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Is There a Need for a Design Thinking Process?

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Abstract

Sequential process models play a core role in design thinking education, although design thinking principles ask for more adaptability and flexibility of design workflows than those models suggest. This paper explores how far there is a need for a design thinking process and suggests an alternative conceptualization that is both congruous with design thinking principles and viable for design thinking didactic.

1. Introduction

Design thinking has become a widespread approach to solve socially ambiguous design problems. In design thinking education, sequential process models are applied to help students to apply design thinking principles to design project exercises. This however entails a paradoxical situation, as there is a fundamental conceptual conflict between the same principles that ask for situational flexibility and adaptability of workflows, and the normalization of workflows as suggested by those models. In this paper, we ask whether there is a need for a design thinking process. We propose avoiding this paradox through an alternative conceptualization, using "working modes" instead of process steps that are interlinked variably following heuristic "working rules". We aim to draw up a design workflow model that is in agreement with design thinking principles as well as concrete enough to be used for design thinking education.

2. Design Thinking Workflow Principles

In the broadest sense, design thinking refers to the "study of cognitive processes that are manifested in design action" (Cross et al. 1992), and thus indicates a general research focus independent of what design paradigms dominate. Research on as well as the application of design thinking has become prevalent over the last three decades. It rooted in 1970/80ties case study research by Lawson (2004; 2006) and Cross (2007b) on how outstanding designers approach problems and develop solution concepts and has evolved to a broad discourse on the exploration and analysis of cognitive strategies that carry the generation, synthesis and creative transformation of divergent knowledge within design processes (Beckmann & Barry 2007; Owen 2007). Moreover, those strategies have been reinterpreted as normative guidelines for design projects and creative problem solving in general [1]. In this connection, design thinking was translated into holistic frameworks moving beyond designer's professional domains and gradually applied to various disciplines and fields of innovation in both academia and business (Brown 2008; Drews 2009; Dunne & Martin 2006; Grots & Pratschke 2009; Martin 2009; Plattner et al. 2009). In particular those normative interpretations of design thinking have led to a vast variety of conceptions and intentions of use, which make it sometimes complicated to see the common traits.

However, we find it helpful to understand the basic principles of problem solving in design thinking with two pairs of terms: *the problem and solution space* on the one hand, and *diverging / converging thinking* on the other hand. While the first gives fundamental insights on how design problems are perceived and constructed, the second basically shows how to learn and deal creatively with relevant knowledge within design thinking-led problem solving.

A concept of the *problem space* was first introduced by Newell et al. (1967). They locate the representation of possible solutions in the problem space itself without regarding a separate solution space—according to the logic once a problem is comprehensively stated, the optimal solution can be rationally derived from the inner structure of the problem [2]. In opposition, Cross & Dorst (cited in Cross 2007b) brought up the notion of "co-evolution of problem and solution". They regard designing as a dualistic approach that regards both problem and solution space as to be explored, whereas it is neither possible to fully understand a problem, nor to deduce rationally an "optimal" solution [3]. Initial problem space exploration aims at constructing subjective representations of diverse stakeholder perspectives setting the problem space's yardsticks. Those representations however are not—according to scientific standards—'representative': they serve as inspiration for an exploration of the *solution space*, first by working out ideas and then by turning ideas into tangible sketches and prototypes. Making things tangible, yet, allows designers to learn again more about the problem space, for instance when communicating about those ideas with the stakeholders. Consequently, the designer's awareness of both problem and solution space will be reviewed and renewed with each other until the designer perceives a distinct match between them (Cross 2007b).

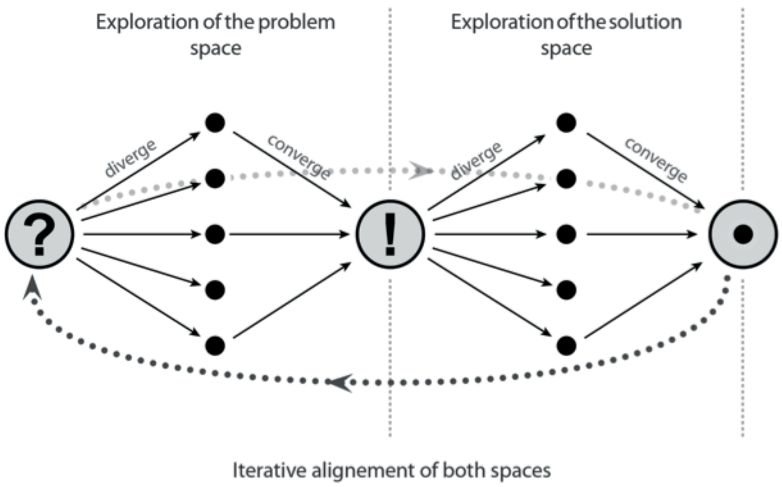

Figure 1. Basic Principles of Design Thinking Workflows [4]

The distinction between *diverging and converging thinking* however shows how both spaces are explored. This pair of terms goes back to Guiltford (1969), who sees 'divergent and convergent production' as elementary cognitive factors of problem solving and in particular the former as an important factor of creative work. Divergent thinking means dealing with a problem by discovering a broad range of its aspects—for instance the divergent perspectives constituting a design problem or the divergent possibilities that make up the solution space. Convergent thinking, conversely, brings together those divergent aspects to comprehensive frameworks and concepts, for example by synthesizing user observations to clear-cut point of views or by prioritizing ideas and specifying design concepts.

The significance of both principles for tackling design problems has been pointed out e.g., by Dym et al. (2005) and Rhea (2003). It is hypothesized that the general course of design workflows within problem and solution space either shows divergent or convergent directions, though both divergence and convergence show in each space fundamentally different traits. In the solution space, divergent and convergent thinking support the creation and elaboration of ideas and concepts. In the problem space, however, they show how to gain and handle relevant external knowledge within 'wicked problem' settings, without being dependent on scientific modes of thinking. Design thinking aspires divergence instead of representativeness in order to develop a broad inspirational understanding about a situation, and it does not expect more (or less) from convergence as to summarize a certain state of knowledge or to capture and elaborate a certain idea or concept.

In consequence, design thinking is the interplay between diverging activities of opening up the problem and solution space and converging activities of synthesizing and selecting. Contrary to scientific thinking, the knowledge processed in design thinking has to be neither representative nor entirely rationalized, rather it serves to obtain an exemplary but multi-perspective understanding in order to creatively transform it to a solution for the ambiguity of wicked problems. Summing up, this interplay can be put down to three basic characteristics, that engenders a system of checks and balances to ensure that the conclusive solution will be both innovative and suitable for the social system that the design problem addresses (see also Fig. I):

- *Exploring the problem space:* When exploring a problem space, design thinking acquires an intuitive, not fully verbalized, understanding, mainly by observing exemplary use cases or scenarios, as opposed to formulating general hypotheses or theories regarding the problem; and synthesize this knowledge to points of view.
- *Exploring the solution space:* When exploring the solution space, design thinking asks for a great number of alternative ideas in parallel and elaborates them with prototyping techniques. In this manner, ideas are being consciously transformed into tangible representatives.
- *Iterative alignment of both spaces:* These representatives of ideas and concepts facilitate communication not only in the design team, but with users, clients and experts as well. Thus, design thinking helps to keep in touch with the problem-relevant environment and can use this information for refining and revising the chosen solution path(s).

3. Contradictions in Design Thinking Process Models

As argued above, problem solving in design thinking can be put down to three underlying principles. As we discuss in this paper how far it is reasonable to speak about 'design thinking processes', we now would like to distinguish this term from the term 'design process' and discuss certain contradictions that this term entails.

'Design processes' mean basically all the activities put together being premeditated or employed to solve a certain design problem. There is a long tradition of academic discourses on modelling design processes, whereas one can tell between two intents: on the one hand, design process models as explanatory-theoretical representation of design activities; on the other hand, design process models as prescriptive statements on how to solve design problems. Models of the first category generally are rather abstract and support theory building; models of the second category however illustrate already fixed design approaches or paradigms, often with the intention to facilitate the organisation of real-life design activities [5]. The term 'design thinking process' yet has somewhat different connotations. First, 'design thinking' points at only those design activities that address design problems which are rather ambiguous, blurred in character and not definitely definable—so-called wicked problems (Rittel 1972; Buchanan 1992). As a consequence, the way in which design processes are perceived is rather indefinite as well. Thus, the idea of a normalized process that tells in which step sequence designers come to the right solution is ultimately rationalist idea, following rather a scientific way of problem solving [6]. Even if there is also from a design thinking perspective no doubt that each design problem solving constitutes itself in a certain sequence of process steps, the question would be how predictable and thus how determinable those sequences are.

This however is no trivial question. On the one hand, there are—as described—design thinking principles that influence the processes in reality, for instance the principle to explore the problem space before going into the solution space. On the other hand, those principles cannot be taken to derive a normalized sequence of phases as 'optimal' process model—owing to the fact, that design thinking emphasises too strongly problem-related learning and adaptive concept creating to be constricted in a uniform process. Thus workflow standardizations would be contra-productive as the progress of design thinking-led problem solving does not lie as much in sticking to the phases of the process as in understanding and adapting to the ambiguity of a design problem. Design thinking process models therefore have to struggle twofold: firstly, they must depict context-sensitivity and situational adaptability of workflows without loosing conceptual clarity; and secondly, when they propose instructions for real-life projects, they have to make clear that they offer 'only' guidance and no definite means for design problem solving. In sum, design thinking process models have to deal with the fact that design thinking is originally no process, but that it shapes processes.

As a result, there is in design thinking discourse apparently more ease in developing explanatory and theoretical models (as in Fig. 1) than prescriptive and concrete ones. Owen (2006), for instance, models knowledge processes in design thinking workflows from a theoretical standpoint very insightfully, and Beckmann & Barry (2007) do the same with learning terminology. Design thinking processes models with more prescriptive and concrete character however (that is models giving instructions for practical use) tend to struggle finding the balance between flexibility and sequentiality. Brown (2008), for instance, distinguishes the general phases 'inspiration', 'ideation', and 'implementation', and groups and orders for each phase the questions to ask or the actions to do. To weaken sequentiality, he arranges the model in a circular manner and connects the phases with both forward and backward linkages. Another model has been formalized at the Hasso Plattner Institute of Design at Stanford and is used as a didactic process model for design thinking education (Plattner et al. 2009; for a similar model see Grots & Pratschke 2009). It distinguishes the phases 'understand', 'observe', 'synthesis/point of view', 'ideate', 'prototyping', and 'test'. As Fig. 2 shows, though these phases are put in a sequential order, linearity is avoided through iterative links connecting all phases with each other.

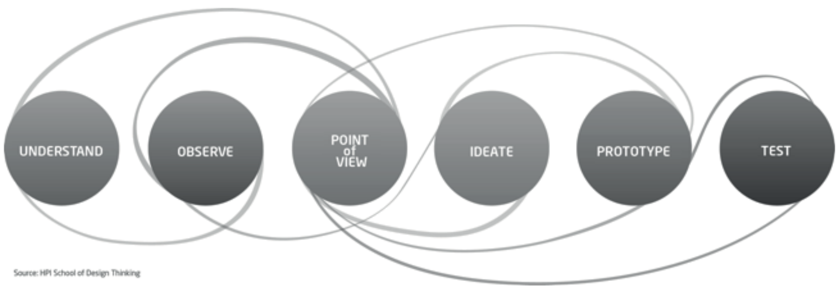

Figure 2. Didactic Design Thinking Process Model (Plattner et al. 2009)

The purpose of such prescriptive design thinking models is to give a comprehensible and rather intuitive picture of an idealized design thinking workflow with the aim of helping people to adapt and apply it. Those models show hybrid traits, as they tend to 'flirt' with sequential process depictions in order to achieve better lucidity while trying to avoid at the same time the impression of linearity through circular logic or all-connecting feedback loops. This 'balancing act' may make sense for didactic reasons in order to help design thinking students to apply design thinking principles in project-based learning courses without having them already internalized. Thus, the sequence of phases can be seen as a case of a design process designed for learners, while the iterations elucidate adaptability and context sensitivity. Yet, we think that those models entail the risk of misconceptions as their sequential framework may obscure that design thinking is no process, but shapes processes.

4. An Adaptive Design Thinking Workflow Model Proposal

As a result of the previous discussion, there is a need for a comprehensive model that guides design thinking learners through project-based learning lessons. On the other hand, there is also a danger of misconception when falling back upon sequential process models, as those models make the underlying design thinking principles somewhat indistinct. To overcome this contradictory situation, we suggest avoiding the traditional process terminology consisting of phases, sequences and feedback loops. We think, that this terminology has been rather chosen on account of its commonness and comprehensibility than its conceptual fit. Considering that design thinking workflows are shaped by underlying principles giving rise to processes without prescribing them, we suggest to model those principles on a *concrete* level by using as basic distinction both terms 'working modes' and 'working rules'. While the former are recurring steps of the problem solving process, the latter are heuristics that help to decide how to interlink the modes to a helpful process.

4.1 Eight Working Modes

By using the term 'working modes', we assume that there are certain sets of activities that recur in any design thinking-led problem solving workflow. As detailed below, we distinguish eight different modes with distinct goals and means:

a. (Re)Framing the Design Problem

Goal: This is the focal mode of problem space evolution. Its goal is to frame and reframe the scope of the problem space and thus the question to ask for further learning efforts (Brown 2010, Schön 1984). This mode opens every design workflow—mostly based on information given by the client as well as the own expertise—and is applied when an altered state of knowledge does not match the way that a problem is framed.

Means: Means how to frame: e.g., Fractionation (e.g., de Bono 1970). Means how to reframe: e.g., Synectics (Gordon 1961).

b. Grasping External Knowledge

Goal: This is the focal mode of problem space exploration. The goal is to collect problem-related knowledge that is not already part of the designers' expertise. Studying who the particular stakeholders of a design problem are and how they think and act is compulsory for this mode—in particular with regard to the users. In this mode, designers deal with two different types of knowledge. While it is rather easy to grasp 'explicit knowledge' as it exists already in forms of documents, reports or clear-cut statements, it is considerably more intricate to gain so-called 'tacit knowledge', containing unspoken thoughts, feelings, habits or needs (Nonaka 2007; Wagner 1987). Tacit knowledge however is a vital part of problem space exploration. Developing empathy for the users' needs, for instance, and exploring what bothers them means to deal with situations in which the most revealing aspects may be not expressed directly.

Means: The basic means of this mode is communicating, observing, recording, and empathizing, supported by manifold methods (e.g., interviews, survey questionnaires, focus groups, cultural probes etc. (e.g., Laurel 2003; Visocky O'Grady 2006). Typical user research can be performed by field studies, interviews, or self-experiments (e.g., Beyer & Holtzblatt 1998; Jones 1992). Additionally information can be obtained by literature and desk research. At a more developed state in the design process, the focus will be put on user feedbacks on visualizations and prototypes.

c. Knowledge Pooling

Goal: This mode presupposes a team carrying out the design project. Its goal is to combine the versatile amount of knowledge so as to create a mutual knowledge base among all team members. It is important not only to transmit explicit information but also impressions and empathic understanding. This mode is important due to two reasons. First, when grasping external knowledge team members often divide their focus because not everyone can attend all appointments due to time and budget restrictions, or there may be dedicated, experienced user researchers for those activities. Second, knowledge pooling is important for developing a multi-perspective understanding of the problem space. As every team member introduces an own personal or disciplinary perspective, the team as a whole enhances sensitivity for a wicked design problem setting.

Means: The most important means is to inform team members about insights from user research and share also the empathic knowledge which was collected. A very common method is Storytelling (e.g., Quesenberry & Brooks 2010; Brandes et al. 2009).

d. Synthesizing

Goal: Recurrently, designers are confronted with a large quantity of information—they may be problem-related or solution-focused –, being too widespread to be completely included in the subsequent design workflow (Kolko 2010). Thus the goal of this mode is to synthesize information by grouping, structuring or condensing them to a (preliminary) conclusion as basis for further work (Howard 1988). Synthesizing is a critical part of a design workflow as it decides about how to converge highly divergent states of information and thus how to process them.

Means: 1. Creating abstract frameworks, e.g., with the help of 'Concept Mapping' (e.g., Kolko 2010). 2. Converging into concrete representations, e.g., in form of a 'Point of View' or 'Persona' (fictional character profile) (e.g., Long 2009; Laurel 2003).

e. Path Selecting

Goal: At certain points in a design workflow, designers learn about several options of proceeding, and—under the condition of limited time and resources—they must decide in which direction they further want to go. This can relate to both what questions guide exploring further the problem space and or ideas will be worked out to solution concepts. The goal of this mode is making those decisions consciously and deliberately with the whole team (and maybe with the client also), as it is otherwise likely to loose tracks of the project as well as to harm the mutual understanding of the design workflow.

Means: 'Group discussions' are a starting point for this mode, followed by methods like 'Elevator Pitches' (e.g., Skambraks 2004; Pincus 2007). For the conclusion of this mode, voting techniques like e.g., 'Dot Sticking' or 'Dotmocracy' (e.g., Baxter 1995; Tague 2005) are useful.

f. Ideating

Goal: Creating a vast variety of ideas is crucial for finding the ones that prove themselves as viable (Brown 2010). The goal of this mode is to create manifold and various ideas on possible solution paths without judging or criticizing them (thus wild or seemingly strange ideas are welcome) in order to achieve a large quantity of ideas. Selecting ideas is not part of this mode (à path selecting). Expressing and applying the personal creative potential of all team members is important. Preferably a diverse team is involved when it comes to ideating, as inputs from people with different backgrounds increases the variance of ideas.

Means: There are many creativity methods supporting this mode, primarily 'Brainstorming' (e.g., Brandes et al. 2009), 'Brainwriting' (aka Method 635) (e.g., Rohrbach 1969; Baxter 1995), Mind Mapping (Buzan & Buzan 1996) and 'Synectics' (Gordon 1961; Jones 1992).

Table 1. Relations of Working Modes to Problem/Solution Space and Diverging/Converging Thinking

	Mode	Problem or Solution Space	Diverging or Converging Thinking
a.	(Re)framing the Design Problem	Problem Space	Starting or Coupling Point (C→D)
b.	Grasping External Knowledge	Problem Space	Diverging
c.	Knowledge Pooling	Problem Space	Coupling Point (D→C)
d.	Synthesizing	Both Spaces	Converging
e.	Path Selecting	Both Spaces	Coupling Point (D→C & C→D)
f.	Ideating	Solution Space	Diverging
g.	Concept Specifying	Solution Space	Converging
h.	Making It Tangible	Solution Space	Converging

g. Concept Specifying

Goal: The goal of this mode is to bring certain ideas on a more detailed level. It asks to think with scrupulousness about an idea and to concentrate on the facets that should be incorporated in the next sketch or prototype. The concept should be further revised and specified with ongoing iterations, eventually leading to a profound strategic planning document. This mode is the preceding step for making ideas tangible (see mode f).

Means: There are different means to support concept generation (Pugh 1990), e.g., 'Concept Mapping' (e.g., Novak & Cañas 2008), 'Frameworks' or 'Process Diagrams'.

h. Making it tangible

Goal: This mode's goal is to visualize and objectify ideas and concepts to enable feedback from potential users and stakeholders. The level of refinement of visualizations and prototypes depends on the stage or amount of iterations in the design. In the beginning, there should only be a rough representation of the concept, such as a sketch on paper or roughly built mock-up (Buxton 2007). Such 'low resolution' depictions or prototypes help to get quick and cheap feedback on the general idea of a design concept and are thus indispensible for rapid learning cycles. As more the designers have filtered out a particular concept, as higher should be the resolution of prototype because they help learning about the details of a concept (Edelman et al. 2009).

Means: In early stages of the design, typical means are simple visualizations in form of sketches (e.g., Visocky O'Grady 2006). Later all different kinds of prototyping methods are used (known by different sometimes inconsistently used labels: e.g., low- and high-fidelity prototyping, paper prototyping, mock-ups or wireframes (e.g., Beyer & Holzblatt 1998; Warfel 2009).

We distinguish these modes both with regards to the pairs of terms 'problem and solution space' and 'diverging and converging thinking'. As Tab. 1 shows, the modes a, b, and c support problem space exploration, the modes f, g, and h solution space exploration, and the modes d and e are supportive in both spaces. Likewise, the modes b and f show fundamental divergent traits and the modes d, g, and h convergent traits. We regard the modes a, c, and e as coupling points linking up divergent and convergent movements.

4.2 Six Working Rules

As described above, we see these working modes as basic activities recurring in every design thinking workflow. We furthermore suggest six working rules that give heuristic assistance on how to apply and combine them in a design thinking workflow. We see these rules in particular valid and viable for design thinking novices. The more advanced a designer is, the less normative should those rules be regarded.

1. *Every Mode Is Important:* All modes should be incorporated in a design thinking workflow.
2. *Initial Problem Space Exploration* (Phase I): At the beginning, the problem space has to be extensively understood before one can pass over to the solution space. The team iteratively executes the problem space modes (see Phase I in Fig. 3). For novice design thinkers, we suggest to start with the following order: Framing the Design Problem, Path Selecting, Grasping External Knowledge, Knowledge Pooling, and Synthesizing.
3. *Finding a Viable Scope Before Entering the Solution Space* (Phase I): Two criteria help to answer the question when to enter solution space for the first time: a) there should be a certain scope of the problem to which the gathered knowledge has been converged and that does not alternate substantially with further iterations; b) the design team should regard this scope as a viable background for ideating and concept development.
4. *Problem Space Exploration as Combination of Unfolding, Selecting and Re-Representing Solution Paths* (Phase II): Solution Space exploration relies on three aspect: a) finding manifold potential solution paths by ideation techniques, b) learning how to select a group of them to put more attention on, and c) learning about their facets by means of diverse representation techniques (e.g., concept drafts, sketches, prototypes). We suggest an order of working modes for design thinking novices: First, ideating for new idea generation, followed by synthesis and / or path evaluation, concept specifying, and making it tangible.
5. *Balancing Solution Paths with the Problem Space when Tangible Representations are Available* (Phase II): The problem space should be re-entered when a tangible object is on hand that allows collecting feedback from stakeholders with the purpose of supporting revising, refining or rejecting a certain concept. For design thinking novices, we suggest the same sequence of working modes as in phase 1: Exploring the Problem Space, Information Pooling, Synthesis, Reframing the Design Problem and Path Evaluation, before entering the solution space again.
6. *Ending the Workflow when a Concept is Saturated:* The design workflow should ideally come to an end when balancing problem and solution does not suggest significant modifications of the design concept. Then the concept is saturated.

With Figure 3, we propose a model that shows how modes and rules interact against the background of the design thinking principles illustrated in Fig. 1. In this model, we draw several distinctions that show the different layers of design thinking workflows. First, we look at problem and solution space in parallel and use this distinction to discriminate two phases: the initial problem space exploration (Phase I) as well as the following co-exploration of solution and problem (Phase II). Second, we depict the alternation of divergent and convergent thinking throughout the workflow by using the quadrants of the circles as metaphors for both kinds of thinking. Third, we tell apart a prescriptive workflow for novice design thinkers (whereas the position of working modes should be seen as suggestion and not as law) and the rather volatile workflows of advanced design thinkers. Fourth, we try to balance both the adaptive toolbox that design thinking offers and the recurring patterns that design thinking demands by showing up where the freedom to decide what to do next is stronger or weaker. We are aware that this model gives in the depicted form very complex information so that it would be viable only for conceptual and not for didactic reasons. The different layers however can be easily scaled down so as to transform it into a more comprehensive form.

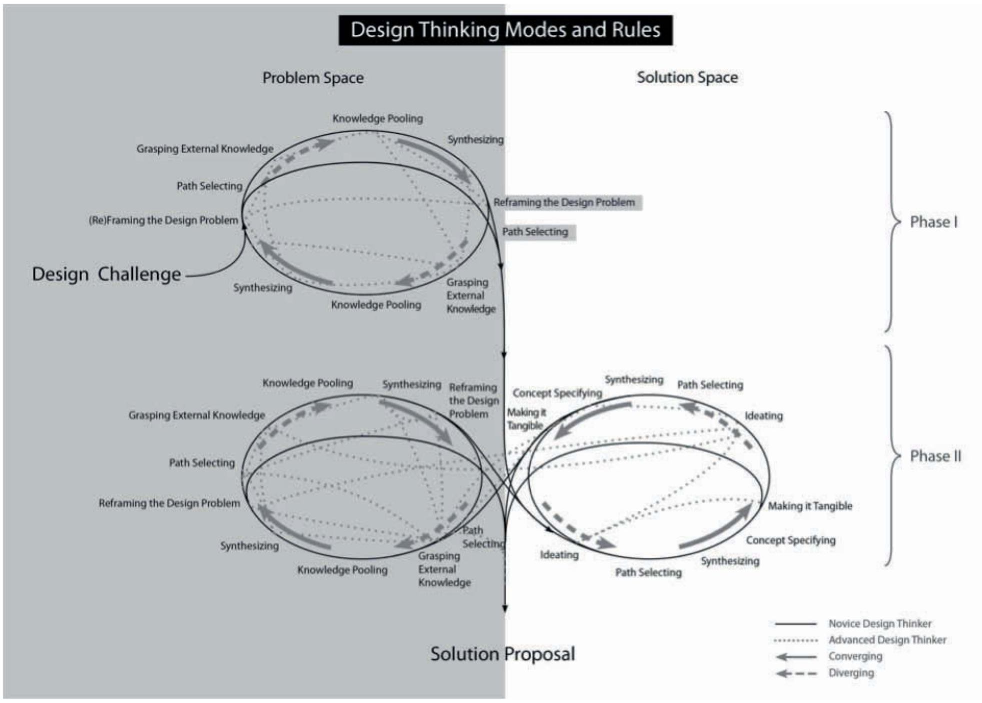

Figure 3. Adaptive Design Thinking Workflow Model

5. Concluding Remarks

Concluding, we answer the question whether there is a need for a design thinking process from two perspectives. First, we described design thinking as a broad problem solving methodology that is as such no process, but shapes processes. There is unavoidably a process in every design thinking project, namely what is constituted by the sequence of the chosen design activities within the broader frame of design thinking. Those processes still are no need or precondition for a design thinking-led project, but a necessary consequence. However, when a design thinking process is understood as a prescriptive series of design actions, the answer is more ambivalent. From a conceptual point of view, such 'design thinking models' create contradictions in themselves, as they would turn the process from a consequence to a precondition. From a didactic point of view, however, they could make sense as guidelines for design thinking novices, but entail a certain danger of misinterpretation when they are interpreted too orthodoxly. In order to circumvent this danger, we think that also didactic design thinking models should not draw on customary process terminology—in order to maintain a clear distinction between prescriptive design thinking methodology and resultant processes. We proposed a model that tries to show ways to combine both claims—the conceptual and the didactic. In a next step, we would reduce the complexity of the model (in particular the illustration in Figure 3) in order to work it up for practical use.

Notes

1. See Lindberg et al. (2010) for a closer discussion of this normative reinterpretation of design thinking.

2. With this approach Newell et al. are representatives of a positivist perspective on design (cf. Alexander 1964) in contrast to a constructivist perspective followed by e.g., Rittel (1972). See Dorst and Dijkhuis (1995) for more details.

3. See also Cross (2007b) and Dorst (2006) for further corroboration of this argument.

4. Own depiction, partly inspired by an unpublished IDEO draft and Buxton (2007).

5. Lawson (2006) gives several examples as well as a profound critique for descriptive-analytical design models. For a comprehensive collection of design models, see Dubberly (2004). For a detailed discussion and further classifications of design process models, see Wynn & Clarkson (2005).

6. See Lawson (2004, p. 14f) or Cross (2007a, p. 109f) for a critique of sequential design process models.

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