Intersections in Design Thinking and Art Thinking:
Towards Interdisciplinary Innovation

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ABSTRACT

As the problem-solving methodology of design thinking has gained legitimacy in business and educational environments, this article suggests we also think about incorporating "art thinking" into approaches in design pedagogy. To study what skills and techniques can be useful in other disciplines, we can first review the stages of the creative process which are centered around preparation, incubation, ideation, illumination, and evaluation. Within those stages, we can tease out specific elements unique to the artistic process that can be particularly useful, including mindsets of emotional engagement, intuition, and tolerance of ambiguity as well as cognitive strategies such as the use of metacognition, resource banks, generators and constraints, prolonged research, problem-creation, conversation with the work, closure delay, and reflection and thematic coherence. Emphasizing these elements and strategies in design pedagogy can expand possibilities for creativity and innovation.

INTRODUCTION

Recent studies have indicated that employers are increasingly concerned about a perceived lack of creativity in the workplace. In an American Association of Colleges & Universities survey of employers, 92% felt that innovation is essential to their company's continued success, and 71% felt that more curricular emphasis should be placed on innovation and creativity (Hart Research Associates, 2013). In the field of design, educators may not be successfully preparing students to enter the workforce and subsequently sustain careers (Davis, 2005). Design educators and practitioners have also sounded the call for designers to be more creative and generative in an uncertain world (Davis, 2015; AIGA, 2017). Designers are being asked to expand their roles into those of inventors or researchers, executing self-generated visions rather than the visions of others (Burdick, 2007).

In addition, speculative future practices need to be utilized to train designers to envision scenarios and design solutions for an unknown future (Teixeira, 2017).

Despite these calls for designers to be more creative and generative, there are few studies of how the creative process occurs in design, and creative strategies do not appear to be emphasized in design education (Oxman, 1999; Dorst & Cross, 2001). In addition, there is a lack of research that examines the *management* of those creative processes (Jacobs, 2017). Given these limitations, educators need to more fully understand, expand, and perhaps reconfigure how we teach the creative process to design students in order to prepare them for a complex and uncertain future.

Design and the fine arts have been historically connected in higher education both philosophically and operationally. While designers and artists share many creative methodologies, designers can be thought of as working to solve externally-defined problems, while artists create internally-defined "problems" to solve (Lawson, 1994). In fact, many creative thinking methodologies share commonalities across domains, including art and design, yet there are differences in both processes, personality attributes, and skills (Kaufman & Baer, 2005). While there are similarities between the creative processes of artists and designers, there are *domain-dominant* aspects of the creative process of artists.

"Design thinking" is a staged process model of creativity that has been developed and exported to management and higher education as a human-centred problem-solving methodology. In many respects, it simply packages problem-solving methodologies that are common across domains into a framework that is easy to understand and apply. The premise of this speculative paper is that these *domain-dominant* mindsets and cognitive skills of artists can be labelled "art thinking", which can be successfully transferred and utilized by designers to develop and self-generate more creative and innovative solutions. "Art thinking" overlaps with design thinking in several areas, but has a domain-dominant emphasis in the following cognitive strategies and mindsets:

Cognitive Strategies

- Metacognition
- Use of resource banks
- Prolonged research
- Problem-creation
- Use of constraints and generators
- Conversation with the work
- Delaying closure
- Reflection and evaluation of thematic coherence

Mindsets

- Emotional engagement

- Intuition

- Tolerance of ambiguity.

Some designers deliberately cultivate some of these practices, but it is not a point of emphasis in the design process/methodology research. If educators embed these mindsets and practices into design pedagogy, it may be possible to develop larger and more expansive frameworks for students to understand creative problem-solving.

To provide context for this inquiry, current discourses in design thinking will be compared to the research on actual creative practices of designers. Then, there will be a brief review of studies of creativity that focus on the practices and process of creativity, specifically on the creativity of artists. Following this review, a set of domain-dominant features of the creative processes of artists ("art thinking") will be proposed that could be infused into the design process and pedagogy to stimulate creativity and self-generative innovation.

DESIGN THINKING: CREATIVE PROCESSES AND MINDSETS OF DESIGNERS

While design thinking has been popularized in recent decades across professional publications, its definition lacks a consensus. In a comprehensive review of the literature to date on design thinking (Johansson-Sköldberg et al., 2013), the researchers posited that design thinking means different things in different contexts, often divided by theory (academia) and practice (management). Design thinking that is connected to a designer's process has been discussed in academic circles for decades, while design thinking as applied to management has only become a discussion topic in the past fifteen years (Hassi & Laakso, 2011). From this research, design thinking embodies two categories of distinction: "designerly way of thinking" and "design thinking" (Johansson-Sköldberg et al., 2013, p. 122). "Designerly thinking" is the more academic discussion of the professional designer's practice and non-verbal processes, while "design thinking" takes place in mainstream management literature outside a purely design context.

The use of the word "thinking" in design thinking is, of course, not fully representative of all of the action and doing inherent in the process. Lindberg et al. (2010) highlight the difference between examining design thinking processes versus design processes. Design thinking is not a process, but shapes processes. For the purposes of this paper, focusing on the "designerly way of thinking" and examining the research about how designers actually practice design provides a fuller picture of how "art thinking" might enhance creativity within those practices and processes. In the research on "designerly thinking", scholars have focused on the working processes (methodologies and activi-

ties), cognitive strategies (thinking styles), and mindsets (cognitive attributes or dispositions) of designers.

Design *processes and practices* include the following activities (Hassi & Laakso, 2011; Cross, 1990; Kimbell, 2011; Lindberg et al., 2010; Bauer & Eagan, 2008):

- iterating that moves from generating insights about users, generating ideas, prototyping, testing and implementing ideas
- forming multidisciplinary teams
- asking "what if?" to imagine future scenarios
- visualizing
- thinking by doing
- using a human-centred approach
- using convergent and divergent modes of thinking
- collaborating multidisciplinary teams
- resolving ill-defined problems
- exploring the problem space and the solution space
- understanding through immersion and subsequent redefinition.

Design *cognitive strategies* (or thinking styles) include the following (Hassi & Laakso, 2011; Bauer & Eagan, 2008; Lindberg et al. 2010; Tovey 2015):

- adopting solution-focused cognitive strategies
- abductive reasoning/thinking
- oscillating between divergent and convergent thinking
- reframing problems in a reflective manner
- utilizing a holistic view of the problem
- practicing integrative thinking
- imagining possible solutions .

Design *mindsets* include the following cognitive attributes or dispositions (Hassi & Laakso, 2011):

- experimental
- tolerant of ambiguity
- optimistic
- future-oriented.

By examining the creative problem-solving methodologies across domains and specifically for fine artists, we can begin to think about how "art thinking" - cognitive strategies and mindsets of artists - can weave in and out of some of these components to enhance creatively throughout the generative process.

CREATIVE PROBLEM-SOLVING: DOMAIN COMMONALITIES, SPECIFICITY AND DOMINANCE

What do we mean when something is labelled as creative? Definitions vary somewhat, but there is some consensus around Mayer's (1999) definition that creative describes something that is both *original* and *useful*. Kozbelt et al. (2010) provide a thorough summary of theories of creativity, all of which support the idea that creativity can be understood simply as a problem-solving process featuring different modes. Lubart (2000) takes a broad view of creativity in a thorough summary of staged and componential models of the creative process. The majority of this research focuses on elucidating working methodologies of the creative process which have many similarities to the design process.

The majority of these methodologies have been developed through research that takes a general view of creativity across domains. There are few studies that focus on the creative process of the artist, and the extent to which that process is domain-specific continues to be debated (Kaufman & Baer, 2005). In an analysis of the overview of creativity across domains, Kaufman and Baer (2005) noted that all of the authors in their edited volume found differences in creative processes, personality attributes and skills, including differences within individual domains themselves (Kaufman & Baer, 2005). Kaufman and Baer (2005) concluded that a skill or trait may not necessarily be unique to that domain, but it has a special emphasis within it. This is the presumption of this paper as well - that creativity can be conceptualized in a loose model in which some skills or traits are important across domains, some are shared by a limited set of similar domains, and some are quite domain-dominant or domain-specific.

ART THINKING: CREATIVE PROCESSES AND MINDSETS OF ARTISTS

Artists are not necessarily more creative than non-artists nor do they generate more creative solutions. However, the artistic process allows for a different kind of understanding of creativity, one that emphasizes self-generation, metacognition, and thematic coherence. These attributes could help designers in a contemporary environment in which creativity is seen as essential in developing novel solutions to complex and rapidly evolving environments, conditions and problems.

There are limited, yet influential, studies on the creative process specifically in artists (Getzels & Cszikszentmihaly, 1976; Kay, 1991; Dudek & Cote, 1994; Sapp, 1995; Mace, 1997; Mace & Ward, 2002; Botella et al., 2013; Glăveanu et al., 2013). In these studies, it is interesting to note that the researchers' methodology models differ from the previously mentioned models of creativity across domains. The artist models feature fewer discrete stages and allow for much more movement between stages. Prominent varia-

tions on the more general creative problem-solving models in general include Getzels and Csikszentmihalyi (1976) stages of experiencing conflict, formulating problem, expressing problem visually, resolving conflict through symbolic means, achieving cognitive and emotional balance; Sapp's (1995) stages of associative exploration, problem parameter exploration, multiple focus exploration, primary focus exploration, and refinement; Mace and Ward's (2002) stages of artwork conception, idea development, making the artwork, and finishing the artwork and resolution; Botella et al.'s (2013) stages of idea/vision, documentation/reflection, first sketches, testing forms and ideas, provisional objects (drafts), and series. Additional domain-dominant traits of artists that emerged in these studies will be highlighted in subsequent sections of this paper.

FROM DESIGN THINKING TO ART THINKING: DESIGNERS OF THE FUTURE

Designers are increasingly asked to research and understand their work more deeply and become more inventive, self-generating solutions to design challenges. "Designers are assuming leadership roles in which they are called upon to imagine systems, services, ecologies, experiences, and networks… As researchers and entrepreneurs, they must be prepared to generate self-defined areas of investigation and opportunity" (Burdick, 2007, p. 2). In response to these changing conditions, several streams of design scholarship have called for more connection between design practice and pedagogy, including the study of the creative processes of working designers (Dorst & Cross, 2001; Moultrie & Young, 2009), the study of design management pedagogy (Jacobs, 2017), and the need for designers to be more creative and responsive to complex environments (AIGA, 2017; Burdick, 2007). Designers need to function in a cross-disciplinary fashion in teams with multiple and varied expertise (Davis, 2015). They also need to be collaborative and able to navigate within complex systems. In many college curricula, students are not being taught to collaborate together in deep engagement with complex systems and user research (Davis, 2015). In addition, there is increasing pedagogical emphasis on creativity and its elevation to a level equal to or beyond critical thinking and its importance in learning outcomes (Krathwohl, 2002). The convergence of all of these trends calls for more explicit understanding and training of the creative process for designers. Design's close connection to art suggests a natural link and transferability of cognitive strategies and mindsets between artists and designers.

There are clear overlaps in the creative processes of both designers and artists. Some artists' practices, thinking styles, and dispositions may not be domain-specific (in fact, many of these are shared with design), they could be considered domain-dominant. This paper proposes that "art thinking" does not necessarily diverge from de-

sign thinking, but the process has a strong emphasis within a few key cognitive strategies and mindsets. If we take the same approach as efforts to systematize design thinking processes, we can strategize about ways to bring the creative processes of artists, or "art thinking", into design.

DOMAIN-DOMINANT COGNITIVE STRATEGIES OF ARTISTS AND THEIR TRANSFERABILITY TO DESIGN PROCESSES

There are some domain-dominant *cognitive strategies* of artists that designers can study and employ to develop creative ideas and innovative solutions. These include emphases on the use of metacognition, resource banks, prolonged research, problem-creation, constraints and generators, conversation with the work, closure delay, and reflection and thematic coherence.

Metacognition

Embedded within an artist's palette of cognitive strategies is the ability to view one's own work in a metacognitive fashion. Metacognition refers to the monitoring of one's own cognitive processes and influences while focusing on a specific task (Kitchner, 1983). Metacognition plays a key role in problem-solving and is especially important for solving open-ended, creative problems (Jausovec, 1994). Poor problem-solvers are less efficient at monitoring their own creative processes. While metacognition is a skill that designers need, it is especially acute for artists, as their problems are self-generated and successful solutions are primarily assessed against the artist's conception of the problem. Through metacognitive thinking, the artist has knowledge and control over his or her cognitive processes. He or she must constantly be aware of what is known and unknown while developing a strategy for further inquiry. Rather than continually focusing on a solution as a designer might, the artist may reflect on the problem for a more prolonged period of time.

All studies of the creative process of artists highlighted the artist's ability to consciously move between different modes of thinking within a given situation, which reflects a metacognitive mindset. The artist's mind can quickly switch between modalities of thought such as visual, verbal and aural (John-Steiner, 1985). This transition between modalities sparks creativity (Gruber & Wallace, 1999). Artists use different types of mental abilities to be creative and generate ideas, and then to refine and execute those ideas (Csikszentmihalyi, 1996).

Designers also shift often and rapidly between different modes of activity and thinking during creative periods (Cross, 2001). "Six out of a total of eight times a novel design decision was made, we found the subject alternating between these three activity modes (examining-drawing-thinking) in rapid succession" (p. 13). However, metacognitive skills

may not be well developed in designers and design educators, and designers may not be taught to be aware of these shifts in problem-solving modes (Hargrove, 2011). As Oxman (1999) writes about design education in the studio, "the educational focus still remains on the representation of the design object, rather than on an explicit articulation of knowledge" (p. 107). As metacognition is a key component of the creative process across all domains, design educators need to explicitly teach this cognitive strategy.

Hargrove (2011) mapped out some strategies to teach metacognition in his description of a semester-long process in which students continually reflect on their selection and employment of cognitive strategies to solve design problems. This approach promoted more independent, self-regulated thinking. Hargrove (2011) also utilized assignments such as journal keeping and a final reflection that connects cognitive strategies to the final design process and outcome. Design educators should structure projects to allow for multiple modes of thinking that are by various turns lateral, strategic, holistic, creative, reflective, reactive, and analytical. Design students should then be asked to explicitly reflect on these.

Metacognitive awareness allows for switching between modes, a necessary cognitive strategy for designers to develop solutions to complex problems. While metacognition is only briefly mentioned here, it is a central component carried throughout the suggested list of cognitive strategies and mindsets in this paper.

Resource banks

Several of the creative problem-solving methodologies (Osborn, 1953; Amabile, 1988; Puccio & Cabra, 2009) and artistic problem-solving methodologies (Getzels & Csikszentmihalyi, 1974; Sapp, 1995) include an initial stage of pre-preparation, something that is not included in design thinking models. Within this stage, we can find the domain-dominant trait of artists of growing and cultivating "resource banks" which provide a well for creativity. During this pre-preparation stage, the artist is simply consuming information, absorbing input, categorizing it, and filing it for use as possible source material. Artists describe themselves as "sponges" in a receptive stage, taking in the stimuli of the world to be stored in a personal vocabulary (Glăveanu et al., 2013). Ideas emerge from a resource bank filled with previous work and research that the artist has built up over his or her career (Mace & Ward, 2002). During the idea stage, the artist experiences a creative spark after a period of wandering and waiting, during which a stimulus (such as an image, sight, sound) triggers something that has been latent in the artist for a long time (Botella et al., 2013). The artist has a deep understanding of their discipline so that when inspiration or idea strikes, it is recognized and acted upon. This state of awareness functions like a kind of priming device, allowing an artist to be ready to respond when seeking to find, generate, and/or solve a creative problem.

Artists are especially aware of assembling source material as an ongoing process, not just as a means to respond to a creative brief, as a designer might. Experienced designers also exhibit high sensitivity to their internal and external environments (Cross, 2011). Aspiring and beginning designers should be cognizant of this strategy to develop an awareness of their resource banks and consciously build them even when not working on a specific project or client need. This may help to ameliorate the issue of designers quickly scanning through award annuals for inspiration, or copying previous work (Dorland, 2009). Design educators should emphasize this activity with students as an integral part of an ongoing practice, with or without a client commission. Independent of a specific assignment or creative brief, students could record and reflect on the information streaming in from their internal and external environments. This could be achieved through some sort of journaling or recording that identifies sensory information and content from a range of sources including personal thoughts, sketches, news, music, film, independent research, and so on. The development of this intention and practice should be clearly elucidated for students.

Prolonged research

Connected to the practice of using a resource bank is the ongoing, deep immersion in the domain and artmaking practice that provides artists with a source of creativity. Creativity researchers have emphasized the importance of understanding the domain in which one is operating (Ericsson et al., 1993; Gardner, 1993; Csikszentmihalyi, 1996). The artist comes to know his/her own domain and becomes expert in it, both in its traditions and areas for possible problems or new explorations. Artists are then willing to cast out in new directions while less creative types are content to adhere to what is already known (Gardner, 1993). Diving deeply into a new domain is essential for meaningful creative growth and innovation. Artists are continually scaffolding onto previous art forms and paradigms of artmaking (Turner, 2006). In addition, many artists undertake extensive research, either as part of an ongoing practice or dedicated to a specific project.

Design thinking incorporates this domain immersion as well. From the design thinking management perspective, Brown (2009) calls this the inspiration phase, while from the "designerly ways of thinking" academic perspective, Dorst (2004) labels it the formulation phase. Research is a standard of learning for thinking critically within a discipline and immersion and planning are key components of the design process. However, unlike designers, artists are more likely than designers to *linger* in this phase, thinking about the domain and the problem before jumping to the solution (Cross, 2010; Dorst, 2004). In his study of how designers think and practice, Lawson (1994) writes:

> *The problem for the designer is when the attempt should be made to reconcile all the ideas, or lines of thought, which are developing. If this is attempted too early, ideas which are still poorly understood may get lost, while if this is left too late they may become fossilized and too rigid* (p. 140).

Designers often jump quickly into developing a solution without examining the problem thoroughly. In fact, it may be that designers need to take the time to reframe the problem or proposal (Cross, 2001). Asking designers to consciously linger in the research phase can lead to increased openness to multiple solution paths. Applying this aspect of art thinking to the design process can call for less goal-oriented work and provide more room to explore paths that might not lead to fruition. It can also allow for different methods of recording research, such as visual notetaking, scrapbooking or blogging. Design educators can build this extra time into their assignments in order to emphasize the importance of refraining from jumping to the solution too quickly without spending adequate time focusing on problem generation and clarification.

Problem-creating

A key difference in processes between designers, artists, and other domains (such as scientists) is in the problem-finding aspect of creativity (Kozbelt et al., 2010). Many creators and researchers have noted that *finding* the right problem (or asking the right question) is far more important than *solving* the problem (Getzels & Csikszentmihalyi, 1976). During the preparation phase of the creative problem-solving process, understanding the domain-dominant feature of problem-creating in art might help designers employ other methodologies to develop more creative solutions. Getzels and Csikszentmihalyi's (1976) in-depth longitudinal study of college students that examines personality traits, process, creative production and career success is one of the most-cited accounts of the creative process of artists. As in other general creative process studies, the researchers' key discovery is that finding a problem is more indicative of creative behaviour than solving a problem. Researchers found that time artists spent working on the drawings did not increase their quality. Rather, the time spent formulating the problem before beginning did increase the quality of the drawings.

While designers may search for new problems, the search usually occurs within the context of the design brief. Artists, on the other hand, are unique in their driving force of self-generating their 'problems' (Cross, 2001). Lawson (1994) offers the following distinction between art and design: "Design is directed towards solving a real-world problem while art is largely self-motivated and centers on the expression of inner thoughts" (p. 138). Therefore, design will always inevitably be guided by rational thought and evaluation that is relevant to the real-world. Lawson continues:

Designers must consciously direct their thought processes towards a particular specified end, although they may deliberately use undirected thought at times. Artists, however, are quite at liberty to follow the natural direction of their minds or to control and change the direction of their thinking as they see fit (p. 141).

Studies also demonstrate that designers generate more varied solutions when the problem (rather than the solution) is precisely defined (Cross, 2001). So while a designer's tendencies are to immediately begin iterating and developing solutions, they may be better able to generate solutions by examining the problem further before moving into the solution phase of the process.

"Art thinking" is distinctive in the artists' self-generation of the problem. Artists do not wait for a problem to be handed to them or look for a problem in what already exists; rather, they create it from within, through their primed and prepared mind. Unlike designers, artists are more comfortable creating and reframing the original problem and less focused on a solution (Cross, 2001). This can be valuable when inventive thought is needed. Artists are adept at creating challenges for themselves, asking new questions of their work and applying new constraints to it. In lieu of having the problem defined externally (as in design), the artist generates his/her own problem based on emotion and input, connecting to larger themes throughout his/her work.

Adopting a stance of being open to a new approach to viewing and constructing a problem is a transferrable skill to a variety of disciplines, including design, which can lead to increased creativity and innovation. Design students are often uncomfortable in the absence of being given a specific assignment or brief. Therefore, educators need to include more assignments that allow for self-generated creativity. Rather than provide the design problem for students in the brief or assignment, instructors could ask students to first define the problem, which could be based on a given set of circumstances, environmental conditions, business needs, social problems, and so on. Rather than immediately focus on solving a problem as quickly as possible (which can often lead to traditional, non-innovative solutions), "art thinking" can encourage people to take the time to think more deeply about the problem itself.

Generators and constraints

Following the pre-preparation and preparation stages of the creative process, artists begin to synthesize their research and domain knowledge in the incubation stage. As - which characterize the work of visually talented individuals as they link their impressions into a landscape" (John-Steiner, 1985, p. 24). Moments of inspiration are often described in magical, mysterious terms; however, they are actually the product of creating the space to allow the mind to make connections between various inputs.

In a valuable study of limited scope, McDonnell (2011) compared the creative process of two fine artists to the creative process in design. She focused on the differences in strategies used by designers and fine artists to impose constraints on a project. McDonnell utilized Darke's (1979) term "primary generators" as frameworks that artists use for their practice in which they set their own challenges. The thematic, aesthetic and material constraints that artists set for themselves are employed in order to maintain thematic coherence across a body of work (McDonnell, 2011). Gruber and Wallace (1999) noted that most creative thinkers work on themes or threads of thought constantly throughout a lifetime, maintaining continuity across multiple projects at once. Inevitably, one project leads to another and the projects inform one another, leading to the development of new points of view. Kay (1991) described this use of generators or frameworks as a "personal aesthetic bias", a support structure or framework that forms an organizing principle for the creative thought process of the artist (p. 248). This guides the search for the problem, providing selection criteria through which the artist explores and forms the basis of language for the artist's body of work. The art making process is overarching and includes an ongoing practice rather than single finite pieces of artwork.

Constraints can be seen as the flip side of generators. Constraints impose further limitations on the work in order to proceed with a guiding framework. Much of the literature on creativity addresses the idea of constraints - how the creator perceives them, when they are introduced into the process, and how they may or may not impact creativity. A difference between art and design is that in design-related fields, problem parameters are often already decided on, and the progression through the creative stages will be defined by these parameters (Sapp, 1995). If the parameters are too restrictive in the early stages of the process, the potential for creativity may be limited (Sapp). The way in which the artist proceeds through the problem-solving stages depends heavily on the restrictiveness of the parameters. As in the self-generated problem definition of the preparation stage, the constraint for an artist is most often internally (rather than externally) determined. This is in contrast to the designer for whom constraints are usually set by client demands, budget, project needs, and so on. Similar to the creative process in science, the creative process in design is more likely to have a consistent process because the constraints are stronger, whereas art will not (Simonton, 2004). Artists' processes are therefore more likely to vary.

By transferring this domain-dominant practice of artists to their own practice, designers could be more metacognitively aware of the frameworks and primary generators that they are using. Building on resource banks and problem-finding, if students deliberately reflect on the development of their ideas, they could also clearly identify a given set of

generators and constraints. Educators can also consciously introduce constraints to stimulate more generative creativity. In addition, students could identify and utilize their own generators and set their own constraints.

Conversation with the work

Moving from the incubation stage of the creative process into the ideation stage of the process (it should be noted that these stages occur within a methodology in which stages are not always linear), conceptual development coalesces for the artist as he or she synthesizes diverse source material to make connections and develop concepts. In the studies of the creative process of artists, the researchers' examinations of this stage of idea development revealed the ways in which artists would have "conversations" with their pieces, developing a dialogue with the pieces, reacting to them, and making incremental changes along the way. (This can be framed as another metacognitive approach.) Problem-finding is not limited only to the preparatory phase; rather, it is ongoing for the artist, often in conversation with the artwork (Dudek & Cote, 1994). Mace (1997) described the decision-making process as a responsive interaction between artist and work in which the artist responds to the work and adjusts accordingly. As the artist makes decisions, he or she converses in a way with the work as they proceed, a unique experience that develops situationally (Mace, 1997). If artists let the solution develop while responding to the work throughout, rather than just applying a known solution, more creativity results. This is a phenomenological appraisal of artistic creativity in which the artist "feels" their way towards the creation of the work.

Botella et al. (2013) also described artists' accounts that their work "posed questions" to them (p. 167). Artists enjoyed engaging in this dialogue with the work, "confronting" the art object (ibid.). Glăveanu et al. (2013) described this as a "dynamic between doing and undergoing" in which artists refer to the back-and-forth nature of developing a work and series (p. 6). It is a constant negotiation between the artist and the developing concept of the work (Mace & Ward, 2002). The development and evolution of the work is altered via this conversation and response to the medium. It also demonstrates how artists are comfortable with openness, working on open-ended problems, allowing the problem they have created to evolve.

While design students may already be asked to reflect on their final products, this simple rhetorical and phenomenological device of framing the iterative process as a *conversation with* the work could be a valuable pedagogical tool. This encourages a metacognitive understanding of the interplay between the practices of doing and thinking by asking students to answer "What did you try? How did it work?" This reconnects to Hargrove's (2011) research on utilizing ongoing reflective practices in his design studio courses.

Delaying closure

Creativity studies across domains show that some of the most creative ideas may come later in the process, after the ideation stage. In studies of artists, professional artists were found to have "delayed closure", continuing to experiment with solutions longer than non-artists (Walker, 2004, p. 10). By refusing to settle for an initial early solution, creativity can emerge in the form of new combinations and associations. Artists were shown to do this more than non-artists, and they found the experimentation phase of their projects to be quite enjoyable (Mace, 1997). In another study of art students, those who were willing to delay closure during the art making process moved beyond obvious possibilities and generated more creative artworks (Walker, 2004).

This strategy of delaying closure works in tandem with the rush to problem-solution mentioned earlier. If design students feel that they have satisfied the assignment or the parameters of the brief, they may stop development too early in the process, possibly thwarting the development of a more creative solution. Design educators can emphasize the importance of deadlines, but at the same time allow for solutions to come later in the process. Educators should explicitly communicate this opportunity for students to rework an idea after a stage has been passed if a more creative solution has been identified and developed.

Reflection and thematic coherence

During the final evaluation phase of the creative process, metacognition is enacted again via reflection. At this point, artists understand the need to step back from a project, regroup, and reassess from an objective point of view (John-Steiner, 1985). Artists can be thought two employ two types of metacognition, both internal and external: "The first type involves verifying or measuring the product against an internal standard - the original purpose of the creative enterprise and the mental image formed during illumination. The second type of metacognition involves verifying the product against an anticipated external standard - a would-be audience" (Armbruster, 1989, p. 180). Artists become especially attuned to responding to both internal and external standards, and this awareness could be useful in other disciplines (Armbruster, 1989).

Artists and designers are continually reflecting on what they are producing and using those assessments to move forward with their work. This is often built into their daily working process and speaks to the dialogue between process and product (John-Steiner, 1985). Beyond the completion of a finite project, an artist must continually reflect on their body of work within the arc of a career. Artists are expert in self-reflection on what they have done, seeing it from a metacognitive perspective (Turner, 2006). The artist has an internal dialogue in which s/he is continually pushing his or her thinking, taking risks to move past the safe and reliable solutions to continually raise new questions (Walker,

2004). In Botella et al.'s (2013) methodology of the artistic creative process, the final stage process is called "series" during which artists iterated more variations and engaged their work in the world. Just as an artist thinks about problem-solving with the work to execute the initial idea or concept, he or she also sees their work as part of a larger body of thematic coherence, as part of his or her "streams" of work overall.

The iterative nature of design thinking highlights that designers are also continually framing and reframing their work. While experienced designers do this (Cross, 2011), are design educators teaching students to do this? Is it built into the curriculum beyond a simple portfolio class? As an artist develops a body of work and assesses it, so too should a student be given the opportunity and tools to assess their own work on the path towards improving it. This metacognitive, reflective arc could be explicitly identified, scaffolded into lower-level courses, and embedded into upper-level capstone or portfolio courses in design curricula.

DOMAIN-DOMINANT MINDSETS OF ARTISTS AND THEIR TRANSFERABILITY TO DESIGN PROCESSES

In addition to analysing these *cognitive strategies* of the creative process of artists for potential transferability to design processes, there are some domain-dominant, overarching *mindsets* or artists that designers can look to cultivate in order to generate more creative solutions. These points of emphasis include emotional engagement, intuition, and embracing ambiguity.

Emotional engagement

In one of the first research projects to study the creative process of artists, Patrick (1937) found artists to have more "emotional feeling" than non-artists during the process (p. 54). Dudek and Cote's (1994) analysis also highlighted artists' intense emotional involvement during the artmaking process. The authors relate this to the artists' "emotional preoccupation with self", to create or communicate the experience of emotion. Artists are highly aware of these feelings and use them as source material for their work. They are also excited and engaged about getting an idea, and this emotional connection, which is mostly positive, continues throughout the project (Botella et al., 2013).

Studies indicate that artists are more emotional than scientists, and designers fall somewhere in between (Feist, 1999). Wakefield (1994) uses the term "empathy with one-self" as a way to describe the artist's exploration of emotional states and conflicts as source material or a means of problem-finding (or concept/theme-finding) and solving. This use of the word empathy is notable in relation to the empathy stage of the design thinking process in which the focus is on empathy for the user (through the use of ethnographic studies, research, etc.). For the artist, the focus is towards the self. Glăveanu et

al. (2013) described the ongoing emotions of the process: "These range from pleasure and satisfaction to melancholia and even depression but, most of the time, the reported states are positive and have to do with the 'jubilation of being alive'" (p.5-6). This is clearly a key distinction for artists - to be in tune and connected with their emotions.

Self-awareness and emotional connection, both to self and others, can be a key fulcrum from which designers and design students can think about operating. Research in social psychology indicates that self-empathy and self-awareness lead to more empathy for others (Neff, 2003). Through more conscious emotional engagement with oneself, one's intuition, and one's work, a designer might become truly empathic and in touch with themselves on a path to becoming more human-centred, self-aware, and generative of a broader range of creative solutions. Design educators can find a way to include more exercises to develop reflection and self-awareness. Possible strategies to increase empathy include teaching mindfulness, reflective writing during multiple stages of the design process, debriefing and class discussion, and role playing.

Intuition

Connected to the personal and emotional engagement of artists, intuition is a key point of emphasis in art thinking. Most successful artists are in touch with their intuition (Wakefield, 1994). For artists, ideas don't always come from a brief or an assignment, but they spring internally from life experiences and knowledge of their medium. While one may think of a magical 'aha!' moment that occurs in the creative process, it is more often the case that artists are making connections and associations between embedded knowledge. For designers, Cross (2001) notes that the idea of a creative leap is better described as a key moment that bridges the problem and solution. This bridge can also be thought of as a two-stage process with an initial intuitive, emotive phase as well as a more analytical, iterative second phase (John-Steiner, 1985).

Experienced designers have also been shown to deeply rely on their intuition, but they are unaware or at least unable to express how that intuitive sensibility developed for them. "They believe that this 'intuitive' way of thinking may be something they inherently possess, or it may be something that they developed through their education" (Cross, 2011, p. 9). Cross speculates that what the designer describes as intuition is actually a pool of knowledge derived from extensive experience.

As evidenced by the designers' inability to identify the source of intuition, the cultivation and translation of experience into intuition has not been transferred to design pedagogy. Rather, designers are expected to accumulate this knowledge through experience, trial and error. Developing a metacognitive awareness of intuitive decision-making and

identifying key moments of intuitive bridging from problem to solution might allow designers to tap more consciously into emotion and intuition, generating more questions and alternative problems. In design education, we should demonstrably allow for these emotional and intuitive stages and respect that not everything that arises from these processes will lead to fruition. Techniques and strategies can be employed to foster intuitive and associative thinking. Projects should be facilitated in a way that allows for increased room for exploration and reflection prior to evaluation. Again, design educators should build in space for metacognitive reflection to understand and cultivate these mindsets.

Embracing ambiguity

Descriptions of the creative processes of artists and designers often include a tolerance for ambiguity which has been described as the most mature stage of ego development (Loevinger, 1987). Both designers and artists are comfortable with ambiguity, which may be evident in the sketching process (Cross, 2001). However, the artist seems to go beyond mere *tolerance* to an *embrace* of ambiguity. This is something that can be useful for educators as they scaffold students through critical thinking and developmental stages of learning.

As an integral part of their process, artists are accustomed to trying an idea and failing. From the outset, one doesn't know how the problem created can be solved, so trial and error is vital. Successful artists produce a prolific amount of good work as well as bad work (Gardner, 1993). While designers are comfortable with iteration and failure within the context of the larger project or design brief, artists operate in an uncertain and limited marketplace, often attempting problems and solutions for which there is no audience or acceptance. Without a client to serve or a finite 'problem' to solve, artists may be more tolerant of ambiguous solutions and non-productive explorations.

Experienced designers understand that ambiguity and uncertainty are essential to the exploratory nature of the design process (Bucciarelli, 1994). However, design students are often uncomfortable without specific guidance, permissions, rigid frameworks with which to proceed. They become reluctant to move forward and test an idea, restricting their capacity for learning. In a business setting, less experienced designers may generate fewer innovations and creative solutions because their tolerance for ambiguity is too low, making them risk-averse to an extent that it hinders their growth. On the contrary, artists are more tolerant of ambiguity which allows them step back and make connections between and assessments of ideas (Lewis, 2014). We should explicitly model this *embrace* of ambiguity for our design students. This could be achieved by relaxing rubrics, allowing for multiple problem solutions, and rewarding novel solutions.

CONCLUSION

There is a problem-solving process that is common to all domains and all human cognition. However, a range of factors influence how those problems get solved, how they get solved creatively, and how innovation is generated. A comparison of the creative process of designers and artists illustrates key areas of overlap and distinction. Both use key cognitive strategies and mindsets that fall within loose methodological stages of pre-preparation, preparation, incubation, ideation, elaboration and evaluation.

In the same way that design thinking has been applied in the classroom and workplace, we can expand our methodologies to include "art thinking", specifically through the education of designers. There are some key domain-dominant points of emphasis in both cognitive strategies and mindsets specific to artists that may be especially transferrable to design students. Artists are expert at the mindsets of emotional engagement, intuition, and an embrace of ambiguity. They also employ such cognitive strategies as the use of metacognition, resource banks, generators and constraints, prolonged research, problem-creation, conversation with the work, closure delay and reflection and thematic coherence. Utilizing some of these approaches within design pedagogy may address the previously mentioned calls for designers to have more creativity and self-generativity.

Future research might then strategize how to expand upon and apply these processes beyond art and design to other disciplines. In an educational environment, all of these elements and strategies can help students mature developmentally and engage with subject matter from a more critical, creative, and engaged perspective. The creative process could be pulled out into individual components and highlighted in the classroom, or more effectively, used as an arc for a project or an entire class. Projects can be constructed to allow for more freedom to discover connections and iterate new ideas. Just as in the classroom, the ability to critique and metacognitively reflect upon ideas in the workplace would be invaluable to developing innovative new solutions. As businesses look to hire more employees who are creative, educators have a responsibility to infuse some of these techniques into all of the disciplines in which we teach. Finally, by systematizing the problem-solving approach of "art thinking", we can possibly shift the focus from the creative person/personality to the process itself. Therefore, creativity and innovation can (and should) be taught to many people, not cultivated exclusively in the gifted minority. Creativity is a skill that can be developed, practiced, and improved upon over time.

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