

Opening and Constraining: Constraints and Their Role in Creative Processes

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ABSTRACT

Requirements and constraints are important notions in framing the problem space for design processes. Linear models of creativity have difficulties in accounting for the double influence of constraints on creativity as opening and constraining simultaneously. After a review of relevant literature from the creativity, insight and design requirements literature we propose a conceptual H model. It is able to accommodate seemingly opposing findings concerning the roles of requirements/constraints on creativity in an integrative manner.

Keywords

Requirements, constraints, design, design processes, creativity, aporia

INTRODUCTION

How to create something novel and useful is one of the central questions for designers and people interested in creativity and profound innovations [44]. Related to that is the issue of how to set up and perform creative processes that are able to bring forth solutions that can be considered to be of a game changing quality. Numerous techniques, methods and procedures are out there claiming to support creativity and innovation in design processes [4]. We are currently specifically interested in three sets of questions regarding design processes and study them in real world design settings: (1) How are design requirements generated, handled and applied in design processes? (2) Which roles play insights or AHA moments in design processes? (3) How is the relationship between requirements/constraints and creativity expressed through insights that lead up to profound changes/innovations in the respective projects?

Two in-vivo-in-vitro [8] case studies of real world design processes build the larger context of this paper. We have published preliminary results from that studies together with elaborate reviews of the related creativity and insight literature elsewhere [46, 47], and want to take the

opportunity with this paper to work in a more conceptual manner with the notion of requirements/constraints and their relationship to creative processes.

When reviewing the literature on creative processes and the role of constraints on creativity in the context of our own observations we were puzzled by an observation: The existing approaches in the creativity literature (for overviews see [45] and [35]) seem to have a hard time in accommodating the double role attributed to constraints affecting creative processes and outcomes in ONE single conceptual framework in a “BOTH AND” manner.

Therefore we set out with this paper to discuss the relevant approaches and findings in the literature regarding this issue and propose a conceptual model. This model sets the seemingly opposing influences into a relational structure that is able to keep four meaning dimensions of constraints in mind simultaneously. This is important for mapping questions of how to enable creative outcomes (or even insights) through handling requirements and constraints while appreciating the dynamics emerging from the underlying opposition/polarity. We hope thereby to build a fundament for connecting and reconciling some of the theories trying to understand how designers work with constraints in creative design in real world settings.

The paper starts with a brief review of literature on conceptual design spaces and creative processes. In the following, different notions of requirements and constraints and their role in design processes are discussed. From literature looking closer at such constraints and their relation to creativity somehow paradoxical evidence can be derived. Empirical data shows that constraints can be perceived as both enhancing and/or constraining creativity. Entering the aporia [13] as a rhetorical tool, we propose an H model that allows us to accommodate both aspects of the polarity. We then relate the model to historical and self-observed empirical material, and conclude with a discussion of the different qualities of creative processes influenced by constraints. Considerations for further applications of the H model as a solution to overcome HX mix-ups in related design fields form the concluding part of the paper.

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CONCEPTUAL DESIGN SPACE AND CREATIVE PROCESSES

In this section we want to point to the broader context of our arguments in the literature on creativity [35, 38, 45] and insight [25, 37]. We have provided more thorough reviews elsewhere [46, 47] and want to focus here on mainly two themes that are important for accommodating our conceptual model later on: (1) the notion of a design or problem space and how it is shaped through constraints as well as (2) the relations of creative processes to the ideas of conceptual design spaces. In general we are committed to an approach to cognition as embodied, situated and in relations in-between people and things [2, 19], and the epistemology of practice based studies [11]. We like the idea of an “ontology of minimal creativity” [39] starting with novelty and agency as key elements.

Designing as Constructing, Navigating and Manipulating a Problem space

At the center of our considerations is the notion of a design or problem space that is formed by requirements/constraints. Following Newell and Simon [29] a problem space can be considered as a somewhat abstract representation of the “task environment” by an actor/subject trying to solve the problem/task at hand. “This is not a space that can yet be pointed to and described as an objective fact for a human subject. [...] [T]he subject in an experiment is presented with a set of instructions and a sequence of stimuli. He must encode these problem components – defining goals, rules, and other aspects of the situation – in some kind of space that represents the initial situation presented to him, the desired goal situation, various intermediate states, imagined or experienced, as well as any concepts he uses to describe these situations to himself.” [29]

In the last decades a considerable amount of work has been critically acclaiming that approach and set out to elucidate the related processes and practices applied by designers [7, 26]. Building on it, a design process can be considered to be dealing with setting up, exploring and altering such a conceptual space. Possible solutions have to simultaneously satisfy all the relevant requirements in play. Thereby changing one of the requirements as boundary condition immediately changes the whole space of possible solutions. For our purposes the heuristics, tools and representations used by skilled designers for constructing, navigating and manipulating these conceptual spaces through the handling of requirements and constraints are of special interest. In that respect data on what experienced creative people/designers do in order to be more creative or even reach insight moments in their work processes is of significant importance [28].

In summary, we can say we are confronted with a multidimensional space here: Constraints form the force field that builds up the design space through which designers have to navigate in order to arrive at a solution to their design task. Thereby constraints influence and shape the designer's creative process. Crucial questions are related

to the ways of building up the design space, the different types of pathways through such a multidimensional space and the heuristics designers could apply when confronted with a call for profound innovations [32].

Creative Process Models

Models of creative processes in the tradition of Graham Wallas' [42] seminal book on “The Art of Thought” somehow assume a linear succession of stages. Wallas is talking there about five stages: preparation, incubation, intimation, illumination and verification. Insights or AHA-moments are at the center of the illumination stage, following an impasse during the incubation stage and possible feelings of “getting there” as intimations. Similar basic linear structures of creative process can be found in models from psychology and engineering alike [18]. Iterations that include recursive, parallel or circular movements are omitted by such structures.

Additional theories about the generation of new ideas that are of interest in the context of this paper are the model of divergent thinking by Guilford [14, 15], that describes a phase of opening the creative process followed by a phase of selecting and limiting down ideas. Brainstorming rules [31] seem to hold the assumption that a general unconstrained process is best for coming up with fresh and novel ideas considered to be “creative”. Also criticism (as application of constraints) should be held back for later. Therefore the whole method has a strong emphasis on “creation/generation” and leaves evaluation and selection to later stages.

The issue with all those descriptions is, that due to our perception of time as a linear flow we are tempted to come up with stories that are structured in phases and as “serial”. That is also how our language and even this text is structured. We seem to have a hard time to account for simultaneous and parallel events in written sentences without having to use structures that again have this linear character. This problem can be tackled more easily in mathematical formulas and graphical representations that can be perceived as totality first and then analyzed in sequences or segments.

Considerations that put the ability to keep opposing concepts or sets of requirements simultaneously in mind or even integrate them are relatively rare. Roger Martin's suggestion of the importance of “integrative thinking” of “opposable minds” [27] is one of the more recent attempts. He suggests a broader framework that is based on Charles Sanders Peirces notion of “abductive reasoning” and a series of examples from interviews with designers and business leaders demonstrating these ways of thinking as key success factor.

We have now discussed the notion of problem spaces and processes to get from a problem to a creative solution. Constraints were mentioned as constituting and defining the problem space and thereby possible solutions. In a next step it is crucial to review different notions of constraints

systems [21], and within software design the importance of requirements has even led to the emergence of the research field requirements engineering [6]. On a personal level, Amabile [1] points at constraints as limiting on personal choices and feelings, pointing to both experimental and non-experimental evidence.

Furthermore, the subject of requirements is linked to time usage in design. Evidence suggests that the process of working with constraints represents a substantial part of the time spent in design projects, in software design the cost of the requirement handling in itself is estimated to represent approximately fifteen percent of the overall development cost [36]. In computer-based information systems requirement handling is even estimated to represent more than half the cost of the development [43]. In a study of design meetings in three organizations, Herbsleb and Kuwana [16] found that the most recurrent question between the designers was regarding requirements. In the meetings, the most frequent single type of target asked about was simply what the requirements were.

Constraints and Creativity

It is important to take a closer look at the role that constraints play in relation to the creative process and the creativity of the outcomes created. When investigating descriptions of the relationships between constraints and creativity, we focus on two distinct views presented in the literature. The first is put forward by Teresa Amabile in her book “Creativity in context” [1]. Here Amabile is using quantitative experimental data to show that imposed constraints have a negative influence on the creativeness of the outcome, concluding that imposing constraints leads to diminished creativity.

The other view is presented by Patricia Stokes in her book “Creativity from constraints” [40], a text solely devoted to the topic of constraints and creativity. Here Stokes claims that without any constraints creative work is impossible, and furthermore that working with the set of constraints is a creative act in itself. She concludes that constraints are all-important for enhancing creativity and that without constraints there can be no creativity.

If we take both perspectives and the observations that lead to their formulation seriously we are faced with a somehow paradoxical situation from a strictly logical standpoint. It should be expected that one type of factors should only have one type of influence. Indeed it should not have opposing influences. At the same time designers seem to be able to handle both of the described, potentially opposing influences of constraints simultaneously in their real world working environments every day.

A CONCEPTUAL MODEL INTEGRATING THE OPPOSING INFLUENCES OF CONSTRAINTS ON CREATIVITY

When observing designers in real world settings, they seem to be able to bridge the two aspects in their everyday work. We should not have to decide between one or the other influence of constraints on creativity, and we have

therefore set out to construct a conceptual model that accommodates both strands of researching constraints and creativity at the same time. Through this model, we seek to argue for a third approach that accounts for the dynamic relationships between the two archetypal views on the role of constraints in creative processes.

In order to do so we propose to conceptualise the influence of constraints on a creative design process as an aporia following the Socratic rhetorical figure [34] and newer proposals for their application to contemporary issues by Herbert Pietschmann [33]. If we follow him the relationship between the two approaches can be rephrased as an “HX mix-up” (German: “HX Verwirrung” [33]). Such a mix-up occurs if two opposing arguments are both applicable to a certain observation/issue. The conflict is arising, if proponents of one line of argument try to discard the opposite even though both are obviously right. Taking a concept which was introduced to psychology by Carl Jung, it can be assumed, that they are fighting the “shadow aspect“ of the other rather than trying to avoid the “shadow” of their own principle [23, 33].

Let us make the structural relationships of the X and H situation in the HX mix-up explicit in the following model where the polarity between constraining and opening a creative process is conceptualised as “framing” respectively “relaxing constraints” together with their shadow aspects “limiting” and “getting lost in space”.

X situation

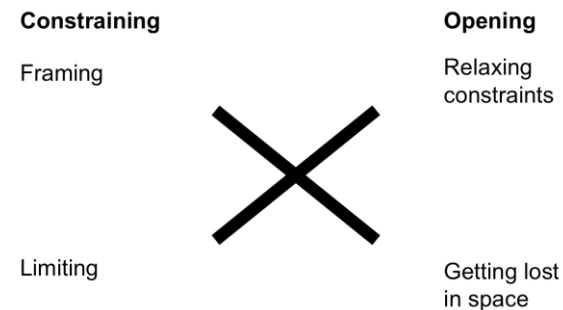


Figure 2 X situation

The relations between the conflicting factors in play can be considered to form an X shape made up of the diagonal lines between the opposite arguments. If we start from the position and evidence that framing the process through constraints and requirements is necessary, we could criticise the “shadow” side of the claims for opening the process by removing/relaxing constraints. The argument would go against the absence of borders, claiming that this leads no where because people simply get lost in the vastness of the possibility space without any constraints or boundaries.

If we start vice versa from the evidence for the necessity of opening up through relaxing of constraints as prerequisite for a fruitful creative process we would argument against the shadow of the “constraining” pole that would lead to

limiting the possibility space to an extent that it appears rigid.

H situation

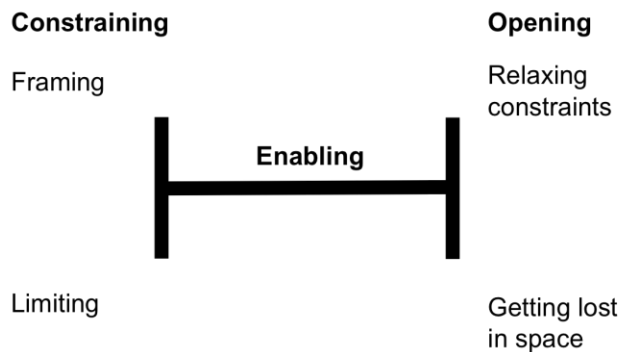


Figure 3 H situation

If we recognise the necessity to balance the polarity/paradox appreciating both poles, the problem transforms into an H-shaped relationship: the two vertical lines hinting at the necessity to avoid one's own shadow – “constraining” to the extent of limiting to rigidity resp. “opening” to an extent of getting lost in space.

The horizontal line shows that enabling creative processes contains the need to balance the whole polarity between opening and constraining. Overall it would be at least helpful to be aware of the four aspects involved in the polarity between constraining and opening in order to fight one's own shadow rather than that of someone else.

Historical example

As a next step we work through the model with empirical material introduced by Amabile [1] and one of the key examples from Stokes [40] for further illustration. Amabile is using painting tasks in her study of the influence of constraints on the rated creativity of artwork produced by the participants. Therefore it makes sense to choose an example from Stokes related to painting as well – namely the constraints chosen and introduced for their artworks by the founders of the cubistic movement in Paris in the early 20th century.

Amabile reports how the ratings for creativity of the paintings produced in the constrained condition of her experiments decreased compared to the condition that allowed the participants to work more freely. Thereby she provides evidence for the opening side of our H model and for increasing creativity through relaxing of constraints. Stokes describes with the example of cubism how the self-selection of a quite rigid set of principles and ways of visualisation that “were allowed” in cubistic artworks led to a new art style considered as highly creative. This shows how a quite strict framing can be considered to enhance creativity as well.

It is important to note here that one element that connects the two examples is the notion of “self directedness” in terms of choosing constraints in the cubism example and in

terms of the loose task description provided by Amabile in the opened up experimental condition. It seems to make a difference whether one operates under enforced constraints or has the feeling to choose the constrained working conditions freely.

Empirical example

In several situations observed in our real life studies, the challenge of applying existing literature on constraints and creativity has become apparent. It has become obvious that the constraints present in the design projects are not either enhancing or limiting the creativity, but that the designers manage to balance how they use the different constraints in such ways that any constraint can be both – dependent on what might lead to the best solution. When observing such balancing of the constraints done by the designers, the H model is useful when seeking to understand how the designers are working actively with the constraints. A very straightforward example of such usage of the H model is an observed situation where a design team was discussing a specific design constraint: the production method. The team members were informed that the product had to be designed to fit one specific production method. In the situation observed, the team was discussing the consequences this constraint would have for the rest of the project. In the meeting, views representing all four sides of the H model were present: 1) the constraint was framing the further process, so that a lot of previously considered solutions could be excluded, 2) the constraint was limiting the number of possible solutions, 3) the constraint could be relaxed, for instance by using the production method in a novel manner and 4) if the constraint was not introduced, the number of possible production methods would have been numerous and therefore challenging to explore. Even though all these four views were present in the rest of the project, the designers managed to constantly balance between the four perspectives in relation to what perspective was most suited at a given point in the process.

Further in our work, we will use the model when analyzing recorded interviews of designers talking about what they use to spark their creativity. In these analyses, we will use the model to better understand how the designers are balancing the views on constraints when seeking to come up with creative solutions.

DISCUSSION

In the following we take the H model to discuss the qualities of creative processes and explore the possibility to take the notion of HX mix-up and the H model as rhetorical tools to inquire similarly structured problems in the field of design research. We also discuss the practical and theoretical value of the model, and the challenges related to the aspects of dual processing implied by the model.

Qualities of creative processes and the role of constraints

In the H model four qualities of creative processes in relation to requirements/constraints can be identified:

- (1) Creative processes are framed by requirements/constraints
- (2) Creative processes are opened through the introduction and removal of constraints
- (3) Creative processes can be limited through too rigid constraints
- (4) In absence of any constraints the creative process becomes borderless and impossible to evaluate

Designers are confronted with the task to navigate in their creative process with two movements:

- (1) Framing the process through introducing constraints
- (2) Opening the process through relaxing, changing, reframing, negotiating and/or removing constraints in order to find something new

The art of enabling creative processes lies in balancing these two movements as a polarity getting beyond the HX mix-up likely to occur if we emphasise only one aspect.

As exemplified above, we see the model as valuable both as way to appreciate two seemingly opposing theoretical claims, and as a tool to understand the balancing of constraints performed by real life designers. In our work, the model therefore has both theoretical and practical appliances. Still, we recognize that the model, as other models that claim a “BOTH AND”-situation, simultaneousness or parallelism, is in need of a more developed theory of mental dual processing [9]. This also follows the suggested importance to develop skills of integrative thinking, thereby transferring experiences from the design realm to management and other areas.

SUMMARY AND CONCLUSION

In this article we have discussed the concept of constraints and requirements as descriptors of “what to build” in design processes. After reviewing the literature relevant to creativity and constraints we have discussed the types and roles of constraints further. From an example of an attempt to accommodate different types of constraints and their origin in one model, we moved to suggesting to account for them in a multidimensional space of continua.

With the assumption that constraints form the force field in which designers have to navigate in their creative processes we showed apparently contradicting evidence of the influence of constraints on creativity from the literature. As designers seem to be able to accommodate both perspectives – constraining and opening creative processes – we proposed an HX mix-up to account for the aporia and the H model as resolution from a theoretical point of view.

In concluding we discussed and summarized the qualities of creative processes in relation to the influence of constraints.

Outlook

The work presented is somehow still in the “cognitivist” tradition of studying individuals in context. But we would argue that the model should hold also for

dialogical/conversational models, and hopefully it might even be useful for describing the polarities in conversations. In our real world studies we have observed how members of design teams often play out different roles representing the different aspects of the H model.

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