-world ideas may be combined	Character, appearance, action, role of exaggerated user are all combined
	Metaphor	May occur, but this is not critical	Often occur in conjunction with the rise of analogies	Often occur in conjunction with the rise of analogies
	Analogy	Cards may trigger analogies, but this is not critical	Exotic narrative to ensure conceptual distance between real and fictional world	Introduced props and materials as 'placeholders' meant to enable analogies
Design Space Aspects	**Framing**	Established, delimited by selected cards	Established by distinct fictional framing	Established, expanded by exaggerated characters
	Divergence	Selection of specific cards aims at divergence	Aims at divergence in case of design fixation or if need for new creative input	Generation of exaggerated characters aims at divergence
	Convergence	Not significant. Design concepts are discussed, evaluated	Concepts, insights from fictional inquiry are transferred to real-world design situation in focus	Not significant. Aims at generating new perspective on user group

Table 1. The three selected creativity methods for ideation in design as analyzed using the analytical framework's nine components.

to whom students explained otherwise taken-for-granted aspects of how they conceived of and used their schoolbag since they now had to explain it to Martians rather than to a group of adults who they would expect to already know these things. The method does not prescribe a fixed *process structure*, but urges designers to consider the process of weaving together narrative elements and collaborative design activities in each individual workshop. *Materials* as sources of inspiration are often used, e.g., in the shape of props and visuals to support the narrative *framing*, but *tools* as such are rarely present.

In another example, the authors explain how the method was introduced to help develop interactive exhibits at an aquarium through a fictional *framing* in which participants helped the king of the lost city of Atlantis understand what humans perceive to be extraordinary experiences. *Materials* in the form of props such as seashells and the king's scepter were presented, and workshop participants used them to explore how undersea phenomena could be conveyed to aquarium visitors. Several of the emerging design concepts *combined* props with fictional aspects and elements of the real-world aquarium setting. FI usually builds a fictional *framing* that often yields *metaphors*, but the point is the rise of clear *analogies* to the 'real' design situation so that design concepts and insights from the fictional inquiry itself can be transferred to it to generate novel design ideas and solutions to be unpacked and singled out via *convergence*.

Extreme Characters (EC)

Described in detail by Frens [32], *Extreme Characters* (EC) is an oft-used creativity method in design and aims to impart richness to the *design space* by expanding its limits.

This creativity method is very *divergent*, which is mirrored in the *process structure*. Through scenarios supported by visuals (collages) as design *materials* (often augmented by role playing), EC exposes controversial, tabooed emotions and character traits normally hidden in assumingly more 'normal' scenario characters, as such character traits, views,

and emotions are usually deemed undesirable or abrasive [27]. By introducing extreme characters, the method displays a wider spectrum of human personalities. This provides a more nuanced understanding of the user group of the product being designed. As a creativity method, EC aims to avoid *convergence*. This is done by prioritizing new *combinations* of "the character, appearance, action and role" (p68) in the scenario. Exaggerated fictitious characters could include, e.g., a cynical drug dealer, a polyandrous young woman, or even the pope [32]; all portrayed using mainstream culture, movies, music, and music videos, etc. as inspiration. This is supported by character-specific props as design *materials*. An example could be a design brief about a new digital appointment manager (PDA). A drug dealer's golden rings could act as a physical 'placeholder', a temporary substitute for the object being designed, so that touching the flashy jewelry could be interpreted by *analogy* to represent switching between appointments. Since the aim in *analogical thinking* is transferal of entire structures and relations, the importance of *metaphors* is less significant in this creativity method. While Extreme Characters may lead to the creation of stereotypical personalities, and possibly convey an impression of prejudice, it remains an efficient method for *(re)framing* a design problem by forcing designers (and potential workshop participants) to challenge their mindset in order to reach an increased attentiveness to the richness of human personalities within the user group.

DISCUSSION

Based on the above analysis, we argue that the nine key concepts emerging from the extensive literature review of design and especially creativity research can indeed serve as relevant components of an analytical framework to reveal some of the inner workings of creativity methods in design. Rather than compartmentalize each of these components and in detail assess their individual relevance, we wish to bring attention to how these concepts—when examined in the light of actual design practice—are tightly interwoven and must be seen as working as a whole. Therefore, we deem it more useful to synthesize and discuss the most important insights from the analysis based on the three overarching categories (aspects) in order to conclude on the explanatory power of the analytical framework.

The Analytical Framework's Relevance for Improving Understanding of Creativity Methods in Design

As Table 1 shows, the three creativity methods each have a unique profile with regard to the nine components. The individual differences stand out when examining the results in more detail. This forms the basis on which we build our conclusion on the relevance of the analytical framework for improving understanding of creativity methods in design.

The Relevance of the Proposed Concrete Aspects

With respect to one of the most basic components, *process structure*, the diversity between the three creativity methods is evident. In ICW, there are three well-established phases (and two secondary phases) supported by guidelines. This contrasts with the much more ad hoc-like approach of both FI and EC. The three methods differ less in terms of use of *materials*, as all three employ these. Here, the cards used in ICW require research, design, and preparation, whereas the props in FI and EC need to be selected to fit the purpose of the design event, but apart from that, they may be used as-is. Interestingly, the three methods offer few *tools* for the support of ideation. Only ICW require specific technology-based tools, a web-based tool for selection of Technology Cards and a flatbed scanner for eventual distribution of the new design concepts. Conversely, FI and EC demand little technological underpinning unless circumstances call for it.

On this basis, we argue that the proposed Concrete Aspects, process structure, materials, and tools, are all relevant components of the analytical framework. Particularly with regard to process structure, the analytical framework reveals the dissimilarity of the three creativity methods.

The Relevance of the Proposed Conceptual Aspects

The selected creativity methods all contain an element of *combination*, *metaphor*, and *analogy*, albeit to varying degrees. In ICW, *combination* is critical both on an abstract level, as concepts are merged, but also on a concrete level, as selected cards are physically combined. This aspect is less tangible in FI since the combination occurring here is comprised by real-world and fictional ideas based on the chosen theme for the design workshop. In EC, combination works on an almost exclusively conceptual level, as the aim is to combine ideas, assumptions, and even prejudices using physical props in order to create exaggerated user personas to challenge preconceptions about a given user group. None of the methods rely on *metaphor* although it may emerge collaterally. *Analogy*, however, is essential in FI especially, as workshop participants are encouraged to seek and create analogies to spur insights of relevance to the design task. In EC, analogy is used very concretely, as various props serve as 'placeholders' specifically intended to kindle analogies.

On this basis, we argue that the proposed Conceptual Aspects, combination, metaphor, analogy, are all relevant as components of the analytical framework. Comparing the results from the analysis using the Conceptual Aspects has revealed that combination and analogy in particular are very relevant. Metaphor is less pronounced in the three creativity methods. Still, we argue that metaphor should be included in the analytical framework, as other studies have shown the importance of metaphors in design [16].

The Relevance of the Proposed Design Space Aspects

When looking at Table 1, it is evident that *divergence* is central in all three creativity methods. In ICW, the selection of specific cards is intended to create divergence. The same goes for the application of (often exotic) props in FI as a means to help participants create ideas and see the design situation in a new light, or if the design process stalls. This visibility contrasts with *convergence*, which is much less pronounced. Indeed, in EC, it is so insignificant that it becomes a goal to avoid it. In ICW, convergence mainly occurs toward the end of the design process when design

concepts are discussed and evaluated. In FI, convergence is relevant when ideas and concepts from the imaginary exploration are transferred to the specific real-world design situation. This evident variance between divergence and convergence is unsurprising since divergent thinking is a critical part of ideation. As for the importance of *framing* in the creativity methods, this is significant in all three. In ICW, the selection of cards serves to both establish and delimit the design space, as the cards function as creativity constraints. In FI, the framing is decidedly fictional and set from the start through the choice of narrative (e.g., Martians visiting Earth). Framing is equally central in EC since it is not only set, but also further expanded by the creation of exaggerated characters.

On this basis, we argue that the proposed Design Space Aspects, framing, divergence, and convergence, are all relevant as components of the analytical framework. By examining the results of the analysis using these components, it is evident that divergence plays an important role in all three creativity methods. The same is true for framing in the form of applying creativity constraints as a way to not simply establish, but also expand and alter the design space. Convergence was proven to be less critical in the three examples here. Still, we maintain its relevance in the analytical framework, as we have yet to see a creativity method (or a design process model) that does not include convergence in some form; at least as decision-making on a basic level. Therefore, we argue that all three Design Space Aspects should be included in the analytical framework.

Limitations of the Analytical Framework

Our analytical framework is intended as a first attempt at unpacking and conceptualizing a highly complex topic—the anatomy of creativity methods in design. To this end, we argue that our analytical framework is well grounded, which we have shown by testing it against three dissimilar recognized creativity methods in design. Still, we have yet to test it systematically in a real-world setting by applying it to a concrete design project whose complexity extends beyond the three distinct creativity methods examined here. Thus, we cannot at this stage assess its usability in actual design practice. We realize that it can be argued that it is a somewhat artificial grip to analyze these three creativity methods—Inspiration Card Workshops, Fictional Inquiry, and Extreme Characters—disconnected from their use in a particular project or design activity. Our response to such concerns is that we, given the scope of this paper, have found it necessary to treat the three creativity methods on a theoretical level in order to bring to the fore their anatomy, i.e., how they are in fact composed. For the methods' use in actual design projects, we refer to the original papers. We further acknowledge that our analytical framework may be more cumbersome (and time-consuming) to apply directly than the phase-based categorizations that it is meant to supplement, as these mainly require identification of the present phase so that a relevant creativity method can be selected and applied based on fit and pertinence. Our analytical framework has another goal, namely to offer a vocabulary from design and especially creativity research to help unravel and better understand how creativity methods in design work—and why. As with any literature review, there is a risk of inadvertently having missed an important text or topic. In admission of this, we have presented our nine key concepts forming the components of our analytical framework as *propositions*. The framework has not been empirically validated, but rendered *plausible*, *timely*, and *relevant* as propositions in accord with Whetten's work on what makes a theoretical contribution [86]. We recognize that we could have chosen other (or even more) creativity methods than these three. Our choice of exactly these three is based on considerable experience with using the methods in design workshops as well as both analytical and domain insight to ensure fit with the scope of the paper. Also, we maintain that these three creativity methods show adequate dissimilarity. When conducting this study, we have tried to balance analytical, explanatory power and level of detail and comprehensiveness. We see our analytical framework not as exhaustive, but as plausible and relevant to this end.

CONCLUSION

We have identified *nine key concepts* from design and creativity studies that form an *analytical framework* whose explanatory power we have shown by using it to display the different composition of three creativity methods in design. We agree that "method choice affects design outcomes" [42,p261], and that "*the design of the design process* […] may well be the most important design work in a typical project" [55,p16,orig.emphasis]. There is no substitute for expertise from extensive use of creativity methods in design practice. Still, our analytical framework can help designers make even better and more informed choices of creativity methods. Also, it is valuable when designers 'design the design process', as the framework reveals some of the main inner workings of creativity methods in design. Quantified scores have been proposed to help select one method over another [19,71,74]. Our aim has been different, i.e., to apply key concepts from design and especially creativity research to explore in more depth how and why such creativity methods work. In our view, improving understanding of the potential of creativity methods in design is particularly relevant for combinational creativity since this has been demonstrated to be highly productive for ideation [20].

Given the richness of modern creativity research, we believe it is fruitful to further probe how this discipline can contribute to coming design research. We hope that our contribution may inspire even more studies into creativity methods in design whose insights will appeal to the design theorist and the design practitioner alike.

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REFERENCES

1. Michael F. Ashby and Kara Johnson. 2014. *Materials and design: The art and science of material selection in product design* (3rd ed.). Butterworth-Heinemann, Oxford, U.K. (Original work published 2002).
2. Hedda Haugen Askland, Michael Ostwald, and Anthony Williams. 2010. Changing conceptualisations of creativity in design. In *Proceedings of the 1st Conference on Creativity and Innovation in Design* (Desire 2010). ACM, New York, 4-11.
3. Sara L. Beckman and Michael Barry. 2007. Innovation as a learning process: Embedding design thinking. *California Management Review* 50, 1: 25-56.
4. William Ian Beardmore Beveridge. 1951. *The art of scientific investigation*. William Heinemann, London.
5. Michael Mose Biskjaer, Peter Dalsgaard, and Kim Halskov. 2010. Creativity methods in interaction design. In Proceedings of the 1st Conference on Creativity and Innovation in Design (DESIRE 2010). ACM, New York, 12-21.
6. Michael Mose Biskjaer, Peter Dalsgaard, and Kim Halskov. 2014. A constraint-based understanding of design spaces. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (DIS 2014). ACM, New York, 453-462.
7. Michael Mose Biskjaer and Kim Halskov. 2014. Decisive constraints as a creative resource in interaction design. *Digital Creativity* 25, 1: 27-61.
8. Annemiek Van Boeijen, Jaap Daalhuizen, Roos van der Schoor, and Jelle Zijlstra. 2014. *Delft Design Guide*: *Design Strategies and Methods*. Bis Publishers, Amsterdam.
9. Boris Blumberg, Donald R. Cooper, and Pamela S. Schindler. 2011. *Business Research Methods* (3rd ed.). McGraw-Hill Education, Berkshire, UK.
10. Margaret A. Boden. 2004. *The creative mind: Myths and mechanisms* (2nd ed.). Routledge, New York. (Original work published 1990).
11. Nathalie Bonnardel. 2000. Towards understanding and supporting creativity in design: Analogies in a constrained cognitive environment. *Knowledge-Based Systems*, 13(7), 505-513.
12. Nathalie Bonnardel and Evelyne Marmèche. 2004. Evocation processes by novice and expert designers: Towards stimulating analogical thinking. *Creativity and Innovation Management* 13, 3: 176-186.
13. Eva Brandt and Camilla Grunnet. 2000. Evoking the future: Drama and props in user centered design. In *Proceedings of the 6th Participatory Design Conference* (PDC 2000). ACM, New York, 11-20.
14. Alan Bryman. 2012. *Social research methods* (4th ed.). Oxford University Press, Oxford, UK.
15. Mario Bunge. 2003. *Philosophical dictionary*. Prometheus Book, Amherst, New York.
16. Hernan Pablo Casakin. 2007. Metaphors in design problem-solving: Implications for creativity. *International Journal of Design* 1, 2: 23-35.
17. Hernan Casakin and Shulamith Kreitler. 2011. The cognitive profile of creativity in design. *Thinking Skills and Creativity* 6, 3: 159-168.
18. Henri H.C.M. Christiaans. 2002. Creativity as a design criterion. *Creativity Research Journal* 14, 1: 41-54.
19. Vicente Chulvi, Elena Mulet, Amaresh Chakrabarti, Belinda López-Mesa, and Carmen González-Cruz. 2012. Comparison of the degree of creativity in the design outcomes using different design methods. *Journal of Engineering Design* 23, 4: 241-269.
20. Fintan J. Costello and Mark T. Keane. 2000. Efficient creativity: Constraint-guided conceptual combination. *Cognitive Science* 24, 2: 299-349.
21. J. Daniel Couger. 1995. *Creative problem solving and opportunity finding*. Boyd & Fraser Publishing Co., Danvers, MA.
22. J. Daniel Couger, Lexis F. Higgins, and Scott C. McIntyre. 1993. (Un)structured creativity in information systems organizations. *Mis Quarterly* 17, 4: 375-397.
23. Nigel Cross. 2008. *Engineering design methods: Strategies for product design* (4th ed.). Wiley, Chichester, New York. (Original work published 1989).
24. Christian Dindler and Ole Sejer Iversen. 2007. Fictional inquiry—Design collaboration in a shared narrative space. *CoDesign* 3, 4: 213-234.
25. Alan Dix and Layda Gongora. 2011. Externalisation and design. In *Proceedings of the 2nd Conference on Creativity and Innovation in Design* (Desire 2011). ACM, New York, 31-42.
26. Peter Dalsgaard, Kim Halskov, and Ditte A. Basballe. 2014. Emergent boundary objects and boundary zones in collaborative design research projects. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (DIS 2014). ACM, New York, 745-754.
27. J. P. Djajadiningrat, William W. Gaver, and Joep W. Frens. 2000. Interaction relabelling and extreme characters: Methods for exploring aesthetic interactions. In *Proceedings of the 3rd Conference on Designing Interactive Systems* (DIS 2000), ACM, New York, 66-71.
28. Itiel E. Dror and Stevan Harnad. 2008. Offloading cognition onto cognitive technology. In *Cognition distributed: How cognitive technology extends our*

minds, Itiel E. Dror and Stevan Harnad (eds.). John Benjamins, Amsterdam, the Netherlands, 1-23.

29. Hugh Dubberly. 2004. *How do you design? A compendium of models*. Dubberly Design Office, San Francisco.
30. Gilles Fauconnier and Mark Turner. 2008. *The way we think: Conceptual blending and the mind's hidden complexities*. Basic Books, New York. (Original work published 2002).
31. Ronald A. Finke, Thomas B. Ward, and Steven M. Smith. 1992. *Creative cognition: Theory, research, and applications.* Bradford Books/MIT Press, Cambridge, MA.
32. Joep W. Frens. 1999. *Design of a portable appointment manager which considers content and emotional value of appointments*. Unpublished Master's thesis. Delft University of Technology, Delft, Belgium.
33. Dedre Gentner. 1989. The mechanisms of analogical learning. In *Similarity and analogical reasoning*, Stella Vosniadou and Andrew Ortony (eds.). Cambridge University Press, Cambridge, UK, 199-241.
34. Raymond W. Gibbs, Jr. 1999. Metaphors. In *Encyclopedia of creativity*, Mark A. Runco and Steven R. Pritzker (eds.). Academic Press, San Diego, CA, 209-219.
35. Sarah Gielen, Elien Peeters, Filip Dochy, Patrick Onghena, and Katrien Struyven. 2010. Improving the effectiveness of peer feedback for learning. *Learning and Instruction* 20, 4: 304-315.
36. Michael Golembewski and Mark Selby. 2010. Ideation decks: A card-based design ideation tool. In *Proceedings of the 8th Conference on Designing Interactive Systems* (DIS '10). ACM, New York, 89-92. http://dx.doi.org/10.1145/1858171.1858189
37. Milene Gonçalves, Carlos Cardoso, and Petra Badke-Schaub. 2014. What inspires designers? Preferences on inspirational approaches during idea generation. *Design Studies* 35, 1: 29-53.
38. Colin M. Gray. 2016. It's more of a mindset than a method: UX practitioners' conception of design methods. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI 2016). ACM, New York: 4044-4055.
39. Joy Paul Guilford. 1950. Creativity. *American Psychologist* 5, 9: 444-454.
40. Joy Paul Guilford. 1967. *The nature of human intelligence*. McGraw-Hill, New York.
41. Kim Halskov and Peter Dalsgaard. 2006. Inspiration card workshops. In *Proceedings of the 6th Conference on Designing Interactive systems* (DIS'2006). ACM, New York, 2-11.
42. Steven Harrison, Maribeth Back, and Deborah Tatar. 2006. It's just a method!: A pedagogical experiment in interdisciplinary design. In *Proceedings of the 6th Conference on Designing Interactive Systems* (DIS 2006). ACM, New York, 261-270.
43. Keith J. Holyoak and Paul Thagard. 1996. *Mental leaps: Analogy in creative thought*. MIT Press, Cambridge, MA.
44. David G. Jansson and Steven M. Smith. 1991. Design fixation. *Design Studies* 12, 1: 3-11.
45. John Chris Jones. 1992. *Design methods* (2nd ed.). Van Nostrand Reinhold, New York. (Original work published 1970).
46. Paul Jones, Paul A. Rodgers, and Bill Nicholl. 2014. A study of university design tutors' perceptions of creativity. *International Journal of Design Creativity and Innovation* 2, 2: 97-108.
47. John Kammersgaard. 1988. Four different perspectives on human-computer interaction. *International Journal of Man-Machine Studies* 28, 4: 343-362.
48. James C. Kaufman, Jonathan A. Plucker, and John Baer. 2008. *Essentials of creativity assessment*. Wiley, Hoboken, NJ.
49. Finn Kensing and Andreas Munk-Madsen. 1993. PD: Structure in the toolbox. *Communications of the ACM* 36, 6: 78-85.
50. Arthur Koestler. 1964. *The act of creation*. Hutchinson, London.
51. Vijay Kumar. 2012. *101 design methods: A structured approach for driving innovation in your organization*. Wiley, Hoboken, NJ.
52. George Lakoff and Mark Johnson. 1980. *Metaphors we live by*. University of Chicago Press, Chicago.
53. Dan Lockton, David Harrison, Rebecca Cain, Neville Stanton, and Paul Jennings. 2013. Exploring problem-framing through behavioral heuristics. *International Journal of Design* 7, 1: 37-53.
54. Panagiotis Louridas. 1999. Design as bricolage: Anthropology meets design thinking. *Design Studies* 20, 6: 517-535.
55. Jonas Löwgren and Erik Stolterman. 2004. *Thoughtful interaction design: A design perspective on information technology*. MIT Press, Cambridge, MA.
56. Bella Martin and Bruce M. Hanington. 2012. *Universal methods of design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Rockport Publishers, Beverly, MA.
57. Jonathan D. Mason. 2007. *Can contemporary art methods facilitate designers' creativity?* Unpublished PhD Dissertation. Loughborough University, Loughborough, UK. Retrieved November 9, 2012, from http://goo.gl/F0igk.

58. Elspeth McFadzean. 1998. The creativity continuum: Towards a classification of creative problem solving techniques. *Creativity and Innovation Management* 7, 3: 131-139.
59. Sarnoff A. Mednick. 1962. The associative basis of the creative process. *Psychological Review* 69, 3: 220-232.
60. Michael Michalko. 2006. *Thinkertoys: A handbook of creative-thinking techniques* (2nd ed.). Ten Speed Press, Berkeley, CA. (Original work published 1991).
61. Michael J. Müller, Daniel M. Wildman, and Ellen A. White. 1993. A taxonomy of PD practices: A brief practitioner's guide. *Communications of the ACM* (36)4, 26-28.
62. Anthony J. Onwuegbuzie and Rebecca Frels. 2016. *Seven steps to a comprehensive literature review: A multimodal and cultural approach*. SAGE, London.
63. Jonathan A. Plucker, Ronald A. Beghetto, and Gayle T. Dow. 2004. Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational Psychologist* 39, 2: 83-96.
64. Mel Rhodes. 1961. An analysis of creativity. *The Phi Delta Kappan* 42, 7: 305-310.
65. Horst Rittel. 1984. Second-generation design methods. In *Developments in Design Methodology*, Nigel Cross (ed.). Wiley, Chichester, New York, 317-327.
66. Lance J. Rips, Edward E. Smith, Douglas L. Medin. 2012. Concepts and categories: Memory, meaning, and metaphysics. In *The Oxford handbook of thinking and reasoning*, Keith J. Holyoak and Robert G. Morrison (eds.), Oxford University Press, New York, 456-474.
67. Mark A. Runco. 2014. *Creativity – Theories and themes: Research, development, and practice*. Elsevier Science, London, UK. (Original work published 2007).
68. Mark A. Runco and Selcuk Acar. 2012. Divergent thinking as an indicator of creative potential. *Creativity Research Journal* 24, 1: 66-75.
69. Mark A. Runco and Garrett J. Jaeger. 2012. The standard definition of creativity. *Creativity Research Journal* 24, 1: 92-96.
70. Elizabeth B.-N. Sanders, Eva Brandt, and Thomas Binder. 2010. A framework for organizing the tools and techniques of participatory design. In *Proceedings of the 11th Participatory Design Conference* (PDC 2010). ACM, New York, 195-198.
71. Prabir Sarkar and Amaresh Chakrabarti. 2009. Analyzing creativity methods. In *Proceedings of the 2nd International Conference on Research into Design* (ICoRD'09). The Design Society, Bristol, UK, 3-10.
72. R. Keith Sawyer. 2012. *Explaining creativity: The science of human innovation* (2nd ed.). Oxford University Press, New York. (Original work published 2006).
73. Donald A. Schön. 1983. *The reflective practitioner*. Basic Books, New York.
74. Jami J. Shah, Steve M. Smith, and Noe Vargas-Hernandez. 2003. Metrics for measuring ideation effectiveness. *Design Studies* 24, 2: 111-134.
75. Paula A. Silva. 2010. BadIdeas 3.0: A method for creativity and innovation in design. In *Proceedings of the 1st Conference on Creativity and Innovation in Design* (DESIRE 2010). ACM, New York, 154-162.
76. Gerald F. Smith. 1998. Idea-generation techniques: A formulary of active ingredients. *Journal of Creative Behavior* 32, 2: 107-134.
77. James P. Spradley. 1979. *The ethnographic interview*. Wadsworth, Belmont, CA.
78. Martin Stacey and Claudia Eckert. 2010. Reshaping the box: Creative designing as constraint management. *International Journal of Product Development* 11, 3: 241-255.
79. Susan Leigh Star and James R. Griesemer. 1989. Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Xoology, 1907-39. *Social Studies of Science* 19, 3: 387-420.
80. Erik Stolterman. 2008. The nature of design practice and implications for interaction design research. *International Journal of Design* 2, 1: 55-65.
81. Erik Stolterman and James Pierce. 2012. Design tools in practice: Studying the designer-tool relationship in interaction design. In *Proceedings of the Designing Interactive Systems Conference* (DIS 2012). ACM, New York, 25-28.
82. Mark Turner and Gilles Fauconnier. 1999. A mechanism of creativity. *Poetics Today* 20, 3: 397-418.
83. Graham Wallas. 1926. *The art of thought*. Harcourt, Brace and Company, New York.
84. Thomas B.Ward, Steven M. Smith, and Jyotsna Vaid. 1997. Conceptual structures and processes in creative thought. In *Creative thought: An investigation of conceptual structures and processes*, Thomas B. Ward, Steven M. Smith, and Jyotsna Vaid (eds.), APA, Washington, D.C., 1-27.
85. Hans Welling. 2007. Four mental operations in creative cognition: The importance of abstraction. *Creativity Research Journal* 19, 2-3: 163-177.
86. David A. Whetten. 1989. What constitutes a theoretical contribution? *Academy of Management Review* 14, 4: 490-495.
87. Fritz Zwicky. 1969. *Discovery, invention, research*. Macmillian, Toronto.