The Ambiguous Role of Constraints in Creativity: A Cross-Domain Exploration

Biskjaer, Michael Mose; Onarheim, Balder; Wiltschnig, Stefan

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Michael Mose Biskjaer
Department of Information and Media Studies
Aarhus University
Aarhus, Denmark
imvmmmb@hum.au.dk

Balder Onarheim
Department of Marketing
Copenhagen Business School
Copenhagen, Denmark
bo.marktg@cbs.dk

Stefan Wiltschnig
Department of Marketing
Copenhagen Business School
Copenhagen, Denmark
sw.marktg@cbs.dk

Abstract
The relationship between creativity and constraints is often described in the literature either in rather imprecise, general concepts or in relation to very specific domains. Cross-domain and cross-disciplinary takes on how the handling of constraints influences creative activities are rare. In this paper, we explore these particular issues in two creative domains: art and engineering design. These domains vary so greatly in terms of number and types of constraints in play that we argue for considering them as opposite extremes of a continuum of levels of creative freedom. By comparing two case studies of Danish cutting-edge proponents of creative expertise thus exemplifying each domain, this preliminary exploration mainly focuses on similarities in how such successful professionals work with constraints to frame their creative process and ensure its progression toward the final outcome. Our main observations suggest that despite vast differences between the two domains, significant patterns and strategies reoccur. From a list of nine such similarities identified, four patterns are analyzed across the two domains in more detail as a contribution to encourage further advancement of cross-disciplinary research into the ambiguous role of constraints in creativity.

Keywords
Design, engineering design, creativity, constraints, art, filmmaking

1. Introduction
While conventional wisdom might suggest the benefit of having infinitely many ways to proceed during the first phase of a creative process, recent scholarly work on the complex role of constraints in such activities points in another direction. In common use, the term ‘constraint’ is easily associated with limitation and requirements. Within design, a basic working definition is provided by Vandenbosch & Gallagher (2004:198): “Constraints are limitations on action. They set boundaries on solutions”. Based on a more mathematical view, the ‘problem solving paradigm’ meant to operationalize creative processes assumes that if the constraints of a given problem are known and well-defined, a solution can even be computed (Simon & Newell, 1972; Simon, 1996).

While the delimiting feature of constraints is obvious, this paper builds on the idea that certain constraints can also be helpful and even crucial in creativity. We have discussed the double role of constraints as restrainers as well as enablers for creative processes together with the possibilities of balancing the polarity in a more conceptual and theoretical manner elsewhere (Onarheim & Wiltschnig, 2010). With this paper, we want to take a more exploratory and hands-on approach grounded in empirical data stemming from our current broader research projects. Our aim is to compare the role of constraints as creative enablers in two seemingly opposing domains: art and engineering design. After introducing the theoretical foundation for the paper, we present data stemming from award-winning experimental filmmaking (Biskjaer et al, 2010) to epitomize artistic creation, and data from studies within cutting-edge industrial engineering design (Onarheim, 2011).
We deploy a multi-perspectival and multidisciplinary approach in our analyses to unearth similarities and confirmative examples of some of the archetypical patterns of the complex role of constraints as described in the literature. Our discussion and outlook suggest further work regarding more profound microanalyses that would have to look for additional patterns and demonstrate dissimilarities and domain-specific discrepancies as well.

2. Theoretical foundation
Consensually understood as the generation of something novel (i.e. original, unexpected) and appropriate (useful) following Sternberg & Lubart (2009:3), creativity seem to be tightly intertwined with the challenge of surmounting delimiting factors such as obstructions, demands and other restrictions on the path toward completion of a creative task. In recent years, ‘constraint’ has become a terminological catchall to facilitate articulation of these concerns. The influence of constraints on creativity has been investigated on an abstract level and in several more domain-specific settings, but no cross-disciplinary framework with clear-cut terminology has yet been established.

2.1 Typologies of constraints
The fact that the term ‘constraint’ lends itself so easily to numerous heuristic initiatives, research into constraints has become a tangled aggregate comprising studies within philosophy of sports (Lewandowski, 2007), literary history (Andrews, 2003), engineering (Nuseibeh & Easterbrook, 2000) and management theory (Goldratt, 1990), to name a few. Despite this interest in constraints across academic fields, current scholarly work on the topic tends to aim either very broadly by focusing on creative agency in a nearly all-embracing, abstract manner or very narrowly by investigating the role of domain-specific, concrete requirements in various creative processes.

This schism is exemplified by the three main contributions to a tentative typology of constraints so far. One of these can be found in ‘How designers think’ by architect and designer Bryan Lawson (Lawson, 2006) who has developed a cube-like model of constraints specifically related to design problems. Given the metaphor of a (static) cube to represent a total of 32 (2*4*4) kinds of constraints, Lawson's model does not address issues of dynamic correlativity between the different types, nor does he probe voluntarily chosen obstructions and how they influence the specific solution space.

The idea of an agent freely setting up challenges and obstacles for himself in a creative process is pursued by artist and psychologist Patricia D. Stokes whose book 'Creativity from constraints: The psychology of breakthrough' (Stokes, 2006) explores the role of self-imposed constraints. In her view, creative breakthrough can be achieved somewhat systematically by employing a dichotomic conceptual framing of the problem space. Along the lines of the ‘problem-solving paradigm’, Stokes argues that artistic creation is about solving ‘the creativity problem’, whereby she emphasizes conceiving the framing of the creative process in highly rational terms. Stokes uses studies of one domain (art) to launch a nearly all-embracing framework to capture what she sees as a common, conceptual structure across various creative disciplines, from visual art and literature to fashion and advertising. Even though she embarks onto building generalized typologies, the seminal work of Norwegian philosopher and social scientist Jon Elster in that regard seems to have slipped her attention.

In his book ‘Ulysses unbound’ (2000), Elster explores the notion of self-binding and pre-commitment in its broadest sense, from democracy to voluntary curtailment in the arts. Most interesting for our present purpose is his suggestion for an overarching tripartition of 1) intrinsic (inherent in the material), 2) imposed (by external agents and clients, e.g. in the
form of a design brief or a commission for a work of art) and 3) self-imposed constraints (voluntarily self-binding). Elster’s proposal for a fundamental typology is a big contribution to ongoing research into constraints as it addresses the basic question of the ontic origin of constraint. In our view, such a theoretical bottom-up approach seems the more fruitful way to proceed toward establishing a tentative typology of constraints. Rather than launch yet another typology to merge key conceptualizations across creative disciplines based on various down-stroke examples, our aim is to begin somewhat more cautiously by probing what we see as two strongly opposing, creative domains based on real world datasets.

2.2 The ambiguous role of constraints
Stacey & Eckert (2010) propose a continuum of levels of ‘constrainedness’ of problems from various domains, essentially with over-constrained problems (i.e. engineering) on one side and under-constrained problems (i.e. artistic creation) on the other. The premise for this continuum of relating challenges in engineering to artistic creation is the assumption that constraints possess a more complex role than simply being a set of conditions that concentrate a given solution space (Dorst & Dijkhuis, 1995; Dorst & Cross, 2001). A natural question to ask, therefore, is whether the presence of constraints in fact benefits creative agency or rather hinders it.

Current literature suggests two opposing answers: based on quantitative experimental data, Amabile (1996) has tried to show that imposing constraints on creative agency reduces the actual creativeness of the outcome. Other researchers such as Stokes (2006; 2007) argue that constraints are a vital element in any creative process, and that they might in fact leverage creativeness. Hence, it appears that constraints play a dual role as a catalyst for both delimiting and opening creative activities by simultaneously restraining, obstructing and narrowing down the solution space as well as enabling, promoting and emancipating creative intentions. Merging this paradoxical ambiguity has been attempted by Onarheim & Wiltschnig (2010) with a specific focus on design processes. This approach, though, has put less emphasis on the art perspective

2.3 Cross-disciplinary views
As existing literature either tends to employ abstract levels of analysis (Amabile, 1996) or look toward specific domains (Lawson, 2006), we see a potential in cross-disciplinary comparisons of concrete elements of the relationship between constraints and creativity. In our view, there is a need to find points of departure for cross-disciplinary, theoretical advancement to help bridge findings from art and design based on a shared focus on how constraints, given their dual role as restrainers and enablers, can leverage the productivity and the level of aptitude of creative agency. In our further considerations, we use some of the general, abstract conceptual considerations together with our domain-specific studies to analyze how different groups of expert professionals employ constraints to enhance their creativity.

3. Methodological approach
In our individual research, we are interested in the dual role of constraints and what enables and spurs creativity from various perspectives, based on our backgrounds ranging from philosophy and aesthetics through industrial and engineering design to cognitive science and management. This allows for a cross-disciplinary view on these matters, and in this exploratory paper we apply these angles to a comparison of two sets of data (A and B). The datasets can be conceived as extended case studies, following Weisberg (2006). We have selected what we argue are ‘extreme’ cases representing the opposing ends of a continuum of creative freedom or ‘constrainedness’ as described by Stacey & Eckert (2010): experimental filmmaking to exemplify art as the ‘under-constrained’, open extreme,
and industrial engineering design with its specific technologies, materials and regulations (Nuseibeh & Easterbrook, 2000) as the ‘over-constrained’ or rigid end of the continuum. It is a nice coincidence that we all have access to such complementary domains through our current empirical works. Being located in Denmark, we are in a somewhat unique position to be able to access data from two world-class players working on cutting-edge issues in their respective fields in close vicinity of each other: the engineering design teams of Coloplast A/S, a Danish company being the global market leader in specific medical plastics, and the world-renowned Danish film directors Lars von Trier and Joergen Leth. Coloplast is well known for its innovation processes (Tidd et al, 2005; Roetnes & Staalesen, 2009), and in 2000, von Trier won the prestigious ‘Palm d’Or’ at Cannes Film Festival, honoring his outstanding creative work as the director of the film ‘Dancer in the Dark.’ Moreover, Leth has won numerous awards for his many poetic short art films and documentaries.

The material for the two case studies were each collected in slightly different manners, but analyzed with the same general approach. The selected film, ‘The Five Obstructions’ (dataset A), can be seen as a highly innovative, self-referential, experimental documentary of the creative process of film director Joergen Leth. The footage contains documentary parts as well as conversations and interviews. The data in set B was collected in a longitudinal participatory ethnographic study at Coloplast, consisting of field notes, audio and video recordings as well as interviews. The perspective of participatory and engaged observation – transcending the illusion of a neutral, detached and thus objective observer - is shared in both cases.

For our analytic purposes, we searched for and selected sequences from both sources around the key notion of how the observed actors work actively with constraints to enhance creativity. Both datasets were then analyzed individually. The analyses were then compared by employing our cross-disciplinary backgrounds as a heuristic resource and to avoid the focus getting biased. Our aim was to screen our data from a ‘designerly perspective’ and employ our diverse backgrounds for triangulation (van de Ven, 2007) between our three individual observations. With regard to the film, this was performed as individual parallel coding for examples of such creative handling of constraints, done by the authors during a screening of the film as a basis for a later selection of representative scenes based on a group discussion. The final case study from Coloplast was analyzed by all three researchers and the results compared in relation to the material from the film.

4. Data
The datasets we base our analyses on may be seen as rich descriptions of observations of creative processes conducted by leading professionals in their respective field of expertise. Both the two Danish directors and Coloplast are consensually considered world-class proponents of creative practice, which ensures a wide-ranging relevance of the findings these cases thus facilitate. Even though we base our analytical exploration on material conveniently at hand in our familiar working environments in Denmark, we would argue that this research design may contribute to yield insights of relevance to various creative disciplines and areas of research.

4.1 Dataset A - ‘The Five Obstructions’
Joergen Leth, a nestor among Danish film directors, released his short art film ‘The Perfect Human’ to critical acclaim in 1967. What reviewers and film buffs were attracted to was not least the innovative way in which Leth had set up obstructions for himself to help spur creative vigor. Leth called these measures ‘rules of the game’. Some thirty years later, another lauded Danish director, Lars von Trier, conceived a cunning homage to his mentor.
Although the project emerged from conversations between the two auteurs, the overall design for the film was von Trier’s idea. As a sly, provocative artistic challenge, Leth was asked to recreate his old masterpiece five times, each time succumbing to shrewd constraints conceived by von Trier. After the completion of each task, Leth got in touch with von Trier who then reviewed the film and thus proposed even more challenging constraints for Leth in the ensuing task. The outcome of these remakes and conversations was released as ‘The Five Obstructions’ in 2003 to much acclaim.

The conceptual design of the film and the nature and role of the various constraints has been explored in more detail in (Biskjaer et al, 2010). As the film is not a mainstream production, we deem it relevant to provide a brief overview of the five sets of constraints, i.e. the five obstructions. To challenge Leth’s preferred long-take idiom and detach him from familiar surroundings, von Trier’s Obstruction no. 1 means that Leth must go to Cuba and make a highly abrupt film with additional stylistic demands such as no use of artificial lighting etc. The abruptness is caused by a material constraint, namely that Leth can only use a frame rate of 12 frames per second (12 fps), which yields a jerky, convulsive feel to the film. Leth, however, uses this constraint imaginatively by letting a Cuban gentleman dance and then edit the film in a way that creates a distinct flow despite the abrupt movements of the dancer. For Obstructions no. 2, von Trier challenges Leth’s moral constitution by ordering him to what Leth sees as the worst place in the world and there, in the appalling surroundings of Mumbai’s red light district, enjoy a luxurious meal while starring as the male lead in the film. Leth’s use of translucent screen to partially detach himself from the location upsets von Trier who devilishly claims that Leth has cheated. So in Obstruction no. 3, Leth can either go back to Mumbai and remake the film or work with no constraints at all. Although perplexed by this sneaky punishment, Leth eventually opts for the latter and decides to do a film noir in Brussels. For Obstructions no. 4, von Trier provokes Leth by making him do a cartoon; a genre they both hate. In Obstruction no. 5, von Trier has already made the remake. Leth must do a voice-over narration written by von Trier and abandon all control by taking full artistic and formal responsibility for the film.

Given the ingenious, sly design of the film as conceived by von Trier, various hermeneutic approaches have been suggested, in particular in (Hjort, 2008a). A psychological stance in which Leth is considered as being prone to having to taste his own (aesthetic) medicine has been suggested by Dwyer (2008). Following a homo ludens perspective (Caillois, 1961; Huizinga, 1998; Rodriguez, 2008), Ponec (2008) suggests seeing the film as an agonistic game whose object of rivalry is Leth’s artistic autonomy. This view is supported by the Danish title itself, ‘De Fem Benspænd’, where ‘benspænd’ literally means the foul of (illicitly) clipping an opponent on a football pitch to make him lose his balance and fall. The importance of constraint handling is in this way emphasized in the very title of the film.

4.2 Dataset B – ethnographical data from a study at Coloplast A/S
Data set B consists of ethnographical data from a longitudinal participatory study at the Danish company Coloplast A/S, an international producer of disposable medical equipment. The researcher, Balder Onarheim, spent more than six months as a designer and researcher working with the company with the purpose of gaining a better understanding of the relationship between constraints and creativity in a real-world engineering design setting. In the study, creativity is understood as suggestions that the team or organization considers both novel and useful. The study employed a mix of observation methods and documentation techniques with the main activity being participation in the company environment and day-to-day design processes as an active design team member.
At Coloplast, constraints were found to play a fundamental role and the observations showed the important dual role of constraints in terms of being both a limitation to and a prerequisite for creativity. Too few or too many constraints seemed to have a negative impact on creativity, whereas the formulation, rationale and ownership of formal constraints played a significant role in defining their influence on creativity. The tacit constraints held by the designers appeared to have an equally significant function, and the designers were highly focused on constraints in their work. Observations showed that the designers were using four main strategies for creative management of constraints:

- Blackboxing constraints
- Temporarily removing constraints
- Introducing own constraints (self-imposed constraints)
- Revising problematic/challenging constraints

A full description of the study and the observations can be found in (Onarheim, 2011).

5. Analysis

Based on the two data sets above as exponents of art and engineering design, we have used the data to compare different aspects of constraint management in the two domains. When comparing our individual analyses from the datasets, we produced the following list of shared observations across the domains:

1) No constraints is often the hardest challenge
2) Even the cruelest constraint can be seen as a motivational challenge, i.e. the ability to turn constraints into enablers
3) The importance of self-imposed constraints
4) Bending constraints to facilitate new solutions and to provoke the initiating agent
5) Pairing constraints to solve different constraints with the same element
6) Turning down ideas based on non-verified constraints
7) Using constraints to control the creative process
8) The playful, crafty duel between constraint initiator and constraint executor
9) Several levels of constraint construction (e.g. Trier→Leth→Actors and Marketing→Designers→Production experts)

From matching this list against dataset A and B once more, four clear patterns emerged:

5.1 Pattern no. 1: The limiting effect of no constraints

While engineering design is recognized as a constraint-intensive domain (Ajit et al, 2008; Stacey & Eckert, 2010), art might be seen as a creative domain marked by very few and loose constraints. In ‘The Five Obstructions’, it is evident that von Trier and Leth see constraints as drivers for creative agency, and that Leth is actively seeking to be constrained in his creative process. Leth and von Trier agree that ‘no constraints’ is the most evil challenge Leth can get, and when faced with this completely free task in Obstruction no. 3, Leth chooses the ‘film noir’ genre, which relies heavily on constraints understood as conventions (Hirsch, 2008; Naremore, 2008) or what Elster (2000:190-200) calls ‘soft constraints’. When von Trier asks Leth to help him to come up with obstructions, Leth explains that he prefers the rules to be externally imposed. Later, von Trier shows disappointment with the fact that Leth seems to get more confident for each constraint that is imposed on him. All these observations resemble both the deliberate search for a constrained setting and the importance of constraints for creative agency as described in the Coloplast case.

5.2 Pattern no. 2: Playfulness and balance

As discussed by Onarheim & Wiltschnig (2010), constraints can be seen as both restringers and enablers in creative processes. In (Onarheim, 2011), it is a key observation that at Coloplast, the exact same constraint was described as both limiting and enabling...
on different occasions, supporting the assumption that it is not a question of constraints being either-or, rather they are both-and. At Coloplast, one designer could describe a constraint as limiting one day and as enabling the next and in the same meeting, two designers could express completely opposite views on the same constraint. Also, constraints that were highly unpopular when introduced ended up as triggers for new innovative solutions.

This duality of constraints is also apparent in the film. Some constraints are initially seen as severely limiting by both Leth and von Trier, e.g. the demand of maximum 12 frames per second in Obstruction no. 1 to which Leth replies: “[i]t will end up as a spastic film”. However, as soon as Leth starts to work with the challenges, his strong motivation and positive approach render the limiting constraints powerful enablers for creativity. So what is first seen as a highly restraining set of requirements ends up producing innovative and fascinating solutions. Leth notes this himself: “[a]t first it feels suicidal, but then I think that I have to find motivation and turn it into something motivating”. Also, Leth describes the process as just a game where he tries to make the best of it and even calls one of the constraints ‘a gift’ (Hjort, 2008b:25), while von Trier complains that no matter what kind of obstruction he comes up with, Leth just gets inspired and creates something brilliant. Our comparison emphasizes the importance of the attitude by which the designers approach the constraints as such, and their selection of the constraints they consider enabling.

5.3 Pattern no. 3: Levels of constraint handling

Motivation, openness and playfulness appear to be essential to the various ways Leth works creatively with the constraints introduced by von Trier. At Coloplast, the most creative processes observed were all associated with a playful and positive view on the constraints at hand. In the film, this ‘playing with constraints’ operates on three levels: a) individual (Leth’s view on the constraints), b) between the initiator and executor of constraints (the relationship between von Trier and Leth) and c) in between the executor, or receiver, of constraints and his subordinates (the relationship between Leth and his actors). All three levels can be found at Coloplast as well, both in hierarchical terms and in a production line perspective. In hierarchical terms, the same dynamics are apparent inside the design teams, between executives and project managers and between the project managers and the designers. In a production line perspective, the last two can be compared to the relationship between marketing (defining initial constraints) and the design teams, and the relationship between the design teams and specialist functions such as production engineers. All three levels represent the importance of balancing constraints, between seeing them as absolute and limiting or flexible and enabling, and in deciding which of these roles to give certain constraints at certain points in the process.

On the individual level (ad a)), Leth consciously chooses how he perceives different constraints, seeing some as absolute while playing and relaxing others. Also, he introduces his own motivational constraints such as his level of ambition: “I want to make a good film despite whatever constraints I get.” At the end of the film, Leth is even questioning whether: “[a] rule alone can block anything”. The same playful balancing, confidence and positive approach was observed in the successful creative processes at Coloplast, where no constraint could ever hinder a good outcome.

The communication between von Trier and Leth involves the same elements where von Trier is consciously trying to control Leth through the constraints while Leth makes it a challenge to bend the constraints without breaking them. Leth illustrates this dynamics as a tennis match, playing back and forth over the net. Some of the same dynamics can be seen at Coloplast between the marketing department formulating the initial constraints and
the designers, where the designers like to ‘surprise’ the marketing representatives by turning their constraints into something exiting and unexpected. In (Onarheim, 2011), it is stressed that constraints at Coloplast were often formulated with a certain type of solution in mind and with the purpose of governing the following process in that direction. The designers, however, focused on bending the constraints in order to explore all possible solutions, including those conceptually outside of what could be considered the initial intention.

In his communication with his actors, Leth gives them what he himself considers ‘half-open’ constraints. In this way, he in fact takes the role of von Trier, seeking to formulate constraints that will provide a desired result, but utilizing the skills and creativity of the receiver of the constraints. By doing so, he translates the constraints from von Trier to fit his own constrained setting, and then formulates new constraints for his actors within this environment. The same translation and reformulation of constraints was observed at Coloplast, both in the project managers communicating with their teams and in the design teams collaborating with specialists such as production engineers.

5.4 Pattern no. 4: ‘Pick your battles’
At any given stage of the creative process at both Coloplast and in the film, a vast number of constraints were at play – even in projects whose purpose was to have ‘no constraints’. At Coloplast it was observed that the experienced designers started new projects by looking for the tricky constraints and then focused mainly on these throughout the process while blackboxing the rest. Leth employs the same strategy, choosing some constraints to explore/relax while accepting other constraints, e.g. when he exclaims: “[t]hat is a fantastic idea, but it is not following the rules”. In both domains, the creative experts will carefully ‘pick their battles’ as a way to navigate in a complex setting and to focus their creative efforts on a graspable part of the problem. This relates to balancing the poles as described by Onarheim & Wiltatschnig (2010). Additionally, the creative professionals will add their own constraints to the already complex problem space, seemingly as a way to make it easier to navigate. In both domains, these self-set constraints were observed to be as important as the externally imposed, formal constraints.

6. Conclusions and outlook
In the above, we have provided an initial exploration into palpable similarities of creative handling of constraints across two domains, art and engineering design, characterized by a highly different degrees of ‘constrainedness’. This investigation is based on proposed conceptual considerations from the current body of scholarly work and two datasets, A and B. Across both domains and in all patterns analyzed, the role of motivation, playfulness and embracement of constraints seems to be the key to achieving a highly creative result, and it is an important point that the selective treatment of constraints in Pattern no. 4 ‘Pick your battles’ appears equally important in art as in engineering design. Intrinsic constraints such as the delimiting, typically physical, features of a material, be it plastics or digital media, appear in both domains, as do imposed constraints like deadlines, costs and other concrete requirements. What our exploration has revealed, however, is that the role of the self-set constraints and their crucial importance when first introduced seems essential in both domains. Even though there were evidently more such self-set constraints in the art case (A), these constraints appear as important for the directors as the most absolute, external constraints did for the designers. Thus, all three types of constraints as proposed by Elster (2000) in his basic tripartition of intrinsic, imposed and self-imposed constraints appear in both case studies, but in different numbers and with varying degree of flexibility for each domain – stressing the fundamental differences between these opposing domains.
In further research into this field, the linkage between creative handling of constraints and emergence of inspirational spurs and insight moments should be investigated, describing the actual consequences of the creative patterns in each domain (Wiltzchnig & Onarheim, 2010). While we in this paper as a preliminary exploration have focused primarily on the similarities between art and engineering design as opposing creative domains, future work should of course also study the differences between the two. As ‘The Five Obstructions’ admittedly is an example of experimental filmmaking, the film’s relation to other modes of artistic creation should be further probed. The present comparisons have been performed on a macro-level, but the observed similarities could profitably be investigated in more detail to disclose potential nuances and discrepancies within each pattern, e.g. by comparing single scenes from the film with video recordings from Coloplast. Starting from Stacey & Eckert's (2010) continuum and the assumption that the two domains compared in this paper may be seen as extremes of this disciplinary scope, we presume that the observed similarities in creative constraint handling are present in the intermediate part of the continuum as well. The need to pursue and validate this hunch calls for further studies, too. By exploring differences in types of constraints and levels of severity across domains and comparing their influence on creativity, future work can hopefully help advance cross-disciplinary research into constraints and creativity of relevance to both art and design.

7. References


