

A Typology of Design Ideas

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ABSTRACT

Design ideas are commonly used as an indicator of success of design methods and processes. Yet it is very rarely defined what precisely constitutes “an idea”, and how such an idea manifests itself to the researcher. This paper presents an examination of design idea definitions based on a thorough study of 75 research contributions. We construct a typology of seven definitions of design ideas. The purpose of the typology is to offer shared definitions and descriptions of design ideas to design and creativity researchers, aiding a higher degree of specificity when studying and analyzing the emergence of ideas in design processes.

Author Keywords

Design ideas; idea definition; idea generation; design processes; ideation; creativity; design theory

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

INTRODUCTION

In interaction design research, we comfortably speak about ideas and idea generation although the very core concept of a *design idea* lacks a consensus definition. It is often used interchangeably with words like *concept*, *solution* or *design move* [4,64]. In this paper, we present a thorough literature review to identify definitions and uses of the term “design idea” in design and related disciplines. We suggest a typology of design ideas, consisting of seven categories of ideas. This work is motivated by challenges in our own research into the emergence of ideas during design processes: if we cannot clearly define what a design idea is in the cases we study, we cannot systematically determine if and when ideas emerge. And in a wider perspective, if we do not have clear common definitions of design ideas in the design and creativity research communities, we argue that it

hinders joint discussions and renders it hard to compare and evaluate findings across cases.

In design vernacular, the notion of a design idea often refers to a potential solution to a design problem. While this holds true in some cases, things are not always that straightforward. The following example from Dorst & Cross’ 2001 canonical work on creativity in the design process illustrates how design ideas extend beyond potential solutions for a design problem. In this study, the designer is redesigning the litter bins in the trains in the Netherlands:

“In the 26th minute, the designer has the idea of doing away with the litter bins all together, and just make a hole in the floor of the train. He then asks whether or not such an idea would be out of the scope of the assignment, saying he likes to manipulate assignments, because they are often too narrow. Then he realises that there is already a litter system in the trains, namely the toilets. He asks for some information about that, and is genuinely shocked to hear that they are just a hole in the train floor, which opens onto the rails. He finds this an ugly, primitive, and very backward solution, and adopts a new goal, namely to change this also” [22].

Dorst & Cross show that defining and framing the design problem is a key aspect of creative design. In this example, the idea of changing the toilet system in the train appears as a design idea, yet it doesn’t offer a solution to the original design task. Furthermore, if the designer had discarded the problem reframing in his final design, would this idea of reframing have been counted one of his ideas? This example shows how ideas can take other forms than mere solution suggestions.

Motivation

One of the key reasons for striving for a clearer definition and typology of design ideas is that it can help us evaluate ideas with respect to both their contribution to the outcome of the ideation process, and their contribution to the process itself [69,70]. If a design idea is not incorporated in the final design, but inspires one or more ideas that are, the creative value of the idea goes unnoticed if we evaluate only the outcomes of the process.

The example above also shows that it may not be feasible or preferable to establish a one-size-fits-all definition. To be

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C&C '17, June 27–30, 2017, Singapore, Singapore

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ACM 978-1-4503-4403-6/17/06...\$15.00

DOI: <http://dx.doi.org/10.1145/3059454.3059464>

clear, we are not stating that the notion of a design idea has not been defined in research contributions, but the definitions are mostly constrained to one or few studies, while other studies offer different definitions. This is expected, given that the studies have different foci; but it comes at the cost of a limited opportunity to compare across cases. Taken together, this points to the need for a typology of design ideas. Our aim is that the typology in this paper can be of value for design researchers who, like us, are interested in analyzing the early stages of design processes.

We focus on ideas in context of the early stages of design, what is epitomized by e.g. [38] as the *conceptual design phase*. We use the term ‘design idea’ to limit the scope of the analysis to ideas as they manifest themselves in design processes. Though the reviewed literature sources span from cognitive psychology to engineering design, they all add to design discourse.

Structure of the Paper

The paper is structured as follows: first we clarify our position regarding design as a creative- or problem solving activity. Secondly, we present previous works that have attempted categorizations of design ideas and their results. In the third section, we describe our methodology in commencing the literature review and present an overview of the selected works. In the fourth section, we describe a typology of ideas, and examine each of the categories and their corresponding references. For the sake of overview, we describe each idea type in two sections: a *description* based on the cumulative references to this idea type, and what an *externalization* of the idea may look like in empirical data. Finally, in the sixth section we discuss potentials and limitations of the typology and opportunities for future research.

CREATIVITY, PROBLEM SOLVING AND DESIGN

While not every idea qualifies as creative, every creative outcome can be traced back to the good ideas that started it [33]. And while creative ideas can happen during design, they are not exclusive to design processes [2]. Designing is, nonetheless, inherently a creative activity: “... *there can be no guarantee that a creative ‘event’ will occur during a design process (...)* However, in every design project creativity can be found” [22]. In this section, we will explain how we differentiate the term design idea from the term creative idea and from problem-solving tasks.

Design and Problem-Solving

One of the ways designing differs from objective problem-solving is that the designer often works with ill-defined and unique problems, making every design process an ultimate particular [72,54]. Studies of subjects in fMRI’s show that a more extensive neural network is involved in the activity of understanding and resolving design tasks than the network involved in “normal” problem-solving tasks [2].

Creative problem solving is often described in terms of a dual model: the *associative* mode of thinking lets us explore

our neural network for potential new connections, and the *analytic* mode evaluates new associations in terms of their feasibility [8,26,51,68]. There are many variations of this model, but it is largely agreed that two systems are simultaneously involved in creative cognition. One way of distinguishing design ideas from other creative ideas in their degree of goal-orientedness: “[*Design*] is essentially guided by human purposes and is directed towards the fulfillment of intended functions” [2], whereas creative thinking is deployed in many activities besides design [24]. Not every design process results in a flash of creative genius, and often ideas won’t appear as *complete illuminations* [8], but rather the solution and problem framing are both negotiated during the process, co-evolving [22,89]. Design ideas emerge when the designer discovers a matching problem-solution pair that satisfies his or her requirements, or when “*loose, surprising information is linked into a coherent chunk, which offers a simplification of the design problem*” [15].

RELATED WORK

Design ideas take many forms, even on a semantic level. We can *have* ideas, we can *carry them around*, *generate* and *discard* them, and they can both live and die [52,9]. They are *elements of thought* [40], conceptions, that serve us to reason with [33]. They can also be conceptual places, that one can make lateral and vertical movements between [62], while at the same time they can represent movements themselves [31]. Physically, design ideas are often represented as a simple sketch or sticky-note, though the external representation is clearly not the idea itself – the idea exists before even verbal externalization as a kind of opportunity or glimpse of what could be in the future [45,27,64]. In this section, we will explain how previous selected works have conceptualized or categorized design ideas. We will focus particularly on *types of ideas*, and how such types have been defined.

Alpha, beta, gamma and delta ideas

A frequent way of characterizing design ideas is by their relation to the design process they contribute to. One such process-based classification by [5] divide ideas into three types: 1. New idea, 2. Revisited/repeated idea and 3. Third type (built on a previous idea). Idea development during the design process is viewed as the activity of elaborating, detailing or revising the idea along the timeline of design thinking. [38] divide ideas into alpha-, beta-, gamma- and delta ideas based on their temporal distribution in the design process (see figure 1). Evidently, delta-ideas will usually have a higher degree of complexity or richness than alpha-ideas. The best delta-idea is the one who passes the stage gate and enters the next level of the development process. It is not further defined what the different idea types entail, other than that they can be sorted sequentially.

Initial and developed ideas

Some studies make a distinction between ideas based on their evolutionary state. [44] distinguish between *initial*

ideas as the first instance of any idea, and *developed ideas* as an initial idea, which is developed with more features and/or details. In the participatory design study in [63], 120 teenagers generated about 50 design suggestions (and more than 700 different design features) for an interactive water bottle. The authors consider each design feature an idea, and each design proposal is considered a *design suggestion*. After an evaluation of all design suggestions, a group of investigators made their own design suggestions based on the participant ideas that they liked the best, resulting in four final designs. Each of the final designs was then broken down into its salient features, with the purpose of analyzing how ideas (design features) had moved from the original participant's suggestion and been integrated into the investigator's final idea. As a result, the authors identify four types of ideas:

- *Core ideas*: those which many teenagers suggested and more than one investigator used
- *Add-ons*: those which many teenagers suggested but only one investigator used (ADD-ONS)
- *Novel ideas*: those suggested by only one teenager that one or more investigators used
- *Ideas that came from outside the design space* (which were not in the participants' suggestions) [63].

We see several examples of characterizations of design ideas based on their relation to the design process they are part of. However, research has also shown that designers often make use of what [32] calls *stock ideas*, ideas which are stored in the designer's own memory or personal archives, and that could become usable at another time. These cannot be defined in terms of their relation to any specific process, but as stand-alone items, sometimes based on found information from other sources [43]. In summary, we can confirm a lack of consensus among researchers, and that methods for classifying design ideas have applications in design research.

METHODOLOGY

In the following, we present our approach to the literature review and discuss its scope, benefits, and limitations. We reviewed a total of 75 literary works: 73 academic papers and the two books *The Creative Mind* by Margaret Boden (1990) and *Creative Cognition* by Finke, Ward & Smith (1992) (the overview of all the sources are presented in

table 1). As stated, our objective was to examine how the concept of a design idea is articulated and defined, motivated by the broader question "What is a design idea?". Our study focuses on research papers within design and closely related fields (such as creativity studies, creative cognition, engineering design and architecture), specifically the stages of idea generation.

We were interested in both explicit definitions of design ideas, such as "An idea, in this case, refers to a statement by one of the designers that..." [4] and derived definitions, where the author offers a description of design ideas, e.g.: "Ideas emerge from sources of inspiration mediated by design materials, the way in which they are negotiated throughout the workshop, and combined into design concepts" [35]. The reviewed materials build on various types of data, which influences which aspects of design ideas are discussed in the work. For instance, while studies based on in-vitro experiments often look at obvious externalizations of ideas, studies based on anecdotes and interviews describe often the internal experience of ideas. The data types for all the reviewed sources are indicated in table 1.

We have strived to follow the principles for a *systematic literature review* as defined by [56]. The systematic characteristics can be defined as "a set of rigorous routines, documentation of such routines, and the way the literature reviewer negotiates particular biases throughout these routines" [Ibid.]. For this reason, we will lay out our approach in more detail in this section. Moreover, the review interprets and reflects in the terminology of [ibid.], aiming to bring forth "the salient and critical aspects of the most current knowledge" including "substantive findings, as well as conceptual, theoretical, and/or methodological contributions". Pre-existing knowledge of the domain among the reviewer(s) is a central component to this approach, and the review is thus informed in part by theory, in part by the reviewers' prior work in the field of design creativity and ideation [6,7,17,34,35].

To clarify the systematic approach, we initiated the review using a keywords-based search through Google Scholar, and selected readings based on the abstracts and citation count (papers with less than 3 citations from before 2010 were deselected in favor of scientific impact). The following terms identified a total of 33 unique papers (tier 1): *design idea*, *design idea development*, *definition idea*,

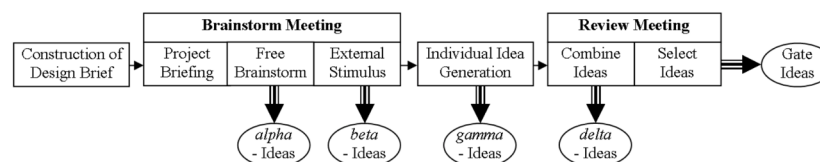


Figure 1: Idea classifications by Howard, Culley & Dekoninck (2011) [33]

	1970-1980	1981--1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016
Design	Simon '73	♥Goldschmidt '90	♦Akin & Akin '96	♦Cross '97 Purcell & Gero '98 ♦Suwa et al. '98 ♦Verstijnen et al. '98	♦Dorst & Cross '01 ♥Kan & Gero '05 ♥Goldschmidt & Tatsa '05 ♦Van der Lugt '01 ♦Van der Lugt & Van der Graaf '02 ♦Van der Lugt '03 ♥Suwa & Tversky '02 ♥Jonson '05	♣Murty & Purcell '07 ♦Bilda & Gero '08 ♦Girotra et al. '10 ♦Baker & van der Hoek '10 ♦Dix et al. '06 ♦Kan et al. '06 ♦Halskov & Dalsgaard '07 ♦Tseng et al. '08 ♦Liikkanen et al. '09 ♦Yamamoto et al. '09 ♦Yilmaz et al. '10 Nelson et al. '09 Howard et al. '08	♦Goldschmidt & Sever '11 ♦Howard et al. '11 ♦Daly et al. '12 ♥Lund & Prudhomme '13 ♦Sjangliulue et al. '15	♦Read et al. '16 ♥Bratteteig et al. '16 ♦Cardoso et al. '16
Engineering		Holt et al. '85		Shah et al. '00	♦Shah et al. '03 ♥Badke-Schaub & Gehricher '03	♦Perttula & Liikkanen '06 ♦Perttula & Sipilä '07 ♦Perttula et al. '06 ♦Perttula '06 Sosa et al. '09 ♣Tanaka et al. '09	♦Toh & Miller '15	
Creativity research		♣Davies & Talbot '87 ♣Boden '90			♦Ishii & Miwa '02 Scardamalia & Bereiter '03	♥Wiltschnig et al. '10 ♥Wiltschnig & Onarheim '10 ♣Coughlan & Johnson '08	♦Wiltschnig et al. '13 ♦Kerne et al. '14 ♥Sosa & Dong '13	♦Starkey et al. '16
Cognitive science			Finke et al. '92 ♦Seifert et al. '94	Soufi & Edmonds '96	Gabora '02 ♣Colunga & Smith '03	♦Liikkanen & Perttula '10	♦Kim & Kim '15	
Neuroscience						♦Alexiou et al. '09 ♦Goel '10	♦Mayseless et al. '15	
Management or marketing research					♦Dahl & Moreau '02 ♣Goldenberg et al. '01 ♣Tschang '03	Riedl et al. '09 Fleischmann '06 ♣Prabir & Amaresh '07	Fernández & López '11	

Table 1: Overview of selected works based on year, field, relevance to the study, and methodology.

♥ indicates that the work is mainly based on in-vivo observations.

♦ indicates that the work mainly builds on in-vitro experiments, and

♣ means the work is largely informed by anecdotal interviews, surveys, or after-the-fact analysis.

No indication means the work does not build on empirical data.

ideas design process, insight moments design, design idea emergence, idea emergence, what is an idea. Secondly, we used the search engines for all issues of Design Studies and proceedings of the conference Creativity & Cognition, which revealed another 14 works, bringing the tier 1 total to 47. Assuming that the total tier 1 works would build on sufficient material to provide us with a sound historic perspective, we collected tier 2 based on references from tier 1, and recommendations and suggestions from peers collected in conversations while composing this paper. Tier 2 adds another 28 papers to the stack, bringing the total to 75 works.

The authors used a scoring of 1-3 to classify the literature, where 1 is highly relevant (offers a direct definition of design ideas), 2 is relevant (uses the term ideas with a vague or no definition, or builds directly on a relevance 1-paper) and 3 is not relevant to the study. The rating 3 was given to papers where the subject didn't relate to our study, for instance when using the term "idea" in the philosophical sense, i.e. "*The idea of entrepreneurship as emancipation*" [25], or if it presented revised algorithms for idea metrics [53]. The substantial amount of papers with the rating 3, highlights how ambiguous and widespread the word idea is within research. Of the total 75 works, 26 were given a

rating of 1, 26 were given a rating of 2, and 23 were rated 3. Arbitration was carried out as continuous dialogue while the typology was being developed.

After completing the work of collecting, reading and annotating the papers, we were able to group the different categories of contributions by identifying similarities and differences in semantic use of the term idea. We found that there was a clear correspondence between research field and semantics. Thus, the overview in table 1 is organized by year and field. The references are coded in line with our relevance assessment: **Bold** means we classified the paper as having relevance 1, *grey* is relevance 2 and *italics* is relevance 3. If the work is a contribution to more than one field, we have made a subjective assessment of which one to categorize it within.

Our main challenge in the review was scoping. We kept a very open approach in the initial steps, looking for definitions from various fields. Then we narrowed our search by only following references that guided us towards specific definitions. Table 1 shows that a majority of the reviewed material stems from the design field, and lies within the years 2001-2010. We chose not to extensively pursue historic references from the fields of cognitive

<p>Particular type 1 (Re)framing the problem</p> <p>Dorst & Cross (2001), Baker & van der Hoek (2010), Wiltchnig et al. (2013), Alexiou et al. (2009), Cardoso et al. (2016)</p>	<p>Particular type 2 Opportunity</p> <p>Finke et al. (1992), Sosa & Dong (2013), Kerne et al. (2014), Mayseless et al. (2015), Bratteteig et al. (2016), Dix et al. (2006), Coughlan & Johnson (2008)</p>	<p>Particular type 3 Suggestion for part-solution</p> <p>Cross (1997), Perttula & Liikkanen (2006), Baker & van der Hoek (2010), Kim & Kim (2015), Read et al. (2016), Van der Lugt (2001), Halskov & Dalsgaard (2007)</p>	<p>Particular type 4 Suggestion for solution</p> <p>Shah et al. (2000), Goldenberg et al. (2001), Dorst & Cross (2001), Shah et al. (2003), Perttula & Sipilä (2007), Riedl et al. (2009), Goldschmidt & Sever (2011), Howard et al. (2011), Dahl & Moreau (2002), Badke-Schaub & Gehrlacher (2003), Perttula (2006), Perttula et al. (2006), Tseng et al. (2008), Liikkanen et al. (2009), Girotra et al. (2010), Yamamoto et al. (2009), Yilmaz et al. (2010), Fernández & López (2011), Daly et al. (2012), Toh & Miller (2015), Starkey et al. (2016)</p>
<p>General type 1 Design move</p> <p>Goldschmidt (1990), Purcell & Gero (1998), Van der Lugt & Van der Graaf (2002), Van der Lugt (2003), Kan & Gero (2005), Goldschmidt & Tatsa (2005), Kan et al. (2006), Bilda & Gero (2008), Baker & van der Hoek (2010)</p>			
<p>General type 2 Insight (moment)</p> <p>Davies & Talbot (1987), Boden (1990), Seifert et al. (1994), Akin & Akin (1996), Murty & Purcell (2007), Wiltchnig & Onarheim (2010), Wiltchnig et al. (2010)</p>			
<p>General type 3 Plan for action</p> <p>Riedl et al. (2009), Van der Lugt (2001)</p>			

Table 2: A typology of design ideas.

Some references appear more than one time, if they offer more than one definition of design idea.

science, neuroscience and marketing and management research, due to our focus on the design field.

The review has been comprehensive in the sense that we found a great overlap in definitions and references in all the literary sources surveyed. It has also been possible to identify overarching themes in the literature, such as a general confirmation of our research question; the term design idea is often vaguely or not at all defined. In some instances, the authors clarify directly how they view the term for their personal analysis purposes, suggesting again that such a definition is useful and needed.

We must stress, however, that our review is not exhaustive. Because we look for definitions on a semantic, textual level, we are constrained by search engine capabilities, and we ask that the review is read with this stipulation in mind. Information retrieval systems are imperfect, and it is unlikely to achieve perfect recall while having useful precision. Rather, best-effort is the preferred method, and some documents may escape retrieval [65]. The review is also subject to some degree of subjectivity, as we have used our best judgment to arrive at useful categories for the different definitions of ideas. Several papers pointedly use, for instance, the term *design move*, interchangeably with *ideas*. We will return to this topic in the descriptions of the different idea types. In the following section, we will present our typology of design ideas and explain how the categories have emerged.

A TYPOLOGY OF DESIGN IDEAS

Table 2 shows the different uses of the term *design idea* we discovered and their corresponding references. Each cell represents a *form* a design idea can take. By *form* we mean a conceptual shape which previous research has considered ‘a design idea’ and used as a basis for analysis - either to be able to quantify ideas or to be able to delimit ideas for the purpose of saying something about them. The diagram should be read as follows: There are 4 types of *particular* idea types, meaning they are by and large mutually exclusive. Normally, an idea is not both a reframing of the problem *and* a solution¹. There are 3 types of *general* idea types, which are categories that any of the particular ideas can also be, but are not necessarily. A new, innovative feature of a product can, at the same time, be both a *suggestion for a part-solution*, a *design move* and an *insight moment*. A design idea cannot be of general type, if it is not a particular one.

When a reference falls into more than one category (i.e. explicitly uses more than one definition), the reference is listed under both categories. References that offer a specific definition or that investigate an original definition of design ideas are presented in **bold** font while references building

¹ With the exception of the concept co-evolution of problem and solution [22,89], which we will elaborate further on under the description of these types.

on another paper's definition are presented in *italics* directly following the original reference. References where the definition has been derived from context or use examples in the analysis are presented in a regular font.

General Comments on the Typology

During the analysis, it became clear, perhaps unsurprising, that the definition of idea depends on the research scope of the paper in question, and thus the data collection. When the aim is to study efficiency of a design method, the authors have often put a constraint in the study design, allowing them to quantify the generated ideas, e.g. asking the subjects to externalize every unique idea on individual sheets of paper or sticky-notes [e.g. 59,71]. Some fields show relatively constrained definitions of the term idea, particularly the fields of business and engineering, which generally view the design idea in light of a production chain. In these fields, an idea is a suggestion for a solution to a design problem (e.g. [69,70]), or a proposal towards development of a new product [23]. A design idea can be quite a large entity, containing a lot of information about features and potential uses. Fields like cognitive science, creativity research and psychology tend to use much broader definitions, viewing design ideas as various forms of *creative discoveries* or *insights* (e.g. [8,24]).

Design fields generally study externalized ideas: "*notions related to a (design) task that have been communicated verbally in studio sessions, in one-on-one critiques or group discussions*" [33], whereas especially the fields of creativity research and cognitive science do not draw this distinction: "*ideas are the basis of conceptual design activity, whether they are drawn as they come into mind or not drawn*" [5]. In these fields, design ideas can be as small as "notions", not necessarily externalized.

Another interesting observation is that while a vast majority of the references fall under the *suggestion for part-solution* and *suggestion for solution* categories, many of them don't offer their own distinct definition. Meanwhile *all* the references under *insight moment* are in bold, indicating that they provide a first-hand definition or that they directly investigate this definition. Since insight moments are often related to Big-C-discoveries [73], discoveries that change the world, it might be unsurprising that these have had a lot of scientific focus. The type *design move* was clearly defined in one distinguished paper [31], which several later works refer to and build upon.

In the following section, we will elaborate on each of the definitions. For the sake of clarity and applicability, we will divide each section into a description and examples of how the types are recognizable for the design researcher. One of the central challenges of conducting studies of creative processes is our limited access to the mental processes that precede an externalized idea [2,51]. Often, written or drawn externalizations such as sketches and sticky-notes are our primary indication of idea emergence - a tangible way of quantifying ideas. In this study, we have reviewed both

works that only look at externalized ideas (e.g. [4,33,91]), and works that focused on ideas as neurological activity (e.g. [26,51]), but for the sake of applicability of the typology, we try to offer a description of how the different types of ideas may be externalized and observable to the researcher. We understand externalization as any expression of computational offloading [66] or discoverable manifestation: "*a way of taking information or mental structure generated by an agent and transforming it into epistemically useful structure in the environment. It is a way of materializing structure that first was mental*" [45].

Particular Type 1: (Re)framing the Problem

Description

Studies have found that defining and framing the design problem is a key aspect of achieving creative design solutions [22] and that experienced designers often deliberately modify or manipulate a design brief to make it challenging or interesting, and to provoke new creative responses from themselves [2,21,22]. A creative design process involves a period of exploration in which the problem and solution spaces are said to be co-evolving, remaining unstable until (temporarily) fixed by a 'creative bridge' that identifies a problem-solution pairing [15,89]. Design ideas can therefore be an attempt to develop or frame the problem space.

Framing or reframing the problem offers a new way of structuring the design process: "*Design is not a matter of first fixing the problem and then searching for a satisfactory solution concept, but of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration of analysis, synthesis and evaluation processes between the two notional design 'spaces'*" [22]. Some designers have been shown to habitually try to 'break' instructions of a design proposal simply for the purpose of revealing opportunities that weren't there before [2].

Externalization or indicators:

Problem framing can often be observed directly in design conversations or think-aloud-individual work [22]. During group work, high-level questions can indicate an exploration of the problem space, in that questions can facilitate so-called inflection moments in the group [10]. [4] describes a definition of an idea as statements by one of the designers that *characterize* the provided problem. Some studies have looked for transcription segments that contain "references" to the design requirement, specifically statements that either: a) add a novel requirement, b) interpret or make revisions to an existing requirement, c) bracket a requirement ("we're not going to be dealing with that here") or d) delete a requirement [89].

Particular Type 2: Opportunity

Description

Design ideas can be understood as expressions of possible choices within a design process. With the creation of the

Geneplore model, [24] suggests that different aspects of creativity, whether it is artistic creation or scientific discovery, lie along the same continuum. All forms of ideation can be understood within the same model of generative and explorative phases. First, the ideating individual constructs mental representations called *preinventive structures*, having various properties that promote creative discoveries. These properties are then exploited during an exploratory phase, where the individual seeks to interpret the preinventive structures in meaningful ways. When a creative discovery is made, an opportunity presents itself.

Opportunities can also be expressed as curations of inspirational material; what [43] calls Inspiration Based Ideation or IBI. In their work, they demonstrate how the act of finding, choosing and curating inspirational material can both express ideas and lead to new idea emergence revealed only by combining other elements – such as can be seen when designers create mood boards. Another example of utilizing ideas as opportunities is the technique BadIdeas, as developed by [21]. The technique encourages designers to make up 'bad' or 'silly' ideas, that aren't technically feasible or even desirable, with the purpose of inspiring creativity and critical thinking. An example could be a glass hammer or a chocolate greenhouse. BadIdeas are instances where ideas can be both creative and novel, but not actually suggestions for solutions.

Externalization or indicators

An example of an idea as an opportunity is an idea that opens up a possibility, but doesn't have immediate application - at least not in relation to the design at hand. It may have immediate application to the process, such as BadIdeas. Some studies have looked for opportunities in textual communication by looking for suggestive keywords such as: *Would be, wish, maybe, could be, guess, mean, version, if you/it we, wonder* and *also* [74].

Individual designers often store ideas and inspirational material for later use. The value of an idea is largely related to the context it is deployed in, which gives designers an incentive to keep good ideas until they are in a position to use them [14]. Hence, the designer's personal archive can be said to represent opportunities for design.

Particular Type 3+4: Suggestion for Solution or Part-Solution

We have chosen to describe *suggestion for part-solution* and *suggestion for solution* in the same section, as their characteristics are categorically similar.

Description

Ideas as solutions or suggestions for part-solutions is by far the most represented and commonly used definition in our survey. While externally, these two types look different, they share the same descriptive characteristics, so we will include them both in this section. Due to the amount of references in these categories, we will not go through all of

them in depth, but simply explain how they relate to the category in terms of contribution.

The idea as a suggestion for a (part-) solution can be defined as "An explicit description of an invention or problem solution with the intention of implementation as a new or improved product, service, or process within an organization" [64] and "- a design concept which was generated to satisfy the design brief, and has at least one determined feature related to the product itself such as shape, functionality, or material" [44]. Searching for or exploring solutions (or sub-solutions) is a core activity in design [15]. The majority of studies that use the term solution suggestion synonymously with ideas, are in-vitro experiments that examine different design methods [16,18,23,32,46,57,58,83,92,93].

Our initial search revealed several works that explore ways to qualify design methods from an outcome-based perspective [23,28,30,69,70 among others]. An outcome-based approach means that the ideas that are generated in the process are the basis for evaluating how successful the design method is. The outcomes are here analogous to suggestions for solutions. The four most common effectiveness measures for ideas in this sense are *quantity* (total number of ideas generated), *quality* (feasibility of the idea), *novelty* (how unusual or unexpected the idea is) and *variety* (how well the idea explores the solution space) [38,69,70]. Interestingly, [81] has shown that engineering students tend to focus primarily on the technical feasibility of a design idea, even if they are explicitly instructed to look for creative solutions. Another study has shown that while design methods often focus on making the designer(s) explore the solution space, overall creativity during the idea generation does not necessarily predict the creativity of the final design [77]. The decisions and selection of solutions appear to play as significant a role in the design process as the generation of ideas [3,81], as the ability to assess the quality of an idea is not analogous to the ability to generate creative ideas [28,77].

Externalization or indicators

The greater amount of our literature sources look at sketches or written design proposals when distinguishing a part-solution or a solution. A way of discerning and quantifying ideas as solutions in a design process is to simply make the participants self-assess their idea count by asking them to externalize their ideas on separate pieces of paper [59]. In group studies, it has been shown that a significant amount of agreement has often been reached before a solution concept is externalized [35]. Often the externalization marks the termination of the development of that concept, and participants will move onto a new concept or a new subject of conversation [4,35]. While the designer is developing a design solution, different *design features* evolve, which correspond to our understanding of part-solutions or sub-solutions [15,63].

Solution suggestions have conceptual strength if they embody a potential solution form that satisfies key problems, but still have the malleability to be modified and refined [15]. The externalizations of solution suggestions tend to summarize a *recognizably good solution* [15]. Often, they are sketches, which can serve several functions: *thinking sketches* support the individual thinking process, *talking sketches* support the group discussion, *prescriptive sketches* communicate design to people outside the design group and *storing sketches* archive the designer's own ideas [84].

General Type 1: Design Moves

Description

The term "design move" originates from Goldschmidt's significant work on linkography as a method for investigating the integratedness of a design process [31]. The hypothesis is that the more links to subsequent discussions, an idea creates, the better it is. In this method, a design process is represented by sequential 'design moves', and links between them. Design moves were originally defined as individual design propositions made with the purpose of arriving at satisfying visual representations, but the definition has been expanded and elaborated in later studies, e.g. [33,41,86]. The process of designing is seen as a succession of acts of reasoning, and each of these acts is called a design move [31]. A design move is therefore any (reasoning) act within design, even if it doesn't involve a visual representation. Later works have used the term design move interchangeably with ideas [4,32,33] which is why the term belongs in the typology. Design moves help identify good ideas in the design process: good ideas are critical ideas, in the sense that they generate a large number of links (they motivate many other design moves), and *very good ideas* are those that spin the largest number of links among themselves and other ideas [85]. However, studies have also shown that ideas with too many forelinks might indicate fixation [41]. While the term design move is sensible in terms of analyzing a design discussion, there is a blurry line between design moves and ideas. Building on Schön's terminology, [9] offers a distinction based on the "move"-property: "A 'design move' (...) consists of the designers' evaluation of a situation, a move to change it and an evaluation of the move as a step closer to the final result. In this light a design idea is what the move is about: a suggestion for a particular (part of) a design solution to be tested and evaluated through the move". In such understanding, each design move, however small, towards a satisfying design can be viewed as a design idea.

Externalization or indicators

As described in the previous section, design moves have the analytic advantage that they are confined to observable acts. Some studies delimit single moves by tagging utterances

sequentially [42], and some studies rely on the designers' own after-the-fact assessments [31]. The common method among the researchers using linkography is protocol studies. If designers use sketching, design moves can be identified from the ongoing generation of representations and restructuring of these representations as they move forward [62]. [86] establish a set of context criteria to identify links between design moves based on observation alone: *time span* (temporal closeness can mean conceptual closeness), *inspection*, *physical reaction*, *verbal reaction*, *withdrawal*, *explanation*, *addition*, *location* (spatial closeness can mean conceptual closeness) and *scheme resemblance* (resemblance in visual representations). These context criteria are useful in establishing links, however not moves themselves. Even though linkography is widely accepted as an analysis method, previous works have concluded that defining design moves undeniably requires a great amount of subjective assessment and common sense of the researcher [86].

General Type 2: Insight Moment

Description

Insight moments, or "Aha!"-moments, are at the very core of creativity. They are what most people think of, when they think of ideas. These are the moments symbolized by the famous light bulb turning on, indicating a new exciting idea. An insight moment can be described as "a *flash of lightening or the sudden appearance of a solution to a problem the individual had been working on*" [8], and [19] reports a designer describing the moment as a feeling of "becoming aesthetically literate". In an instance, suddenly and unexpectedly the solution to a problem becomes apparent together with feelings of clarity and satisfaction [90].

According to Wallas' model of creativity [88], the insight moment, or *illumination* is the third of four stages, preceded by the preparation stage, the incubation stage and followed by the verification stage. Research into the cognition of these moments have shown the importance of reaching an *impasse* (e.g. failure to solve a problem on the first try) before the insight moment can be reached. The impasse is thought to leave failure indices in long-term memory, preparing the mind for the moment when relevant information, which can be used to solve the impasse, may be available [68,52,1].

The insight moment or *imago* is often experienced when the designer knows that the idea is *just right*, a momentary glimpse of absolute perfection, where the physical-world manifestation of the ideas is always less than satisfactory to the designer [19]. The experience can be quite addictive, and it is hypothesized that particularly creative designers may be distinguished by their ability to achieve these moments more often than others [ibid.].

Insight moments can be related to the finished design solution as well as the process, for instance when a problem solver breaks free of unwarranted assumptions or discovers a new way of approaching the problem. They usually have the character of *unexpected discoveries* [52]. Insight moments can happen during all forms of problem solving work, and are not exclusive to design [1]. An example of a problem-solving insight is the classic nine-dot-puzzle, where people often set up self-made constraints by assuming they have to stay “within the box”, to be able to solve the puzzle. When the solution is discovered, it is often results in an aha!-moment [ibid.].

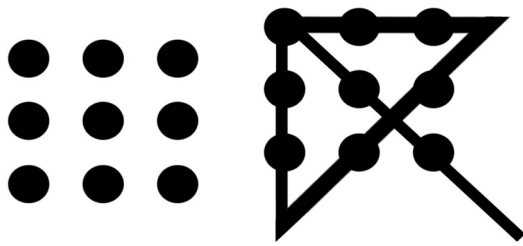


Figure 2: The nine-dot puzzle. The task consists of connecting all 9 dots with four straight lines, leading many people to believe that the lines have to stop within the frames of “the box” [48].

Externalization or indicators

Designers have reported experiencing, among others, the following phenomena during an insight: Oneness, transcendence of self, ecstatic feelings and lack of anguish, synthesis, obviousness and effortlessness [19]. Due to this emotional character, insight moments can usually be identified by the designer’s self-appraisal or memory [40].

They can even happen to a group of people simultaneously: “One of the nurses stood up and used an existing product to demonstrate a specific user challenge. At a certain point in her demonstration members of the design team suddenly interrupted her, as they wanted to share an idea with the team. As it turned out, four out of six team members had got the same idea” [91]. Often an insight moment can be observed as a pivotal moment in the design process, providing an immediate focus for the designer(s) [15].

General Type 3: Plan for Action

Description

Design ideas can be expressed as planning for the next steps in the process. [84] divides creative problem solving into three main components:

- Understanding the problem, where the goal is to identify specific directions for ideas
- Generating ideas, preferably many, varied and unusual ideas

- Planning for action, where ideas are transformed into action).

Due to the goal-oriented nature of design [70], the designer will often be aware that ideas have to be transformed into action at some point. This planning can be a part of the idea development process. Furthermore, plans for how to structure the future parts of the design process (such as which part of the project to work on next) can also be viewed as design ideas, although this definition is not very common.

Externalization or indicators

Action plans in a group process are often verbalized. [64] defines an idea: “An explicit description of an invention or problem solution with the intention of implementation as a new or improved product, service, or process within an organization”. By this definition, a design idea contains the specific intention of implementing it, which we understand as a plan for action. By this definition, if a designer says “I’ve seen this material used in a similar construction before”, but he does not intend to implement the material, he is not making a plan for action. If he says “We’re going to use *this* material!”, he is making a plan for action.

APPLICATIONS AND DISCUSSION

We intentionally do not offer one common definition to the term design idea, but rather propose a typology to suggest that a design idea, depending on the perspective, situation, and research focus, can appear in different forms. The most prevalent definition of a design idea falls in the category of suggestion for solution. Since design is in a broad sense about creating novel solutions, this is not entirely surprising. However, the main part of the definitions fall into other categories, emphasizing that there is no consensus about what constitutes a design idea.

Documenting and Analyzing Design Ideas

We argue that a more precise documentation of design processes will lead to heightened awareness, deeper reflection and ultimately, better design processes, for both researcher and practitioner. We see the typology as serving several purposes. Firstly, it offers an overview of contributions in the field, which can help researchers situate their work in relation to existing work. Secondly, the typology can serve as a platform for identifying and studying various types of design ideas; this can help us in documenting and analyzing design processes by enabling us to define which idea unity we are particularly interested in. Thirdly, it can support discussions and comparisons across cases, potentially yielding novel insights through studying similar phenomena across multiple design projects.

When documenting the design process, a palpable problem is how to visualize our data. How do we know when an idea has emerged? What the limits of an idea are? Can a sentence contain an entire idea, or is it merely a part of an idea? A clearer definition of design ideas can make documentation of observed design processes more rigorous.

As design researchers, we need tools for documenting the design process to study and compare our results.

Limitations and Potentials of the Typology

The design idea typology is a first attempt at structuring what has proven to be a highly complex concept. It is first and foremost a deep dive into literature on design and creativity in order to establish an overview and identify common definitions. One potential limitation in our approach is that we could have applied a wider set of search parameters, e.g. by looking to other fields beyond design and creativity research. E.g. the field of philosophy has a long history of studying the nature of ideas. We have deliberately kept the survey more contained in order to focus on works that specifically address the notion of a design idea, but further studies that integrate other perspectives and articulations of ideas can add to this work, e.g. via insights into how different types of ideas are related.

A second limitation is that we have condensed a large selection of design idea definitions into the seven categories in the typology. By offering these relatively broad types, we may miss subtle, but important distinctions between different pre-existing definitions of design ideas. Also, we have located most literary works in one category, while some span across two or more categories. Here, we have sought to balance comprehensiveness, overview, and explanatory power. We consider the typology adequate, but since it is a first attempt at a structured overview of design ideas, it is not necessarily exhaustive. We have sought to make the selection and categorization process clear, so that others may challenge it and for instance argue for alternative categorizations.

The typology in its current form is not intended as a directly applicable framework in design practice. However, it may still be of use for designers, who seek a better understanding of how and why design concepts emerge and evolve, and who wish to better steer a design process by understanding when it is pertinent to strive for certain types of design ideas. It may also help idea development by giving specific definitions by which to communicate and evaluate ideas. A characterization of idea concepts could moreover aid idea management. In line with this, the next step in our work will be to explore how the framework can be operationalized to support design practice.

The typology opens up for studies of how different idea types are distributed. [28], among others, point to the problem that we lack quality measures of design processes. When evaluating the creative aspects of design processes, many evaluations tend to focus on the number of ideas generated, ignoring what most designers are interested in: a few really great solutions. Documenting the different types of ideas that emerge during a design process might help us better understand their interrelations, and identify patterns in how certain ideas evolve and lead to successful outcomes. The typology could thus be used to characterize

different types of design processes, and indicate which types of ideation or further concept development initiatives might be preferable in a given design process.

CONCLUSIONS

On the basis of a wide range of existing research contributions, our typology of ideas is meant to serve as an overview and analytical frame for studying design ideas. The literature review has presented us with several insights. The most striking one is that the definitions of what constitutes a design idea are diverse, ranging from relatively open opportunities over ways of reframing the design problem to more specific plans for how to proceed with the design process. Our literature survey was initially motivated by the lack of a common definition, and this has been confirmed. This diversity indicates that there is indeed a need in the research community for clarifying what is meant by a “design idea”.

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