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An Introduction to ‘Creativity Constraints’

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Abstract: Constraints play a vital role as both restrainers and enablers in innovation processes by governing what the creative agent/s can and cannot do, and what the output can and cannot be. Notions of constraints are common in creativity research, but current contributions are highly dispersed due to no overall conceptual framing or shared terminology. This lack of unity hinders overt opportunities for cross-disciplinary interchange. We argue that an improved understanding of constraints in creativity holds a promising potential for advancements in creativity research across domains and disciplines. Here, we give an overview of the growing, but incohesive body of research into creativity and constraints, which leads us to introduce ‘creativity constraints’ as a unifying concept to help bridge these disjoint contributions to facilitate cross-disciplinary interchange. Finally, we suggest key topics and sub-concepts, including ‘late’, ‘self-imposed’, and ‘continua of creativity constraints’, to inform future cross-disciplinary work on creativity constraints.

Keywords: Creativity; constraints; creativity constraints; creativity concepts; types of constraints; design; art; engineering; cross-disciplinary.

1 Introduction

At any point in a creative process, a number of constraints will exist: limitations or restrictions for what can or cannot be done, and for what the output should fulfil (Gross, 1986; Hull, 2011). Following Elster’s (2000) tripartition, such constraints can be intrinsic (inherent in the material), imposed (by external agents), or self-imposed (freely initiated by the creative agent). Over the last couple of years, we have conducted studies on the intriguing relationship between constraints and creativity and in this work, we have favored a generic understanding of constraints as ‘*all explicit or tacit factors governing what the agent/s must, should, can, and cannot do; and what the output must, should, can, and cannot be*’ (Onarheim, 2012b), spanning from technical and practical to social and cognitive constraints. This broad understanding of constraints has enabled us to draw upon a wide selection of existing work investigating various aspects of constraints in relation to creativity.

Unsurprisingly, notions of constraints, restraints, demands, and requirements are familiar topics in creativity research (Guilford, 1950; Mednick, 1962; Sternberg and

Kaufman, 2010), but except from recent developments, little effort has been devoted to studying or conceptualizing the specific relationship between constraints and creativity. Existing work mainly focuses on the effect of specific types of constraints (Amabile, 1998; Baer and Oldham, 2006; Karau and Kelly, 1992), theoretical considerations (Johnson-Laird, 1988; Sternberg and Kaufman, 2010; Stokes, 2006), and specific approaches to constraint handling (Darke, 1979; Maiden and Robertson, 2005; Richard, Poitrenaud and Tijus, 1993). Recent contributions emphasize the need for further work on the relationship between creativity and constraints (Joyce, 2009; Liikkanen, Björklund, Hämäläinen and Koskinen, 2009), and the focus on constraints in the concluding chapter of the most recent, seminal *Cambridge Handbook of Creativity* (Kaufman and Sternberg, 2010) exemplifies an increasing interest in this complex topic.

Still, the contributions listed above cannot be said to be part of a joint research effort, and it is only our broad definition of constraints that makes it possible for us to draw together these contributions and thereby see them as in fact closely related. In our comprehensive literature reviews (Biskjaer, 2013; Onarheim, 2012b), we have learned that remarkably few contributions thus far provide insight into a more general understanding of the relationship between constraints and creativity (exceptions can be found in e.g. Boden, 2004; Johnson-Laird, 1988; Sternberg and Kaufman, 2010), and we have yet to come across contributions that specifically aim to provide cross-disciplinary, domain-general concepts and/or definitions for aligning future inquiries into this complex relationship. To help stimulate knowledge on constraints on creativity and study how constraints affect creative processes regardless of domain or discipline, we argue for the need of a shared conceptual scope and clear terminology to better conjoin both existing and future research efforts.

In our current research (comprising comparative studies) on creativity in engineering, filmmaking, and poetry, we have found that the notion of ‘constraints’ is an especially useful one – both in discussions with researchers from other fields and with creative practitioners. No matter the domain or the discipline, any creative endeavour will feature constraints. Practitioners know this and are often able to articulate this in an insightful and nuanced manner. Their dissemination of practical knowledge derived from personal experience, (cf. Schön, 1983; Schön, 1987) renders it possible for researchers – within that specific domain – to scaffold an elaborate understanding of the prevailing constraint terminology – within that specific domain. In this regard, the notion of ‘constraints’, typically articulated via a closely related term such as ‘requirements’, ‘rules’, or ‘guidelines’, makes for a semantic foundation for fruitful discussions on and studies of creative processes and approaches – within that specific domain. In a creativity research perspective, this domain seclusion is problematic because it makes it hard to conjoin research contributions across disciplines. Engineers will often refer to constraints as *requirements*, however, that is unfamiliar, semantic terrain for poets who, judging from our studies (Biskjaer, Onarheim and Beatty, under review) will tend to be more comfortable talking about *styles*, *idioms*, and *genre conventions*, etc. Another obstacle is the fact that the term ‘constraint’ itself is too vague and widespread to act as a conceptual unifier for creativity and constraint research as such. These considerations lead us to propose ‘*creativity constraints*’ as a simple, but concise concept to bridge studies of creativity in various domains, as we believe a better cross-disciplinary understanding of ‘what a constraints is’ and ‘what a constraint does’ remains crucial for future cross-disciplinary studies of creativity in general.

In this paper, we give an overview of existing contributions to studies on various constraints in relation to creativity and current research efforts targeting the relationship between constraints and creativity. To show the lack of shared concepts and thus some of the terminological discrepancies, we employ three brief examples representing three separate domains. We then introduce ‘*creativity constraints*’ as an efficacious concept

that we argue may help conjoin previous and future research efforts across creative domains and research traditions. In doing so, we present '*set of creativity constraints*' and '*constrainedness*' as useful concepts for future studies. On this backdrop, we end the paper by suggesting potential future directions for research into creativity constraints. In our view, fruitful concepts to stimulate further cross-disciplinary interchange in creativity research could include '*late*', '*self-imposed*', and '*continua of creativity constraints*'.

2 Research into Constraints and Creativity

Investigating aspects of the entwinement of creativity and constraints is in itself nothing new and as mentioned in the introduction, the notion of constraint recurs in the creativity literature (Amabile, 1996; Guilford, 1950; Johnson-Laird, 1988; Sternberg and Kaufman, 2010). Guilford (1950) stresses the important relationship between creativity and restraint, and the notion of task and constraint is frequently used in definitions of creativity (Amabile, 1982; Mednick, 1962; Wolff, 1981). Constraints are built into the construct of creativity itself (Kaufman and Sternberg, 2010), and many authors have consistently stressed that without constraints, there can be no creativity (Boden, 2004; Dyer, Gregersen and Christensen, 2009; Johnson-Laird, 1988; Stokes, 2006).

Both theoretical and empirical contributions investigating the entwinement of creativity and constraints exemplify the dual role of constraints, as constraints can be both limiting and enabling in creative processes (Joyce, 2009; Negus and Pickering, 2004; Onarheim and Wiltschnig, 2010; Stokes, 2008). This duality might seem counterintuitive (Anthony, Johnson and Sinfield, 2008), and most pertinent creativity literature appears to focus on freedom rather than constraints (Joyce, 2009). Joyce (2009) lists researchers who have pointed out that too vaguely defined problems may lead to confusion, and other authors state that implying constraints can help focus creative effort (Anthony et al., 2008; Isaak and Just, 1995; Reitman, 1964; Ward, Smith and Finke, 1999) and thereby yield creative breakthroughs (Stokes, 2006). In addition to this dual role, constraints are related to generative and evaluative aspects of creativity (Ball, Onarheim and Christensen, 2010).

While various aspects of the relationship between creativity and constraints have been discussed widely in theoretical contributions, historically, the number of empirical studies related to this relationship remains limited. Exceptions can be found in work on the role of external evaluation (Amabile, 1978), effects of constraint on freedom (Amabile, 1984), and surveillance (Amabile, 1990). In the last decade, an increased effort has been directed to studying this relationship with predominant research areas being psychology (Knoblich, Ohlsson, Haider and Rhenius, 1999), science (De Cruz and De Smedt, 2010), marketing (Moreau and Dahl, 2005), art (Stokes, 2006), music (Kao, 1997), management studies (Joyce, 2009), computer games (Bogost, 2010), and software engineering (Maiden and Robertson, 2005). The role of specific constraints has been investigated in various studies, mainly focusing on time and perceived time pressure, e.g., a study by Dow *et al.* (2009) on prototyping under time constraints. Two studies by Karau and Kelly (Karau and Kelly, 1992) on time constraints conclude that scarcity of time bears a negative impact on creativity. Later studies on organizational time constraints by Amabile (1998) and Baer and Oldham (Baer and Oldham, 2006) suggest that the most creative output is produced in the intermediate time condition. Savage *et al.* (Savage, Moore, Miles, J.C., and Miles, 1998) have produced experimental evidence on the various impacts of both removing and adding time and cost constraints and in a survey of engineering designers, and Salter and Gann (2003) found that respondents indicated that time, cost, and too many projects were limiting factors for creativity. Other effects have been studied, and Amabile (1996) points toward both experimental and non-

experimental studies consistently showing how constraints placed on task engagement have negative effects on creativity. Janis and Mann (1979) have studied the importance of stress for creative performance, and more recently, Joyce (2009) has performed experimental studies indicating an inverted U-shaped curve to denote the relationship between creativity and different degrees of constraint.

Recent Development and Relevance

While the above contributions all investigate various types and roles of constraints in relation to creativity, the vast majority of contributions mainly focus on contributing to a specific domain, e.g., psychology, management, knitting, and art. To a large extent, these studies utilize the specific, established terminology inherent in these domains. These studies seem to have little in common apart from their focus on various types of constraints (e.g. time, evaluation, stress, and cost) and how these constraints are entwined with creativity. This makes it unfeasible to consider these contributions as elements of a joint research effort aiming to gain domain-general insight into the crucial relationship between constraints and creativity. Rather, we cannot but see them as dispersed snippets that we in hindsight can fit together only through our broad and thus highly inclusive understanding of constraints conceived as all limitations or restrictions for what can or cannot be done, and for what the output can and cannot fulfil in a creative process.

The list of constraint researchers, who seem less concerned with contributing to a particular domain and more interested in considering constraints and creativity in a more general and unifying perspective, is surprisingly short. Johnson-Laird (Johnson-Laird, 1988) offers an elaborate conceptual contribution of the entwinement in the book chapter ‘Freedom and Constraint in Creativity’, while Stokes’ book *Creativity From Constraints* (Stokes, 2006) sets out to explore the same topic, but soon moves toward a step-by-step oriented approach focusing on attaining creative breakthroughs. In her PhD dissertation, *The Blank Page: Effects of Constraint on Creativity*, Joyce (Joyce, 2009) offers a broad, thorough introduction to the topic of constraints on creativity before she narrows down her scope by focusing on time constraints in organizational creativity. In her seminal work on creativity, Boden (2004) employs a less domain-bound approach and stresses the same intimate relationship between creativity and constraints: “(f)ar from being the antithesis of creativity, constraints on thinking are what make it possible. This is true even for combinational creativity, but it applies even more clearly to exploration-based originality” (p. 95). Furthermore, the most recent edition (2010) of the *Cambridge Handbook of Creativity*, Kaufman and Sternberg summarize the book in their final chapter ‘Constraints on Creativity’ (Kaufman and Sternberg, 2010) where they point out how ‘constraints’ may be seen as the very unifying topic among all the various contributions in the handbook. Finally, and here just noted in passing, the growing scholarly interest in the entwinement of constraints and creativity in a cross-disciplinary perspective may be observed from the journal *Creativity and Innovation Management* that has issued a June 2013 call for papers entitled ‘Organizing Creativity: Creativity and Innovation under Constraints’ (<http://goo.gl/wNOeH>). Given that we have devoted the last couple of years to studying constraints and how they shape creative processes, this development is something we follow with great interest.

In addition to the very few general (non-domain specific) theoretical contributions specifically focusing on creativity in a constraint perspective, we also see a lack of decidedly *cross-domain* work on constraints in creativity by which we mean comparative studies on the utilization of constraints in two or more creative domains. Apart from Stacey and Eckert (2010) who have compared constraints on creativity in knitting versus engineering design, and our own work comparing filmmaking with engineering design (Biskjaer, Onarheim and Wiltschnig, 2011) and poetry, filmmaking and engineering

design (Biskjaer et al., under review), seemingly little work has yet sought to cross domains to investigate the relationship.

A Fundamental Typology of Constraints

One of the hindrances to cross-disciplinary advancements in research into creativity and constraints so far appears to be that the very concept of constraints is often studied in relation to creativity with no deeper consideration of the concept ‘*constraint*’ itself. As the concept covers a broad spectrum of factors, issues, and characteristics, it is beneficial to develop a deeper, more nuanced understanding of the various types of constraints to help inform future work on constraints on creativity (Jul, 2004). Typologies of constraints *unrelated to creativity* can be found in many areas. For instance within our own domains spanning engineering, interaction design, philosophy, and aesthetics, there are long traditions for typologies of various constraints (see also Elster, 2000; Lawson, 2006). As a fundamental typology of constraints in an ontological perspective, here meaning focusing on origin, we see Elster’s tripartition of constraints as a promising starting point for studying constraints on creativity (Elster, 2000). Elster suggests three basic categories of constraints: *intrinsic* (inherent in the material), *imposed* (by external agents client), and *self-imposed* (freely initiated by the creative agent himself in expectance of a higher creative payoff). Useful as it is, Elster’s tripartition, however, has its gray areas, insofar as he does not seem completely clear as to whether self-induced constraint pressure (self-imposed constraints) is always related to the attainment of an original outcome (causality), or whether there just seems to be a connection between the two (correlation). For a more detailed discussion of Elster’s constraint concepts, see (Biskjaer and Halskov, in press; Levinson, 2003).

The Need for Improved Cross-Disciplinary Concepts

To sum up the work on creativity and constraints so far is no easy task, inasmuch as it is a field of research marked by numerous domains and disciplines of which we have only studied a few in depth. Given the scarcity of shared concepts, cross-domain creativity studies focusing on, say, how lyricists versus software designers manage severe time constraints are difficult to realize, no matter how easily they can be contrived in a moment of inspiration. Obviously, many variables and domain-specific characteristics must be taken into account, however, not even the term ‘constraint’ lends itself to clear-cut interpretation as shown above. To follow up on the example in this section, most engineers tend not to talk much about ‘constraints’, let alone the dual role of constraints as being both restraining and enabling for creative agency. Engineers prefer ‘requirements’ (Ball et al., 2010; Hull, 2011; Maiden, Jones, Karlsen, Neill, Zachos, and Milne, 2010; Nuseibeh and Easterbrook, 2000; Zachos and Maiden, 2008), which etymologically means something that is obligatory, a necessity, a demand, a prerequisite (TFD, 2012). In poetry, few creative professionals refer to ‘requirement’ as something integral to composition (see also Beatty and Ball, 2010; Beatty and Ball, 2011). In this domain, most talk about ‘genre conventions’ or other types of normative guidelines stating what can and cannot, should and should not be put into words or published, and how the creative process itself should be conceived. Accordingly, embarking on a comparative analysis of poetry versus design as creative domains by gathering data on ‘genre conventions’ versus ‘requirements’ runs the grave risk of comparing apples to oranges (i.e., incommensurability), if the study undertaken does not rely on a clear and sturdy, shared conceptual basis. Comparing ‘design requirements’ to ‘genre conventions’, however, may not even pose the gravest challenge for such creativity research studies.

In 2010, the British paper *The Guardian* (TG, 2012) asked a number of eminent writers to disclose their individual rules for writing. Among the interviewees was American novelist Jonathan Franzen, who wrote up his ten rules for writing. A selection of these is as follows:

- “1. Fiction that isn't an author's personal adventure into the frightening or the unknown isn't worth writing for anything but money.
2. Never use the word "then" as a conjunction – we have "and" for this purpose. Substituting "then" is the lazy or tone-deaf writer's non-solution to the problem of too many "ands" on the page.
4. Write in the third person unless a really distinctive first-person voice offers itself irresistibly.
8. It's doubtful that anyone with an Internet connection at his workplace is writing good fiction.” (TG, 2012)

What Franzen states here is of course his individual take on genre conventions, personal idiosyncrasies, and lessons learned (such as bullet no. eight by which he refers to his habit of turning off his Internet connection while writing). Based on years of experience, he has come to learn that adhering to these rules works for him. It is conducive to his creative performance, satisfaction, and productivity as a novelist. However, inasmuch as his tens rules comprise a mixed bag of experience and normative preferences, it seems hard to refer to them in a manner that immediately enables a fruitful comparison to creative processes among software designers such as the creativity research example proposed above. Another example of such initiated rules to help stimulate creative performance and hopefully attain a more original creative output is the Danish avant-garde film movement *Dogma 95* and their ‘Vow of Chastity’, according to which the Dogma Brethren’s filmmaking should comply with ten carefully devised rules of which the first three are as follows:

- “1. Filming must be done on location. Props and sets must not be brought in. If a particular prop is necessary for the story, a location must be chosen where this prop is to be found.
2. The sound must never be produced apart from the images or vice versa. Music must not be used unless it occurs within the scene being filmed, i.e., diegetic.
3. The camera must be a hand-held camera. Any movement or immobility attainable in the hand is permitted. The film must not take place where the camera is standing; filming must take place where the action takes place.” (Dogme 95, 2011)

The argument we wish to make is that engineering, fiction, and filmmaking seem to share certain features; crucial characteristics closely related to the creative process, i.e., to what can and cannot be done, and what the outcome can and cannot be. Probing and understanding these features is essential to cross-disciplinary (comparative) studies, not only within fiction, filmmaking, and engineering, but in all creativity research if the problem of incommensurability is to be avoided. Denoting the shared creativity characteristics simply as prerequisites, requirements, conventions, rules, demands, etc., is not fruitful, as these terms each entail connotations not readily accessible to or easily adaptable by all three domains. Thus, it should come as no surprise that in our view, the notion of ‘*constraints*’ seems a promising starting point for a generic, conceptual framing intended to promote the feasibility of cross-domain studies within creativity research. In

itself, the term ‘constraint’, however, does not suffice. It needs qualification and as a first step, our suggestion is the coinage:

3 Creativity Constraints

Derived from the Latin verb ‘constringere’ meaning to restrain, compress or bind together (TFD, 2011), the noun ‘constraint’ is in itself problematic. Semantically, ‘pressing’ or ‘binding together’ points to the concept of *convergence*, which is in accord with the role of constraints conceived as *restrainers*. However, this semantic expounding misses the importance of constraints as *enablers* as presented above, which may be understood in terms of *divergence* (this point is discussed in more detail in Biskjaer, Dalsgaard and Halskov (2010)). Another reason why the term ‘constraint’ alone does not suffice has to do with the broad and often scarcely defined conceptual use of the concept in creativity and other strands of research. In our experience, when introducing the notion of ‘constraints’, students and colleagues often appropriate the term very quickly and utilize it to denote various individual aspects of their creative practice. In our view, this demonstrates the potentiality, accessibility, and applicability of the term ‘constraint’; however, following Mamykina *et al* (2002), it also proves the need for a clear conceptual terminology when engaging in projects across disciplines and domains. Otherwise, each participant quickly and easily charges the concept of ‘constraint’ with his or her individual meaning, which is not necessarily unanimously shared by the other team or project members. This scenario is obviously not desirable; especially not if a large cross-disciplinary team must work against the clock and every minute counts. Admittedly, for the sake of further studies on the pivotal entwinement of creativity and constraints, it could be discussed even more in-depth and on the basis on comparisons of various sets of empirical data whether the term ‘constraint’ alone is (not) too vague to be genuinely useful as a unifying descriptor for the various existing types of constraints on creativity. We believe it is and in accordance with the points made above, this is also our personal experience from working in various collaborative, cross-disciplinary projects within interaction design, aesthetics, and engineering design.

To offer a clearer distinction between the dispersed uses of the word ‘constraint’, thereby hopefully avoiding future confusion while also contributing to facilitate new joint, cross-disciplinary interchange within creativity research, we propose a specific descriptor for constraints when seen in relation to creativity. As outlined above, researchers within creativity studies tend to use numerous different descriptors – often as synonyms – for what we simply denote generically as *constraints*, cf. our preliminary, highly inclusive, tentative definition in the introduction. Initially settling for this deliberately broad understanding allows us to pool together and thus assimilate a number of the oft-used terms in previous studies, including (but not limited to) terms such as frames, rules, regulations, demands, conditions, terms, limitations, obstructions, prerequisites, guidelines, and many others. While some researchers use many of these terms interchangeably, other researchers deliberately narrow down their use of the term ‘constraint’ in order to describe very concrete, delimited elements in creative processes, e.g., cognitive constraints (Amabile, 1996), subject constraints (Stokes, 2006), and time constraints (Dow, Heddleston and Klemmer, 2009; Joyce, 2009), to name but a few examples. In order to assimilate many of these important contributions, we see the need for coining one generic term to embrace the heterogeneous usage of the term ‘constraint’. Introducing such a generic term does in no way mean that we believe this to be a semantic stroke of magic, as it were, by which many strands of complex, domain-bound creativity research efforts suddenly may be tied together and thereby become reciprocally comparable. Rather, we wish to propose the overall term ‘*creativity constraints*’ as a

basic, but clear, conceptual means to address *the entirety of constraints that might affect creative agency*, spanning from technical and practical to social and cognitive constraints. Accordingly, a tentative conceptual definition of ‘creativity constraints’ is as follows:

Creativity constraints are 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.

This does not entail abolishing the need for more specific sub-typologies of constraints. On the contrary, our proposal of the term ‘*creativity constraints*’ is intended to serve as a *synthesizing concept* to help scaffold a stronger framework to tie together a number of strands of research each sprawling with their own understandings of constraints in the context of creativity. Similarly, to return to the examples in the previous section, introducing ‘creativity constraints’ as (in our view) an efficacious, generic concept does not override, let alone obviate, the need for highly specific sub-types of constraints and well-established, acute analytical concepts pertaining to a specific domain. What it does, though, is help facilitate new forms of fruitful, cross-disciplinary interchange. When Franzen polemically asserts that an author must never use the word ‘then’ as a conjunction (as quoted above in his rule no. two), this is inarguably a normative statement and, it must be assumed, a personal, aesthetic preference. Conceiving his assertion in this view solely, however, makes it hard to compare his musings on his creative process to the experience of, say, an equally capable software designer who is at home with the notion of ‘requirements’. The same challenge of hazy and incommensurable terminology arises with Dogma 95 when directors Lars von Trier, Thomas Vinterberg, and their fellow Dogma Brethren formulate a ten-point dogma (inspired by French director François Truffaut’s famous 1954 article in *Cahiers du Cinéma*, ‘Une Certaine Tendance du Cinéma Français’; Truffaut, 1954). Aesthetic idiosyncrasies like Franzen’s are not exactly closely connected to, let alone easily reconcilable with, requirement engineering, but a self-written dogma seems even farther away. However, approaching these three exemplary ways of engaging in and managing a creative process in the overall framework of *creativity constraints* enables a new cross-disciplinary mode of comparison.

Reintroducing Elster’s (2000) three types of constraints - here, qualified as *creativity constraints*, namely constraints that are inherent (in the material or situation), imposed (by others), or self-imposed (voluntarily evoked by the agent) - renders it possible to cut across the domains. Thus, when an engineer or software designer states that requirements are integral to his or her work, the question arises as to what constitutes these requirements. When seen as *creativity constraints*, it becomes possible to discuss whether they are imposed by others (peers, managers, etc.), non-negotiable given that they are inherent in the material, or whether some of them are in fact – intentionally or not – imposed by the designer or engineer him-/herself. Accordingly, when Franzen formulates a rule that restrains him from using the word ‘then’ as a conjunction, is that in fact a self-imposed creativity constraint, or is it rather imposed by others by being integral to fiction as a genre, i.e., is it generally regarded as a kind of hallmark of literary aptitude to be able to avoid such phrases? When the Dogma 95 directors restrain themselves so severely, is that then in fact an example of self-imposed creativity constraints? Or rather, is it in reality due to production constraints (inherent in the production or imposed by others) such as budgets, so that the Dogma 95 directors essentially make a virtue of necessity? If so, American film critic Armond White may not be completely off target (albeit unknowingly as he sees it as a genuinely favored idiom)

when he claims that the Dogma 95 manifesto is the creative initiative that brought filmmaking closer to amateur porn (White, 2012).

The point we wish to make here is quite simple. Employing *creativity constraints* as an overall, conceptual framework to denote the many tacit or explicit factors that govern the actions of a creative agent as well as the creative output itself may serve to scaffold an improved cross-disciplinary and cross-domain understanding of creativity and creative processes in particular. As the above example suggests, creativity constraints in conjunction with Elster's (2000) basic model of the ontic origin of constraints immediately enable feasible analytical concepts cutting across domains, in this case fiction, filmmaking, and software design. Far from abolishing established concepts such as 'requirements' and 'genre conventions' and 'idioms', creativity constraints is a concept intended solely to supplement such domain-specific studies by augmenting the potential for fruitful, cross-disciplinary interchange within creativity research based on a shared conceptual framework. With creativity constraints as a first step, we will now sustain the cross-disciplinary perspective while considering:

4 Future Research

Based on a shared understanding of creativity constraints, we see the potential for a more aligned, cross-disciplinary research effort on the complex entwinement of constraints and creativity. If an enhanced creativity research effort gets established with a focus on creativity constraints in various creative domains and research traditions, we argue that we may get closer to better grasping the general *and* specific roles of constraints on creativity. This would contribute to a more integrative understanding of creativity in general. Such cross-domain studies should seek to further probe and conceptualize the various continua of creativity constraints, the types and roles of creativity constraints, and the strategies employed by practitioners when working with creativity constraints. In this section, we will briefly discuss some of the, in our view, most promising coming concepts within research into creativity constraints.

Set of Constraints and Constrainedness

In our previous work (Onarheim, 2012b), the notion of '*set of creativity constraints*' (see also Ajit, Sleeman, Fowler and Knott, 2008; Johnson-Laird, 1988) is utilized as an expression of the sum of creativity constraints at any point in time during a creative process. In our comparison of creativity constraints in engineering design and filmmaking (Biskjaer, Onarheim and Wiltschnig, 2011), we employ another term that we deem equally important in studies of creativity constraints: '*constrainedness*' (Glück, Ernst and Unger, 2002). This concept articulates the total level (intensity) of the experienced creativity constraints at a given point in a creative process. Conversely, it states the perceived degree of freedom. Informed by the fruitful distinction between over-constrained versus under-constrained problems (Stacey and Eckert, 2010), our notion of constrainedness expresses a total indication of the intensity of the pertinent set of creativity constraints at any given stage in a creative process.

The two concepts '*constrainedness*' and '*set of creativity constraints*' do not imply the existence of a complete entity perceived as 'all creativity constraints'; nor does it suggest that all creativity constraints may be exhaustively captured, understood, or mapped. Thus, since there is no objective measure for all creativity constraints, or for the limiting effect of each creativity constraint, there is no exact or objective measure for levels of constrainedness. Rather, the concept is a theoretical (phenomenological) construct to state how free – or restrained – a practitioner experiences a given situation in a creative

process at a given time. Also, due to the complex nature of creativity constraints, the relationship between number of creativity constraints and the level of constrainedness should not be considered fixed.

Continua of Creativity Constraints

In addition to distinguishing between various types of creativity constraints, we would argue that it is important to contemplate various continua of creativity constraints. For instance, let us consider an example involving a *budget constraint*, which, following our proposed terminology, should be conceived as a *specific sub-type* of ‘creativity constraints’ as it affects the creative process and its outcome. When faced with a given budget constraint such as a cost constraint in engineering dictating a unit cost price of \$3, the creativity constraint at hand may be conceived in terms of continua such as *flexibility*: Is \$3 per unit an absolute, *fixed* limit for the product cost, or is this particular budget constraint more *flexible* so that the final price could also be \$4 without putting an end to the project? In our studies of engineering designers (Onarheim, 2012a), we observed four such continua used by the expert engineers when discussing various ways of managing creativity constraints: *Flexibility*, *Hardness*, *Importance*, and *Formalization*. Based on extensive reviews of current literature, we have added three supplementary continua used in the existing literature, i.e., *Complexity*, *Origin*, and *Timing*, which result in a (non-exhaustive) list of seven such continua of creativity constraints (Onarheim and Biskjaer, in press). These dimensions are theoretical constructs, but they exemplify the various continua already employed in both practice and creativity research understood broadly.

Each specific sub-type of creativity constraint affecting a creative process may feature these seven dimensions – at least, because the list is not exhaustive. For each of these dimensions, the creativity constraint can be analyzed, which reveals its tentative placement on the continuum adhering to the individual dimension. Some creativity constraints will be fixed, some are flexible; some will be abstract, others very concrete; some will be presented from the beginning, while some will only arise late or at the very end of the process. Thus, the higher/lower an individual ‘score’ on each of these continua, the higher/lower the final ‘score’ for each creativity constraint. Each constraint pertinent to the creative process, i.e., each sub-type of creativity constraint, may be articulated in this manner, and the *total ‘sum’* of creativity constraints expressed on continua thus indicates the total level of *constrainedness* perceived by the agent/s involved. Creative situations and processes feature varying levels of constrainedness depending on the number and abstraction of constraints (Onarheim and Wiltchnig, 2010), and altering a single sub-type of creativity constraint leads to a new *set* of creativity constraints with a different level of *constrainedness*.

For future research into creativity constraints, the usage of these seven, and other equally relevant continua, should be investigated in depth and in different domains, and the relationship between constrainedness and continua of creativity constraints should be carefully analyzed to gain more insight into how continua of creativity constraints may support further, more comprehensive studies of creativity constraints. Guiding research questions could profitably address and discuss the perceived malleability of the creativity constraints as well as how they shape various stages of the creative process by fluctuating between an enabling and a restraining role.

Types and Roles of Creativity Constraints

In our current work on creativity constraints, we have described and studied various types and the roles they play in creative processes (Biskjaer, Onarheim and Wiltchnig, 2011; Biskjaer and Halskov, in press; Biskjaer, 2013; Onarheim and Biskjaer, in press;

Onarheim, 2012a; Onarheim, 2012b). Of these, we are currently working specifically with two types of creativity constraints: *Late* and *self-imposed creativity constraints*.

Late Creativity Constraints

Initial (pre-given) creativity constraints are often changed, or creativity constraints are externally added or removed throughout a creative process. Each time a set of creativity constraints is internally or externally changed, the existing concept/s and guideline/s must be revised. As remarked in (Onarheim, 2012a), when such late creativity constraints were introduced, the engineering designers studied made a big effort to adapt the existing solution to these new creativity constraints in order to avoid discarding previous efforts. This observation is closely related to the ownership bias found in (Ball et al., 2010), when studying company-wide voting schemes for idea selection in product development. In the study, the individual evaluators of ideas tended to prioritize their own ideas for furtherance; an effect so potent that for every evaluator there was a higher average proportion of picks for ideas that the voter had worked with than ideas not worked on. In the projects described in (Onarheim, 2012b), the process of adapting existing ideas often required painstaking creative work motivated by “*not giving up on a good idea we’ve worked on*” (p. 346). Thus, it may be assumed that if the given sub-type of creativity constraint had been included in the set of creativity constraints from the outset, some of the solutions successfully adapted would have been discarded as incompatible, and it is in fact the addition of *late creativity constraints* that lead to the investigation of these solutions. This shows how the introduction of a given, specific creativity constraint, regardless of source, may initiate new creative processes and momentum, which emphasizes the importance of ‘late creativity constraints’.

Future work should further study this time-dependent effect of late creativity constraints and their ability to spark creative progress. Also, studies should explore differences between being presented with all creativity constraints up front versus distributing creativity constraints throughout the process. In one of our ongoing studies, we analyze a protocol study of 12 teams of professional designers in two scenarios, one where all creativity constraints are provided up front, and one where the creativity constraints are distributed throughout the projects. Preliminary findings confirm that all teams adopt the existing concepts to the late creativity constraints, but the analysis has yet to show in what scenario the most creative output is produced. This particular research question’s focus on the time-dependency of creativity constraints, up front versus late, may easily be augmented to serve a cross-disciplinary aim, for instance by conducting research into fiction, poetry, music, interaction design, filmmaking, and other art-oriented domains in order to explore how early versus late introduction of creativity constraints affect the creative output.

Self-Imposed Creativity Constraints

In a comparative study of filmmaking and engineering design, the creative professionals we have observed all added their own creativity constraints to the given set of creativity constraints, seemingly as a way to make it easier to navigate (Biskjaer, Onarheim and Wiltschnig, 2011). At first, this seems highly counterintuitive: Why enhance the complexity of a creative process already marked by severe constrainedness (constraint intensity)? With regard to the engineering designers in (Onarheim, 2012a), the self-imposed creativity constraints were furthermore observed to be as important as the externally imposed constraints. This has intrigued us and has led to cross-disciplinary studies on creative self-limitation using various creativity constraints.

Although our initial findings strongly suggest that creative practitioners continuously rely on self-imposed creativity constraints during a creative process, the

question arises as to these self-evoked limitations' relative importance on action. Future research on self-limitation, self-depletion, and self-efficacy should study more closely the importance of self-imposed creativity constraints, the point/s in a creative process where these are most frequently used, and to what extent such self-imposed creativity constraints are mixed with externally imposed creativity constraints. In an ongoing comparative study, we have developed a '6i model' for discerning self-imposed creativity constraints, and we utilize this model's six parameters to analyze ten instances of self-imposed creativity constraints in poetry, filmmaking, and engineering design. Early findings show self-imposed creativity constraints to be clearly discernable across all three domains. Creative self-limitation seems to possess a fascinating resourcefulness that we are currently exploring in relation to both interaction design (Biskjaer, Dalgaard and Halskov, 2010) and in a more exploratory theoretical perspective (Biskjaer, 2013). The role of self-imposed creativity constraints in general is only scarcely explored and holds promise for new cross-disciplinary studies exploring various domains where creative agent/s voluntarily set/s up obstacles, rules, or other kinds of restraining initiatives in order to help attain a more original output. We have noted how one such particular category of self-imposed creativity constraints may be discerned since it is related to not simply an incremental progression, but a turning point in the creative process by becoming decisive for the final result. We have observed how such *decisive creativity constraints* are rooted in radical decision-making and closely related to creative outcomes of high originality. This exemplifies how manipulation of the creative space of action and the level of constrainedness make for a resource that can help attain highly original creative outcomes. This, too, is something we propose be studied further by other disciplines and in various domains, as we have narrowed down our own study to interaction design by looking at media façade installation projects (Biskjaer and Halskov, in press). Finally, we would like to note that *cognitive constraints* and neuroscientific research seem an exciting new frontier for future research into creativity constraints. It is one thing to manipulate the material and the creativity constraints present out there on the desk, in the design brief, and in the communication with peers and stakeholders, it is another to skilfully manage the creativity constraints that are always-already, out of sight, but never out of mind.

5 Conclusions

In this paper we have aimed to show that although notions of constraints and their complex dual role as restrainers and enablers of creative agency recurs in creativity research, current contributions are too dispersed and thus disjointed to genuinely inform each other within an ambitious, cross-disciplinary research agenda. We believe that employing the proposed concept 'creativity constraints' as a unifying descriptor, including (some of) the suggested sub-concepts as presented above, may contribute to render such mutually beneficial cross-disciplinary interchange a little bit more feasible. The reason for this, we argue, is that the generic concept 'creativity constraints' brings together a number of important, current disparate contributions to research into the essential entwinement of creativity and constraints – although few researchers in fact use the term 'constraint' in a consistent way. Thus, in our view, 'creativity constraints' may serve to enable further cross-disciplinary research into creativity constraints and the complex ways in which they shape creative processes – regardless of domain. One concrete form such future research could take is comparative analyses where key findings from different domains are studied on the basis of shared concepts. This research aim requires acute terms and a clear scope, and our proposed concept 'creativity constraints' is motivated by exactly this need. Balancing creativity constraints in an efficient, skillful,

and innovative manner is integral to all creative domains and disciplines, and with this paper, we hope to have offered a small contribution to facilitating new ways of understanding this exciting practice.

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