HOW INTERACTION DESIGNERS USE TOOLS TO MANAGE IDEAS AND WHAT WE CAN LEARN FROM IT

PhD Dissertation | Submitted by Nanna Inie
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“Everything I need to keep my life running is stored online. Somewhere. I just can't find it. (...) It's like I wrote everything in a notebook and then got drunk, ripped out each page and hid them in different places around my house”.

David Pierce in The Wall Street Journal 2018
This PhD dissertation presents three years of work studying the design idea management practices of professional interaction designers. I investigate three primary research questions:

1. How might we define, delimit, and understand ‘design ideas’?
2. How do professional interaction designers currently use tools and systems to capture, manage and retrieve their design ideas?
3. How might novel digital tools support idea management for professional interaction designers?

Idea management can be characterized as the process of capturing, organizing, retrieving, and collaborating on ideas [Inie and Dalsgaard 2017; Efimova 2009; Barreau 1995] in multiple media forms [Coughlan and Johnson 2008]. Idea management is a salient discipline for professional interaction designers, a subcategory of creative professionals in a general sense. Professional interaction designers are in the business of transforming the current state of events through the introduction of something novel [Biskjaer et al. 2010]. Ideas are key to this transformative creative practice. Yet we do not know much about how to define design ideas, how idea management unfolds in professional practice, how different tools and systems are utilized to accomplish creative goals, or how technology might support creative and efficient idea management for professional interaction designers.

Interaction designers face various challenges when working with tools, among these organizational barriers, the ever-changing state of technology, as well as technical difficulties [Dow et al. 2006]. They work with digital materials on a daily basis, and they employ an extremely versatile assemblage of digital and analog tools throughout their career, yielding rich empirical evidence for answering the research questions. Interaction designers have a broad array of analog and digital tools available to aid their idea
management, from sticky notes and notebooks to digital tools such as smartphone galleries and Trello (Figure 1). Such tools are distinguished by their ability to support and extend the limited cognitive systems and abilities of humans, and previous research has shown promising results in their support of creative thinking as well [Smith et al. 2009]. Humans are highly resourceful at exploiting their environment to extend their cognitive capabilities [Scaife and Rogers 2005, Kirsh 2009], hence there is great potential in analyzing and understanding the cognitive benefits that particular representational formats and technologies may provide – among these, the potential to support professional design ideation [Scaife and Rogers 2005].

The collective contributions of the dissertation are the following:

• I identify and analyze definitions of the concept “design idea”, as it has been used in research up until now, and unfold the meaning of the concept by identifying and analyzing externalized instances of design ideas from professional interaction designers’ archives.

• I identify a theory of the actions involved in idea management of professional interaction designers. Based on this theory, I develop a framework of strategies of tool-use, based on the creative objectives tools fulfill to professional interaction designers.

• Finally, I identify four design opportunities for novel, digital idea management tools under the headings of ‘utilizing the potential of the design idea archive’, and ‘increasing focus on the creative designer’.

The dissertation consists of this framing document as well as six research papers: five peer-reviewed and published articles, and one article under review. Each of the papers is summarized and reflected upon in connection to the others in this introductory frame. In this document, I also reflect on the cumulative findings of the papers, and how they are relevant for researchers, developers and designers, respectively.
Denne ph.d.-afhandling præsenterer tre års studier af professionelle interaktionsdesigneres praksisser for organisering af designidéer. Jeg undersøger tre primære forskningsspørgsmål:

1. Hvordan kan vi definere, afgrænse og forstå 'designidéer'?
2. Hvordan anvender professionelle interaktionsdesignere værktøjer og systemer til at indfange, organisere og genfinde deres designidéer?
3. Hvordan kan nye, digitale værktøjer understøtte organisering af idéer for professionelle interaktionsdesignere?

Afhandlingen præsenterer tre års arbejde i CIBIS-projektet (Creativity in Blended Interaction Spaces) på det bredere forskningsområde af at afklare hvad der sker når designidéer opstår, og hvordan idéer bliver repræsenteret og transformere med forskellige teknologiske enheder og i forskellige rum. Afhandlingen bidrager til vores forståelse af hvordan professionelle interaktionsdesignere bruger værktøjer og systemer til at organisere designidéer i deres private og professionelle liv. Jeg har indsamlet en omfattende mængde kvalitativ data fra empiriske observationer, spørgeskemaer, interviews og gennemgange af idéarkiver med formålet at kaste lys over den kompleksitet og de dynamikker, som er på spil i professionelle designeres organisering af idéer. Jeg har primært anvendt en grounded theory-tilgang til datamaterialet, med hensigt at udvikle analyser og modeller som er solidt funderet i feltet og studiedeltagernes egne oplevelser.


Interaktionsdesignere møder en række forskellige udfordringer i deres arbejde med teknologi, heriblandt organisatoriske barrierer, et konstant ændret teknologisk landskab, og tekniske vanskeligheder [Dow et al. 2006]. De arbejder dagligt med digitale materialer, og de anvender en ekstremt alsidig kombination af digitale og analoge værktøjer gennem deres professionelle

Afhandlingens primære forskningsbidrag er følgende:

• Jeg identificerer og analyserer definitioner af begrebet "designidé", som det er blevet anvendt inden for forskning indtil nu, og undersøger betydningen yderligere ved at kigge på eksternaliserede former for designidéer i professionelle interaktionsdesigners idéarkiver.

• Jeg identificerer en teori for interaktionsdesigneres nuværende aktiviteter i forbindelse med organisering af idéer. Med udgangspunkt i denne teori, udvikler jeg en model over strategier for brug af værktøjer, baseret på de kreative mål, værktøjerne understøtter for professionelle interaktionsdesignere.

• Endelig identificerer jeg fire designpotentialer for udviklingen af nye, digitale idéorganiseringsværktøjer. Potentialerne falder under kategorierne ’anvendelse af designidéarkivets potentielle’ og ’øget fokus på den kreative designer’.

Afhandlingen består af denne kappe samt seks videnskabelige artikler: fem peer-reviewed og publicerede artikler, og én under review. Hver af disse artikler er opsummeret og reflekteret over i forhold til forskningsbidragets helhed i denne kappe, som også indeholder en refleksion over det samlede bidrags relevans for henholdsvis forfatterns felt, professionelle interaktionsdesignere, og udviklere af værktøjer til organisering af idéer.

**Figur 1:** Designidéer i forskellige designeres arkiver. Fra venstre top til højre bund: et screenshot af en artikel med tegnet annotation, printede sider af brugerflowet i en app, et Trello-board og en side fra en fysisk notesbog. Gengivet med designernes tilladelse.

INTRODUCTION

1.1 PROFESSIONAL DESIGN IDEA MANAGEMENT

This dissertation presents three years of research on how professional interaction designers manage ideas as part of their daily and continuous design practice. The research questions follow a logical order, where we need to answer the first to answer the second, and the second to answer the third:

1. How might we define, delimit and understand ‘design ideas’?
2. How do professional interaction designers currently use tools and systems to capture, manage and retrieve their design ideas?
3. How might novel digital tools support idea management for professional interaction designers?

The questions are motivated by an increasing interest in creativity support within the field of interaction design research, and a desire to move our understanding of professional, in-vivo interaction design practice forward. Although the topic of design creativity has been of growing interest to the interaction design research community, there is a gap in our understanding and knowledge about the influence of tools on day-to-day design creativity [Stolterman 2008; Pedersen et al. 2018]. We simply do not know much about how and why tools are used. Many empirically based publications within interaction design research study novel tools developed by researchers, rather than the tools interaction designers already use in their professional practices [Pedersen et al. 2018]. In many instances, this leads to research outcomes that are difficult to apply in real-life practices, because the research is based on an inadequate understanding of how design happens in professional settings [Stolterman 2008]. This dissertation represents a move towards using qualitative analysis with the goal of expanding our knowledge of design practice.

1.1.2 DEFINITIONS AND DELIMITATIONS

The research questions ask for some initial definitions and delimitations: What is meant by ‘design ideas’, what is meant by ‘interaction designers’, and what is included in the term ‘tools’. I will clarify the scope and my understanding of these terms here.

Design ideas: In this dissertation, design ideas are largely defined as outcomes of creative processes performed as part of interaction design practice [Biskjaer et al. 2010]. Design ideas specifically contribute to solving or addressing design problems and challenges, and rate from the simple (such as a
single utterance) to the detailed (such as a slideshow with a full design brief) - see Figure 2. Various definitions of design ideas are presented and analyzed in paper 1 [Inie and Dalsgaard 2017a], which is about establishing a definition of design ideas based on previous research. An inclusive definition of 'design ideas', based on both a research definition as well as a practitioner’s definition, is suggested and discussed in chapter 5.

**Interaction designers:** The research in this dissertation focuses on designers who design interactive products as a main part of their professional career. Although I recognize that many design idea repositories are shared, the focus of the dissertation is on individual designers and their personal idea management. In the dissertation an ‘interaction designer’ is understood as someone who ideates for and/or give form to interactive products, environments, systems, and services [Cooper et al. 2007] with careful attention to forming or transforming the user experience [Forlizzi and Ford 2000].

The distinctions between industrial job descriptions such as ‘interaction designer’, ‘UX designer’ and ‘experience designer’ are often unspecified, but from a research perspective, designers in these professions share numerous skills and characteristics that are significant in the perspective of design idea management. First, interaction designers practice design constantly and over an extended period of time. As I will expand upon in chapter 2, capturing, managing, and utilizing design ideas are pivotal skills during a professional design career. Second, their design ‘material’ (user experience and user interaction) is often difficult to represent and manipulate using existing tools [Löwgren and Stolterman 1998; Dow et al. 2006]. How does an interaction designer represent experiential concepts like ‘feeling overwhelmed’ or ‘sleek performance’? And third, interaction designers are technically literate. They have the language and often reflection ability to communicate their relationship to and choice of tools because they are trained in describing these things. The work of interaction designers revolves around the use of digital tools and systems, for which reason we can expect them to have devoted thought and effort into creating appropriate and sufficient workflows using both digital and analog tools (an expectation which was confirmed by the studies conducted as part of this doctoral work).

**Tools:** Tools can be both analog and digital, and denote a range of artefacts. The focus of this dissertation is on tools that are
used deliberately to obtain a goal: to serve the management of ideas in professional design work. For the sake of clarity in descriptions, I categorize the general term ‘tool’ into platforms, tools, and auxiliary tools:

**Platform:** Platforms can ‘host’ or encompass several other tools. Examples would be ‘computer’, ‘smartphone’, or ‘pen and paper’ (the latter of which can, in practice, mean everything from sticky notes to sketchbooks). I use the term to indicate on which ‘device’ a tool is used when the tool is cross-platform, for instance Evernote or Notes, which run on both smartphones, tablets, and laptops.

**Tool:** When I describe ‘tools’, I refer to tools which serve a relatively well-defined purpose for the designer, and may run on several different platforms. Examples would be different software applications (Evernote, OneNote etc.) or specific variations of analog tools (notebook, sticky notes, whiteboard etc.).

**Auxiliary tool:** A fine-grain description of tools, more commonly used by researchers than practitioners (in my studies, at least). This definition is sometimes used by researchers to describe: “individual tools within design applications such as Adobe Illustrator and InDesign. [...] individual panels and commands such as color pickers, alignment commands, levels panel, Adobe Photoshop filters, etc.” [Maudet 2017].

My research is primarily focused on the mid-level tools. That description corresponds to our study participants’ understanding of the word. A body of work has previously explored how we might develop auxiliary digital tools to function across different software, which is an extremely interesting line of research (e.g. [Ciolfi Felice et al. 2016; Jalal et al. 2015; Maudet 2017; Maudet et al. 2017]), but this is not within the scope of this dissertation.

### 1.2 MOTIVATION

Creative idea generation and exploration are essential parts of cognitive processing and therefore is inherent to everyone who thinks [Guilford 1968; Ebert 1994]. In a societal perspective, creativity and complex problem solving are described as being among the top ten most important future work skills [World Economic Forum 2016]. Creative thinking is an imperative skill in the field of interaction design. Because every design problem is an ultimate particular, processes, models, and design knowledge must be reiterated and appropriated in novel ways every time the designer faces a new design space [Buchanan 1992; Löwgren and Stolterman 2004; Nelson and
Stolterman 2003]. Prior research has established that generating ideas is of critical importance in order to effectively explore the problem space and achieve successful outcomes [Crismond and Adams 2012; Simonton 1990]. Managing design ideas - capturing, organizing and cultivating them - is therefore critical to designers at large, and to interaction designers as a subset of that group.

Interaction designers work with tools and technology on a daily basis, designing both with and for interactive, digital interfaces. Current research does not know much about how such tools influence design creativity. Several design and HCI researchers have pointed out that there is a bias in computational tools towards a product rather than a process focus (i.e. [Kidd 1994; Maudet 2017; Bernal et al. 2015]). This highlights a significant potential in the development of creativity support tools and systems. “Current computational tools are design-centric, with interfaces from the perspective of the physical components, rather than designer-centric, with a focus on supporting the actions that designers execute while they manipulate the patterns that drive the arrangement of the parts” [Bernal et al. 2015]. Shneiderman has often addressed the potential for tools to accelerate discovery and innovation, usually motivated by the underlying question: “How can designers of programming interfaces, interactive tools, and rich social environments enable more people to be more creative more often?” [Shneiderman 2007]. While we see increasingly complex software outperforming human capacity in skills that include computational assessment and scalability, the most basic human skills like empathy and creativity, are the most difficult to mimic (also known as Moravec’s paradox [Moravec 1988]). The goal of this doctoral work has therefore been to investigate how interaction designers currently engage in the tool-supported management of their creative ideas, how they use tools to support this practice, as well as to discover potential directions for novel idea management practices and tools.

1.3 APPROACH

The scope of this PhD dissertation is to investigate what is understood (both by researchers and practitioners) by design ideas; to unfold what interaction designers do with their ideas in their daily practices; and to develop frameworks to explain some of these patterns of creative behavior. In addition to identifying potentials for existing and novel digital tools, this dissertation provides insight into the elusive world of design creativity outside
of research labs and educational classrooms. The nature of the research is qualitative, as the objective of the dissertation is first and foremost to gain an understanding of the participants’ worlds [Janesick 1994]. I have utilized a set of qualitative methods elaborated in chapter 3, including observations, qualitative surveys, lengthy interviews, and extensive analysis of design idea archives.

For the convenience of the reader, the contributions relate to the research questions as follows:

**Research question 1:** How might we define, delimit and understand ‘design ideas’?

**Contribution:** I identify and analyze definitions of the concept “design idea”, as it has been used in research up until now, and unfold the meaning of the concept by looking at externalized instances of design ideas in practicing interaction designers’ archives.

**Research question 2:** How do professional interaction designers currently use tools and systems to capture, manage and retrieve their design ideas?

**Contribution:** I identify patterns and challenges in current strategies for idea management of professional interaction designers and consolidate these into a theory explaining the activities of idea management. Based on the use patterns, I develop a framework of strategies for using different idea management tools in terms of the creative objectives they fulfill to professional interaction designers.

**Research question 3:** How might novel digital tools support idea management for professional interaction designers?

**Contribution:** Finally, I identify four design opportunities for novel idea management tools under the headlines of ‘utilizing the potential of the design idea archive’, and ‘increasing focus on the creative designer’.

This dissertation is written for researchers in interaction design and idea management. Additionally, these insights might offer inspiration to researchers in related fields, particularly Human-Computer Interaction and creativity research. In chapter 6, I discuss the practical implications of the findings and describe how they might be relevant for practicing designers as well as developers of creativity support tools.
The complete dissertation is comprised of six research papers in addition to these seven summative chapters. In the research papers, I present my empirical studies and their results, and in these summative chapters I provide an overview of the cumulative results of the papers in the context of previous and current interaction design research.

This introduction is followed by six chapters in addition to the reference list (chapter 8) and appended papers (chapter 9): In chapter 2, I give an introduction to the theoretical background and related work of this dissertation: interaction design, Human-Computer Interaction, creativity research, and cognitive science. In chapter 3, I describe the research design and methodology. In chapter 4, I present an overview and summaries of the appended papers and describe how they relate to each other. In chapter 5, I summarize the cumulative research contributions by subject: design ideas, current idea management strategies, and tool support for idea management. Chapter 6 is dedicated to a discussion of the results, as well as a description of future work. Finally, the dissertation is concluded in chapter 7.
BACKGROUND AND RELATED WORK

The following chapter summarizes and discusses related work. Professional design idea management is a complex phenomenon, and a process which is influenced by many factors at any given time: work environment, professional and personal goals, company culture norms, and personal work style and time management, to name a few. As a research phenomenon, idea management is distributed, creative, and in many cases IT-supported, and this dissertation therefore draws on knowledge from several fields to analyze the phenomenon exhaustively.

In this chapter, I will first outline related research in the field of interaction design, specifically idea externalization and design documentation, which provides a foundation for understanding why interaction designers have a reason to deliberately manage ideas in the first place. Secondly, I will describe relevant research from the field of Personal Information Management, which has led the most research in understanding how and why professional knowledge workers keep track of information in general. Thirdly, I will describe how creativity- and cognitive research can lend theoretical frameworks for interpreting real world creative practice, especially within the scope of distributed creativity. Distributed creativity elucidates the role that tools play in co-shaping creative interaction design practices.

The dissertation is first and foremost grounded in the field of interaction design. I understand interaction design broadly as “the creation of a dialogue between a person and a product, system, or service. This dialogue is both physical and emotional in nature and is manifested in the interplay between form, function, and technology as experienced over time” [Kolko 2011]. Because the practices of interaction design are multi-faceted, the field itself draws upon knowledge from several other disciplines, from interpersonal communication to computer science. It was evident from the studies of the dissertation that the daily work of an interaction designer is versatile – from doing user research, designing websites, to designing large-scale, digital installations in public space. In this background chapter, I will focus on theory and knowledge that existing research considers to be unifying for interaction design as a discipline.

2.1 IDEA MANAGEMENT IN PROFESSIONAL INTERACTION DESIGN PRACTICE

2.1.1 ORIGIN OF DISCIPLINE: FROM HUMAN-COMPUTER INTERACTION TO INTERACTION DESIGN RESEARCH

Interaction design can be viewed as concerning a broader scope of topics and methods than the field it springs from, Human-Computer Interaction (HCI). Interaction design can be said to spring from a historical shift in focus from highly computer-centered to the diversity of design and the evaluation processes involved [Rogers et al. 2011]. A part of this shift is an increased attention to all digital artifacts in our lives, rather than a narrow focus on desktop computers. Interaction design concerns the same computational interfaces as HCI (desktop computers, mobile phones, ATM machines, smart homes etc.), but the focus
shifts from computing to people: “While drawing from many of the older disciplines, [interaction design] has a distinct set of concerns and methods. It draws on elements of graphic design, information design, and concepts of HCl as a basis for designing interaction with [and habitation within] computer-based systems”. [Winograd 2003]. In this perspective, humans are not merely viewed as a component in the computational system, but as actors in social and cultural contexts. Interaction design therefore also studies the social and cultural context in which interaction design takes place.

2.1.2 “IDEAS” IN INTERACTION DESIGN RESEARCH

The goal of interaction design work is to arrive at a concrete or abstract product as a result of conscious actions and decisions by the designer [Biskjaer et al. 2010]. Ideas are essential in moving from a problem state to a desired outcome, in that they express a design vision, aimed at solving a design problem [Löwgren and Stolterman 2004]. It is therefore paramount for interaction design research to investigate, define and analyze design ideas. This dissertation is a contribution to moving that particular strand of interaction design research forward.

There is a multitude of models describing and explaining the creative design process (e.g. [Cross and Roy 1989; Löwgren and Stolterman 2004; Council 2006; Howard et al. 2008]). Whether the models are grounded in the tradition of engineering design, or the tradition of creative design, design process models are roughly characterized by iterative phases of analysis of data, idea- or concept generation, evaluation of ideas, and communication/ implementation [Howard et al. 2008]. The phases of generation and evaluation, whether it is of ‘ideas’ (typically in creative design) or ‘concepts’ (typically in engineering design) are central to all theories of design practice.

The ability to generate many or good ideas and the ability to select the best ideas have thus been areas of extensive research in the field of interaction design research. A significant share of such studies are aimed at the development of methods for generating more or better ideas (often defined as idea fluency and idea quality). Examples of such studies include, among others, [Perttula et al. 2006; Girotra et al. 2010; Howard et al. 2011; Goldschmidt and Sever 2011; Halskov and Dalsgård 2006; Siangliulue et al. 2015; Sosa and Dong 2013; Dahl and Moreau 2002; Dix et al. 2006]. These studies usually either investigate existing methods or develop novel methods for idea generation.
These methods are tested in settings with a varying degree of control, and the methods are seldom used in professional design practice, but by students or experiment participants chosen by the researchers. Similarly, research contributions that investigate the ability to select promising ideas (for instance [Toh and Miller 2015; Nelson and Stolterman 2003; Badke-Schaub and Gehrlicher 2003; Cardoso et al. 2016; Starkey et al. 2016; Shah et al. 2000; Goldschmidt and Tatsa 2005]) often look at discourse during a design process where it is possible to evaluate the outcomes, that is, often a student design course.

Such studies differ in scope and method from the work of this dissertation, however they indicate that the ability to generate and manage design ideas can be said to be a fundamental competency for the interaction designer. Research in the generation and evaluation of ideas is of great interest to the field of interaction design research and -education. Thus, an intricate understanding of ‘design ideas’ should be of principal importance for the design researcher.

2.1.3 EXTERNALIZATION AND DESIGN DOCUMENTATION

In professional practice, the value of a design idea is highly dependent on the context it is to be employed in, giving designers a reason to store ideas until they are in a position to use them [Coughlan and Johnson 2008]. According to Gaver and Bowers [2012] and Löwgren and Stolterman [2004], the work of a great designer is extensively based on experience from similar design cases - often more than it is based on theoretical knowledge. Buxton [2010] argues that it often takes a decade for a good idea to have practical value in the world, which makes deliberate idea management critical to the professional interaction designer.

Externalization can be described as the active shaping of the world as an intellectual resource, and it is a core activity for most professional designers [Dix and Gongora 2011]. In a more direct sense, externalization can be anything from verbalizing an idea to actively shaping it through interaction with the environment, for instance in the form of modelling or prototyping. In the tradition of cognitive science, externalization is considered any expression of computational offloading [Scaife and Rogers 2005] 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” [Kirsh 2009].
Design idea externalizations can address both the product, the problem space, the design space, and the process [Dix and Gongora 2011]. Externalizations can serve informational-, formational-, transformational-, and transcendental purposes to the designer (Figure 2 through 5, all from [Dix and Gongora 2011]). The different purposes of externalization may explain the multitude of representations found in practicing interaction designers’ archives [Inie et al. 2018c]. Some designers may use externalizations primarily to address the design product for informational purposes and thus consider their idea archive to be a collection of slide decks or physical presentation boards. Some designers may spend more time on externalizations addressing the design process with a transcendental purpose and therefore accumulate idea archives that consist largely of textual reflections.

Interestingly, the transcendental purpose of externalization was not broadly spoken about in the data of this dissertation, which begs the question of whether professional designers themselves utilize the potential of externalizations. As concluded by Dix & Gongora [2011] themselves: “Externalisation is ubiquitous in design and it is important to understand its role so that we can make the most of it, and develop ways to improve its power”.

The purposes of externalizations described in [Dix and Gongora 2011] contribute to a basic understanding of the importance of external idea archives, and understanding which my studies build upon and extend. I will refer back to the these terms repeatedly throughout chapter 5.

An example of an acknowledged, formalized approach to deliberate and rigorous idea management over extended time is the practice of design documentation. Systematic design documentation and reflection has been the subject of substantial research in the field of interaction design, e.g. [Gaver and Bowers 2012; Dalsgaard and Halskov 2012; Gardiner and Others 1994; Bowers 2012; Gaver 2011; Sharmin and Bailey 2011]. In one study, providing novice designers with a tool to support continuous, reflective design documentation showed numerous benefits: supporting shared reflection in groups, discussion in on-going projects, and scaffolding longitudinal and cross-project studies [Dalsgaard and Halskov 2012]. Documentation of design ideas is not only instrumental in terms of reporting facts and findings, but the act of documenting itself can be generative and lead to new

**Informational purpose:** The designer uses an externalization to pass on information about an idea to another person. For instance, sketching a suggestion for the layout of a software interface out to show where the elements might be placed in relation to each other.

**Formational purpose:** The designer externalizes their own idea to get a clearer picture of a vague idea. For example, the designer may have a vague sense of where part-elements fit into the whole design, and use a sketch to make this sense clearer.

**Transformational purpose:** The designer uses different materials to think with. The designer may try to move elements in the design around to “see how it feels” and form a conversation with the design material [Schön 1983].

**Transcendental purpose:** The designer uses the externalization to form thoughts about their thoughts. This is a metacognitive process which lets the designer reflect on their designerly knowing – for instance comparing their latest designs to each other in order to identify patterns or gaps in their professional development.

Figure 3 to 6: The purposes of externalization.
Source: Images from [Dix and Gongora 2011], my paraphrase explanations.
insights and ideas [Bardzell et al. 2016]. Purposeful documentation allows the designer to not only reflect on the product, but, and perhaps more importantly, to reflect on the design process and rationale behind key decisions [Schön Donald 1983]. For experienced interaction designers working with more matured design proposals and concepts, documentation in the form of design workbooks [Gaver 2011] and annotated portfolios [Bowers 2012] has been argued to be both fruitful sources of inspiration, development and communication of ideas internally and externally. Specifically, Bowers [2012] emphasizes seven important features of annotated portfolios, of which I will highlight four that demonstrate the transcendental purpose of deliberate documentation in portfolios:

**Perspective:** A portfolio can be annotated in different ways, each demonstrating a specific perspective on design ideas and products. Different annotations reflect different purposes and interests and can communicate these to different audiences.

**Communication:** Annotations communicate the nature of a portfolio and enable its comparison with other portfolios. Annotations specifically have a complementary ‘outward-looking’ aspect, making them suitable as informational externalizations.

**Relationships:** Annotating portfolios captures resemblances and difference between designs (ideas) over a long-term career.

Design workbooks and annotated portfolios are usually a combination of during-the-fact externalizations and after-the-fact documentation, allowing the designer and others to retrace the steps of the process that led to the finished artifact [Moran and Carroll 2016]. Design workbooks and portfolios can be said to be a long-term collection of different externalizations, curated to serve a specific purpose to the designer.

As articulated repeatedly during the interview studies of this dissertation, professional designers rarely have the time to create such elaborate documentative artifacts. Some of the interview participants expressed regret about the ad hoc, impromptu management style they employed towards the management of, and reflection about their creative ideas in day-to-day practices, but said that they simply did not have the time to change this.

The research on externalization and design documentation described in this section have informed my studies in the sense that it has already been shown that idea capture and management is significant for professional designers. It seems to
be a practice naturally performed, but one which we do not know much about - and interestingly, a process or set of processes which are performed ad hoc and without any ideals of "best practice" or benchmarks. As such, there is no unifying theory or model describing to designers how they might manage ideas to accomplish certain goals. It is important to highlight that this dissertation does not attempt to prescribe such best practices to practitioners, but rather to establish an understanding of how and why professional idea management is currently accomplished.

### 2.1.4 TOOLS IN DESIGN PRACTICE

For interaction designers, action is of critical importance to aid thought: "Reflective practice, the framing and evaluation of a design challenge by working it through, rather than just thinking it through, points out that physical action and cognition are interconnected" [Klemmer et al. 2006]. This perspective prompts us to explore how the artifacts, prototypes and things interaction designers think through, become windows into their worlds. Mackay [1990] showed how humans use tools to shape their environment, meanwhile tools equally shape human actions and cognition, a duality termed co-adaptive phenomena.

Dalsgaard [2017] identified five qualities of tools which frame how they aid designers:

1. **Perception**: tools help designers perceive and understand the design situation and formulate the design problem,

2. **Conception**: tools help designers understand and articulate the problems they face as well as develop hypotheses about how to address these problems,

3. **Externalization**: tools allow designers to make imagined design solutions part of the world,

4. **Knowing-through-action**: tools allow new knowledge to be generated through acting with an instrument, and

5. **Mediation**: tools support mediation between actors and artefacts in a design situation and establish stable shared points of reference.

These five qualities express the cognitive attributes that tools support through the design process. They are akin to the purposes externalizations fulfill to the designer [Dix and Gongora 2011], with the difference that tools are more often considered
instruments to help the designer arrive at externalizations - the means to attain the goal, rather than the goal itself. However, tools, like externalizations, tools affect the behaviors and possibilities of the designer. As a simple example, if an interaction designer is working on a wooden mock-up (the externalization), he or she might use different tools to manipulate this externalization, such as scissors, sticky tape, or pens. If the designer learns that the sticky tape does not stick to the type of wood they are using for this particular mock-up, they may have learned something about the properties of this tool (the sticky tape), but not about the externalization per se. If, then, the designer wants to join the pieces of wood in, say, a finger jointed cut (see Figure 7), they might need a different tool: a laser cutter. This laser cutter affords a whole new set of possibilities and constraints to the designer’s work, allowing for new perceptions, conceptions, and externalizations. Tools have a meaningful impact on creative practice, and I will return to this subject under the topic of distributed creativity, later in this chapter.

In summary of this section, externalizing ideas is vital to practicing designers. We do not know much about how externalization and tool use happens in professional practice, or which role externalizations and tools play in a long-term project or across a creative career. In the following section, I will therefore emphasize some of the research from a related field that has studied organizational practices in professional life: Personal Information Management.

2.2 PERSONAL INFORMATION MANAGEMENT

Idea management is related to the field of Personal Information Management (or PIM), in that ‘design ideas’ is one of many categories or types of information that need managing throughout a professional design career. Personal Information Management is a term used in HCI to describe the collection, storage, and retrieval of digital and analog information [Jones 2010], such as emails, reference files, copies of finished projects et cetera. Several in-depth studies have been conducted on how office workers manage information, often involving extensive ethnographic field work, e.g. [Whittaker and Hirschberg 2001; Boardman and Sasse 2004; Barreau and Nardi 1995]. The amount of field work carried out in this discipline accounts for most of our existing knowledge about information storage for professional workers. A central objective of PIM is to ensure access to the right information, in the right format, and of sufficient completeness and quality to meet the professional’s needs.

2 For a detailed discussion of the characteristics of ideas in relation to information, see section 2.3.1 of this chapter.

Figure 7: Finger jointed laser cut box.
Source: http://thelaserco.com/
current need [Jones 2004]. One of the goals of research in PIM is therefore to define those needs and to develop systems to help users achieve them. PIM is a relatively well-developed field and there is an extensive body of empirical work to draw from. In this dissertation I have reviewed studies which offer guidelines for how to navigate empirical data, i.e. qualitative surveys and interviews. The following section presents selected studies that establish a set of terms to describe and frame the analysis of data when looking at professional interaction designers’ idea archives. These terms are the basis of the analysis presented in paper 4 [Inie et al. 2018c].

2.2.1 TYPES OF “INFORMATION” IN PERSONAL INFORMATION ARCHIVES

In this section I will describe what previous research has found when looking at general “information” in archives. These studies have informed my analysis to a great extent by offering a set of terms with which to describe and analyze my data. The frameworks described in this section also present a basis for analyzing how ‘ideas’ differ as a specific kind of information. These terms are used in the analysis of “design ideas” presented in chapter 5.

When looking at the contents of archives that knowledge workers3 keep, Barreau & Nardi [1995] found three types of information:

• *Ephemeral information* has a short shelf-life and includes items like to-do-lists and news articles,
• *Working information* is frequently used and relevant to current work. It has a week- or month-long shelf life,
• *Archived information* is often kept around for months or years but rarely accessed.

In their study from 2004, Boardman & Sasse [2004] demonstrate that information can be characterized in terms of its usefulness and ownership, respectively:

**Information usefulness:**

• *Active information* includes ephemeral and working information, for instance reference files for a current project,
• *Dormant information* is inactive, but could potentially be useful,
• *Not useful information* is kept but could be discarded at any given opportunity, and
• *Un-assessed information*, for instance unread emails and messages.

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3 ‘Knowledge workers’ are characterized by adding value to an organisation by understanding a body of knowledge and generating new information from this understanding [Kidd 1994; Jones 2004]. Faced with the same input, each knowledge worker produces a different output, and this is exactly their contribution to the organization. Interaction designers are an example of a type of knowledge workers, in that they add value to the company by virtue of their personal perception and analysis of a design situation and the development of concepts and products in response to it. There are traits of interaction designers which distinguish them as a subgroup of knowledge workers, i.e. that they are in the interventionist business of creating and introducing something novel to the world; to rethink and transform a situation by means of innovation and creativity resulting in novel interactive products or services [Biskjaer et al. 2010].
Information ownership:
- **Mine** includes self-created files and files that have been assessed as having value,
- **Others’** includes one’s email inbox and information found on the internet.

These terms expand upon the findings from Barreau & Nardi [1995]. Boardman and Sasse show that the perceived value of information influences the selection of PIM strategies. The paper additionally finds that organization of personal information is highly influenced by the medium and place of acquisition. An example from the world of interaction design is if a designer receive a reference file on their desk, they would be very unlikely to scan the document and store it in a digital format while discarding the analog file [Inie and Dalsgaard 2019, forthcoming].

Later studies have found that knowledge workers judge the adequacy of their archives primarily on how well the archive helps them identify and keep what they have decided to keep, and to display what they need to display, rather than the efficiency of information retrieval [Kaye et al. 2006]. This means that we can assume that the contents and format of interaction designers’ archives are an accurate reflection of why designers capture and archive ideas. In their study of academic knowledge workers, Kaye et al. [2006] identified the following value-goals for archiving:

- **Building a legacy.** Some archives were constructed to let visitors take a visual sweep of the room for an insight into the important aspects of the archive owner’s life’s work.
- **Sharing resources.** Some archives were constructed for several people who shared the same resource of something, thus, the archives were constructed with respect to several people’s goals.
- **Fear of loss of the information.**
- **Identity construction.** Some archives had the primary purpose of showing aspects of the archive owner’s personality, for instance ‘an organized person’, or ‘a creative person’.

In the study it was also found that asking the question “What is your personal archive for?” revealed a strong connection between each archive’s function and its structure, indicating that the archive can teach us something about the creator. Kaye et al. suggest an increased focus on values when designing tools to support the organization and management of information. They
identified a challenge for designers of such systems in designing not only for customization in structure but also for the archive’s use in identity construction, while maintaining appropriate levels of privacy. They pointed to a discrepancy in current digital archiving tools which are often optimized towards the value of “finding it later” [Ibid.]. This challenge is discussed in more detail in the following section.

An overview of the PIM terms summarized in this chapter is presented in Table 1. As described, these terms have offered a theoretical foundation for the analysis of the data I have acquired through the work of this dissertation. Specifically, they have provided a guideline for navigating the data. Studying the informational purpose of design idea archives has revealed both similarities and differences between ‘information’ and ‘ideas’ and shown that different designers have very individual and appropriated strategies for utilizing their personal idea archives in their daily work [Inie et al. 2018c]. Additionally, I will use the terms to characterize the informational role of ‘design ideas’ in chapter 5.

### Table 1: Terms in PIM.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>• Ephemeral • Working • Archived</td>
<td>• Active • Dormant • Not useful • Unassessed</td>
<td>• Mine • Others</td>
<td>• Finding it later • Building a legacy • Sharing resources • Fear of loss • Identity construction</td>
</tr>
</tbody>
</table>

2.2.2 ACTIVELY INFORMING OR PASSIVELY STORING - PROCESS VERSUS PRODUCT FOCUS

As technology has advanced and we have more tools and systems than ever available to manage our personal information, it does not necessarily lead to increased satisfaction. On the contrary, several empirical studies, including the ones in this dissertation, have shown that many interaction designers experience frustration with their information becoming fragmented [Inie et al. 2018a]. As the introductory quote of this dissertation suggests, despite more available tools, information does not necessarily feel more readily available.

In 1994, Kidd claimed that developers of PIM tools “have lost sight of humans as highly-tuned learners and actors whose internal form is constantly changing in order to refine their ability to act in the world” [Kidd 1994]. The paper describes how, once informed by some material, knowledge workers have little need to retain a copy of the informing source. However, if a piece of material has not yet informed them, then they cannot sensibly file it in a computer system, because its subsequent use or role in their world is still undetermined. Therefore, Kidd suggests that “computer support for knowledge work might be better targeted on the act of informing rather than on passively filing large quantities of information in a “disembodied” form” (my emphasis).
This position – that computational tools should move beyond a focus on passive information storage and towards actively informing and supporting knowledge workers – is echoed by various later studies, e.g. [Kaye et al. 2006; Herring et al. 2009; Bernal et al. 2015; Maudet 2017]. As described in the motivation, this dissertation promotes the point that creativity support tools should move beyond a product focus and towards a process focus, that is, actively supporting the designer in their creative process, rather than only being aimed towards allowing increasingly advanced products. As will be iterated in chapter 5, it is, then, crucial for tool developers to understand the creative processes they develop support for.

2.3 CREATIVITY RESEARCH AND COGNITIVE SCIENCE

There are many ways of defining creativity. In this work I adopt the understanding definition presented by Stein: “The creative work is a novel work that is accepted as tenable or useful or satisfying by a group in some point in time” [Stein 1953]. Practicing creativity can be said to broadly refer to the generation of novel and useful approaches or ideas [Biskjaer et al. 2010]. For the purpose of this research, this is a suitable description, as it accurately describes the practices of the interaction designers who took part in the empirical studies presented in this dissertation. Although creativity is a desirable characteristic of design, and exceptional designers are creative thinkers, creativity is not a necessary condition for design [Alexiou et al. 2009]. Gero formulated a distinction between routine- and nonroutine design problems and tasks [2000]:

- **Routine design**: designing activity that occurs when all the necessary knowledge is available.

- **Nonroutine design** can be subdivided into two further groups:
  
  **Innovative designing** equals designing activity that occurs when the context that constrains the available ranges of the values for the variables is jettisoned, so that unexpected values become possible.

  **Creative designing** can be defined as the designing activity that occurs when one or more new variables is introduced into the design. Importantly, creative processes do not necessarily result in outcomes that are rated as creative.
Interestingly, design is commonly theoretically described as 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" [Dorst and Cross 2001].

Creativity research is founded in psychology and is often described as being comprised of a first wave and a second wave [Sawyer et al. 2003]. The first wave took place between approximately 1950 and 1970, and focused on individual personality traits and internal cognitive processes. The second wave began in the 1980s and focused on groups in contexts, exploring sociocultural understandings from an interdisciplinary perspective [Ibid.]. Creativity research now spans several disciplines in psychology, including cognitive-, differential-, developmental-, and social psychology [Simonton 2012]. Fields like HCI and interaction design have begun to expand their focus on desktop computing into more diverse spheres of human activity, among these, creative aspects [Nelson and Stolterman 2003; Pedersen et al. 2018]. The traditional methods of interaction design research (e.g. ethnographic research, in vivo observational studies, and qualitative analysis) offer the type of insights that complement traditional (often in vitro) methods of creativity research [Sawyer and DeZutter 2009]. One of the pioneers of creativity research, Simonton, so expressed: “the scientific understanding of creativity should be extended to lead to ever more useful applications. (...) the gap between scientific knowledge and practical interventions is often so wide that doubts are cast on both science and practice” [2000].

Findings and results from creativity research are imperative to a comprehensive understanding of the worlds of practicing interaction designers working creatively in a social, computer-supported environment. Practicing designers can be said to operate daily between what Kaufman and Beghetto [2009] label little-c-, and Pro-c creativity, where little-c represents everyday creativity (which emphasizes characteristics such as unconventionality, inquisitiveness, imagination, and freedom) and Pro-c is professional creativity; the developmental and effortful progression beyond little-c.

Even if all designers are not constantly creative, creativity seems an integrated aspect of professional design practice. Creativity theory should thus be relevant to design practice as well. The topic of ‘idea management’ rests firmly on a view of designers as effortful progressors towards creative practice, even when job functions and time constraints do not always allow for it [Inie et al. 2018c]
2.3.1 “IDEAS” IN CREATIVITY RESEARCH AND COGNITIVE SCIENCE

In section 2.1.2 I detailed the theoretical description of ‘ideas’ as described in interaction design research, and in section 2.2. I introduced design ideas as a subcategory of ‘information’. In the current section, it is worth introducing the role of ideas in creativity- and cognitive research, which has offered, perhaps, the most detailed investigation and description of the nature of creative ideas. As reported, the first wave of creativity research was primarily oriented towards describing individual, internal processes. Therefore, the understanding of ideas that spring from this research is grounded in psychology and cognitive science.

While the discipline of design generally studies externalized ideas, creativity research and cognitive science study ideas within the individual’s mind. In these disciplines, ideas are the basis of creative design activities, whether the ideas are externalized or not [Inie and Dalsgaard 2017a].

In creativity research, idea generation is often described in terms of bisociation or ‘the 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 [Boden 1990; Gabora 2002; Mayseless et al. 2015; Seifert et al. 1994]. For an idea to be considered creative, it must be a combination of novel/original and feasible [Guilford 1968; Rhodes 1961].

The Geneplore model [Finke et al. 1992] describes idea generation as an oscillation between a generative phase, where the 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. If these explorations are successful, they result in an idea. If these explorations are unsuccessful, one of two procedures would come into play, either of which would involve a return to the generative phase: The individual will either abandon the initial preinventive structure and generate another that may be more promising, or modify the initial structure and repeat the exploratory phase with this modified structure. Continuing these procedures leads to expanding the structure to explore more general conceptual possibilities (see Figure 8).
Within neither design- nor creativity research it is generally specified how the researcher may look for ideas in collaborative, distributed practice, or how much or how little constitutes ‘one idea’ [Inie and Dalsgaard 2017a]. In chapter 5 I will build on the terms and concepts from both disciplines to introduce a theoretical definition of design ideas as well as demonstrate how design ideas are externalized in professional idea archives.

2.3.2 DISTRIBUTED CREATIVITY

Distributed creativity is a network-oriented theory of creativity that is often used to describe socially distributed creative processes among musicians and improvising actors [Sawyer and DeZutter 2009]. Distributed creativity, as rooted in the theory of distributed cognition [Hutchins 1995], can also, albeit more rarely, describe how creativity happens distributed across both objects, individuals, and tools in our environment [Hollan et al. 2000]. Despite noteworthy research in purposes and roles of externalizations and design documentation, very little research has been conducted in the role tools play in practiced, professional creativity. Traditionally, distributed creativity denotes creativity as distributed between people, rather than the tools and materials they use – even if this perspective is often acknowledged, it is rarely unfolded [Sawyer and DeZutter 2009].

Interaction designers rely upon physical and digital materials and tools constantly. Tools may sometimes serve as a medium for exploring potential expressions, sometimes as the final medium of expression, or sometimes both. Tools and materials serve as an extension or distribution of imagination and memory [Hutchins 1995]. I propose, with this dissertation, that distributed creativity is a promising avenue of research when attempting to illuminate design work in professional settings.

The first wave of creativity research focused, as described, extensively on creativity within the individual mind [Wallas 1926; Boden 1990; Davies and Talbot 1987; Rhodes 1961] – an “intramental” perspective [Gedenryd 1998]. This led several researchers to encourage a recognition of creativity as distributed: “creativity is embedded in social groups, and [...] creative products emerge from collaborative networks. (...) situations where collaborating groups of individuals collectively generate a shared creative product” [Sawyer and DeZutter 2009]. Distributed creativity is part of the second wave of creativity research, acknowledging that cognition does not happen in isolation from the surrounding environment, but across people, environments, tools, and
systems [Hollan et al. 2000; Csikszentmihalyi 1988; Hutchins 1995]. A distributed account of creativity emphasizes its dynamic, socio-cultural and developmental nature [Glăveanu 2014]. When we introduce ethnographic approaches to the study of real-world practiced creativity, it becomes very clear that tools play a significant role. A recent study of design students working on a shared design task showed that the students oscillated between individual and shared work, often mediated by tools [Christensen and Abildgaard 2018]. The students in this study were designing as a group, but rapidly deviating their attention between the shared discussion and their personal devices. The boundary between what we might call a collaborative design process and an individual one is not clear-cut in real-world practices.

One way creativity research has conceptually described the integration of the external environment into our understanding of practiced creativity is by means of The five A’s framework [Glăveanu 2013]. The framework is shown in Figure 9. This framework is an update of the conceptual framework of the four P’s of creativity: Person, Process, Product, and Press (originally proposed by Rhodes [1961]) - the two frameworks are compared in Figure 10. The purpose of the five A’s framework is to help researchers move beyond a focus on isolated components by allowing them to focus on a basic unit of analysis: the interaction between elements rather than the elements themselves (e.g., person, product, etc.) [Glăveanu 2013]. What is especially relevant to the research in this dissertation is the interaction between the elements Actor and (material) Affordances, as indicated in Figure 11.

Although many authors have recognized that creative cognition is distributed across tools and people, there is a very limited amount of empirical research in distributed creativity. In real-world creative work, a defining characteristic of skillful practitioners such as interaction designers is that they often employ and combine a range of different tools in idiosyncratic ways in order to tackle specific challenges [Gedernyd 1998]. An example of the importance of tools from the studies of this dissertation was that almost all designers preferred to work with low-fidelity, analog tools in the early stages of the idea generation process, because these tools mirror the fidelity of the ideas, as well as allowing all stakeholders to participate in the creative process on equal terms. Tools of high-fidelity, or tools which require technical skills, are used in later stages of the creative process, because they allow for creativity to be expressed and distributed by a narrower group of stakeholders (typically only the designers or developers).
When we look at design practice, it is very clear that interaction designers use technology constantly and pervasively. Yet, creativity research in HCI has shown to focus predominantly on in vitro-studies, rather than creativity as it unfolds in the workplace, with and because of tools [Pedersen et al. 2018]. This dissertation thus represents a move towards using qualitative approaches to in vivo-studies with the goal of expanding our knowledge about distributed creativity in professional practice.

In this chapter, I have introduced the fields that this dissertation builds on: interaction design, Personal Information Management, creativity research, and distributed creativity. I study creativity as it happens in the world of professional interaction designers, and this subject is best explored by drawing upon research from more than one theoretical background. My research resonates with the field of distributed creativity, however the empirical research in this discipline is not rich enough to provide a comprehensive explanation of professional interaction design practice without making use of findings from the other fields. It is my attempt to contribute to the field of distributed creativity by utilizing the following:

**Knowledge** about interaction design processes (ideation, externalization, and design documentation) from the field of interaction design.

**Vocabulary and analytical frameworks** from the field of personal information management.

**Theoretical foundation** and understanding of creative ideation from the field of distributed creativity.

In the next chapter, I will unfold how this dissertation is built on methods from the discipline of interaction design to contribute to the field of distributed creativity.

### 2.4 SUMMARY
RESEARCH DESIGN

The goals of the research design presented in this chapter have been to 1) gather and analyze data about design practice, 2) to translate this data into frameworks that represent and communicate this knowledge in context of previous research, and 3) to open design opportunities that inform and inspire other researchers in interaction design.

3.1 RESEARCH ACTIVITIES

My research has been carried out from the foundation of the digital design department at Aarhus University as part of the CIBIS (Creativity In Blended Interaction Spaces) project [Halskov et al. 2018]. I have utilized the industrial partnerships of this project to find and approach study participants (both novice- and professional designers) for qualitative inquiries. In addition, I spent six months at the Design Lab at University of California, San Diego, under supervision of professor Steven Dow. During these months I had the opportunity to interview a diverse group of professional interaction designers working in various companies in the state of California. At UC San Diego I had the opportunity and pleasure to learn about cognitive aspects of creativity under guidance of faculty from the cognitive science department (especially professors Scott Klemmer, Donald Norman, and Jim Hollan), as well as in various feedback meetings with the faculty and students of the Design Lab.

3.1.1 STUDIES, DATA, PARTICIPANTS, AND FOCI

In addition to a thorough literature review, several empirical inquiries have contributed to answering the research questions. I maintained a close relationship with participants across multiple studies to investigate their practice through different lenses. In effect, this means that some of the designers who took part in the online survey also participated in following interviews, and the designers who were interviewed were also the subjects of the walkthrough-inquiry.

The specific details of the studies, and how the data was analyzed, are described in more detail in the appended papers. The results from studies 1 and 2 have not been published, but I am including
RESEARCH DESIGN

A high-level description of the studies here, to provide insight into the process of shaping the research questions. Studies 1, 2, and 4 helped form the research question 1: How might we define, delimit, and understand 'design ideas'?

An overview and timeline of the empirical inquiries is presented in Table 2. The studies build on each other in stages of identifying research questions, gathering information, analyzing and interpreting information, and sharing results with participants [Berg et al. 2004]. I will describe the logical progression below (pictures from studies are shown in Figure 12):

**Study 1:** The initial research questions were formed during an **observational** study of high school students during a design course of four weeks in spring 2015, a total of eight hours of observation. The goal of these observations was to get an overarching understanding of how the students treated ideas over the course of an isolated design project. The main finding from this observational study was that the concept of ‘design idea’ was vague - I did not have a

<table>
<thead>
<tr>
<th>Type of study</th>
<th>Type of data</th>
<th>Participants</th>
<th>Collected</th>
<th>Main focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Observation</td>
<td>Video recordings Transcriptions Field notes</td>
<td>20 high school students</td>
<td>2015-2016</td>
<td>Design ideas in practice</td>
</tr>
<tr>
<td>2 Controlled experiment</td>
<td>Video recordings Transcriptions Concept posters</td>
<td>6 university students</td>
<td>2015</td>
<td>Externalizations of design ideas</td>
</tr>
<tr>
<td>3 Literature review</td>
<td>75 research articles</td>
<td>None</td>
<td>2016</td>
<td>Design ideas in theory</td>
</tr>
<tr>
<td>4 Controlled experiment</td>
<td>Video recordings Transcriptions</td>
<td>9 university students</td>
<td>2016</td>
<td>Externalizations of design ideas</td>
</tr>
<tr>
<td>5 Qualitative survey</td>
<td>Text</td>
<td>24 professional interaction designers</td>
<td>2016</td>
<td>Idea management tools in practice</td>
</tr>
<tr>
<td>6 Semi-structured interviews</td>
<td>Audio recordings Transcriptions</td>
<td>20 professional interaction designers</td>
<td>2017-2018</td>
<td>Idea management tools in practice</td>
</tr>
<tr>
<td>7 Walkthroughs</td>
<td>Digital files Printed files Sketchbooks Sticky notes Notebooks</td>
<td>20 professional interaction designers</td>
<td>2017-2018</td>
<td>Externalizations of design ideas in practice</td>
</tr>
<tr>
<td>8 Open-ended experiment</td>
<td>Text</td>
<td>5 professional interaction designers</td>
<td>2018</td>
<td>Exploration of design idea archives</td>
</tr>
</tbody>
</table>

Table 2: Overview of empirical studies.
theoretical framework for describing what counted as ‘ideas’. Should I look for utterances, facial expressions, or physical externalizations of ideas - or all of them? The original purpose of these observation was to gather video data, transcribe it, and then perform a grounded theory-analysis of the data. This proved, however, futile, until I had established a stronger, theoretical foundation to build the analysis on.

**Study 2:** Study 2 was a controlled experiment, carried out in fall 2015. In this experiment, I asked six digital design students from Aarhus University to individually generate ideas on sticky notes within a set time frame, while I video recorded their process. I then asked the students to present their ideas to each other, and observed how they described their ideas with words. The whole experiment setup lasted one hour.

The design brief was written with very specific instructions such as “Write each idea on a separate sticky note”, “Select your favorite idea or combination of ideas, and develop them into a final solution, to present to the group” (translated from design brief, my emphasis).

This experiment was conducted, not to be able to do an outcome-based analysis of the finished ideas or concepts, but rather to obtain a better understanding of how the students interpreted ideas during their process. The video recordings allowed me to observe how and when the individual student documented ‘one idea’. The experiment was therefore controlled, yet exploratory in nature.

The purpose of this study was to deepen my understanding of practices before deciding on a path for the next inquiries. The study revealed that for the purpose of analyzing the ideation process in detail, it was still a pertinent problem to define when the conceiving of the idea took place, and defining when the students were working on one idea and not another. This study led to the need to establish a clearer framework for understanding design ideas.

**Study 3:** Study 3 was a thorough literature review of previous research that in some way helps define and delimit the concept ‘design idea’. The literature review was conducted as a concept-centric survey, presenting a synthesis of the reviewed papers in a framework (a typology) of design ideas [Webster and Watson 2002]. The purpose of this study was to establish enough theoretical knowledge to be able to analyse real-world practices.
from an informed, theoretical perspective - as well as to compare knowledge from related research disciplines that might contribute directly and indirectly to the work in this dissertation. The typology of design ideas was published as a conference paper at Creativity & Cognition 2017 [Inie and Dalsgaard 2017a].

**Study 4:** In spring 2016 I took part in planning, conducting and analyzing a **controlled experiment** with nine digital design students at Aarhus University, working on a posed design challenge. My interest in the experiment was to verify whether the definitions of design ideas found in literature could be applied to the analysis of design practice. The study was a controlled experiment testing an analog-, a digital-, and a hybrid platform variety of the Inspiration Card Workshop. For more details about the study setup and results, I refer to the paper [Lundqvist et al. 2018].

Again, the purpose of gathering data from this study was exploratory, and not outcome-based. I wanted to investigate whether it was possible to use the typology developed from the literature review as a research framework to analyze real-life design processes. The conclusion of this pilot was that controlled experiments were still too contrived to mirror professional design work. Because the study setup included instructions to separate each idea on a ‘card’ or sticky note, the typology was not yet helpful to describe practiced interaction design processes.

**Study 5:** During study 5, I gathered qualitative empirical data from interaction designers using an online, **qualitative survey**. The survey asked professional interaction designers about how they use tools to manage ideas. The survey was constructed in Google Forms and the collection of responses took place in November 2016. The survey yielded a total of 24 responses.

The purpose of this study was to obtain high-level findings of how professional interaction designers used tools of their own choices to manage ideas (rather than tools provided by a researcher, such as in study 2 and 4). This study, although relatively limited in sample size, yielded many interesting insights and hypotheses for further exploration. For more details about the design and results of this survey, I refer to paper 2 [Inie and Dalsgaard 2017b].

**Study 6:** Study 6 was a longitudinal, semi-structured **interview study** with 20 professional interaction designers, taking place over more than a year and with participants from Denmark, Germany, and the United States. The first interview was
conducted in February 2017 and the last in April 2018. During the interviews, I asked questions directly related to the research questions, and explored the hypotheses and questions formed during the analysis of the qualitative survey responses from study 5. Each interview informed the next, and some questions raised in one interview could be explored in the next, i.e. “Other designers have mentioned they do X because Y. What are your thoughts about that?” The interviews were audio recorded and resulted in more than 30 hours of data. Details about the design of the interviews are published in paper 3 and 6 [Inie et al. 2018a; Inie and Dalsgaard 2019, forthcoming].

Qualitative interviewing is often considered an appropriate method for providing insights into objectives of interaction designers, rather than only behavior (for a detailed discussion of this, see the coming sections of this chapter). This method was therefore chosen as the overarching basis for collecting data and answering the research questions presented in this dissertation.

**Study 7:** Study 7 was part of the interview studies in the sense that each interview consisted of an interview part and a walkthrough part. This study therefore also took place between February 2017 and April 2018, and yielded more than 15 hours of video- and audio recorded data, as well as a large amount of pictures of the different design idea archives. The findings of this study are described and published in paper 4 [Inie et al. 2018c].

Study 7 provided a data-driven perspective on the interview data. During the walkthroughs of archives, we asked the designers to think aloud and asked them encouraging questions such as “What are you thinking about when you look at these ideas?” and “How do these ideas relate (if at all) to your current projects?”. As the designers were taking us through their archives, we also took photos of ideas and archives. The walkthrough allowed us three additional perspectives to the interviews. Firstly, it let us see the contents and structure of archives ourselves. Secondly, it reminded the designers about ideas and tools they had not previously remembered. And thirdly, it confronted the designers with old content they had forgotten about, invoking different feelings of nostalgia, excitement and surprise.

**Study 8:** Finally, study 8 tested a hypothesis originated during the walkthroughs in study 7: that design idea archives could be used as a creative reflection resource. This study was an open-ended qualitative experiment aimed directly at answering
the third research question; how tools might support idea management in practice. In the study, I randomly resurfaced five professional interaction designers’ own ideas to them via email. The study was conducted in December 2017, and produced 40 written responses.

The participants were encouraged share an idea archive of their choice (interpreting ‘idea archive’ as they preferred). From these archives, I selected different chunks of information and emailed them back to the participants at random times. In the emails, the participants were asked two or three open-ended questions such as “What is the best/worst thing about seeing this idea again?”. Following the three weeks, the participants received a questionnaire about their general evaluation of the study, with questions like: “What did you generally think about receiving your old ideas again?” and “What did you think about email as a format?” It was found that resurfacing ideas can encourage creative reflection on several levels. More details and findings of this study are published in paper 5 [Inie et al. 2018b].

Much of our existing knowledge about the role of computational tools comes from research in the discipline of Human-Computer Interaction (HCI). A recent literature survey found evidence that most HCI research focuses on developing functional properties of a given system, rather than exploring the use of such systems in lived practice: “many contributions study new tools, often developed by the researchers themselves, in controlled experiments. In contrast, the field generally lacks studies of how digital tools actually influence creativity in practice” [Pedersen et al. 2018]. Stolterman [2008] pointed out that the discipline of interaction design research has not always been successful in creating knowledge relevant for practitioners, because of a lack of understanding of the nature of design practice. He argues that interaction design research must be grounded in better understanding of the nature of design practice, if research is to produce outcomes that support real-world design.

The methods of this doctoral work are therefore chosen with the attempt to move interaction design research closer towards understanding the nature of design in practice, by studying how tools are used in professional design work, and how these tools influence interaction design creativity. The methods are

### 3.2 A PRAGMATIST, QUALITATIVE APPROACH TO DISTRIBUTED CREATIVITY RESEARCH

3 There are notable exceptions to this, a few of which I will mention here: Candy and Edmonds [1996], studies the knowledge intensive aspects of design based on a case study of the design of the LotusSport bicycle. Jacucci and Wagner [2007] conducted extensive field studies of architectural design workplaces and on examples from artworks. Thoring et al. [2018] conducted a longitudinal case study of the development process of an idea lab from initial planning to final implementation and usage. All of these studies used qualitative data from cases in real-life design practice to form and identify implications for the design of novel interactive technologies and computer support systems.
chosen for their capacity to reveal deep insights into people, not systems. Therefore, qualitative studies has been the most sensible approach to the research questions.

### 3.2.1 THE PRAGMATIST APPROACH

I have approached the research questions from a qualitative, pragmatist position, with an emphasis on the pragmatist conviction of picking the research methods and techniques to best fit the problem matter [Creswell 2013]. There are many interpretations of pragmatism, and I will outline my understanding in this section.

According to a pragmatist research approach, the researcher does not commit to any specific philosophy or reality, but is able to draw liberally from the whole palette of qualitative and quantitative inquiries and analyses [Patton 1990]. From a pragmatist position, the research problem is more important than the specific method, and it is essential to found research in social science research and then use pluralistic approaches to derive knowledge about the problem: “Pragmatist researchers look to the ‘what” and “how” to research based on its intended consequences - where they want to go with it” [Creswell 2013]. It is critical for this type of research to establish a rationale for why methods need to be mixed in the first place. This perspective is meaningful to my research questions for two main reasons, which constitute my methodological rationale:

- The research questions can be informed by several disciplines; mainly interaction design, personal information management, and distributed creativity. There is no unified theory or method for studying distributed, IT-supported creative processes, so my research approach will necessarily be an assemblage of appropriated approaches from other fields. Cross [2001] describes such an assembly of theories as distinguishing for the design field in that the field is building its own “intellectual culture”.

- My goal is to establish an understanding of creative design practice that is representative of the way it is performed and how interactive designers think about it – hence e.g. observations alone would not provide the type of understanding I am looking for. A better rationale is to use questions to understand the social-, organizational-, political-, and other contexts that the research subjects take part in.

### Table 3: Overview of questions in qualitative survey

Source: Reprinted from [Inie and Dalsgaard 2017b].
To give an example of what my pragmatist approach means in practice, I have used several appropriated qualitative methods to gather data. I have, for instance, utilized an online survey, but not as a quantitative data gathering method, as would be a conventional use of a survey. Because I was trying to find out on which level, designers would even interpret the concept of “idea management tools”, before attempting to construct an interview guide, this method was appropriate. In the survey, I asked open-ended, elaborate questions and designed the survey for paragraph-based answers rather than multiple choice-input. The questions in this survey is shown in Table 2.

This qualitative survey did not produce large-scale, quantifiable answers with the intent of generalizing from a sample to a population, which is typically the aim of survey-based research methods [Rubin and Babbie 2010]. The survey did produce detailed answers that allowed me to establish an appropriate initial understanding from which to build an informed interview guide for further inquiries. The priority of this study was to achieve a sufficient degree of understanding of the objectives, values and goals of designers, which is best achieved with qualitative inquiry [Byrne 2004].

3.2.2 QUALITATIVE INQUIRY

Qualitative research can be described as enacting a local, action-oriented approach of investigation and applying small-scale theorizing to specific problems in specific situation [Berg et al. 2004]. A qualitative approach to inquiry appreciates the human capacity to reflect, learn and change through iterative phases of 1) identifying research questions, 2) gathering information, 3) analyzing and interpreting information, and 4) sharing results with participants [Berg et al. 2004]. Following this model, my research progression can be explained as a series of inquiries informing each other and each building on the knowledge created during its predecessor. The specific inquiries and their consecutive structure are described as the research activities in section 3.1.

In the frame of distributed creativity research, my qualitative inquiries can be described as small-sample longitudinal case studies: using interviews, ethnographic observations, or historical records to obtain information on few individuals [Amabile and Mueller 2008]. The advantages of such an approach are, among others, that the approach is very suitable for discovering influences on creativity and for capturing the complexity of
organizational creativity. According to Amabile and Mueller [2008], the method is less suitable for determining causal relationships of creativity and other factors, or for generalizing to other individuals.

For discovering patterns of why instead of mainly patterns of what, qualitative studies are best suited to answer the research questions. For example, large-scale quantitative surveys that tell us about which tools most designers use have previously been published (e.g. [Vinh 2015]), but these findings are superficial in terms of understanding why specific tools are used. Knowing that a large number of interaction designers use, for instance, Photoshop, does not tell us about why they have chosen this tool, whether they use it alone or together with other tools, or how the tool influences their creative practice. Quantitative studies also do not provide additional knowledge about the respondents, nor the opportunity to ask follow-up questions. It is impossible to know a priori how respondents understand e.g. ‘tools’, which can be interpreted in various ways. Therefore, a qualitative, small-sample study is more appropriate for answering a question like “How do interaction designers use tools to ...”.

3.2.3 GROUNDED THEORY ANALYSIS

I have used a grounded theory-approach to analyze data from the studies, particularly the interviews. The goal of this approach is to derive a general, abstract theory about a process or action. A grounded theory-analysis allows us to discover patterns and categories of behavior grounded in the views of the participants [Creswell 2013]. The process of data gathering in grounded theory involves several stages and refinement, while simultaneously and continuously developing categories of information [Strauss, A., & Corbin, J. M. 1990]. This approach resonates with the procedural stages of inquiry in [Berg et al. 2004]: identifying questions, gathering information, analyzing and interpreting information, and sharing the results.

Grounded theory research involves a great deal of repeated theoretical sampling of different groups to maximize both similarities and differences of information [Creswell 2013], which has manifested itself as repeated, but temporally and geographically distributed, inquiries. In practice, I have conducted interviews over an extended period of time and in several countries, for example. The goal of a grounded theory-analysis is understanding a process or an action involving several individuals, and in this case several tools [Ibid.]. The theory thus explains how
professional idea management is performed and supported over time, by tools, through actions and strategies taken by individuals, who experience individual outcomes. The theory and categories developed from the grounded theory approach are presented in detail in chapter 5 and paper 6.

The intent of qualitative inquiry is, generally, to move beyond description and towards generating or discovering a theory [Ibid.]. The big question is: when has enough data been obtained, and when can the theory be considered valid? I have tackled this issue by reflecting on the lenses applied in my treatment of the data, and by using “validity-as-reflexive-accounting” [Altheide and Johnson 1994]. In this research frame, the researchers, the topic, and the sense-making process interact:

“Researchers determine how long to remain in the field, whether the data are saturated to establish good themes or categories, and how the analysis of the data evolves into a persuasive narrative. Patton (1980) describes this process as one where qualitative analysts return to their data “over and over again to see if the constructs, categories, explanations, and interpretations make sense” [Creswell and Miller 2000].

I have obtained the following “change of lens” validity procedures to solidify the legitimacy of the findings in this dissertation [Ibid.]:

**Prolonged engagement with the field.** Although this validity process originally applies to observational studies, I have attempted to apply it to an interview study. The interviews I have obtained have been temporally distributed over more than a year, usually at designers’ own workplaces. I have been able to continuously establish, test, and reestablish hunches and compare interview data from many interview participants over time. Completing interviews after the qualitative survey and with sessions of analysis in between has also made it possible to build interview respondents’ views into the ongoing analysis. In organizational creativity, creative ideas and products often evolve over long periods of time, thus the real influences on creativity might only reveal themselves through a temporal lens [Amabile and Mueller 2008]. As an example, one interview led me to the realization that I had presumed that all interaction designers captured and managed their ideas over time:

3.3 **REFLECTIONS ON METHODOLOGY**
“I sometimes met some entrepreneurs who have an idea where they are very protective about it, you know, and they have a lot of ideas, and you know, it becomes unhealthy. It ends up being an aquarium with a lot of little nice fish you sit and look at, right? And they swim around, and at some point they get tired of looking at that aquarium, and the fish, they writhe and everything, but they never get any further. And I think that happens to a lot of people, that overproduction of ideas. [...] I think maybe we don’t need any more idea management tools, we need more launching pads for ideas” (Interaction Designer P4 - for more detailed descriptions of the interview participants, see paper 6).

This designer’s view made me realize I needed more emphasis on the why of idea management to understand the deliberate goals - if there were any. I added the questions “Why do you capture your ideas? What’s the end goal product?” to the interview guide for the interviews following this interview.

Thick, rich description. Because I have aimed for deep knowledge, it has been a significant priority to communicate the data in a rich fashion, describing the setting, the participants, and the themes of studies in great detail. One example of this is the use of vignettes describing design practices (see paper 4 [Inie et al. 2018c]). Furthermore, the analyses are continuously scaffolded by, sometimes lengthy, participant quotes to illustrate how I have arrived at the results and conclusions in the papers. To truly understand the context of idea management, it is necessary to understand the work setting and assemblages of tools unique to the specific designer.

Peer debriefing. By virtue of being a PhD by Publication, my reports of studies have been continuously peer-reviewed and evaluated. This has pushed the methodology significantly, and resulted in several reevaluations and appropriations of study designs. One example of this was first submitting an article based on the findings of study 7 (described in section 3.3: Research activities), idea archive walkthroughs, as an indication that looking at old ideas could provide beneficial reflection on said ideas. The reviews for this manuscript agreed that it could not be methodologically proven whether reflection was spurred only by looking at the archives or by a researcher asking questions about them. After this feedback, I then conducted study 8, which acquired a different participant group, and tested the hypothesis in a different setup, separating the researcher from the participant by communicating only through an already used information management tool: email.
Furthermore, I have been part of different research groups who have continuously provided early-stage feedback and general comments for all studies and findings since the beginning of the doctoral work.

3.3.1 ADVANTAGES OF THE METHODOLOGY

I have utilized qualitative interviewing because of its strength as a means of accessing attitudes and values that would not otherwise have been observable or discoverable [Byrne 2004]. The major qualities of qualitative, open-ended studies as a means of studying real-world creativity are the following [Amabile and Mueller 2008]:

They are appropriate for generating interesting new hypotheses about causes and relationships. As I am attempting to shed light on a cross-disciplinary field of both high complexity and very limited established knowledge, the generation of well-supported hypotheses is fundamental for further research.

The methods are likely to provide new insights into how the creative process operates. Qualitative interviewing in some form is not only the best, but the only method to gain insight into the “why” of how designers operate. A more detailed picture will be obtained if the method is combined with other, but simply asking why is a logical first step.

They allow for a glimpse into the complexities of organizational creativity. A relatively small sample allows for thorough engagement with the data in a way where individual differences and distinctive approaches do not get lost in the general. The methods usually offer good ecological validity, which is a term often used in psychology to describe a method’s closeness to the actual phenomenon as it unfolds in an individual’s life or in an organization [Ibid.].

3.3.2 CHALLENGES AND CAVEATS OF THE METHODOLOGY

As with any research method, there are challenges and caveats of qualitative inquiries in studying creativity. The following describe the main challenges of the methodology [Ibid.] in this dissertation, and my rationale in attempts to reduce their impact:

The methods do not allow for determining causal influences on creativity. Simply asking why does not necessarily provide access to the entire truth. Interviewing always have the caveat that the interviewee might tell the story that they would like to
be true - or simply that the interviewee might not know or be aware of the full answer. I have tried to address this challenge by asking, for instance, for a tour of the designers’ idea archives - thus inspiring the designers to remember things they might not have remembered otherwise.

**The methods do not allow for hypotheses about relationships between creativity and other constructs to be tested.** The data of this dissertation mainly opens hypotheses in terms of implications for the design novel creativity support tools. I intentionally leave these hypotheses open for future work and discussion with the aid of other methodologies and research questions. See chapter 7 for reflections on future work.

**They do not allow for generalization of results to other individuals, groups, or organizations.** Small samples do not allow for generalizations of results. Still, I argue that when findings are centered around establishing knowledge about individual practices, generalizations do not necessarily make sense. One of the main findings of this dissertation is that designers have highly unique approaches to both idea management and the design process in general, and to truly support creativity, we should not aim to design one-size-fits-all-solutions.

The advantages and caveats to my research approach influence the results of the study in the following ways:

- The results are narrow and rich rather than broad and generalizable.
- The results provide empirically based insights into how the creative process operates, but do not prescribe best practices.
- The results have good ecological validity, that is, closeness to the studied phenomenon.

The merits of the results are especially as a useful starting point for research programs on a little-studied, little-understood phenomenon [Ibid.],

The primary criterion for any research design is that it should generate knowledge about the field of inquiry. Understanding how creativity is already performed in practice brings us significantly closer to an understanding how to support it in practice.
In this chapter I have explained my research approach as a pragmatist, qualitative inquiry, and explained how this epistemology has influenced the outcome results. I have discussed the advantages and challenges to my methodological approach and reflected on the steps taken to meet these challenges. I finished with a summary and description of the studies conducted, the data gathered and motivated the analysis performed on this data. In the next chapter I will present the appended papers of the dissertation and explain how they contribute to answering the research questions.

3.4 SUMMARY

“I am looking forward to seeing what comes out of the study ... And then I would actually like the IdeaBot to continue in some format, so you could have this tool reminding yourself that you had some ideas ... Other bots could actually also be interesting .. Inspiration bots that shoots you some pictures/quotes/whatever is relevant in some field ... ”

Participant P2 of the email experiment, in finishing survey.
OVERVIEW OF APPENDED PAPERS

The papers included in this dissertation are five published conference papers and one journal paper manuscript. They have different scopes, but all contribute to answering one or more of the research questions:

1. How might we define, delimit and understand ‘design ideas’?
2. How do professional interaction designers currently use tools and systems to capture, manage and retrieve their design ideas?
3. How might novel digital tools support idea management for professional interaction designers?

An overview of the relation between the appended papers, the studies they build on, and the research questions they contribute to is shown in Table 4. This table shows the chronological order of the papers, which illustrates that there has been a progression from first defining the subject matter (design ideas), over exploring the current behaviors and tool use, to then identifying current challenges and potentials for future design tools. The table also shows the individual research questions and contributions of each paper.

Papers 1 and 2: defining concepts to build on. The line of reasoning in the research questions is to first establish an understanding of design idea management, by framing the concept on a primarily descriptive level. In the case of this dissertation, beginning with “design ideas” and self-reported idea management tool use in papers 1 and 2. From several empirical observations of design processes during the first year of this PhD it was clear that there is no common or straightforward definition of design ideas, and it was therefore necessary to collect and establish information about what we already know [Inie and Dalsgaard 2017a]. This part also included asking practicing designers how they understand idea management and the role of tools in this process [Inie and Dalsgaard 2017b].

Papers 3 and 6: describing idea management and tool use practices and challenges. Based on the preliminary findings of paper 2, it was possible to construct an informed interview guide to inquire deeply into the experienced challenges of idea management tools, reported in paper 3 [Inie et al. 2018a]. These findings also informed the grounded theory and framework presented in paper 6 [Inie and Dalsgaard 2019, forthcoming].

Papers 4 and 5: exploring how to support design idea management practice. During the interviews, I asked designers to walk me through their existing idea archives and imagine ideal tools for working with their ideas. The analysis of these led to the identification of different strategies for utilization of idea archives presented in paper 4 [Inie et al. 2018c]. In this paper we can start to see how different practices require different forms of creativity support. Paper 5 presents a pilot study of utilizing idea archives in a very concrete way by resurfacing isolated ideas to designers at random points in time, and shows promising results in terms of system-supported utilization of idea archives [Inie et al. 2018b].
<table>
<thead>
<tr>
<th>Title, year, authors, venue</th>
<th>Based on study</th>
<th>Research question(s)</th>
<th>Main contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designing Idea Management Tools: Three Challenges. Nanna Inie, Steven Dow, and Peter Dalsgaard. 2018. Proceedings of Drs 2018 International Conference.</td>
<td>6: Qualitative interviews</td>
<td>What are the perceived challenges that interaction designers experience when working with digital and analog tools to capture, store, retrieve, and collaborate on ideas?</td>
<td>Describes challenges that designers currently experience when working with their idea management tools as well as opportunities for how to address challenges in novel tools.</td>
</tr>
<tr>
<td>The Problem Solver and The Artisan Designer: Strategies for Utilizing Design Idea Archives. 2018. Nanna Inie, Allison Endo, Steven Dow, and Peter Dalsgaard. The problem solver and the artisan designer: strategies for utilizing design idea archives. 2018. In Proceedings of the 10th Nordic Conference on Human-Computer Interaction (NordiCHI ’18). ACM, New York, NY, USA, 397-406.</td>
<td>6: Qualitative interviews and 7: Walkthroughs</td>
<td>Which ideas do professional interaction designers archive, why do they do so, and how might we describe strategies for how designers utilize their archives of design ideas in their current work?</td>
<td>Identifies two different strategies for utilizing design idea archives, which are then translated into ways to support these strategies in the design of idea management tools.</td>
</tr>
<tr>
<td>How Interaction Designers Use Tool to Manage ideas. Nanna Inie and Peter Dalsgaard. Manuscript. In submission at ACM Transactions on Computer-Human Interaction (TOCHI).</td>
<td>6: Qualitative interviews</td>
<td>How do professional interaction designers use tools to manage design ideas, and how might tools be categorized and characterized in terms of the way they are used in practice, rather than by their functional properties?</td>
<td>The paper identifies tool-supported idea management strategies and needs of professional interaction designers. Based on our analysis, a conceptual framework of ten strategies of tool-support is also identified.</td>
</tr>
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Table 4: Overview over appended papers. Research questions and contributions.
4.1 PAPER 1: A TYPOLOGY OF DESIGN IDEAS

Nanna Inie and Peter Dalsgaard.


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, which condenses the different uses of the term design idea we discovered and their corresponding references in research. Each type in the typology represents a form, a design idea can take. By ‘form’ we mean a conceptual shape which previous research has considered ‘a design idea’ and/or 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. There are four particular idea types, meaning they are mutually exclusive. There are three general idea types, which are categories that any of the particular ideas can also fall under, but that they do not necessarily fall under. 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.

4.2 PAPER 2: HOW INTERACTION DESIGNERS USE TOOLS TO CAPTURE, MANAGE, AND COLLABORATE ON IDEAS

Nanna Inie and Peter Dalsgaard.


In this paper, we present the findings of a qualitative survey of how interaction designers use tools to capture, manage and collaborate on ideas. The results show that interaction designers report very varied and unique processes in their idea management, and that no dominant tool is present for idea capture or development. Our discoveries are summarized in three key insights, suggesting ways for interaction design research to support these practices:

1. Capturing: Many interaction designers retain ideas with the purpose of looking back at them later and these ideas take many different forms. Could idea capturing be supported by one common tool?

2. Managing: It is hard for both designers and researchers to explain what happens between the time of idea capture and idea development, where the designers refine their ideas using various
tools. Could novel tools make management easier and enhance development of ideas during this stage?

3. Collaborating: Most respondents collaborate using analogue tools. The main challenge seems to be transitioning from digital to analogue, and back to digital space. Could novel tools make this process easier?

The paper subsequently finds, that designers appear to individually and idiosyncratically customize their personal work practice to a great extent, and the variety of available tools may greatly reinforce this personalization in a meaningful way.

Nanna Inie, Steven Dow, and Peter Dalsgaard.
Proceedings of DRS 2018 International Conference

The third paper is based on in-depth interviews with 16 professional designers. The goal of these interviews was to investigate the discoveries of the survey from paper 2 more deeply, as well as to explore how designers themselves might imagine tools for working with their ideas. We focus on the tools designers use to manage their early stage creative ideas - during the phases where more creative ideation takes place. The study revealed three perceived challenges for designers working with existing idea management tools. These challenges are:

1: Idea management tools are rigid in capture medium, 2: Idea management tools offer inflexible interfaces and representations, and 3: Idea management tools focus mainly on ideas, not ideation.

Together with the designers’ own suggestions for tools, we elucidate the discovered challenges into operational examples of how builders of novel tools might approach the development of next-generation idea management tools.

Nanna Inie, Allison Endo, Steven Dow, and Peter Dalsgaard.

The Problem Solver and The Artisan Designer is a paper about how professional designers utilize their existing personal idea archives. Results from the field of Personal Information Management (as described in the background section) has proved that knowledge workers archive information for purposes well beyond the need for information retrieval, and this paper explores which motivations and strategies designers have for keeping and retrieving ideas. While we
know that designers archive creative ideas in many different formats and use various different tools, we were interested in how designers utilize these idea archives in their daily practice. Through a series of interviews (n=20) and elaborate walkthroughs where the designers guided us through their design idea archives, we identified two archetypal strategies. The Problem Solver is concerned with the task at hand, keeps relevant ideas around, and discards them when the ideas have served their purpose. On the other hand, The Artisan Designer systematically archives potentially useful ideas in carefully selected formats, and continues developing ideas over extended time spans. We conclude with a discussion about how these different strategies might be supported by technological archiving tools.

4.5 Paper 5: Supporting Reflective Use of Design Idea Archives Using Email

Nanna Inie, Steven Dow, and Peter Dalsgaard
Based on the walkthroughs of professional design idea archives, we hypothesized that there might be value in resurfacing designers’ old ideas to them at random times. We conducted a pilot study where we emailed professional designers’ own archived ideas to them daily over a period of three weeks. We found that resurfacing ideas at random can provide reflective and creative value to designers in three ways: 1: By encouraging them to reflect on their old ideas, 2: By encouraging designers to reflect on themselves as practitioners, and 3: As motivation to pick up forgotten or dormant ideas.

4.6 Paper 6: How Interaction Designers Use Tools to Manage Ideas

Nanna Inie and Peter Dalsgaard.
Currently under second review at ACM Transactions on Computer-Human Interaction (TOCHI).
This paper presents a grounded theory-analysis based on a qualitative study of professional interaction designers (n=20) with a focus on how they use tools to manage design ideas. The paper identifies tool-supported idea management strategies and needs of professional interaction designers, and discusses the context and consequences of these strategies. Based on our analysis, we identify a conceptual framework of ten strategies which are supported by tools: saving, externalizing, advancing, exploring, archiving, clustering, extracting, browsing, verifying, and collaborating. Finally, we
discuss how this framework can be used to characterize and analyze existing and novel idea management tools designers experience digital tool fatigue.

In the next chapter I will present and discuss the findings of the appended papers in greater detail under three themes: what are design ideas, strategies for idea management, and implications for the design of idea management tools and systems. The next chapter is a synthesis of the findings from the papers as well as a reflection on the findings in relation to previous research presented in chapter 2.
This chapter summarizes the findings and results of the dissertation. It is divided into three sections, corresponding to the three research questions. The first section defines design ideas as a necessary foundation for the rest of the work. The second section reports on findings regarding the current tool-supported use patterns of idea management, and the third section identifies the implications of the findings and presents four design opportunities for the design of novel, digital idea management tools.

5.1 WHAT ARE DESIGN IDEAS?

In this section, I sum up my answers and contributions to research question 1: How might we define, delimit and understand ‘design ideas’? This question is treated directly in paper 1: A Typology of Design Ideas, and informed by studies 1, 2, and 3.

The core concept of a design idea lacks a consensus definition in interaction design research. In his paper from 2005, Jonson [2005] states: “Design ideation is a matter of generating, developing and communicating ideas, where ‘idea’ is understood as a basic element of thought that can be either visual, concrete or abstract”. This quote emphasizes how unspecific the concept of an idea is - how do we distinguish ideas from other thoughts or sentences? For design and creativity researchers it is essential to establish a working definition of ideas as they can be observed or recognized in some form. For our analyses of ideation in design processes to be valid and comparable, we must be able to determine if and when ideas emerge. As an example of the importance of such definition, many research contributions, such as the works of Remko van der Lugt and Gabriela Goldschmidt [van der Lugt and Others 2003; van der Lugt and van der Graaf 2002; Goldschmidt and Sever 2011; Goldschmidt and Tatsa 2005; Goldschmidt 1990], analyze creative processes in terms of the links between ideas. It is fundamental, then, to define and delimit individual ideas for the analyses to have scientific merit and comparability. As researchers, we must clarify what our understanding of ideas are, when we describe our findings and analysis.

5.1.1 UNITS OF ANALYSIS

Table 5 shows an excerpt from the transcript from study 1, that I will refer to in the following section. It is difficult to describe exactly which part of this transcript constitutes one idea. The first step is to define the unit of analysis.
We could consider the idea the mental concept, that is, when a new concept for a solution emerges but before it is externalized verbally or physically. By the end of the transcript, Designer 2 says he had the idea of using the form of a dead tree while Designer 1 was still elaborating on the idea of using leaves as a figure. If we consider the emergence of the idea to be the forming of the mental concept, the time stamp for the emergence of the design idea is earlier than the utterance itself. Defining a design idea as a mental concept is prevalent in the field of neuroscience, but not represented in interaction design research [Inie and Dalsgaard 2017a]. Traditional interaction design research tools and methods (for instance ethnographic observations, interviews, and case studies [Stolterman 2008]) do not give us access to knowledge about when a mental concept is forming or what it looks like. A limited amount of previous research has looked at how body language and context indicate cognitive insight moments or indicate the relation between different ideas [Wiltschnig et al. 2010; van der Lugt and van der Graaf 2002], but most methods only provide us with indications at best. This unit of analysis is therefore not a feasible one for design researchers at this point in time.

A common level of analysis is the level of utterances [i.e. [Goldschmidt 1990; Baker and van der Hoek 2010; Bratteteig et al. 2016]]. An example is when Designer 1 clearly expresses an idea, e.g. “I had an idea just before... Right, leaves maybe”. In such an analysis, the researcher must define the level of granularity - “leaves” and “leaves that stood opposite of each other” could be viewed as two different ideas, for example. Utterance analysis has the caveat that it is subject to a high degree of subjective judgment because the unit of analysis depends on the individual researcher’s interpretation of the content, but such an argument can be made for all qualitative analysis [Altheide and Johnson 1994], and only emphasizes the requisite for transparent, quality definitions. In many cases the designer will be a lot more subtle in their expression than in this excerpt, for instance not directly using the phrase “I have an idea”.

Finally, there are physical externalizations of ideas. In the transcript above, the designers use sticky notes to represent individual ideas (see Figure 13). These designers’ externalizations serve a primarily informational purpose in this design process [Dix and Gongora 2011]. When doing design research experiments, asking designers directly to use physical externalizations is a very useful method to let designers self-

Table 5: Excerpt from study 1. Transcript from conversation during a design course at a technical high school in Aarhus, Denmark. The students are working on designs for salt and pepper shakers.

Source: Study 1, April 2016, author’s transcription and translation. Not previously published.
assess the boundaries of each design idea (examples in i.e. [Halskov and Dalsgaard 2007; Toh and Miller 2015; Read et al. 2016]). As with utterances or analysis on a sentence-level, defining the amount of info that constitutes one idea can vary from study to study. In some studies the full proposal for a finished design artifact is considered one idea (i.e. [Halskov and Dalsgaard 2007; Girotra et al. 2010]), while in others, incremental modifications to artifacts are seen as individual ideas (i.e. [Cross 1997; Bratteteig et al. 2016]).

In interaction design research, it is common to use a combination of spoken language and externalizations as units of analysis, both in analyses of individual design processes, and of collaborative design processes. The method protocol analysis [Ericsson and Simon 1993] is a commonly utilized strategy to gain knowledge about internal processes and thoughts, asking designers to “think aloud” and transcribing the monologue as the primary data. Both verbal utterances and physical or digital representations can be seen as externalizations of the mental concept of the idea, illustrated in Figure 14.

Figure 14 illustrates the difference between what we can observe with the naked eye and the cognitive activity that precedes it. In this model, the mental concept is expressed by an utterance, “you could make some kind of leaves that maybe stood opposite to each other” (Table 5) and then by a physical externalization in the form of a sticky note (Figure 13, bottom). Because verbalizations can also be regarded as externalizations of ideas, I have clustered utterances and physical/digital externalizations under the concept of “expression” of the idea.

The “unobservable” section of the model is discussed in detail in the field of cognitive science (i.e. [Finke et al. 1992; Nijstad and Stroebe 2006; Gabora 2002; Seifert et al. 1994]), while the part of the model that describes what is observable is generally the phenomenon of interest to interaction design research [Inie and Dalsgaard 2017a]. As described in chapter 2, this dissertation draws upon knowledge and vocabulary from creativity research to illuminate a phenomenon that is of great relevance to interaction design.

With an aim of defining design ideas in a way that is useful to design research, the next section will summarize and analyze a comprehensive theoretical definition.
5.1.2 A THEORETICAL DEFINITION OF DESIGN IDEAS

Cognitive science has offered more elaborate analyses of ideas than interaction design research. As reported in chapter 2, the Geneplore Model [Finke et al. 1992] describes ideas as discoveries formed in the mind on the basis of mental preinventive structures - precursors for the final externalized creative products or ideas. Preinventive structures usually refer to visual patterns, object forms, or mental models [Finke et al. 1992], and may, in a design context, also refer to cognitive structures that rely on external support, such as sketches or prototypes [Christensen and Schunn 2007]. These discoveries are then explored and evaluated against external and internal constraints (such as knowledge about external requirements of appropriateness to the problem, or internal expectations or personal taste) before they come to a form of expression.

What is characteristic about a design idea (in relation to a more generic understanding of an idea) is that the idea is oriented towards moving a design process forward - what can be described as the discovery of a matching problem-solution pair [Inie and Dalsgaard 2017a; Dorst and Cross 2001]. The problem-solution bridge is described by Dorst & Cross [2001] as the event when pieces of information about the design problem are connected into a coherent chunk, which offers a simplification of the design problem. The finding of coherence between pieces of information gives the designer a feeling of having grasped ‘the core of the problem’, and a bridge is formed between the problem space and the solution space.

As described in the first section of this chapter, ideas can have multiple expressions in design processes. This multi-modality of ideas was confirmed by the literature review in paper 1 [Inie and

<table>
<thead>
<tr>
<th>Type of idea</th>
<th>(Re)framing the problem</th>
<th>Opportunity</th>
<th>Suggestion for part-solution</th>
<th>Suggestion for solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus of externalization [Dix and Gongora 2011]</td>
<td>Problem space</td>
<td>Process</td>
<td>Design space</td>
<td>Product</td>
</tr>
<tr>
<td>Example</td>
<td>Ideas that do not specify a design, but a framing of the problem or design setting - for instance a moodboard.</td>
<td>Expressions of possible choices within a design process - for instance a suggestion for a new technology that could be utilized.</td>
<td>A design possibility relating to a limited part of the design artifact - for instance a sketch of part of the design artifact.</td>
<td>Representations of the finished design artifact itself - for instance a design proposal or a concept poster [Halskov and Dalsgaard 2007].</td>
</tr>
</tbody>
</table>

Table 6: Idea forms and their externalizations.
Source: Not previously published.
Dalsgaard 2017a], which, for this reason, resulted in a typology rather than a suggestion for one common definition. In the typology, there are four distinctive forms, ideas can take (Table 6): 1) a framing or reframing of the problem, 2) an opportunity, 3) a suggestion for a part-solution to the design problem, and 4) a suggestion for a design solution. The types correspond to the forms of idea externalizations presented by Dix & Gongora [2011]; externalizations can address the product, the problem space, the design space, and the process.

Based on the idea forms in Table 6, I suggest the following four definitions of design ideas, as they can be observed in interaction design processes:

1. **A problem-framing idea**: An expression of a novel way to approach or frame the design problem or problem space.

2. **An opportunity-introducing idea**: An expression of novel potential steps to take or technologies to utilize.

3. **A part solution-suggesting idea**: An expression of a novel suggestion for a part of, or modification to, the final design solution.

4. **A solution-suggesting idea**: An expression of a novel suggestion for a solution to the design problem.

For a design idea to be considered creative, it must introduce something novel or original to the specific design process [Guilford 1968; Rhodes 1961].

The above definitions highlight two particularly ‘designerly’ aspects of design ideas: 1. Design ideas can both pertain to identifying and defining the design problem and the design solution, as identified by previous research [Dorst and Cross 2001; Buchanan 1992], and 2. Design ideas are directed towards changing the current state of events into something perceived as more desirable (which can involve both the design of a design product as well as the design of the design process [Inie and Dalsgaard 2017a]).

In this section, I have identified and analyzed definitions for the concept “design idea”, as it has been used in research until now (research contribution 1). In the next section I will continue along the line of this contribution by describing and unfolding the concept by looking at externalized instances of design ideas in professional designers’ archives.

---

4 ‘Novel’ in these definitions means novel in relation to the designer that expresses the idea and the specific design process the idea relates to, rather than novel with respect to historical creativity [Boden 1990]. It is important to note that, while there is a consensus for defining creative ideas as novel and useful towards solving a design problem, this is actually not essential for design ideas, as exemplified by idea generation techniques such as BadIdeas [Dix et al. 2006], where designers are encouraged to come up with design ideas that are as useless as possible (such as ‘a chocolate greenhouse’ or ‘a glass hammer’) to stimulate out-of-the-box thinking.
This section presents answers to research question 2: How do professional interaction designers currently use tools and systems to capture, manage and retrieve their design ideas? The papers that inform this question directly are papers 2: How Interaction Designers use Tools to Capture, Manage, and Collaborate on Ideas, 3: Designing Idea Management Tools: Three Challenges, 4: The Problem Solver and The Artisan Designer: Strategies for Utilizing Design Idea Archives, and 6: How Interaction Designers Use Tools to Manage Ideas. These papers describe and analyze, in different aspects, how interaction designers currently use tools. I will begin the section in continuation of the previous section’s discussion of a theoretical definition of design ideas, by describing how design ideas were interpreted and represented in the archives of the participating designers.

5.2.1 HOW INTERACTION DESIGNERS INTERPRET AND REPRESENT ‘DESIGN IDEAS’

The empirical data that this dissertation builds on provides additional data to the theoretical definitions of design ideas presented in the previous section. When the participants in the interview- and walkthrough studies (studies 6 and 7) were asked to describe and show their design idea archives, they presented information of four different categories [Inie et al. 2018c]5:

1. Old project files
2. Notes and recordings from meetings
3. Action items
4. Inspirational examples

The relationship between these terms and the mental concept of ideas is illustrated in Figure 15.

Old project files were working files that related to specific design artifacts that were either already implemented or abandoned before completion for various reasons. In Personal Information Management-terms, old project files can be categorized as the type archived, the usefulness dormant, and the ownership mine, as described in chapter 2.

Notes and recordings from meetings were documentation files which had been captured during a social setting where there was a need to retain what was said and agreed upon. This type of information could be of the types ephemeral,
working, and archived (depending on the specific content), of the usefulness active, dormant, and not useful, and usually of the ownership mine.

Action items were reminders about an action that had to happen at a specific or unspecified time in the future. This type of information was of the type ephemeral, of the usefulness active, and the ownership mine.

Finally inspirational examples were descriptions, photographs, screenshots, or links that referenced other design artifacts that the designers found inspirational and potentially relevant to their current or future design work. This information is quite particular to design work, and can neither be described as entirely the type working nor entirely archived. It is certainly of the usefulness dormant, in that it is potentially useful. It is created by others, but when the designer saves it to their archive, its informational ownership becomes mine, and often accompanied by a tag or an annotation. Only the designer knows why this specific piece of information is relevant to them, and how it could potentially be utilized in the future [Herring et al. 2009].

Relating these categories of representations of ideas to the Personal Information Management terms presented in chapter 2 helps characterize the informational characteristics of design ideas (see Table 7).

Old project files and notes/recordings from meetings are often kept as design documentation [Dalsgaard and Halskov 2012; Gardiner and Others 1994], which can serve multiple purposes for the designer. One of the most important purposes is that they become part of the designer’s portfolio; allowing the designer to retrace their steps along the design process, and to make this process visible to internal and external stakeholders [Gaver and Bowers 2012; Gaver 2011]. Where old project files are related to the design artifact or design outcome, notes from meetings are often related to the design process, documenting what has happened and what has been agreed upon should happen in the future.

Action items are also related to the process, but they serve as concrete reminders of a specific action that needs to or could be taken (in the typology of ideas, these are called opportunity or plan for action [Inie and Dalsgaard 2017a]), and they are usually discarded after the action they concern has been taken. If the action item is still part of the

<table>
<thead>
<tr>
<th>Types of information in archives [Barreau and Nardi 1995]</th>
<th>Old project files</th>
<th>Notes and recordings</th>
<th>Action items</th>
<th>Insp. examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ephemeral</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Archived</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information usefulness [Boardman and Sasse 2004]</th>
<th>Active</th>
<th>X</th>
<th>X</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dormant</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Not useful</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information ownership [Boardman and Sasse 2004]</th>
<th>Mine</th>
<th>X</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: The informational role of design ideas in archives.
Source: Not previously published.
interaction designer’s archive, it is either because it is ‘active’ information or because it is ‘not useful’, but kept as process documentation [Inie et al. 2018c].

Inspirational examples are, as mentioned, rather specific to the design practice, and the category is not described perfectly by Personal Information Management terms. It is not clear when the information is going to be useful, however some interaction designers go through their inspirational archives with regular intervals, so the information is sometimes working, sometimes dormant. Often, inspirational examples are images, screenshots or bookmarks of others’ work, with no or little annotation about why the designer who captured it found this particular piece interesting, or what they intend to do with it [Herring et al. 2009]. The information is created by others, but the informational purpose of ownership is mine. Inspirational examples can be said to represent an idea (opportunity) for the designer, one that is not visible to the observer [Inie and Dalsgaard 2017a]. The file/screenshot/bookmark is the expression of that idea.

In paper 5: Supporting Reflective Use of Design Idea Archives Using Email it was shown how random resurfacing of the designer’s own, archived ideas, could also be utilized as inspirational examples [Inie et al. 2018b]. It was found that even in a simple setup, resurfacing ideas encouraged creative reflection by the designer on several levels. The designers of the study especially found value in reflecting on the idea in itself, in reflecting on their personal and professional development, and in sudden motivation to work on an idea they had left dormant for a while. These results were very promising for developers of idea management tools, and I will return to this opportunity in section 5.3, describing the design opportunity of actively utilizing the design idea archive.

In this section I have described the expressions of ideas found in professional interaction design archives. This is a bottom-up description, summarizing and analyzing the results from the empirical studies of the dissertation. This description completes the answer to research question How might we define, delimit and understand ‘design ideas’? by empirically unfolding the theoretical definitions put forward in the first part of the chapter. Moreover, the descriptions also creates the foundation for analyzing the tools, that interaction designers use to manage design ideas.

Figure 15: A model of design ideas and their manifestation in interaction design archives. Every expression of every idea that is formed during a given design process is part of the design process as a whole. The process eventually results in a design artifact, in most cases. The manifest expressions of ideas make up a designer’s design idea archive(s). In the case of a design process ending before there is a finished design artifact, and the expressions of ideas are archived, the idea archive still contains expressions of ideas that were part of the design process, though not representations of the finished artifact. Representations of finished design artifacts can also be saved in personal design idea archives, but they are then representations of others’ design artifacts.

Source: Not previously published.
The participants in the studies of this dissertation mentioned using more than 50 different tools in total, for managing ideas. An overview of the tools that were mentioned by at least two study participants, or as a primary tool for one study participant, is shown in Table 8. Of course, different tools were used for different activities of idea management, but it was clear that no dominant tool or strategy exists to support these processes. I highlight that this overview is not intended to provide any quantitative evidence of tool use, as this is not the aim of the dissertation. The table is only intended to provide an insight into the types of responses tools which were mentioned by study participants, and a high-level overview over the types of tools in play.

In paper 6: How Interaction Designers Use Tools to Manage Ideas, I present a grounded theory-analysis of professional idea management as processes of core activities influenced by causal conditions, resulting in specific strategies, which are in turn influenced by contextual and intervening conditions. These strategies result, then, in consequences of either continued or discontinued tool use. This model is shown in Figure 16. A detailed description of the analysis leading to this model is presented in the paper. The central value of this theory is that it offers an explanation and analysis of idea management processes, which is central if we wish to be able to increase focus on tools as process-focused rather than product-focused.

The theory, represented in the model in Figure 16, contributes with a deeper analysis of the activities of capture, development, organization, retrieval, and sharing of ideas. These and related terms are often used vaguely in interaction design research. One example is the term ‘collaboration’. In interaction design research terminology, collaboration is often used to describe the co-located, distributed work of several designers, or designers and other stakeholders, on generating or developing ideas together [Bratteteig et al. 2016; Kvan 2000]. However, a recent study has shown that the distinction between individual and collaborative is not binary; people can work in a group and oscillate rapidly between a shared dialogue and individual tool-use [Christensen and Abildgaard 2018].

---

<table>
<thead>
<tr>
<th>Tool</th>
<th>Capture</th>
<th>Development</th>
<th>Organization</th>
<th>Retrieval</th>
<th>Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notebook/notepad</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sticky notes (phys.)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sticky notes (digi.)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evernote</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reminders app</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Google Keep</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screen dumps</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Phone) camera</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Phone) dictation</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Powerpoint/Keynote</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Adobe Illustrator</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adobe Photoshop</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Google Drive</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Google Docs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Procreate</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pinterest</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Whiteboard (phys.)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slack</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asana</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dropbox</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table 8: An overview of idea management tools.
Source: Not previously published.
Similarly, several respondents to the qualitative survey (study 5) answered that they used slideshow creation software (such as Microsoft PowerPoint and Apple Keynote) to collaborate with others. During the interviews (study 6), when we asked for elaboration on this, the designers explained that they used slideshows to communicate and present concepts to stakeholders [Inie and Dalsgaard 2019, forthcoming]. Slideshow tools helped the designers externalize already well-formed ideas for the purpose of communication, not for allowing several stakeholders to participate in idea generation:

“When presenting ideas, I find it most effective using a PowerPoint or a Keynote. The reason why is because people can only intake so much information, like if I showed them the entire Google Doc or something, they don’t know (...) So, I just present bits and pieces of information so it’s easier to digest” (Designer P8).

This does not mean that externalizing the idea in a slideshow can not also serve formational or transformational purposes [Dix and Gongora 2011], but the strategy of using slideshow software is rarely chosen for this purpose primarily.

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**Figure 16: A grounded theory of professional idea management.**

Source: Reprinted from [Inie and Dalsgaard 2019 (forthcoming)]
This and similar findings led to a distinction between *collaborating* on ideas and *verifying* ideas, which are both strategies under the activity of sharing ideas with others.

A strategy is a high-level plan for how to obtain certain goals and describe the actions taken in response to the core phenomenon (idea management) [Creswell 2013]. In this case of this paper, the goal within the strategy is to manage ideas. The main contribution of the paper is a framework of strategies for professional idea management, shown in Table 9 and described below:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Strategy</th>
<th>Degree of certainty about goal</th>
<th>Desired properties of support tools</th>
<th>Primary tools and platforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture</td>
<td>Saving</td>
<td>High</td>
<td>Efficiency, availability</td>
<td>Phone camera, digital note taking software, variations of pen and paper</td>
</tr>
<tr>
<td></td>
<td>Externalizing</td>
<td>Low</td>
<td>Freedom of expression</td>
<td>Pen and paper, whiteboard</td>
</tr>
<tr>
<td>Development</td>
<td>Advancing</td>
<td>High</td>
<td>Efficacy, efficiency</td>
<td>Design and UX software, pen and paper, whiteboard</td>
</tr>
<tr>
<td></td>
<td>Exploring</td>
<td>Low</td>
<td>Freedom of expression, different visualizations</td>
<td>Pen and paper, whiteboard</td>
</tr>
<tr>
<td>Organization</td>
<td>Archiving</td>
<td>High</td>
<td>Accessibility, reliability</td>
<td>Cloud storage services, computer folders, physical storage units, desktop</td>
</tr>
<tr>
<td></td>
<td>Clustering</td>
<td>Low</td>
<td>Different visualizations</td>
<td>Sticky notes, computer folders</td>
</tr>
<tr>
<td>Retrieval</td>
<td>Extracting</td>
<td>High</td>
<td>Accessibility, efficiency</td>
<td>Cloud storage services, computer folders, physical storage units, desktop</td>
</tr>
<tr>
<td></td>
<td>Browsing</td>
<td>Low</td>
<td>Providing inspiration, showing the core of the idea</td>
<td>Cloud storage services, computer folders, physical storage units, desktop</td>
</tr>
<tr>
<td>Sharing</td>
<td>Verifying</td>
<td>High</td>
<td>Correctly communicating the idea</td>
<td>Presentation software</td>
</tr>
<tr>
<td></td>
<td>Collaborating</td>
<td>Low</td>
<td>Freedom of expression, providing overview</td>
<td>Whiteboard, pen and paper</td>
</tr>
</tbody>
</table>

Table 9: A framework of strategies for professional idea management. Source: Reproduced from [Inie and Dalsgaard 2019 (forthcoming)]

Saving. When the interaction designer captures something with the intent to (be able to) return to it later.

Externalizing. Initial capture of ideas that serves informational, formational, transformational, or transcendental purposes [Dix and Gongora 2011].

Advancing. The development of an idea with relatively specific objectives in mind.

Exploring. The open-ended exploration of the idea, or different properties of the idea, without a particular goal in mind.

Archiving. The archival of ideas in a digital or analog storage facility, either deliberately or automatically.

Clustering. Clustering or applying systems to existing externalizations.
Extracting. Trying to find or identify a specific idea and the rationale or decisions surrounding it.

Browsing. When the designer looks through old ideas without a particular goal in mind.

Verifying. Sharing ideas with others with the purpose of communicating and potentially getting feedback.

Collaborating. Several individuals working simultaneously together on generation and/or development of ideas.

The strategy, or action taken, to capture an idea is highly influenced by the purpose of the capture. If the purpose of capture is to retain the idea better, rather than to refer to it later, this purpose affects the strategy: “Do you normally go back and look at [your notebook] again? No, I have so many of these notebooks. And often times it’s more for me as a tool to just write it for retention versus recall. I don’t use it as much for recall” (Designer P9).

Knowledge of the designer’s strategy can both inform and inspire the development of any tool to support the designer in achieving the underlying goal or objective. The framework in Table 9 is intended to support and inspire researchers within interaction design and HCI in analyzing, characterizing, and evaluating any given digital or analog tool in terms of the role the tool plays in professional idea management. Idea management is just one of many aspects of interaction design practice, and this framework contributes to an understanding of that particular aspect in professional settings.

Categorizing tools in terms of the goals they fulfill to interaction designers may also reveal which goals are not fulfilled using specific tools, or how designers modify tools to fit their purposes. For example, one designer (P18) had created a personal Slack channel with herself, which she used as a to-do list, as she would always have Slack open during her work day. If we looked purely at the functions of Slack, the tool is designed for collaboration purposes rather than for individual idea capture. But if we consider the desired property in a tool for archiving (accessibility and reliability), Slack clearly fulfills these needs. Another designer (P5) used a separate email account as both a storage and development tool for his ideas. This is another use we might not expect from looking at the inherent functions of email as a tool. If we think of desired properties of a tool for saving, advancing, archiving, and retrieving, email is quite an obvious tool to fulfill these purposes.
Now, after having established a solid understanding of what design ideas are - and how interaction designers use tool to manage these, this third section of the findings of studies 5, 6, and 8 will explain the implications for novel idea management tools. In this section, I will summarize my contribution to the third research question: How might novel digital tools support idea management for professional interaction designers? Based on insights from the qualitative studies 5 and 6, as well as results from the open-ended experiment in study 8, this section presents potential directions of idea management tools. The sections refer to papers 3: Designing Idea Management Tools: Three Challenges, 4: The Problem Solver and The Artisan Designer: Strategies for Utilizing Design Idea Archives, and 5: Supporting Reflective Use of Design Idea Archives Using Email.

The implications are framed as four design opportunities compassed in two categories: 1. Utilizing the potential of the design idea archive, and 2. Increasing focus on the creative designer.

5.3.1 UTILIZING THE POTENTIAL OF THE DESIGN IDEA ARCHIVE: DESIGN OPPORTUNITY 1 AND 2.

One of the main challenges identified during study 4 was that idea management systems are rigid in capture medium [Inie et al. 2018a]. Interaction designers often capture ideas based on ease and availability of capture, and not based on where the idea will be used later. This means that there is a significant problem with ideas being distributed over many archives and are not readily available for later retrieval: "Do you ever go back and look at your old ideas? Why or why not? Not often enough, and that's because they're not necessarily filed properly for me to find them easily" (Designer P13, excerpt from paper 3). This is especially a problem when digitizing analog notes and sketches with a smartphone camera, where the image ends up in a cloud folder, usually associated with private photographs.

There is a design opportunity in creating a way for designers to capture in their preferred medium while also being able to retrieve and develop the idea in a different medium. One way of bringing this about is consolidating design ideas into one shared archive, which should be accessible across multiple tools and platforms. This opportunity is also presented in paper 4 as supporting the objectives of the Problem Solver [Inie et al. 2018c].
In paper 5, we experimented with resurfacing ideas from interaction designers’ existing idea archives to them at random times. There is some anecdotal evidence suggesting that the resurfacing of ideas from one’s personal idea archives may be fruitful as creative prompts [Johnson 2012; Erickson 1996].

We found, that even in the relatively simple frame of this study (study 8), resurfacing ideas encouraged creative reflection on several levels. Designers especially found value in reflecting on the idea in itself, in reflecting on their personal and professional development, and in sudden motivation to work on an idea they had left dormant for a while. The results are very promising for developers of creativity support tools as well as idea management tools.

There is a second design opportunity in resurfacing old ideas at relevant times. This opportunity echoes a claim from the much earlier work by Kidd: “Computer support for knowledge work might be better targeted on the act of informing rather than on passively filing large quantities of information in a “disembodied” form” [1994]. Information management software might be developed beyond acting as passive filing cabinets, and towards being active agents in the information processing performed by knowledge workers.

The categorization of ideas into problem-addressing, opportunity-introducing, part-solution-addressing, and solution-addressing (section 5.1.2) has relevance in determining when different ideas may be relevant to re-introduce. A problem-addressing idea may be more relevant during early stages of the design process, while a solution-addressing idea may be more relevant while the interaction designer is actively developing a similar design artifact for another project.

This opportunity is also presented in paper 4 as supporting the objectives of the Artisan Designer [Inie et al. 2018c]. In paper 3, the opportunity of better tagging and annotating was suggested as a way to provide cues for bringing ideas up again in relevant future situations, as well as additional cues for retrieving ideas – i.e allowing tags of temporal context, people involved in project, quality of idea at cetera. Designers currently utilize makeshift signifiers for themselves, such as an arrow in the document title or documents in different colours to achieve different (visual) forms of tagging [Inie et al. 2018a].
5.3.1 INCREASING FOCUS ON THE CREATIVE DESIGNER: DESIGN OPPORTUNITY 3 AND 4.

There is a considerable potential for idea management tools to support the creative designer in their process, rather than to focus primarily on the product being designed. As described, it is paramount to understand the processes which need support. The grounded theory analysis of professional idea management presented in paper 6 is one approach to establishing a better understanding of processes.

A latent design opportunity for novel, digital idea management tools is that such tools might be developed to support the creative process as well as the creative product.

Productivity support tools reduce manufacturing costs, tighten supply chains, and strengthen financial management. They are designed to meet clear requirements related to quantitative measures: storing large amounts of data, performing functions quickly, rendering files correctly, translating properties of interfaces between designers and developers [Shneiderman 2007]. On the other hand, creativity support tools support the individual designer in discovering, conceiving and exploring design ideas: bridging the problem-solution gap and envisioning desired states of affairs. A well designed idea management tool may, in this regard, support both quick navigation of files (functional property) and unobtrusive clustering of files in emergent patterns (creative goal) [Inie and Dalsgaard 2019, forthcoming]. If we accept that creativity is distributed across people as well as tools, as discussed in chapter 2, then tools used for idea management carry potential for storing files passively, and more importantly, for actively informing the creative process.

As shown in the analysis in paper 6, practicing interaction designers do not always work with a high certainty of the goal they are trying to achieve. Generating and developing design ideas involves a high degree of open-ended exploration and experimentation, and currently available tools do not always support this. Developing tools with a process focus might entail providing the interaction designer with open-ended, easily customizable interfaces, different visualizations, and continuously offering inspiration from external and archived resources of ideas. Another example might be working deliberately with the strategy of verifying by, for instance, offering different visualizations/representations of the same file, depending on the stakeholder the designer is presenting to.
The fact that designers have an abundance of tools available is not unequivocally good or bad. The main challenges that interaction designers experience, is to a large extent, the interoperability of the tools, or lack thereof [Inie et al. 2018a]. During the studies, there were several examples of designers relying on hacked or customized versions of software to make their ideas available to them at all times, such as designer P5, who utilized a separate email account solely as an idea repository and designer P2, who used didigital sticky notes on his computer desktop, and programmed his Evernote app to retrieve those notes and then push them as notifications on this smartphone front screen. Because Evernote has the functionality of pushing content to his phone, and digital sticky notes do not, he used Evernote as a mediator between the two devices [Inie et al. 2018c]. The greatest potential for idea management tools is, in this case, tools that translate from one platform to another, or work across different tools. This reinforces earlier arguments made in the field of graphic design tools that auxiliary tools, such as a color picker or alignment grid lines, should be available unbound by one specific software application [Maudet 2017; Maudet et al. 2017].

To summarize my contributions to the third research question, I have identified four design opportunities under two categories:

**A. Utilizing the potential of the design idea archive:**
1. Consolidating design ideas into one shared idea archive
2. Resurfacing design ideas at relevant times

**B. Increasing focus on the creative designer:**
3. Support the creative process as well as the creative product
4. Design tools that work across software and platforms

State-of-the-art in applied idea management tool-use seems, to a large extent, to still be designed for productivity support rather than creativity support, despite indications that informed interaction design can make a significant difference in supporting the creative designer [Coughlan and Johnson 2008; Shneiderman 2009; Shneiderman et al. 2006; Shneiderman 2007]. I propose that an implication of the research in this dissertation is that idea management tools have critical potential to shift focus from improving the productivity of the designer to equally improving the creative process.
The findings of this dissertation contribute to our theoretical knowledge about interaction design practices by drawing on empirical studies, as well as knowledge and frameworks from this and related fields. There are many challenges to studying tool-use and creativity in practice, and many ways to approach this complex subject. In this dissertation I have aimed towards gathering small-sample, deep knowledge and thereby establishing a foundation for understanding and designing for professional interaction designers. This methodology produces complex information and a detailed understanding of the people and case studied [Yilmaz 2013]. This allows us to generate further hypotheses of high ecological validity. Ecological validity is extremely relevant for further studies of how tools affect professional creativity, and for pointing towards some of the essential causal influences on practiced creativity [Amabile and Mueller 2008]. In this chapter I will discuss the implications of the results in the perspective of different audiences of the research.

The intent of the grounded theory approach is to move beyond description and towards discovering a theory [Creswell 2013]. As described in chapter 3, the findings of this dissertation are based on small-sample studies, and thus not statistically generalizable. However, the theories derived from the data, such as the model explaining the processes of tool-supported idea management, or the framework of strategies for using tools, are transferable, in the sense that the models might be applied to the analysis of other groups of individuals, workplaces, or tools. Where generalizable results suggest that we can assume that other interaction designers will behave in the same way as the participants of the studies of this dissertation, transferability invites the reader to use, contest, and enrich the terms, models, and frameworks derived.

One of the aims of this dissertation has been to describe the individual appropriations of tools in a way which is true to the practices of professionals. This means that models should be constructed in a way which takes account for significant individual differences - in fact, models and frameworks to explain design practice ought to help bring these differences to light. As said best by Lincoln and Guba [1985]: “It is, in summary, not the naturalist’s task to provide an index of transferability, it is his or her responsibility to provide the data base that makes transferability judgements possible on the part of potential appliers”. Hopefully, the stories and findings from this dissertation provides a deep enough data base that the models and theories will be useful for future researchers.
Firstly, the dissertation creates **descriptive knowledge** about creativity in interaction design practice. Even at a descriptive level, this knowledge is not trivial, as it is inherently difficult to gather knowledge about creativity in organizational settings [Amabile and Mueller 2008] and outside the work environment [Coughlan and Johnson 2008]. For example, previous research has told us very little about the different effects on creativity on using an analog notebook and using google docs, or the difference between using an analog and a digital whiteboard.

Secondly, the dissertation **advances several theoretical concepts** within its area of examination, especially the terms of design ideas and design idea management. Although the term ‘idea’ is used in abundance in related research, it has not been defined very well, as argued in paper 1 [Jnie and Dalsgaard 2017a]. The second term, ‘design idea management’, is both less used and less defined, but I present support that it is an area of practical significance within interaction design. Constructing, defining and discussing concepts is an essential basis for research, and thus the discussions and definitions in this dissertation advance the discipline of interaction design research. The definitions of design ideas make it possible to more rigorously compare different research analyses, and the definition and description of design idea management opens up an alley of research with the potential to influence professional interaction design practice positively.

Thirdly, the dissertation **offers a theory and a framework for understanding professional idea management strategies**, described in chapter 5 and in paper 6. This framework is useful for researchers aiming to characterize the role of tools used in creative practice. The framework can support other researchers with related research questions in approaching their inquiry, even if their method of studies might differ from the ones used in this dissertation. A rich understanding of idea management processes is central if we wish to be able to develop tools to be process-focused as well as product-focused. Managing design ideas involves a high degree of uncertainty, exploration, and experimentation, and currently available tools do not always support this.

By demonstrating the richness of idea management practices, it is clear that interaction designers’ needs are quite individual - perhaps a natural consequence of their business of dealing with wicked problems [Rittel and Webber 1973]. It is furthermore...
clear from the empirical studies that there is not one perfect tool for idea management, nor one standard process or system. Interaction designers create their own assemblages of tools, methods, and systems which work for them exclusively. Even though each idea management system described in the study was unique, each system was internally coherent. One designer would not use Evernote to keep track of ideas for one project and Google Docs for the next project, for instance. They would adhere to some system that fit their individual needs. Based on the findings of the empirical studies discussed in chapter 5, as well as the individual papers, I plead that interaction design research has much to gain from deliberately focusing on individual, professional idea management.

6.2 IMPLICATIONS FOR PRACTICING INTERACTION DESIGNERS

There were two primary implications for the interaction designers who directly took part in the studies: inspirational value, and reflective value. The first was the inspirational value of learning about others interaction designers’ approaches to idea management. Interaction designers are rarely taught any specific idea management practices. They rely on makeshift approaches and inspiration from others. During the interviews, I experienced that several of the interaction designers asked to see the final results of the study. Their primary reason was “I am curious to know how others manage their ideas, I might be inspired or learn about a tool I did not know about”. In general, the designers were very interested in methods or tools for optimizing their idea management – but they were looking for optimization of individual creative objectives. One designer explained, for instance, never experiencing problems retrieving his old ideas, while another complained that it happened all the time, and so forth.

The second implication for practicing interaction designers was the reflection that the intervention of participating in the study started. This is of course an implication only to the local group of designers who directly took part in the studies. The interaction designers who participated in both the qualitative survey and the interview study mentioned that between the survey and before the interview, they had given their idea management practices a lot more thought than previously. Four or five of the designers found something unexpected when they walked me through their archives – something they had forgotten about. It points to another potential benefit of the qualitative method of inquiry, and is in line with Schön’s notion of reflection-on-action as one
of the cornerstones of continuous, professional learning [Schön 1987]. Several of the designers said, during the interviews, that they simply had not dedicated the time or thought to develop an ideal idea management system and that, even at this scale, the interviews triggered positive reflection. Active reflection as part of creativity support tool design has been previously explored with very promising results [Sharmin and Bailey 2013], and paper 5 [Inie et al. 2018b] also demonstrated the potential for creativity tools to support continuous reflective practice.

The final implications are for designers, developers, and builders of idea management tools. This is a broad category and can entail both researchers who actively build systems and industrial developers working on all products related to idea management – from Moleskine to Evernote. Both the papers included in the dissertation and chapter 5 describe design opportunities. The recommendations based on this research are overarchingly: to move towards being designer-centric rather than design-centric. In the appended papers, the recommendations are described in greater detail with several suggestions of operational features and functions that would support these high-level objectives.

The logical step for future research is to test these opportunities in practice. Approaching such a topic from an informed perspective, which this dissertation helps establish, provides both inspiration and guidelines for tool builders. I demonstrate with the analyses presented in this dissertation, that tool-supported idea management is such a situation-unique and context-bound subject that open-ended testing of tools in real-life settings (such as the one presented in paper 5 [Inie et al. 2018b]) is the most suitable approach for learning about practiced creativity while leaving the adaption of tools open to designers themselves. Integrating novel systems into already utilized tools may be the most promising avenue if we wish to avoid “crippled, research grade tools” with no industrial impact [MacIntyre et al. 2004].

6.3 IMPLICATIONS FOR BUILDERS OF IDEA MANAGEMENT TOOLS
CONCLUSION

This chapter briefly summarizes each previous chapter of the dissertation, and describes some of the possible directions for future research.

In chapter 1 I introduced and defined the research questions:

1. How might we define, delimit and understand ‘design ideas’?
2. How do professional interaction designers currently use tools and systems to capture, manage and retrieve their design ideas?
3. How might novel digital tools support idea management for professional interaction designers?

I also introduced and motivated the research area of tool-supported, professional design idea management by addressing a knowledge gap in research about how tools can and do support day-to-day creative design practices.

Chapter 2 was dedicated to introducing and discussing the theoretical complexity of the research space. The first element of this was situating the work of the dissertation within interaction design research according to the three research questions.

The second element of the theoretical background was highlighting some of the findings from the field of Personal Information Management (PIM) - an area within HCI - which has contributed with studies and frameworks that provide a foundation for the analysis of data from research in archives. From the field of PIM I also highlighted a significant challenge for PIM systems: that computational tools for information management should move beyond passive filing of information and towards actively informing users of tools.

The third element of the theoretical background was situating the work in relation to creativity research. Especially the notion of distributed creativity provides a useful frame for in vivo-creativity as something that is formed and practiced between people, environments, and tools. The research of this dissertation contributes to our existing knowledge about distributed creativity by looking specifically at the role of tools in professional creative practice.

In chapter 3, I presented and discussed the research approach and its advantages and challenges, as well as provided a detailed description of the logical progress of the various studies which have informed the dissertation.

First, I described the concrete research activities of the doctoral work, consisting of eight empirical studies, including experiments, observations, a literature review, a qualitative survey, qualitative interviews, and walkthroughs.
Second, I explained how the methodological starting point was motivated by a pragmatist worldview, in that the research is informed by several research fields and applied methods from these based on their appropriateness to the research questions.

Finally, I reflected on the research approach and the steps taken to ensure validity of the results, particularly prolonged engagement with the field, thick, rich descriptions of practice, and peer debriefing. I identified the main advantages of the research approach as its appropriateness for generating new hypotheses, providing new insights, and ensuring ecological validity. The main challenges, on the other hand, were described as determining causal influences on creativity, testing hypothesis, generating generalizable results, and the subjectivity involved in qualitative analysis.

**Chapter 4** was a summary of and comparison between the appended papers of the dissertation and their contributions. The connections between the papers were described as follows: papers 1 and 2 were primarily directed towards defining concepts within design ideas and design idea management for the following work to build on. Papers 3 and 6 defined and characterized current strategies and challenges in tool-supported design idea management, and papers 4 and 5 explored how interactive, digital tools might support idea management practices.

**Chapter 5** was the summarized and consolidated presentation of the findings and results of the doctoral work in accordance with the three research questions.

The first section of the chapter was therefore directed at defining, delimiting and understanding design ideas. The difference between an observable and an unobservable unit of analysis was discussed. The following theoretically based definitions of design ideas were offered:

A design idea can assume the form of 1: A problem-addressing idea, 2: An opportunity-introducing idea, 3: A part solution-addressing idea, and 4: A solution-addressing idea.

The second section of chapter 5 summarized the findings from the studies of professional interaction designers’ current tool-use for idea management. This involved identifying the externalized representations of ideas found in practicing interaction designers’ idea archives: old project files, notes and recordings from meetings, action items, and inspirational examples. The
externalizations were also related to the theoretical definitions of ideas presented in the beginning of the chapter, and a model was drawn that encompasses the various concepts found and used about ideas throughout the results of the dissertation.

Following the presentation of design ideas as they are represented in practicing designers’ archives, I provided a model of theory of professional idea management process. I also presented a framework of strategies in tool-supported idea management, and explained how this framework can be utilized to analyze tool-use in practice.

In the third section of chapter 5 I treated the question of how novel, digital tools may support professional idea management. This was framed as four design opportunities under two categories: utilizing the potential of the design idea archive, and increasing focus on the creative designer. The design opportunities were as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Design opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilizing the potential of the design</td>
<td>1. Automatically consolidating ideas from different captures into one, shared design idea archive.</td>
</tr>
<tr>
<td>idea archive</td>
<td>2. Resurfacing design ideas at relevant times.</td>
</tr>
<tr>
<td>Increasing focus on the creative</td>
<td>3. Support the creative process as well as the creative product.</td>
</tr>
<tr>
<td>designer</td>
<td>4. Build systems that translate from one platform or tool to another.</td>
</tr>
</tbody>
</table>

In summary, the core contributions of this dissertation were:

**Research contribution 1:** I identified and analyzed existing theoretical definitions of the concept “design idea”, and offered a consolidated theoretical definition of design ideas. I further elaborated the theoretical concept by demonstrating how design ideas are empirically represented in practicing interaction designers’ archives.

**Research contribution 2:** I presented a grounded theory-analysis of the processes involved in professional idea management. These processes included a framework of strategies for idea management, which can be utilized to better understand existing tools, as well as inspire the development of novel idea management tools.
Research contribution 3: Based on the identification and analysis of current idea management strategies, I presented four design opportunities for novel idea management tools.

Finally, in chapter 6 I discussed and reflected on the findings of this dissertation in relation to different intended audiences of this research, namely researchers in interaction design and creativity support tools, as well as design practitioners, and developers of idea management tools.

As a final comment, I will lay out some directions for future studies in the area. I invite other researchers in both HCI, PIM, creativity support tools, and distributed creativity to continue studying and developing tools for professional idea management.

The goal of my research has been to generate knowledge for researchers and developers of creativity support tools to better understand and support real-world practices. Using mixed methods will allow for the generation of more and new insights that were out of the scope of this dissertation. Future research might expand the findings by conducting further studies of, for instance:

Longitudinal observations in the workplace. As discussed in chapter 3, one of the caveats of interviews, is that they report on what study participant think they do, rather than their actual practices. The design idea archive walkthroughs meat this caveat to some degree, but they are still an after-the-fact report that show only archived externalizations of ideas (and they only show the archives that the designers are willing to show). Longitudinal observations of interaction design practices would offer additional deep knowledge of processes for idea creation, management and archiving. This type of study is promising for unfolding some of the findings in this dissertation, such as the processes of switching between different tools during the development of an idea.

Screen capture and video recordings of activities happening at the desktop in real time. To gather more detailed knowledge of tool-use, it would be extremely interesting to have access to screen captures/video recordings of workstations over an extended period of time. Such a study would be less intrusive to the normal work practice, and could help discover tacit patterns or tool-use of the designer. Ideally, such recordings
would be combined with following interviews that allowed the researcher to ask clarifying questions. This type of study would be particularly interesting for discovering the correspondence between what interaction designers say they do and what they actually do. It would be a very promising avenue of research in terms of watching idea development over time, both on a short and long term scale.

**Building and testing tools with a process focus.** As described in the introduction and background chapters, there is a potential in developing tools with a process-, as well as a product focus. That is, tools which support creative objectives and strategies in an unobtrusive manner. Future work would ideally be directed towards testing the hypotheses (design opportunities) generated through this dissertation and presented in chapter 5, as well as exploring how the findings might be beneficially applied in professional interaction design practices.

The research of this dissertation opens up an avenue of interaction design research. Idea management is an imperative part of professional interaction design, and a discipline that has much to offer to both researchers, tool developers, and practicing designers.
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APPENDED PAPERS

09

PAPER 1: A TYPOLOGY OF DESIGN IDEAS
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
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 through 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,
Session: Sense Making for Creativity

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| Engineering |           |           |           |           |           |           |     |
|             | Holt et al. '85 | Shah et al. '00 |           |           |           |           |     |
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| Creativity research |           |           |           |           |           |           |     |
|                     | Davies & Talbot '87 | Ishii & Allexa '92 |           |           |           |           |     |
|                     | Boden '90 |           |           |           |           |           |     |
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| Cognitive science |           |           |           |           |           |           |     |
|                   | Finke et al. '92 | Soff & Edmonds '96 |           |           |           |           |     |
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| Management or marketing research |           |           |           |           |           |           |     |
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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 research, neuroscience, or marketing. Our main challenge in the review was scoping.
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.

<table>
<thead>
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<td>Opportunity</td>
<td>Suggestion for part-solution</td>
<td>Suggestion for solution</td>
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Table 2: A typology of design ideas.

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

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 solution. 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

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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.
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/if 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 ont0 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 designer's 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 [32]. 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.]

They can even happen to a group of people simultaneously: “One of the nurses stood up and used an existing product to demonstrate members of the design team suddenly demonstrate a specific user challenge. At a certain point 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 and Generating ideas, preferably many, varied and unusual ideas.

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 the 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 are 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 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 better understanding of 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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PAPER 2: HOW INTERACTION DESIGNERS USE TOOLS TO CAPTURE, MANAGE, AND COLLABORATE ON IDEAS
How Interaction Designers use Tools to Capture, Manage, and Collaborate on Ideas

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Abstract
In this paper, we present an in-depth survey of how interaction designers use tools to capture, manage and collaborate on ideas. We observe that designers report very unique processes with various tools, and that no dominant tool is present for idea capture and development. Our discoveries are summarized into three key insights, suggesting ways for interaction design research to support these practices.

Keywords
Ideas; Tools; Idea Development; Idea Management

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: Evaluation/methodology, Theory and Methods

Introduction
A crucial component of interaction designers’ work lies in developing, refining, managing, and communicating design ideas. Our wider research focuses on how existing and novel digital tools can support creative work, and as such we have a strong interest in exploring how professional creatives use tools to accomplish these tasks. In 2008, [3] surveyed how creative practitioners manage ideas in their creative lives, and in 2015 [21] did a large-scale study about the favorite tools of designers. Extending on this work, we have conducted an in-depth survey to examine how interaction designers, specifically, use tools to capture, manage and collaborate on ideas. Our objectives are to identify patterns in which types of tools and strategies they employ, to critically examine the strengths and weaknesses of these tools and strategies, and to identify potentials for supplementing or potentially
replacing them with novel tools. Our research is process-focused, as we are interested in how the tools are used and appropriated in working practice.

**Related work: Studying creative practices**

Creativity is an inherently complex phenomenon to study, and many researchers have tried to tackle this complexity by studying only a limited set of parameters in lab-based experimental setups [13], framing creativity primarily as a problem-solving cognitive activity. However, recent contributions have argued that what is studied in lab experiments (in vitro) is a poor model of the complexity of creative work in real world settings (in vivo) [18; 21]. In the terminology of [12], who distinguishes between different scopes of creative endeavors, our domain of study can be defined as Pro-c: professional expertise in a creative practice, here in the form of interaction designers who, through training and experience, continuously work to create novel and useful products. In interaction design practice, creative work is typically not confined to single, distinct tasks, but unfolds iteratively over long stretches of time and on different levels of abstraction.

In real-world creative work, a defining characteristic of skillful practitioners such as interaction designers is that they often employ and combine a range of different tools in idiosyncratic ways in order to tackle specific challenges [7]. This typically entails a mix of analogue and digital tools. [16] has declared the development of creativity support tools to be one of the current “grand challenges” for HCI. In spite of this call to advance creativity-oriented HCI, it remains a niche field in comparison to research with a more functional and productivity-oriented focus. While there are several extensive overviews of creativity methods and techniques for designers [19; 14], similar overviews of tools that designers can use to develop, capture, and manage ideas are lacking. This is a clear lacuna in research, since previous work has demonstrated that the use of such tools is crucial to creative work [6].

Studies have demonstrated the importance of social and cultural aspects of creativity [1;5] and that creative work transitions between individual and collaborative phases [9]. Moreover, while idea generation can be prompted by specific ideation methods [17], ideas can also emerge ad hoc during incubation periods, often at times when we might not be prepared to capture or employ them, but still recognize that they can be of value at some point [15]. Moreover, recent work on CSCW has indicated potentials for combining digital and analogue components in creative collaboration [8;10].

In summary, this overview of related work indicates that creative work practices are highly diverse, that they are influenced and shaped by both the socio-cultural context and the tools at hand, and that ideas can emerge in unforeseen situations. We have devised our survey to account for these issues through relatively open questions that can account for a variety of circumstances under which respondents work with ideas, while also focusing on the role of tools and collaboration.

**Survey design and results**

In particular, we have extended the survey in [3] to examine the use of tools for collaboration. The survey questions are shown in the sidebar. In the design of the survey, we aimed for open-ended questions encouraging respondents to describe their answers in
as much depth as they found appropriate. As opposed to [3], who studied many types of creative practitioners, our focus is on interaction designers specifically, and how they use tools throughout their day. Since [3] executed their survey, almost a decade ago, the technological landscape related to interaction design has changed considerably, e.g. through the proliferation of novel devices such as tablets, and the emergence and refinement of online and cross-device services idea such as Evernote and Pinterest, and we were interested in whether this change is reflected in creative practices of professional interaction designers.

The questionnaire was formed with the intent of letting respondents self-appraise the definition of tools and ideas as much as possible. We thus focus on respondents' own experience and memory of their in vivo practice. Questions 1-4 are designed to inquire into the personal, individual experience with tools. Questions 5-8+12 investigate if and how tools are integrated into collaborative practice, and with questions 9-11 we try to examine ad hoc creativity out of the regular work setting.

Respondents were recruited via a large design mailing list, from personal networks, and via a professional Facebook group for interaction designers. From this approach we recruited 24 anonymous respondents, who came from a variety of interaction design fields, including game design, UX design, and product design. The answers varied from one/two-word responses to longer paragraphs (160 words). The data is dirty in the sense that the descriptions vary from extremely detailed to brief, e.g. "laptop" as a tool versus describing specifically which software is utilized.

However, responses are generally straightforward and easily comprehensible.

Responses were coded in NVIVO, constructing grounded theory-categories [4] from subjective appreciations (coding categories are shown in sidebar). These categories inspired the forming of the three salient themes in the survey responses: Tools for individual use, tools for collaboration and forms, ideas take. In the following, quotes from the survey are lightly edited for grammatical errors, but otherwise presented directly as in the survey responses.

**Capturing ideas**

Different digital tools for capturing ideas were mentioned by more respondents than analogue tools (20 over 16 resp.). This is counter to what [3 and 21] reported. In their studies, pen and paper by far the most used tool for brainstorming and ideation. The most common digital tools in our survey were phone or laptop notes (17 resp.). Contrary to the survey results of [3], mobile technology is now very prevalent: more than half the respondents mentioned their phone as their main tool for "emergency" idea capture when out of the office. A wide variety of digital tools specialized for idea management and brainstorming were also mentioned, among others Evernote, Google Keep, MindNode and IA Writer. Most digital tools were mentioned by only 1 respondent, and by a maximum of 3 respondents (Evernote), showing a great diversity in which digital tools people prefer: 30 different digital services or tools were mentioned versus 5 different analogue tools, the far most common of those being notebooks or notepads (16 resp.) and sticky-notes (11 resp.).
7 respondents described specifically that they only employ their preferred tools for personal use, and that they do not need the tools to be collaborative. This may be due to the roughness or abstractness of individual ideas:

- "Typically for me to convince others that an idea is worth pursuing, it needs to be fleshed out and made more concrete."

Several of the respondents reported keeping their raw, captured ideas in a designated place, to be able to draw inspiration from them at later times, utilizing them as a creative archive or so-called spark file:

- "Online diaries, post its. I have them with me in the fieldwork and in the office. I review them sometimes."

One respondent even reported sending emails to his future self as a form of asynchronous personal communication:

- "I always check my mail in the morning and if I’ve left any info for myself to remember I’ll judge it at that time (often discarding it)."

Most respondents report a chunk of work between the capturing of inspiration or raw ideas and the presentation of them to colleagues. In this in-between phase of development, the designers perform very individual and context-dependent management tasks:

- "Post-it notes are typically action items that I can do with my own personal Memos. Later they get packed up in a form of asynchronous personal communication.:"

Due to the personal character of this work, it is hard for researchers to gain access to what happens to the ideas in that time. The survey results tell us that designers often switch between different tools, leaving development and progress of ideas very hard to track, even for designers themselves:

- "[...] sometimes I lose an idea just because I blink [...] Stuff can disappear in a second, therefore, it’s all the more important to capture!"

Managing Ideas

16 respondents say that their ideas usually take form of written text, and 15 report them often being sketches. Generally, there’s no clear distinction between capturing ideas from brainstorming sessions and formulating them into more concrete text.

- "Typically for me to convince others that an idea is worth pursuing, it needs to be fleshed out and made more concrete."

Several of the respondents reported keeping their raw, captured ideas in a designated place, to be able to draw inspiration from them at later times, utilizing them as a creative archive or so-called spark file:

- "Online diaries, post its. I have them with me in the fieldwork and in the office. I review them sometimes."

One respondent even reported sending emails to his future self as a form of asynchronous personal communication:

- "I always check my mail in the morning and if I’ve left any info for myself to remember I’ll judge it at that time (often discarding it)."

Idea representations take many different forms and are spread across multiple platforms in different forms:

- "My notebook is where I represent raw ideas. The laptop is where I elaborate on the ideas."

Due to the personal character of this work, it is hard for researchers to gain access to what happens to the ideas in that time. The survey results tell us that designers often switch between different tools, leaving development and progress of ideas very hard to track, even for designers themselves:

- "[...] sometimes I lose an idea just because I blink [...] Stuff can disappear in a second, therefore, it’s all the more important to capture!"
Coding categories 1/2

- Tools for idea capturing - analogue
- Tools for idea capturing - digital
- Collaboration - analogue tools
- Collaboration - digital tools
- Forms of ideas
- Tools - Adobe CC, Dictaphone, Axure, Bookmarks, Calendar notes, Direct text annotation, Dropbox Paper, Email, Evernote, Flinto, Google Keep, iA Writer, Invision, Laptop, Laptop notes, Large sheets of paper, MindNode Pro, Notebook, Online diary, Pen and paper, Phone, Phone notes, Phone sketches, Photos, Photoshop, Pinterest, Post-its, PowerPoint, Principle, Reference management software, Screen shots, Sketching, Slack, Texts to myself, Vertical boards, Word

purposes: 1) documenting a new idea (where the designer produces a new idea and makes a kind of externalization of it), 2) saving inspirational material (where the designer sees something that he/she wants to remember, and keeps some representation of the thing, for instance a photo or link) and 3) saving inspirational material with annotation (where the designer saves something and writes comments to him or herself about it). The designers deploy various methods for retaining or bookmarking inspirational material: screenshots, links, photos etc. Most of the respondents are quite meticulous about their systems for organizing ideas:

- “I have different sizes of working papers grouped together. Also, have a separate text book for meetings. I choose which kind of paper to use in parallel with the content of the work. Then I put the used one behind the pile, so when I need to look back, I can find [it]. These piles are placed on different corners of my desk, in a natural way.”

- “I have a comprehensive system of folders for ideas for anything from scientific papers to house renovations and must-have music albums.”

We see that PowerPoint/Keynote/Google Slides presentations are very prevalent. 12 designers use at least one of these tools when they present their ideas to others, and 6 use them for individual or collaborative purposes while developing ideas. One of the main characteristics about these applications is that they allow for most file types to be integrated into one document; text, images, audio etc. Furthermore, presentation software is usually very malleable, in that it is easy to move elements around on the canvas, reshape them, etc. This makes them stand out from other notetaking or representational software in play, e.g. Pinterest or Evernote, which have fixed representation layouts, although different forms of representation can be stored in these applications as well.

Collaborating on ideas

For collaboration, we see the opposite pattern from individual use, namely that 22 respondents report using analogue tools versus only 16 digital ones. The far most predominant setup is some version of pen and paper (sometimes utilizing sticky-notes) (22 resp.). For digital tools, most respondents use some form of file sharing service (e.g. Dropbox or Google Drive), and some mention different tools specifically for team project planning, for instance Slack, Github and Jira. 10 respondents say explicitly that they miss a tool for collaborative idea sharing and/or development, e.g.:

- “Something that could easily combine text, markups, diagramming, drawing, filing and sharing … something that is like an iPad but could also make these things 3D physical and magically collapse back into the virtual”
- “A way to integrate Drive, Dropbox, Evernote, Keep, Office 365, and all the collaboration tools in one space. Everyone I work with has a different preference for collaboration platform and I have to do an email search to find [out] on which platform they shared something with me.”

Surprisingly, 11 respondents claim to mainly use asynchronous, file-sharing tools for collaboration, while only 2 mention synchronous working spaces such as Google Docs, even though these services have become far more widespread within the last decade. 9 say that they still use a whiteboard as a primary tool for
collaboration, and most of these, mention photographing the whiteboard for documentation and retrieval. One participant says about integrating digital tools into his collaborative workflow:

"I often collaborate, but it tends to be through shared Dropbox folders or simply through emails. I have never managed to integrate Evernote in my workflow for this purpose."

6 respondents do not miss a tool for collaborative project management, pointing to an abundance of these tools and the tools not fostering creativity:

- "No. I think there is toooo many"
- "No. Project tools like Jira kills creativity"

The use of tools for collaboration seems highly situation-dependent and appropriated for the specific projects. The biggest challenges appear to be the transitions between analogue and digital rather than sharing of files, as when photographing a whiteboard to digitalize it. A tool that could make virtual files transcend into physical space, and collapse them back into virtual again, was sought after in several responses.

Discussion and future work

Although many interesting points emerge from the survey responses alone, this investigation is of course not exhaustive given the vast amount of work practices in the field of interaction design. From the survey coding, we have identified three key insights beyond existing findings, which we plan to explore in our further work:

1. Capturing: Many interaction designers retain ideas with the purpose of looking back at them later and these ideas take many different forms. Can idea capturing be supported by one common tool?

2. Managing: It is hard for both designers and researchers to explain what happens between the time of idea capture and idea presentation, where the designers refine their ideas using various tools. Can we build a tool to make management easier and enhance development of ideas during this stage?

3. Collaborating: Most respondents collaborate using analogue tools. The main challenge seems to be transitioning from virtual to analogue, and back to virtual space. Can we make this practice easier?

Our next step is follow-up in-depth interviews with selected participants, exploring the three key insights comprehensively. We then plan to explore the possibilities of technology by designing and building a tool to aid interaction designers in individual and collaborative idea management practice.

Our survey indicates that the practices and tools employed to capture, manage, and collaborate on ideas has shifted considerably since the 2008 study in [3], marking in particular a shift towards digital services and mobile devices for personal use, while analogue tools are still preferred for collaboration. It can seem surprising that so many different tools are still in play and that there are seemingly no dominating tools or services. This supports [16]'s claim of creativity support tools being a grand challenge for HCI. Designers appear to individually and idiosyncratically customize their personal work practice to a great extent, and the variety of available tools may greatly reinforce this personalization in a meaningful way.
References


PAPER 3: DESIGNING IDEA MANAGEMENT TOOLS: THREE CHALLENGES
Designing Idea Management Tools: three challenges

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Designers have a broad range of digital and analog idea management tools at their disposal. We know that designers have individual preferences for different tools, but we know very little about why this is, and which practices designers accomplish using different tools. This paper presents the results of an interview study with 16 professional designers, where we investigate the tools, designers use to manage their early stage creative ideas. The study reveals three perceived challenges for designers working with existing idea management tools. These challenges are: 1: Idea management tools are rigid in capture medium, 2: Idea management tools offer inflexible interfaces and representations, and 3: Idea management tools focus mainly on ideas, not ideation. We interpret the findings into operational examples of how builders of novel tools might embrace these challenges in the development of next-generation idea management tools.

\textit{idea management tools; ideation; idea management, design tools}

1 Introduction
Designers employ a broad range of both digital and analog tools to capture and develop their creative ideas (Coughlan & Johnson, 2008; Inie & Dalsgaard, 2017; Vinh, 2015). The tools inevitably shape the work practices, and correspondingly, the preferred mode of idea representation affects the choice of tools (Kan & Gero, 2008; Stones & Cassidy, 2007). Why are these practices so different across designers? In 2015 Khoi Vinh (Vinh, 2015) did a large-scale survey identifying the most commonly used tools by designers for activities such as ‘brainstorming and ideation’, ‘wireframing’, ‘interface design’, and ‘prototyping’. While the survey provides a statistical overview of the many different tools, designers use, it does not elucidate why designers prefer different tools for seemingly similar tasks. The current study explores the perceived challenges that designers experience when working with digital and analog tools to capture, store, retrieve, and collaborate on their ideas.

Coughlan and Johnson (Coughlan & Johnson, 2008) coined the term idea management as a way of describing the various practices, creative practitioners exhibit to keep track of their ideas. They identified three main purposes that creatives try to achieve in their management of ideas: 1: retention and organizing of ideas, 2: feedback, evaluation, and development of ideas, and 3: communication of and collaboration around ideas. These definitions provide a more detailed insight
into the goals of creative practitioners, and suggest a lens through which to view the selection of various tools. In this paper, we share a similar understanding of idea management, and thus our definition of idea management tools is any tool, digital or analog, that designers use to capture and/or keep track of their ideas. When we describe idea management systems, we refer to an assembly of tools that a given designer has told us they utilize for idea management purposes. For instance, email might be mentioned as an idea management tool, but the designer might take a picture with their phone and then send it to an email account. The latter we call the designer’s idea management system. An idea management system often consists of a combination of digital and analog tools, however the design opportunities in this paper focus on digital tools, as analog idea management requires more fundamental redesign of materials and processes.

This paper presents the findings of a series of interviews (N=16) that examine how creative designers use tools to manage ideas. We sought to discover patterns in the types of tools and strategies employed, to examine the use of different tools in combination, and to identify opportunities for supplementing or developing novel tools or applications for supporting idea management.

We identified three core challenges for designers working with idea management. 1: The capture of an idea is often defined by the tool, and designers therefore find ideas to be distributed across several media and archives. 2: Idea management tool interfaces often support only one way of representing ideas; this hinders flexible work with ideas that requires shifting between and combining different representations. 3: Most designers we spoke to were not looking for “yet another app” to help them brainstorm, but they were interested in tools that would help them develop their ideas. We also asked the designers to imagine novel, ideal tools for working with their ideas. The collective answer for these questions was a general desire to see more intelligent tools which could act as an active agent in their various work practices, for instance predicting outcomes of certain design choices ad hoc (P15) and automatically being able to present the designer with “the core concept” (P6, P8). Drawing on these insights, and designers’ imagined tools, we offer opportunities for developing novel tools and enhancing existing idea management tools.

2 Related work

Creative design practice is a complex phenomenon to study, and many researchers have tried to tackle this complexity by studying only a limited set of parameters in lab-based experimental setups (Kozbelt, Beghetto, & Runco, 2010), framing creativity primarily as a problem-solving cognitive activity. However, recent contributions have argued that what is studied in lab experiments (in vitro) is a poor model of the complexity of creative work in real world settings (in vivo) (Simonton, 2003; Wilitschnig & Onarheim, 2010). In real-world creative work, a defining characteristic of skilful practitioners such as interaction designers is that they often employ and combine a range of different tools in idiosyncratic ways in order to tackle specific challenges (Gedenryd, 1998). This typically entails a mix of analog and digital tools.

Designers capture their ideas both for recall and for retention purposes, as well as to explore their ideas (Dix & Gongora, 2011; Finke et al., 1992; Schön, 1983; Suwa & Tversky, 2002). According to Scheideman (Shneiderman, 2009) the development of creativity support tools is one of the current “grand challenges” for HCI. In spite of this call to advance creativity-oriented HCI, it remains a niche field in comparison to research with a more functional and productivity-oriented focus. While there are several extensive overviews of creativity methods and techniques for designers (Saha, Selvi, Büyükcan, & Mohyemen, 2012; Smith, 1998), we do not see similar overviews of tools that designers can use to manage ideas. This is a clear lacuna in research, since previous work has demonstrated that the use of such tools is crucial to creative work (Dalsgaard, 2017). In our work, we have designed our inquiries to account for these issues through open questions that can account for a variety of circumstances under which respondents work with ideas, while also focusing on the role of tools used in social practices.
An online survey among professional designers from different companies and locations (Inie & Dalsgaard, 2017) has previously identified common patterns between designers’ use of tools, namely, all designers need and use tools for the processes of capturing, managing, and collaborating on ideas. These activities correspond with the activities that Efimova (Efimova, 2009) identified as the primary purposes of weblogging (which may be viewed as an example of creative ideation, even though the work was aimed at academic advancement and not design): low-threshold creation of blog entries, organizing and maintaining content, and engaging with others around blog content. In addition to these, she identified the activity of retrieving, reusing and analyzing content, which are activities practiced by designers as well. In fact, we found many similarities between idea management and information management, when we surveyed the field of personal information management (Boardman & Sasse, 2004; Kaye et al., 2006; Whittaker & Hirschberg, 2001). However, there are also differences between creative ideas and other types of information, one of them being that ideas are often captured outside of work settings, and in unpredictable circumstances, when the creative practitioner is not actively trying to ideate (Coughlan & Johnson, 2008).

When creative workers externalize their ideas, it allows them to explore and reinterpret their mental representations, refining their ideas (Dix & Gongora, 2011; Finke, Ward, & Smith, 1992; Schön, 1983). When the process is documented and archived (Moran, Carroll, & Others, 1996), these actions not only inspire the designer, but also allow them to retrace their steps along the way. This operation is essential for the reflective practitioner, because it allows the designer to not only reflect on the product, but also, and perhaps more importantly, the design process and rationale behind key decisions (Schön, 1983). Kirsh (Kirsh, 2009) described how much of our interactivity during sensemaking and problem solving involves a cycle of projecting, then creating structure. Projection is described as exploring a purely mental representation, entertaining possible actions and evaluating consequences. Externalizing a mental projection allows a designer to release some of their working memory, replacing it with a mental projection and then, if it seems fruitful, materializing it by marking the illustration. While we share an understanding of designing as a reflective practice, we know little about how reflective practice unfolds in everyday design processes and how tools support this. Dow, Saponas, Li and Landay (Dow at al. 2006) found that designers of experiences and ubiquitous systems often lack the tools to create adequate representations of ideas, because their ideas unfold over time and are not static images. Bernal, Haymaker and Eastman (Bernal et al. 2015) addressed this challenge by calling for computational creativity support systems to aim more for aiding the designer than the design alone.

3 Methodology

Our data consists of in-depth interviews with 16 professional interaction designers. The interviews lasted between 45 and 80 minutes and were structured in sections about capturing, managing, retrieving and collaborating on ideas. We inquired for which tools the respondents use at which times during their design processes. In each section, we asked the designers which tools they currently use and why, as well as encouraged the designers to envision and describe how they might imagine ideal tools for working with their ideas (see table 1 for an excerpt from the interview questions). Our goal was not to draw general conclusions but to unearth design inspiration, considerations, and questions. We approached our research questions with qualitative interviews because we found the approach suitable for accessing designers’ attitudes and values. We were particularly interested in the interviewee’s views, interpretation of processes, understandings, experiences and opinions (Silverman, 2006) (see figure 1 for examples of different ideas).
Table 1: Excerpt from interview questions. For space purposes, not all questions are included in the table.

| 1: Capturing ideas | 1.1 Which tools do you use to do capture your ideas? When you’re at work? When you’re at home? When you’re at “inconvenient places” (i.e. on a walk, in the shower, at yoga class etc.)?
|                   | 1.2 Can you remember the last time you captured an idea? Describe what happened.
|                   | 1.3 Imagine the ideal tool, in your mind, for continuously capturing ideas. What would the interface of this tool be like? What key features would it have?
|                   | 1.4 Why do you capture ideas? What’s the end goal-product? And how does archiving contribute to that? |
| 2: Managing ideas  | 2.1 Where do you keep your ideas?
|                   | 2.2 How do your ideas look? E.g. sketches, audio files, texts, image collections etc.
|                   | 2.3 Which tools do you use to make them look this way?
|                   | 2.4 Imagine the ideal tool, in your mind, for storing ideas so they are easy to find and use when you need them. What would the interface of this tool be like? What key features would it have? |
| 3: Retrieving ideas | 3.1 Do you ever look at your old ideas? Why/why not?
|                   | 3.1.a If yes: How do you use your old ideas for later projects?
|                   | 3.1.b Take me back to the last time you went through an idea archive of yours. What did you learn from it? |
| 4: Collaborating on ideas | 4.1 Which tools do you use when you collaborate with others in generating/developing ideas?
|                   | 4.1.a Why these tools?
|                   | 4.3 Imagine the ideal tool, in your mind, for collaborating on ideas with your colleagues or team - what would the interface of this tool be like? Which features would it have? |

3.1 Demographics and details about interview participants
We interviewed 11 male-, and 5 female designers working with interaction or digital design. Participants were recruited via the authors’ personal networks, mailing lists, and Facebook groups for UX designers. The age span was between 22 and late 40s, with experience in design ranging between 2 and 11+ years. We didn’t deliberately choose the designers based on their experience or demographics, but rather based on getting a varied sample of different types of designers, and we stopped at the point where the categories of information became saturated (Creswell, 2013).

3.2 Analysis and coding
All interviews were transcribed and coded with a grounded theory-approach (Creswell, 1998), (Glaser & Strauss, 1967) to identify prevalent themes. The initial open categories were based on
identifying the actions and goals the designers were trying to achieve with the tools of their choice (axial coding) (Creswell, 2013). The initial categories are shown in table 2.

Table 2: Initial open categories

<table>
<thead>
<tr>
<th>Idea forms and representations</th>
<th>To do-lists, visual vs. text, screen dumps, bookmarks, notes, sketches, information, prototypes, talking as prototyping, moving from analog to digital, moving from digital to analog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software</td>
<td>Evernote, Reminders, Slack, PowerPoint/Keynote, Illustrator/Photoshop, Asana, Google Keep, Pinterest, email, tool personalization, one master tool, ideas for tools</td>
</tr>
<tr>
<td>Hardware</td>
<td>Sticky notes, paper, tagging, cloud, phone camera, phone dictation</td>
</tr>
<tr>
<td>Ideas-/inspiration archive</td>
<td>Revisiting ideas, naming conventions/archiving practices, idea bank, inspiration materials, finding ideas, folder organization, forgotten ideas, desk area</td>
</tr>
<tr>
<td>Collective ideation</td>
<td>Decision making process, ideation in a company, collaborating with a whiteboard, tools for collaboration</td>
</tr>
<tr>
<td>Communication about ideas</td>
<td>Challenge of collaboration and representing ideas, communication of ideas, flow of ideation</td>
</tr>
<tr>
<td>Personal ideation process</td>
<td>Ideation process, signifiers/markers to self</td>
</tr>
</tbody>
</table>

For this paper, we focused on all instances where designers mentioned experiencing challenges with the idea management tools or systems they utilized. Challenges were especially prevalent in the categories Idea forms and representations and Ideas-/inspiration archive, leading us to focus our analysis on these. In line with the description in Creswell 2013, we focused on identifying causal conditions for the core phenomena (the challenges), strategies applied in response to challenges, contextual and intervening conditions that influence the specific challenges, and consequences of the strategies taken in the process of managing ideas. We have summed up the following selective coding in the three core challenges we present in this paper, and the opportunities for idea management tools to address the challenges in table 4 are based on the strategies, the designers used in response to their perceived challenges.

4 Findings

Table 3 presents an overview over the idea management tools mentioned during this study, as well as the key idea management activities they are utilized for; idea capture, idea development, idea storage, retrieving ideas, and collaboration around ideas. These categories are not mutually exclusive (see example in figure 2). In the next section, we present the core three challenges designers experience in their idea management process in depth.
Figure 2 One software tool (Procreate) that lets the designer capture or save an image and draw/annotate on top of it in one or more layers which can then be turned on or off. This designer used Procreate primarily as a development- and presentation tool for clients.

Table 3 Overview of primary idea management tools (mentioned by at least two designers) and their key function(s) in creative idea management (as experienced by study participants)

<table>
<thead>
<tr>
<th></th>
<th>Capture</th>
<th>Development</th>
<th>Storage</th>
<th>Retrieving</th>
<th>Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pen and paper</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>(Physical) sticky notes</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Digital) sticky notes</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>Evernote</td>
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<tr>
<td>Reminders</td>
<td>x</td>
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<tr>
<td>Google Keep</td>
<td>x</td>
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<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>Screen dumps</td>
<td>x</td>
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<td></td>
<td>x</td>
<td></td>
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<tr>
<td>(Phone) camera</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>(Phone) dictation</td>
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<tr>
<td>PowerPoint/Keynote</td>
<td></td>
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<tr>
<td>Illustrator/Photoshop</td>
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<tr>
<td>Procreate</td>
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<td>Pinterest</td>
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<td>Asana</td>
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<td>Dropbox</td>
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<td>Google drive</td>
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</table>

4.1 Challenge 1: Idea management tools are rigid in capture medium
Designers often capture with a tool based on convenience and availability, and they choose tools for development of ideas based on the tool’s visual representation. This means that the designer has to translate their idea from initial capture, which might be a camera photo or a sticky note, into a different piece of software that allows them to refine their idea into a product or prototype, for instance a wireframing tool or a piece of illustration software. The tool is usually chosen based on the ease of input if offers:
“I use voice memos a lot now when I’m in the car [...] or when I’m running. Running is really difficult because I don’t like to stop to capture that thought (...) it becomes a repetitive thought, almost like a mantra if I think of something, and then I’ll write it down when I stop.” (P10).

Because designers use different tools for idea capture, they often have very distributed idea archives. Several designers described this as a challenge: “Do you ever go back and look at your old ideas? Why or why not? Not often enough, and that’s because they’re not necessarily filed properly for me to find them easily” (P13). The main peril is that potentially relevant ideas get lost or forgotten, because they are hidden away in folders that may never get looked at again. Often, the camera roll on the designer’s phone would be such a place, where many photos of whiteboards from ideation sessions would be saved, but never returned to. Another example would be audio recordings of ideation sessions: while several designers described using audio recordings, they all agreed that nobody actually ever listened to these recordings again. In response to this potential loss of ideas, some designers deliberately build archives of ideas in tools that keep their idea archive restricted to one tool. Three designers described how they use their email accounts as idea management tools. This way, they are reminded about their ideas during their daily workflow, because their email client is always open and available. The email account also allows them to push content from different platforms to a shared database quickly, because they can send links, text, images and other files to the account when they are away from the desktop. The popularity of email as an idea management tool does not correspond with a general preference for visual tools. All designers we interviewed said they prefer extensively visual tools for managing their ideas when we asked them to imagine ideal tools. Email offers something particularly desirable to outweigh its limitations, namely that it is omnipresent and a natural part of the workflow:

“For some reason, right now I’m really stuck on typing everything into email, and I email myself everything. So, I use...I constantly... for my single reminder and my single go to, I have Wunderlist, and I created a Wunderlist, but for some reason, I can’t find myself using to do lists or reminders as a consistent tool. I continue to go back to email, and I don’t know if it’s a crutch right now or if it’s because that’s what’s always visible and that’s the best way to remind myself. (...) email just seems to be the one consistent thing that helps me aggregate all of my thoughts and everything that’s going on.” (P9).

Several designers mentioned an aspiration to tag their ideas more, but they found the process too inconvenient. In most of the cases we encountered in our studies, the archived content was in the form of snippets of information, often without metadata. This type of content is typically detached from the context in which it was originally captured, since it is not feasible to capture all aspects of a design process, as discussed in Dalsgaard and Halskov (2012). As a consequence, most designers rely primarily on their memory to find things, which results in ideas getting lost and being forgotten. One resulting strategy is that many designers rely on other contextual cues than tags:

“So, for you the importance of idea is a little related to when it was created or modified? Yes, well actually maybe not how important it is to me at any given time is sort of dictated by the time I’ve given to that idea. That’s under the presumption that if an idea was important to me, I would have contributed to it more recently than others. However, that does leave room for ideas that I’ve put in the parking lot per say that I just haven’t given headspace to in a long time. Although they may be important or have validity” (P6).

Especially for handwritten notes and sketches, adding tags and annotation is experienced as difficult. While most digital idea capture tools offer a way to add tags or notes to individual files, most designers do not take the time to do so at the point of capture. Consequently, randomness can become the determining factor for whether the idea is ever revisited:
“I would love to think that I have one place where all my amazing ideas live, those ones that I haven’t got to or I haven’t had time to think about (...) it would be a lot easier to then go back, retrieve them and act upon them. Some ideas will sit dormant in a document for months if not years until sometimes you discover them accidentally” (P10).

4.2 **Challenge 2: Idea management tools offer inflexible interfaces and representations**

A core function for idea management tools is offering a representational structure of design ideas. Most often, the interface a tool is chronologically ordered with no other structure: “But as you see it’s just images that’s placed underneath each other not much of a... And no title so there’s not of a system which makes it a bit manual” (P12). The same is the case for analog notebooks, which are inherently rigid in their interface. For many designers, malleability and movability are the major qualities of sticky notes, whiteboards and large sheets of paper. Several designers mentioned they would like some digital imitation of a giant whiteboard when asked to imagine ideal tools for organizing ideas:

“I would love a huge interactive touchscreen in my day where I could doodle, I could draw, I could swipe, I could write, I could pull up images from the net and having everything there at my fingertips.” (P10).

While many idea capture tools focus on offering comprehensive overviews of files, they often do not offer the flexibility of moving things around and clustering them, which is a key element of many ideation sessions. Most tools represent single files in their entirety and not parts of files or context of files. This challenge was also described by (Herring, Chang, Krantzler, & Bailey, 2009), who showed how designers experience difficulty with their example storing strategies because they have no way of keeping track of their thoughts at the point of capture. While, for instance, phone dictation is very suitable for quick capture of thoughts while a person is driving a car, an audio file is not an easy modality to work with after the capture, because it has no visual representation. One designer (P7), who used phone dictation for brainstorming with himself on his 45-minute commute to work, explained his frustration with not being able to mark or annotate specific points in the recording, because he would currently have to listen to the entire file to find 30 seconds of interest. Idea management tools in general do not offer ways to filter out selected parts of files, which designers mentioned as a feature they missed on various occasions.

4.3 **Challenge 3: Idea management tools focus mainly on ideas instead of ideation**

A key activity for designers is the process of developing ideas. One designer (P4) deliberately refused to keep any kind of archive of his ideas because he felt like it became a marinating jar where his best ideas would go to die. This designer suggested that maybe designers do not need another brainstorming tool, but rather a tool for moving ideas from paper and out into the world. When we asked designers to imagine tools they would like to use, most suggested some version of an intelligent tool that would be able to help process data to aid their cognition:

“If you don’t have an idea of what filing system you’re going to use, then it can actually be pretty daunting because you start from somewhere and it becomes a really mess real quickly because you have lots of files without categorization file folders or structure (...) I would love that intelligent interface to file my documents and thoughts without me having to think about it, so it’d be based on the content in there or the type of idea that I’m coming up with.” (P10).

Most idea management tools are product-oriented rather than process-oriented, which means they are passive containers of files. In extension to this, idea management tools in general do not promote reflection on the design process or future thinking. While they aid the designer in the creation and overview of files, they do
not actively help the designer reflect. This could be a significant potential for idea management tools and for designers alike. Digital tools have the potential to record and track all ongoing activities of the designer and to use this data in a constructive way. In our interviews with the designers we asked them to share their thoughts on the idea management tools of the future. While some imagined well-defined features like better Natural Language Processing-search and automatic tagging, others called for entire design environments:

“So, it would be something maybe with VR because then I could just ... Okay, now I’m really out there. But something where I could actually draw when I was standing here, so I’m interacting with the pump, I’m building screen by screen and I’m not, again, caught into a tablet. I’m just drawing and (...) And then it would already know how the communication protocols between the pump and this would work. (...) That would be amazing. But that’s- Utopia.” (P15).

What the ideas for novel tools had in common was that they were all process-oriented, which is a finding that has been suggested by previous studies in related contexts (Bernal, Haymaker, & Eastman, 2015; Dow et al., 2006).

5 Discussion and further work
After defining the core challenges described in the previous section, our analysis then focused on the strategies, designers employ to cope with the perceived challenges. In this section, the challenges are interpreted into practical opportunities for next-generation idea management tools (see table 4). These are by no means the only ways of approaching the challenges, but they are suggestions for how to operationalize of a set of potentially abstract challenges.

Although many interesting points emerged from the interview data, this investigation is of course not exhaustive given the vast amount of work practices in the field of interaction design. The next steps in this research are to test these features in practice. Our group is currently working on the development of prototypes that explore the opportunities presented in table 2.
<table>
<thead>
<tr>
<th>Challenge</th>
<th>Opportunities for novel features or tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Idea management tools are rigid in capture medium</td>
<td>Support different modalities of capture and annotation and allow for saving to a shared idea database. Almost all designers described the challenge of their widely distributed idea archives. A consolidated archive from different tools would allow for designers to capture in the appropriate medium while not having to retrieve ideas from several locations. Build systems to tag ideas easier with other context indicators than words: time, place, temporal context, people involved in project, quality of idea etc. Designers currently utilize makeshift signifiers to themselves, such as an arrow in the document title or documents in different colours to achieve different (visual) forms of tagging. Alternative modes of tagging ideas would provide cues for bringing ideas up again in relevant future situations, as well as additional cues for retrieving ideas.</td>
</tr>
<tr>
<td>2: Idea management tools offer inflexible interfaces and representations</td>
<td>Allow for different views of ideas or files within tools, as well as maneuverability of files in relation to each other. Several designers highlighted the advantages of a large touchscreen that let them view many different files at once, as well as move them around. More flexible interfaces might encourage new clustering of files and lead to new discoveries and possibilities.</td>
</tr>
<tr>
<td>3: Idea management tools focus mainly on ideas instead of ideation</td>
<td>Support the gap between capture and refining of ideas. A general finding was that idea management tools do not actively help the designer revisit their ideas or to translate them into actual design project. One way of doing this might be to allow the designer to mark ideas that they would like to get back to, and offer revisiting of the idea, for instance by push-notifications or encouraging the move from note into a sketch and sketch into wireframe.</td>
</tr>
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</table>

### 6 Conclusions

Although some research has cast light on the tools, designers use, no previous studies have thoroughly investigated why designers choose the tools they do to manage their ideas. Our approach was to conduct qualitative studies with professional designers through interviews to discover shared behaviours and perceived challenges they experience with current idea management tools. The study revealed three core challenges for designers as well as opportunities for tool builders of next-generation idea management tools. We concluded that idea management tools are rigid in capture medium, rigid in interface and representations, and that they focus on ideas rather than ideation. We then offered a list of ways to operationalize this knowledge into practical design features or future tools. We hope the challenges and opportunities will inform
builders of creativity support tools in aiding designers’ continuous work with idea management and inspire tool designers to support continuous ideation as well as ideas.

7 References


About the Authors:

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**Steven Dow**: Assistant Professor of Cognitive Science at UC San Diego where he researches human-computer interaction, social computing, and creativity. Steven received the National Science Foundation CAREER Award in 2015 for research on "advancing collective innovation."

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PAPER 4: THE PROBLEM SOLVER AND THE ARTISAN DESIGNER: STRATEGIES FOR UTILIZING DESIGN IDEA ARCHIVES
The Problem Solver and The Artisan Designer: Strategies for Utilizing Design Idea Archives

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ABSTRACT
This paper presents the results of an extensive qualitative study investigating how professional designers utilize personal idea archives. While we know that designers archive creative ideas in different formats and on different platforms, we know little about if and how designers utilize these idea archives in their daily practice. Through a series of interviews (n=20) and walkthroughs of design idea archives, we identified two archetypal strategies. The Problem Solver is concerned with the task at hand, keeps relevant ideas around, and discards them when the ideas have served their purpose. On the other hand, The Artisan Designer systematically archives potentially useful ideas in carefully selected formats and continues developing ideas over extended time spans. We conclude with a discussion about how these different strategies might be supported by technological archiving tools.

Author Keywords  Design ideas; archiving; idea management; design practice.

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

INTRODUCTION
Designers have many digital and analog tools at their disposal for the capture and management of ideas. Such ideas can consist of notes, sketches, as well as inspiration pieces curated over years of creative work [10,19,27,30,39]. Prior research has demonstrated that externalizing and archiving ideas is essential for designers because it allows them to retrace their steps and to reflect on the finished design product as well as the design process and rationale behind key decisions [39–41]. However, we know little about if and how such archives actually function as creative resources in design practice. It has previously been observed that information archives contain dormant information that the owner intends to return to at a later time [2,3], but not much is known about how and if they ever do, or how their archiving strategy influences this. A related strain of research explores how designers use external examples in their creative process [21,27], but it has not been analyzed how designers use their own archives in current work.

In this paper, we explore the questions: which ideas do designers archive, why do they do so, and how might we describe strategies for how designers utilize their archives of design ideas in their current work? Through an interview study with 20 professional designers, we asked participants to open their idea archives to us and to tell us about the contents and purposes of the archives. We asked them how the ideas had already provided value, and whether the ideas had any relevance to the designers’ current work. The study showed that there were two dominant strategies in how designers utilized idea archives. The designers either described their idea archives as something that contributed to solving a specific design problem, and which would be discarded once it has served its purpose, or as expressions of ongoing creative practice that the designers wished to return to and develop further. We named these strategies after two of the designers’ own self descriptions: The Problem Solver and The Artisan Designer.

Throughout the paper, we use the term idea archive to refer to an either analog or digital collection of ideas that designers have shown us upon request. We deliberately let the designers themselves define the term, because we were interested in their understandings and reflections on archiving practice. The research focuses on professional digital designers, that is, designers who use digital tools to ideate for and/or give form to products, environments, systems, and services with careful attention to forming or transforming the user experience [8,17].

This research contributes to our understanding of how professional designers work with ideas in practice, and how archiving formats affect this practice. Based on our descriptions of the two archetypal strategies, we discuss different implications for the design of archiving systems, that may support designers in utilizing their idea archives. Our analysis of idea archive utilization in practice is mainly written for researchers in design processes and creativity

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support, while the design implications may be relevant for developers of creativity support tools and methods.

BACKGROUND

In this section we introduce a selection of research within the field of personal information management (PIM), which our analysis of design idea archives builds upon. Personal Information Management refers to both the practice- and study of acquisition, storage, organization, retrieval, use, and distribution of information needed to complete certain tasks, and is often oriented towards the study of technological support for such tasks [28]. Because the concept of idea is ambiguous at best [24], we present a selection of frameworks from research on general information archiving which lend themselves well to our research. After this introduction, we will highlight some of the qualities, we believe, make design idea archives a particularly captivating field of research.

Knowledge workers build archives of information both digitally and physically [32,35,38]. Several in-depth studies have been conducted on how office workers manage information, often involving extensive ethnographic field work. As technology has advanced and we have more tools and systems than ever available to manage our personal information, it does not necessarily lead to increased satisfaction for many workers. On the contrary, many studies have found that people experience frustration with information becoming fragmented [3,28].

Knowledge workers have been shown to judge the adequacy of their archives on how well the archive help them identify and keep what they have decided to keep, and to display what they need to display, rather than the efficiency of information retrieval [29]. Barreau & Nardi [2] found three different types of information in their comparative study of archiving practices: ephemeral (which has a short shelf-life and includes items like to-do-lists and news articles), working (frequently used information which is relevant to current work and has a week- or month-long shelf life), and archived (which is often kept around for months or years but rarely accessed). One of the main conclusions of their two studies was that the way information was used, was a primary determinant of how it was organized, stored, and retrieved [2]. In a later study by Boardman & Sasse [3], archived information was further divided into four categories based on its usefulness: active information (which consists of ephemeral and working information), dormant information (which is currently inactive but could potentially be useful), not useful information, and un-assessed information, for instance new emails.

Archives serve much more than purely functional purposes. Kaye et al. [29] identified the following goals for archiving, that were all based on value rather than efficiency: building a legacy (archives constructed to let visitors take a visual sweep of the room for an insight into the important aspects of the subject’s personality and life work), sharing

<table>
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<tbody>
<tr>
<td>- Ephemeral</td>
<td>- Active</td>
<td>- Building a legacy</td>
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<tr>
<td>- Working</td>
<td>- Dormant</td>
<td>- Sharing resources</td>
</tr>
<tr>
<td>- Archived</td>
<td>- Not useful</td>
<td>- Fear of loss</td>
</tr>
<tr>
<td></td>
<td>- Un-assessed</td>
<td>- Identity construction</td>
</tr>
</tbody>
</table>

Table 1: Overview of terms in PIM

Managing Design Ideas

A commonly accepted definition of design ideas is that they are produced by retrieving information from the long-term memory system, and processing this information further [16,37]. Design ideas evolve from conceptual abstractions to increasingly concrete representations, illustrated by e.g. Löwgren & Stolterman’s description of the move from vision through operative image to specification [34]. While there is not agreed upon, rigid understanding of what exactly constitutes a design idea, recent research has identified four types of design ideas prevalent in research: (re)framings of the problem, opportunities, suggestions for part solutions, and suggestions for solutions. These can be understood of different manifestations of design ideas as we can observe them [24].

Documentation of design ideas is not only instrumental in terms of reporting facts and findings, but the act of documenting in itself can be generative and lead to new insights and ideas [1]. Many studies of externalizations of ideas have shown that they allow the designer to not only reflect on the product, but, and perhaps more importantly, to reflect on the design process and rationale behind key decisions [39–41]. In one such study, Gaver [19] demonstrated how sketchbooks ensure that designers do not discard unused ideas, but may return to them years later, and how design workbooks (collections of design proposals and other materials drawn together during projects) served as collective archives of extended thought processes.

The value of a design idea is dependent on the context it is to be employed in, giving designers a reason to store interesting ideas until they are in a position to use them [10,25]. The work of a great designer is extensively based on experience from similar design cases - often more than it is based on theoretical knowledge [18,43]. Buxton [6] argues that it often takes a decade for a good idea to have practical value in the world, which makes careful idea management pivotal to the designer. Formats and media in which designers capture and document their work come to influence how they frame and explore potential solutions.
An illustrative example of the importance of archiving systems is reported in the research of Herrings et al. [21] which showed that designers often have difficulty remembering why they store examples because archiving systems only allow them to store the entire example even when they only found a particular piece interesting. Erickson [15] found that a tool that led to high quality notes created a synergistic loop: “Because the quality of my notes is higher, I reference (and reuse) them more (...). Also, the increased quality means that I am more likely to understand them when I look back at them after six months. (...) the more use I get out of them, the more effort I’m willing to put into them”. Based on previous research, design idea archives could potentially be a useful creative resource. We see a promising line of research in investigating whether practicing designers actually use their idea archives in current work.

**METHODOLOGY**

We conducted in-depth interviews with 20 professional designers to learn about their practices for utilizing their own idea archives. The designers came from the United States, Germany, and Denmark. An overview of the demographics and professional fields of the participants can be found in Table 2. Each interview lasted between 45 and 80 minutes and consisted of a semi-structured question section inquiring about which tools they use to capture, manage, retrieve and collaborate on ideas, followed by an open-ended query for narrative descriptions (“Take me through your archives, we also took photos. We focused on the following themes:

- What was in the archives? Notes, pictures, etc.
- Did the designers remember the ideas?
- Did the designers discover anything unexpected?
- Were the ideas relevant to the designers in their current projects?

During the walkthroughs of archives, we asked the designers to think aloud and asked them encouraging questions such as “What are you thinking about when you look at these ideas?” and “How do these ideas relate (if at all) to your current projects?” As the designers were taking us through their archives, we also took photos. We focused on the following themes:

- What was in the archives? Notes, pictures, etc.
- Did the designers remember the ideas?
- Did the designers discover anything unexpected?
- Were the ideas relevant to the designers in their current projects?

The walkthrough allowed us three additional perspectives to the interviews. Firstly, it let us see the contents and structure of archives ourselves. Secondly, it reminded the designers about archives they had not previously remembered. And thirdly, it confronted the designers with old content they had forgotten about, invoking different feelings of nostalgia, excitement and surprise. During the walkthroughs, the idea archives performed very well as temporal anchors [23,42].

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age/Gender</th>
<th>Design Experience</th>
<th>Work Experience</th>
<th>Background/Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Female, 20s</td>
<td>Works in a large IT-providing company</td>
<td>3 years of UX experience, 9 years of total design experience</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>Male, 30s</td>
<td>Background in Computer Science</td>
<td>Has worked with game design but currently works in academia</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>Male, 30s</td>
<td>Game designer, SCRM-responsible for his team</td>
<td>in a game development company</td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>Male, 40s</td>
<td>CEO of large, world-wide design company</td>
<td>Works with design strategy</td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>Male, 40s</td>
<td>Freelance graphic and UX designer</td>
<td>15+ years of experience</td>
<td></td>
</tr>
<tr>
<td>P6</td>
<td>Male, 20s</td>
<td>Works as an interaction-/product-UX designer</td>
<td>at a design agency</td>
<td></td>
</tr>
<tr>
<td>P7</td>
<td>Female, 30s</td>
<td>UX designer at a medium-sized design agency</td>
<td>7 years of experience</td>
<td></td>
</tr>
<tr>
<td>P8</td>
<td>Male, 20s</td>
<td>Product designer/interaction designer with a focus on software design and experience design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P9</td>
<td>Male, 40s</td>
<td>Founder and CEO of medium-sized design company</td>
<td>Background in graphic and web design</td>
<td></td>
</tr>
<tr>
<td>P10</td>
<td>Male, 40s</td>
<td>Leading design strategy at a medium-sized</td>
<td>Working closely with clients, 16 years of experience</td>
<td></td>
</tr>
<tr>
<td>P11</td>
<td>Female, 20s</td>
<td>Experience Designer at a software company</td>
<td>Focus on visual design</td>
<td></td>
</tr>
<tr>
<td>P12</td>
<td>Female, 20s</td>
<td>UI and strategy designer for some app</td>
<td>7 years of UX design experience, with a background in visual design</td>
<td></td>
</tr>
<tr>
<td>P13</td>
<td>Male, 30s</td>
<td>Freelance brand designer and artist</td>
<td>Works a lot with space and wayfinding design, 11 years of experience</td>
<td></td>
</tr>
<tr>
<td>P14</td>
<td>Female, 20s</td>
<td>Interaction designer at an IT-provider, focus on interface design and service design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P15</td>
<td>Female, 20s</td>
<td>UX and UI designer at a large industrial</td>
<td>Background in sociology</td>
<td></td>
</tr>
<tr>
<td>P16</td>
<td>Male, 30s</td>
<td>Works as a UX designer in a digital agency</td>
<td>Background in multimedia design</td>
<td></td>
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<tr>
<td>P17</td>
<td>Male, 20s</td>
<td>Works as a product designer for a startup that develops a sharing economy-based app</td>
<td>Background in advertising</td>
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</tr>
<tr>
<td>P18</td>
<td>Female, 40s</td>
<td>UX designer for a large e-trade company</td>
<td>10+ years' experience, educated in digital design</td>
<td></td>
</tr>
<tr>
<td>P19</td>
<td>Male, 20s</td>
<td>Under education as a UX designer</td>
<td>Has a long-term student job as a designer for a large international company</td>
<td></td>
</tr>
<tr>
<td>P20</td>
<td>Male, 30s</td>
<td>Works as a 3D product designer for a small company that specializes in product design, Background in industrial design</td>
<td></td>
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</tr>
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</table>

Table 2: Overview over interview participants.

**Participants and Demographics**

We interviewed 14 male and 6 female designers, predominantly working with some form of interaction-, or digital design. Participants were recruited via the authors’ personal networks, mailing lists, and Facebook groups for professional designers. The age span was between early 20s and late 40s, with experience in design between 2 and 11+ years. Some of the participants were self-taught, but most had an educational background in design. They worked
with graphic design, product design, UX design, game design, and in companies of varying sizes. All the participants said they had devoted a significant amount of attention to their idea management practice.

Coding and Analysis
All interviews were transcribed and coded with a grounded theory-approach [11,20]. We did a coarse segment selection of everything where the designers explained or showed something about the use of their archives as part of their work. The research question was meaningfully explored at a relatively coarse granularity because the practices around idea archiving are not isolated, but most meaningfully understood as part of a whole design process. From the initial segments we discovered a main surprise: there were at least two designers who said they did not at all use archiving or archived ideas, contrary to our expectations. These designers were very particular about why idea archives were not important to them. Therefore, we developed the following categories from the data:

- Contents of idea archives
- Ideas that were not archived
- Situations where archives were/were not useful
- Goals of utilizing/not utilizing archives

Our findings are presented in the following sections. The first section presents a glimpse into the contents of idea archives, as these were determining factors of if and how designers returned to them later. The second section of findings describes the two archetypal strategies for utilizing idea archives.

FINDINGS I: CONTENTS OF DESIGN IDEA ARCHIVES
What Do Designers Archive?
The designers’ idea archiving practices were extensively individually appropriated. This is mirrored in the vast amount of different idea archiving systems and tools. Previous research has shown that the format of the archive is largely determined by how it is going to be used [2,28], and we therefore looked the formats and contents of archives as an indicator of strategies for reuse. 6 out of 20 designers had put a what we would deem as a significant amount of effort into designing an archiving system that was intended to assure they could keep developing a large repository of ideas over time. All designers used systems that were convenient for quick cognitive offloading, but not well suited for retrieving (see vignette 1 for an example of a designer that deliberately kept no archive of his ideas).

The designers’ interpretation of idea archives spanned over to do-lists, sticky notes, sketchbooks, email accounts, bookmarks, Evernote notebooks, Trello Boards, Dribble accounts, and many other formats (see [26] for a detailed descriptions of these tools), which echoes the various definitions of the concept “idea” throughout the theoretical landscape [24]. The contents of archives, however, were separable into four primary categories:

1. Old project files
2. Notes and recordings from meetings
3. Action items (tech specs or "to do's")
4. Inspirational examples

Vignette 1: Avoiding archiving all together
Designer P4 is an experienced designer leading one of the largest design companies in Europe. He has many years of experience in different types of design but has been increasingly focusing on company strategy. He puts an effort into keeping his ideas alive by deliberately not archiving them. He highlights his Notes app as his preferred tool for idea capture, because of its simplicity, and the fact that he does not have to wait for his idea to move from one interface to another. He says Slack is now the company’s primary idea tank because the ideas live and develop more organically. He considered starting a Slack channel to use as an idea box but discarded the idea because he says such a place would become a marinating jar where good ideas would go to die and never be advanced.

For practical examples of the categories, see figure 1-4. The categories correlate with the types of information found in earlier studies - old project files (1) would normally be archived information, notes and action items (2,3) would be ephemeral information, and inspirational examples (4) would be either working or archived information [2]. One designer described the differences between his archives in a temporal perspective (see vignette 2 for an elaborated description of this designer’s archiving system): “These things that I put on my post-it notes are more like a to-do list. More short- to mid-term stuff. I have an item on there, and I have to fix it somehow (...) The database is more stuff that someone else under my supervision can do. (...) It’s more like long-term memory, stuff that I want to get out of my system” (P2).

Figure 1: Old project files. Several stages of concept development for a chair design (P20).
The four categories of archived ideas fall in two temporal groups. Whereas old project files and notes belong to or describe the past, action items and inspirational examples are directed towards the future. Old project files and notes are often documentation of already implemented ideas. Action items are things that the designer needs to move forward somehow, and inspirational examples are items that might become useful at a later time. The latter fit the term dormant information [3], where the designer has not yet been able to determine the usefulness.

15 of the designers described keeping both self-created ideas (ideas that the designers had either written down, sketched, or photographically captured themselves, and bookmarked ideas (ideas that were saved from elsewhere, rather than created by the designer themselves, often photos or screenshots of other design cases). This observation agrees with recent findings about how designers manage inspirational material [3,27].

All designers had several design idea archives to show us, often both analog and digital archives. The distribution of ideas across archives was experienced as frustrating by several of the designers, some of whom had developed advanced methods for consolidating their ideas into a single database (see vignette 3 for an example of a system built around an email account). 7 of the designers said that it was frustrating that their ideas were distributed across archives, because they could not always find their ideas when they needed them. For instance, most archives were mostly passive repositories, in the sense that designers would actively have to access and search them to retrieve content. 3 participants expressed that it could be interesting for ideas to be resurfaced by push functionality instead of pull: “I wanted to be reminded of these things at some point in time. (...) it would be cool to be able to see those things brought up to me without me looking for them” (P6).

The walkthroughs also revealed that some designers wanted the complete opposite of being reminded - or at least they wanted to have the choice. At least one designer spoke about deliberately choosing the format of their idea archive because it allowed her to discard ideas: “This [notebook] makes me more depressed, because it does not have a spiral binding, so I can’t tear out the pages. It is a different commitment. (...) I threw out some post its the other day and thought ‘shit, that was a stupid idea’. It can be annoying to be reminded about it. Like old love letters” (P18).

Where some archives contained primarily ephemeral and working ideas, some contained mostly dormant and archived ideas. These contents mirrored the designer’s intent to utilize the archives again. The designers either described their ideas as something that contributed to solving a specific design problem, or as works of creative practice that they might wish to return to and develop, but never as both.
P10 is an educated game designer, and currently works in research. He is an experienced developer. His archives of ideas are purely digital. On his desktop, he keeps digital sticky notes with action items. It is important for him that they are in his face, that he will see them every time he opens his computer. Therefore, he synchronizes his sticky notes with Evernote, and therefore immediately visible, on his phone as well. He has built a complex system where his sticky notes synchronize with Evernote, and his Evernote phone app can push these sticky notes to his phone intro screen. On a safe server, he has built a purely text-based database of ideas for potential future projects. The database is integrated with an NLP system, which lets him search for words that are not directly in the text, allowing him to retrieve related entries without having to type the exact words in the original entry.

The terms are not meant to segment designers into two different groups of practitioners. Rather, they are meant as archetypal descriptions of two ways of working with design archives. Both strategies may be carried out by the same person at different times or as consequences of changing job responsibilities. The strategies should be understood similarly to de Bono’s different thinking hats: the designer can engage in several modes of thinking to be able to tackle different kinds of situations [5], however the strategies presented here are empirically observed, rather than a prescribed or constructed method for practice.

The Problem Solver
The Problem Solver mostly uses ephemeral and working information archives (short- and mid-term). The Problem Solver is primarily oriented towards solving concrete design problems, and therefore less dedicated to storing ideas for potential future use. The Problem Solver generally discards ideas or inspiration when they have served their purpose: “I was making a contact form, and then I would look at other contact form sites and have them as open tabs while I was working. So I didn’t save them, and then I would close the tabs when I was done” (P18).

The group of designers in our study who described utilizing primarily the problem solving-approach to their design idea archives were approximately half the designers: (P1,4,6,8,9,11,14,15,16,17,19). This group described getting more ideas when actively engaged in design work rather than when outside of the work setting. This contradicts earlier findings that indicated that ideas of creative practitioners often emerged outside of the work setting [10].

If the Problem Solver utilize their archives it is for vertical thinking, investigating similar solutions to a concrete problem they are currently working on. One designer described that his design work was more often concerned with looking at data about how customers use their product, and figuring out ways to optimize this use, than with developing new ideas: “Here [in product design], it’s very difficult to separate the ideation phase from the design phase. It’s a lot more mixed together. (...) Design is
dedicated towards solving a problem, and it is not so much about your own style.” (P19).

Because the Problem Solver is often looking for specific things in their archives, they prefer search over browsing for retrieval of ideas. They generally write more than they sketch, and their archives contain mostly project relevant files and action items regarding decisions and specifications. This is because the Problem Solver discards inspiration and information after they are done with it.

It does not mean that the Problem Solver would never look at old ideas. They would just often be files or manifestations of already implemented projects. These were sometimes revisited by the designers to look for opportunities to reuse the original idea: “What did you learn when you looked back and that old journal idea? More to kickstart the ‘is it feasible, conceptually?’ To set a mood. Light candles on a date. Kickstart something. The critical questions I can easier ask myself when I see it” (P17).

The Artisan Designer

The group of designers who utilized primarily an artisan designer-strategy in their idea management were designers (P2,3,5,7,10,12,13,18,20). While the Problem Solvers tended to work in UX or product design, the designers who utilized the Artisan Designer strategies were often graphic or experience designers: “I call myself an artisan designer. Capturing ideas, one at the very least even if you’re not initially doing it, it tells you...It’s history of where you’ve been and what you’ve been thinking about.” (P13). The Artisan Designer utilize their archives a lot for keeping dormant ideas around over extended periods of time.

The designers who utilized the Artisan Designer strategy liked to randomly flip through their old archives for the potential of serendipitous discovery, corresponding to a preference of browsing over search for retrieval [3]: "Often when I flip through that notebook, I come across some things that, like, wow, that was intelligent, did I say that?" (P2). The Artisan Designer utilizes their archives while they are engaged in lateral or divergent thinking [4,36], to search for inspiration or opportunities to develop old ideas. In the archives of these designers, we more often saw inspirational examples and notes for undeveloped ideas.

The Artisan Designer, like the creative practitioners in Coughlan & Johnson’s study from 2008 [10], often gets ideas outside of the work setting, making the right mode of capture very important. One designer thus described using audio recording in his car during his 45-minute commute, which he used as an opportunity to think out loud and discuss and develop ideas with himself.

The Artisan Designer doodles more and does not like to throw away notebooks. They take pride in their idea archives, often displaying them as a legacy or identity construct, as described by Kaye et al. [29]. The Artisan Designer develop their ideas over extended periods of time, making sufficient archiving practices very important.

DISCUSSION

Our study uncovered some, for us at least, surprising insights into how designers utilize or do not utilize their idea archives. In what follows, we discuss the findings and their potential implications for tools and systems for archiving.

As previously described, The Problem Solver and The Artisan Designer are not mutually exclusive roles, but a way of conceptualizing different strategies and thus needs for designers that utilize their archives. The Problem Solver, for instance, is mostly concerned with finding what they need quickly and utilizing that information efficiently. The Artisan Designer is open to detours when looking through their archives, and often equates “ideas” with “inspiration” or “examples” [21,27]. In table 2 we present an overview of how novel archiving tools might differ in aims to accommodate the two strategies.

Table 3: Design implications for archiving systems

<table>
<thead>
<tr>
<th>Problem Solver</th>
<th>Artisan Designer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Productivity goals</strong></td>
<td>Solving concrete problems</td>
</tr>
<tr>
<td><strong>Value-goals</strong></td>
<td>Sharing resources, identity construction: “I am a structured person”</td>
</tr>
<tr>
<td><strong>Priorities</strong></td>
<td>Efficacy</td>
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<tr>
<td><strong>Challenges</strong></td>
<td>Retrieving information</td>
</tr>
<tr>
<td><strong>Design potentials</strong></td>
<td>Consolidating ideas into easily retrievable archives</td>
</tr>
</tbody>
</table>

Archives serve different purposes for different designers at different times. Current archiving software generally supports primarily archiving where the designer knows if and when they would like to be reminded, and labelling (tagging) where the designer already knows how they might search for the idea in the future. No archiving software supports random unarchiving. Creativity is unpredictable, but most digital archiving tools to date have concentrated on the value of “finding it later” [29]. This is great for the Problem Solvers of design, and very few of the designers who employed this strategy mentioned shortcomings in the tools at their disposal. If they did, their challenges most often concerned their own cognitive limitations, for instance, forgetting which name they filed something under.

Previous research has highlighted that labelling and tagging systems only make sense when the user knows exactly with what purpose they are filing the information for [31]. In some examples of such studies, it has been shown that the
experience of unexpected discoveries that old ideas bring stimulates putting more effort in creating new entries.

Interestingly, it seemed like there exists a bias from designers themselves towards Artisan Design strategy being the more correct one in terms of being 'a good designer'. More than three designers said straight up that they felt they should revisit their ideas more often than they actively did: "I mean I would love to think that I have one place where all my amazing ideas live, those ones that I haven’t got to or I haven’t had time to think about, but in my work day, ideas are distributed" (P5). This finding correlates with Malone's [35] discovery that people tended to think filing (immediately archiving most incoming information) was a superior approach to piling (keeping working information around the physical workspace in stacks). Some designers had even taken measures to try to make their process more similar to how they “used to be” at times when they had worked more as Artisan Designers: “I bought an iPad Pro at some point, thinking I would get back to my old self, where I would be sketching ideas, but it didn’t really happen. I’ve become such a writing-type” (P4).

In our study we focused primarily on unearthing the designers' values, views, understandings, experiences and opinions rather than drawing general conclusions. It is plausible that these strategies are expressions of work functions and workplace expectations, more than of any personal preference for idea archiving. For instance, a recent UX industry report with over 750 participants, highlighted the following skills as most important for entering a UX team: research and analysis experience (26%), experience working with a team (21%) and prototyping skills (19%) [33]. Creativity was not mentioned as a primarily desired skill in UX design in this report. Whether the idea archive utilization strategies correlate with professions or even company work styles is an interesting avenue for future research.

In general, we gathered a very rich data set, and the combination of interviews and walkthroughs reached a convincing level of depth and complexity that would not have been available with other, for instance, survey-based approaches [7]. The findings contribute to our current understanding of design practice. Clearly, there are different ways to commit design work - or significant differences in design job descriptions. The findings incite us to ask: is it that designers actually need and are being asked to do in contemporary practice in industry? What does it mean to be a designer as a profession, if not a creative practitioner? If several professional designers identify as designers, but not as creatives, do we need to detail our theoretical understanding of design work as a creative practice? We are enthusiastic about exploring these and related questions in future work by comparing different work practices in long-term observational studies.

CONCLUSIONS

In this paper we presented a study of professional designers’ utilization of personal idea archives. We identified two sets of findings: firstly, designers idea archives consisted of four main categories of contents: Old project files, notes and audio recordings from meetings, action items, and inspirational examples. These contents mirrored the designer’s intent to utilize the archives again. The designers who showed us ephemeral and working ideas often had no intentions of utilizing these ideas in the far future. The designers who showed us archived and dormant ideas had already been utilizing these archives in their work or intended to do so in the future.

Secondly, we named these two different strategies for utilizing idea archives accordingly to the designers’ own descriptions. The Problem Solver is concerned with the task at hand and discards ideas when they have served their purpose, and The Artisan Designer systematically archives potentially useful ideas in carefully selected formats.

Finally, we ended with a discussion of how the implications of the findings to digital archiving tools in terms of productivity goals, value-goals, priorities, primary challenges, and design potentials for the Problem Solver and the Artisan Designer, respectively.

REFERENCES


PAPER 5:
SUPPORTING REFLECTIVE USE OF DESIGN IDEA ARCHIVES USING EMAIL
Supporting Reflective Use of Design Idea Archives Using Email

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Abstract
In this paper, we present the findings of a pilot study where we randomly resurfaced professional designers’ own archived ideas to them over a period of three weeks. We find that resurfacing ideas can provide reflective and creative value to designers by encouraging them to reflect on their old ideas, reflect on themselves as practitioners, and as motivation to pick up forgotten or dormant ideas.

Author Keywords
Design ideas; creativity support; resurfacing ideas; reminiscence; idea management.

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

Introduction
Capturing and archiving ideas is essential for creative designers for reasons beyond memory aid. Archives of ideas allow designers to retrace their steps and to reflect on the finished design product as well as the design process and rationale behind key decisions [7,17]. Designers and many other creative practitioners build repositories of dormant or potentially useful ideas, that they may or may not return to [3]. Previous research has studied how designers use external
examples as part of design practice [6], but it has not been explored if and how designers use their own, personal idea archives in their daily design practice. In this paper we explore the following question: How might resurfacing old ideas to creative designers in a random fashion support utilization of their personal idea archives? We use an email account to do this, as it is a system integrated into most professional designers’ work practices, and as simple messaging systems have previously proven to be a successful mode of supporting joyful reminiscence [2]. We focus on designers because we are interested in encouraging reflective design practice [17] which may be threatened by increasing requirements of efficiency and productivity. This research is a pilot study to provide insights for developers of creativity support tools, notetaking tools and similar systems, that hold potential to support a more long-term reflective practice with different forms of idea archives.

Background and Related Work
Designers build archives of personal information both digitally and physically [14,7]. The long-term value of archives for designers is highlighted by e.g. Gaver [5] in his work about design workbooks: “By serving as archives of a thought process that may extend over a long period, sketchbooks ensure that we do not discard unused ideas, but may return to them years later”. Kaye et al. [10] showed that archiving serves a number of value-based goals, for instance building a legacy (showing the subject’s life’s work) and identity construction (archiving used as an expression and crafting of identity). The study concludes that most personal digital archiving tools to date have concentrated on the value of ‘finding it later’, and not invested much in addressing these value-based goals.

Kidd [12] also expressed a pledge for computer support for knowledge work to be better targeted on the act of informing rather than on passively filing large quantities of information.

While earlier work about design ideation has shown that being exposed to others’ ideas can be useful in terms of increased productivity [e.g. 16], it has not yet been studied whether exposure to one’s own ideas has any effect on ideation. Some anecdotal evidence suggests that it does. For example, Johnson [9] stated the importance of routinely reading through his archive of ideas every three months: “It feels a bit like you’re brainstorming with past versions of yourself”. Erickson [4] found that revisiting high quality notes created a synergistic loop: “Because the quality of my notes is higher, I reference (and reuse) them more (...). Also, the increased quality means that I am more likely to understand them when I look back at them after six months. (...) the more use I get out of them, the more effort I’m willing to put into them”. Some studies have shown positive results of emailing random memories to people, and that such prompts are very well received as encouraging nostalgic reminiscence [2, 15]. In this work we are interested in appropriating similar prompts to support reflective design practice.

Method
We asked five professional designers (see sidebar for details) to share an idea archive of their choice with us. The participants were encouraged to interpret “idea archive” as they preferred. From these archives, we selected different chunks of information (some examples are provided in the second sidebar) and emailed them back to the participants at random times throughout the day, app. one idea per day. In the
emails, we asked them two or three open-ended questions such as “What is the best/worst thing about seeing this idea again?”. We were interested in the types of reflection the ideas inspired (if any), and we tried to ask different forms of questions to encourage different responses each time. We received a total of 40 responses to the 40 emails we sent. The archives we received were a combination of physical notebooks, Evernote archives, Google Docs, and Trello boards. Some of the archived ideas were clearly delimited and defined by virtue of their format (e.g., one Trello card or one Evernote note per idea), and some ideas were part of larger documents. When the latter was the case, we tried to isolate single ideas by blurring out the rest of the page or document. The idea delimitation was based on subjective assessment by the authors. The emails were sent from an account created for the purpose of the study: the IdeaBot. This name was chosen to encourage the participants to imagine that this was an automatized system rather than a human sender.

Following the three weeks, we sent the participants a questionnaire about their general evaluation of the study, with questions like: “What did you generally think about receiving your old ideas again?” and “What did you think about email as a format?”. The total responses were analyzed with a focus on emerging themes and surprising elements—either to us or the participants themselves [1]. Our overall goal was not to draw general conclusions but to unearth creative inspiration, considerations, and questions.

Findings

Four out of five designers said they enjoyed seeing their ideas again—in some cases for purely nostalgic reasons. One designer (P2) said that they would like to keep receiving ideas from IdeaBot permanently if they could. The fifth designer (P4) said it didn’t spark any reflection because their notes were written as design documentation during meetings and school assignments and served a purely functional memory-aiding purpose, rather than a creative one. Whether the archive the designer shared with us can actually be described as an idea archive is a relevant question of definition [8], but one that we will not explore further in this work.

Finding 1: Resurfacing Ideas Can Prompt Reflection on the Idea

Resurfacing ideas can spark further reflection on the individual idea. One designer (P2) described sitting at the hairdresser on the same day as he received our prompt email and thinking about how he could implement the idea. He described three other domains where the original idea might also be useful. Following the three weeks, we sent the participants a questionnaire about their general evaluation of the study, with questions like: “What did you generally think about receiving your old ideas again?” and “What did you think about email as a format?”. The total responses were analyzed with a focus on emerging themes and surprising elements—either to us or the participants themselves [1]. Our overall goal was not to draw general conclusions but to unearth creative inspiration, considerations, and questions.

Finding 2: Resurfacing Ideas Can Prompt Reflection on the Self

Resurfacing ideas can spark reflection on the designer’s self, and where they are in terms of personal and professional development. Designer P5 described that seeing his old notes was a positive reminder about his
own development and approaches that had kept consistent over his years of work: “The model shows a writing process, from collecting and structuring research material to writing the first draft, getting feedback, revising and creating the final text. The best is probably that my writing is still working like that”. Reflection on the self is a different reflection level from reflection on the specific idea and can serve the purpose of developing the designer’s creative confidence [11].

Finding 3: Resurfacing Ideas Can Motivate the Designer to Work on an Idea They Had Forgotten
As well as inspiring the designer to pick up a dormant idea, resurfacing ideas also has the potential to remind the designer about completely forgotten ideas. The format of this study meant designers had picked the idea archives themselves, and thus had recently been reminded of their existence. However, for the designer who provided us with a physical notebook, we saw several examples where he had completely forgotten the entries. Designer P3 replied to one email that he wished he would see the idea again at a point where he had the time to develop it: “[The idea] prompts me to remember a book I’ve read, that I can also draw inspiration from. The best about the way the idea is written is that it is short and precise, and that the reference to the book reminds me where the idea comes from. Without the reference I am not sure I’d be able to remember what the premise of the idea was”.

Limitations and Future Work
We are mindful that the format of the study does not allow for broad generalizations, and that the study setup may have affected the participants’ experience. The participants were asked to answer questions about their ideas, which might have prompted more or different reflection than would have been the case if they had passively received the idea. Several of the responses also said that the specific idea in that email was not particularly valuable. Filtering how much and which “chunks” of idea entries to resurface is the most significant challenge of a system like this. We imagine a latent necessity in providing enough (and the right) context to situate the idea. Two challenges in particular are yet to be explored in this line of research: How do we determine what is an idea and what is not, and how do we determine the best time and context for archived ideas to prompt creative reflection? We do, however, see significant potential for archiving tools to encourage and support reflection in practice by the random resurfacing of archived ideas.

Conclusions
In this paper, we presented the findings of a pilot study where we resurfaced professional designers’ own archived ideas to them over a period of three weeks. We found that even in the relatively simple frame of this study, resurfacing ideas can encourage creative reflection on several levels. Designers especially found value in reflecting on their idea in itself, in reflecting on their personal and professional development, and in sudden motivation to work on an idea they had left dormant for a while. We find these results very promising for developers of creativity support tools as well as idea management tools.

Acknowledgements
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References


PAPER 6: HOW INTERACTION DESIGNERS USE TOOLS TO MANAGE IDEAS
How Interaction Designers Use Tools to Manage Ideas

AUTHOR ONE, University one
AUTHOR TWO, University two

This paper presents a grounded theory-analysis based on a qualitative study of professional interaction designers (n=20) with a focus on how they use tools to manage design ideas. Idea management can be understood as a subcategory of the field Personal Information Management, which includes the activities around capture, organization, retrieval, and use of information. Idea management pertains then to the management and use of ideas as part of creative activities. The paper identifies tool-supported idea management strategies and needs of professional interaction designers, and discusses the context and consequences of these strategies. Based on our analysis, we identify a conceptual framework of ten strategies which are supported by tools: saving, externalizing, advancing, exploring, archiving, clustering, extracting, browsing, verifying, and collaborating. Finally, we discuss how this framework can be used to characterize and analyze existing and novel idea management tools.

CCS Concepts: • Human-centered computing~User studies

KEYWORDS
Idea management; design ideas; design process; design tools; ideation

ACM Reference format:

1 INTRODUCTION

The fields of HCI and interaction design are well-known for studying impacts of novel interfaces and tools, and perhaps less known for studying the impact of tools that are already utilized in professional practice (Smith et al. 2009; Pedersen et al. 2018; Dalsgaard 2017). In the words of Stolterman, this often leads to research outcomes that are difficult to apply in practice, because the research is based on an inadequate understanding of how design happens in professional settings (Stolterman 2008). Therefore, discovering, analyzing, and discussing how professionals already use tools is critical in scaffolding the disciplines of interaction design and HCI research, as well as in moving the fields forward. In this paper, we investigate the question: how do professional interaction designers use tools to manage ideas, and how might tools be characterized in terms of the way they are used in practice, rather than by their functional properties?

Interaction designers face various challenges when working with tools, among these organizational barriers, the ever-changing state of technology, as well as technical difficulties (Dow et al. 2006). They work with digital materials on a daily basis, and they employ an extremely versatile assemblage of digital and analog tools throughout their career. Interaction designers have a broad array of analog and digital tools available to aid their idea management, from sticky notes and notebooks to software applications such as Evernote and Trello. Tools are distinguished by their ability to support and extend the limited cognitive systems and abilities of humans, and previous research has shown promising results in their support of creative cognition (Smith et al. 2009).

1.1 Motivation and positioning

The framework presented in this paper is developed to assist researchers and tool developers in understanding the nature and influence of idea management tools in professional design work. The framework is intended to support and inspire researchers within interaction design and
HCI in analyzing, characterizing, and evaluating any given digital or analog tool in terms of the role the tool plays in professional idea management. Idea management is just one of many aspects of interaction design practice, and this paper contributes to a discussion of how to support creative practices in professional settings. Creativity support tools can be generally defined as tools which support and extend their users’ ability to make ‘creative discoveries’, whether they support the stages of gathering information, generating hypotheses, imagining and refining solutions, or disseminating and validating concepts (Shneiderman 2009) Current research in tool development does not provide many guidelines for how to design creativity support tools according to Shneiderman, however the potential is immense: “creativity support tools enable discovery and innovation on a broader scale than ever before; eager novices are performing like seasoned masters and the grandmasters are producing startling results. [...] The risks are high and the scientific methods novel, but the payoffs are substantial in bringing about thrilling moments of scientific discovery and engineering innovation” (Ibid.).

For the sake of clarity in our analysis, we use the following descriptions of the general term ‘tool’:

**Platform**: Platforms can ‘host’ or encompass several other tools. Examples would be ‘computer’, ‘smartphone’, or ‘pen and paper’ (the latter of which can in practice mean everything from sticky notes to sketchbooks). We use the term to indicate on which platform a tool is used when the tool is cross-platform, for instance Evernote or Notes, which can be used on both smartphones, tablets, and laptops.

**Tool**: When we speak of ‘tools’, we mean a tool which serves a well-defined purpose for the designer, and may run on several different platforms. Examples would be different software applications (Evernote, OneNote etc.) or variations of analog tools (notebook, sticky notes, whiteboard etc.).

**Auxiliary tool**: A fine-grain description of tools, more commonly used by researchers than practitioners, those in our studies at least. This definition is sometimes used by researchers to describe: “individual tools within design applications such as Adobe Illustrator and InDesign. [...] individual panels and commands such as color pickers, alignment commands, levels panel, Adobe Photoshop filters, etc.” (Maudet 2017).

Our research is primarily focused on the mid-level tools, because that description corresponds to our study participants’ understanding of the word. A body of work has previously explored how we might develop auxiliary digital tools to function across different software applications, which we find an interesting line of research (e.g. (Ciolfi Felice et al. 2016; Jalal et al. 2015; Maudet 2017; Maudet et al. 2017)), but which we do not explore in this paper.

In this paper, we systematically analyze how and why professional interaction designers use tools to manage design ideas. The paper offers three contributions: 1. It provides descriptive insights into how professional designers use existing tools to manage ideas. Idea management is a fundamental practice for all creative practitioners, but one that is rarely given deliberate research attention (Inie et al. 2018a). These insights contribute to a stronger, fundamental understanding of how interaction design happens in professional settings. 2. The paper analyzes and synthesizes these insights into a grounded theory of professional idea management. 3. The paper offers a conceptual framework of strategies for tool-support of idea management. The framework is intended to help researchers and developers of creativity support tools characterize and analyze existing and novel idea management tools.

The paper is based on an in-depth empirical study: a series of interviews with 20 professional interaction designers. During the interviews we had the opportunity to ask the designers to demonstrate how their idea archives were structure, what was in them, and how they used these archives on a day-to-day basis. We use the term ‘interaction designer’ to describe
someone who ideates for and/or give form to interactive products, environments, systems, and services (Cooper et al. 2007) with careful attention to forming or transforming the user experience (Forlizzi and Ford 2000). The distinctions between industrial job descriptions such as ‘interaction designer’, ‘UX designer’ and ‘experience designer’ are often unspecified, but from a research perspective, designers in these professions share numerous skills and characteristics that are significant in the perspective of design idea management. First, interaction designers practice design constantly and over an extended period of time. As we will detail in the background section, capturing, managing, and utilizing design ideas are pivotal skills during a professional design career. Second, their design ‘material’ (user experience and user interaction) is often difficult to represent and manipulate using existing tools (Löwgren and Stolterman 1998; Dow et al. 2006). How does an interaction designer represent experiential concepts like ‘feeling overwhelmed’ or ‘sleek performance’? And third, interaction designers are technically literate. They have the language and often reflection ability to communicate their relationship to and choice of tools, because they are trained in describing these things. The work of interaction designers revolves around the use of digital tools and systems, for which reason we can expect them to have devoted thought and effort into creating appropriate and sufficient workflows using both digital and analog tools (an expectation which was confirmed by the study).

Our inquiry and analysis build on the findings of previous studies of idea management for creative professionals (Coughlan and Johnson 2008; Sharmin et al. 2009; Inie and Dalsgaard 2017) and of Personal Information Management for knowledge workers in a broader sense (Boardman and Sasse 2004; Efimova 2009; Kaye et al. 2006; Odom et al. 2012). Our findings differ in the sense that beyond describing the insights from our empirical studies, we seek to create a conceptual framework which can be used in the analysis and evaluation of other tools. We do not intend to map all available tools for idea management, nor to quantify most utilized tools on a global scale (which has been done much more thoroughly in other reports, i.e. (Loop 2018) and (Vinh 2015)), rather, we investigate unique user stories and systems in depth.

We are also very specific about analyzing use of tools, rather than functional properties embedded in the tools. This is based on the premise that technologies can be assessed only in their relation to the environments of their production and use (Suchman et al. 1999). If we base a framework on tool functionality and not the tool use, we would likely end up with a framework that would be less usable for understanding real-life use practices. Bernal et al. (Bernal et al. 2015) addressed the need for a change in focus on the needs of designers, rather than design products: "Current computational tools are design-centric, with interfaces from the perspective of the physical components, rather than designer-centric, with a focus on supporting the actions that designers execute while they manipulate the patterns that drive the arrangement of the parts". A decade before the abovementioned paper, Kidd (Kidd 1994) expressed a similar pledge for computers to inform, rather than passively storing information: “Computer support for knowledge work might be better targeted on the act of informing rather than on passively filing large quantities of information in a “disembodied” form”. By positioning our research within a discussion of creativity support tools, we hope to assist and inspire other researchers in HCI to analyze and evaluate tools in terms of their active support of the social, creative, and reflective human designer.
2 RELATED WORK

2.1 What is idea management?

Longitudinal idea management is a complicated matter to study. Most knowledge we have about long-term use of idea management tools is based on personal accounts and small-sample studies (Amabile and Mueller 2008; Efimova 2009; Erickson 1996). In their study from 2008, Coughlan and Johnson (Coughlan and Johnson 2008) categorize the process of idea management into three essential purposes:

- Retention and organization of ideas
- Feedback, evaluation and development of ideas
- Communication and collaboration of and on ideas

Other empirical studies have found similar categories of activities (Sharmin et al. 2009; Inie and Dalsgaard 2017; Inie et al. 2018a) One study highlights an additional main category of idea management: retrieving and reusing ideas (Efimova 2009). This paper describes the author’s activities of idea management (using her personal blogging processes as an example) as the following:

- Low-threshold creation of blog entries
- Organizing and maintaining content in a flexible and personally meaningful way
- Retrieving, reusing and analyzing blog entries
- Engaging with others around blog content.

Since there is currently no standard definition of which activities exactly constitute idea management, we propose an overarching theory and set of descriptions to frame the activities involved. This model is derived based on both previous studies as well as the empirical studies of this paper. The model is presented in the findings section.

2.1.1 Personal Information Management. Idea management can be said to be a subcategory of Personal Information Management (or PIM), in that ‘ideas’ is one of many categories or types of information that need managing throughout a professional creative career. We will describe the particularities about ‘ideas’ as opposed to general information in the next section. Personal Information Management is a term used in HCI to describe the collection, storage, and retrieval of digital and analog information (Jones 2010), such as emails, reference files, copies of finished projects et cetera. Several in-depth studies have been conducted on how office workers manage information, often involving extensive ethnographic field work, e.g. (Whittaker and Hirschberg 2001; Boardman and Sasse 2004; Barreau and Nardi 1995). The amount of field work carried out in this discipline accounts for most of our existing knowledge about strategies of information management of professional workers. A central objective of PIM is to ensure access to the right information, in the right format, and of sufficient completeness and quality to meet the professional’s current need (Jones 2004). One of the goals of research in PIM is therefore to define those needs and to develop systems to help users achieve them.

As technology has advanced and we have more tools and systems than ever available to manage our personal information, it does not necessarily lead to increased satisfaction. On the contrary, empirical studies have showed that many professionals experience frustration with their information becoming fragmented (Teevan et al. 2006; Inie et al. 2018a). In 1994 Kidd declared that developers of PIM tools “have lost sight of humans as highly-tuned learners and actors whose internal form is constantly changing in order to refine their ability to act in the world” (Kidd 1994). Therefore, Kidd suggests that (as described in the previous section) support tools should devote more attention to actively informing the person, rather than serving as a passive storage unit. Thus, to actively inform the interaction designer, we need discover which...
informational purposes ideas serve to them to be able to enhance the computational support. It is the authors' argument that design ideas bear very unique aptitude which ought not be ignored in the development of personal information management systems and tools.

2.1.2 What are ideas? Practicing professional creativity can be said to broadly refer to the generation of novel and useful approaches or ideas (Biskjaer et al. 2010). Although creativity is a desirable characteristic of design, and exceptional designers are creative thinkers, creativity is not a necessary condition for design (Alexiou et al. 2009). Interestingly, design is commonly described as 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” (Dorst and Cross 2001).

Cognitive science has offered more elaborate analyses of ideas than interaction design research. The Geneplore Model (Finke et al. 1992) describes ideas as discoveries formed in the mind on the basis of mental preinventive structures - precursors for the final externalized creative products or ideas. Preinventive structures usually refer to visual patterns, object forms, or mental models (Ibid.), and may in a design context also refer to cognitive structures that rely on external support, such as sketches or prototypes (Christensen and Schunn 2007). These discoveries are then explored and evaluated against external and internal constraints (such as knowledge about external requirements of appropriateness to the problem, or internal expectations or personal taste) before they come to a form of expression.

What is characteristic about a design idea (in relation to the creativity research-understanding of an idea) is that the design idea is oriented towards moving a design process forward. A design idea can be directed towards framing or reframing the problem statement, discovering an opportunity to work with, suggesting a full solution for the design problem, or part of a solution for the design problem (Inie and Dalsgaard 2017a). Design ideas are essential in practicing creative design. In the next section we will present some of the most prominent research on the importance of idea management for the interaction designer.

2.1.3 Idea management and the interaction designer. The goal of interaction design work is to arrive at a concrete or abstract product as a result of conscious actions and decisions by the designer (Biskjaer et al. 2010). Ideas are essential in moving from a problem state to a desired outcome, in that ideas express a design vision, aimed at solving a design problem (Löwgren and Stolterman 2004). In models of the design process, activities of design roughly consist of iterative phases of defining a problem, collecting data, generating ideas, and selecting the most promising idea to move forward with (Howard et al. 2008) (see figure 1).

The ability to generate many or very good ideas and the ability to select the best ideas have been areas of extensive research in the fields of interaction- and engineering design. Many of these studies are aimed towards developing methods for generating more or better ideas.
(sometimes called the idea fluency or quality), for example (Dahl and Moreau 2002; Dix et al. 2006; Girotra et al. 2010; Goldschmidt and Sever 2011; Halskov and Dalsgaard 2006; Howard et al. 2011; Perttula et al. 2006; Siangliulue et al. 2015; Sosa and Dong 2013). These methods are tested in settings with a varying degree of control, and the methods are seldom used in professional design practice, but by students or experiment participants chosen by the researchers. Similarly, research contributions that investigate the ability to select promising ideas (for instance (Toh and Miller 2015; Nelson and Stolterman 2003; Badke-Schaub and Gehrlicher 2003; Cardoso et al. 2016; Starkey et al. 2016; Shah et al. 2000; Goldschmidt and Tatsa 2005)) often look at discourse during a design process where it is possible to evaluate the outcomes, that is, often a student design course. Such studies indicate that the ability to generate and manage design ideas can be said to be a fundamental competency for the interaction designer.

In professional practice, the value of a design idea is highly dependent on the context it is to be employed in, giving designers a reason to store ideas until they are in a position to use them (Coughlan and Johnson 2008). According to Gaver and Bowers (Gaver and Bowers 2012) and Löwgren and Stolterman (Löwgren and Stolterman 2004) the work of a great designer is extensively based on experience from similar design cases - often more than it is based on theoretical knowledge. Buxton (Buxton 2010) argues that it often takes a decade for a good idea to have practical value in the world, which makes deliberate idea management critical to the interaction designer.

Most professional interaction designers manage externalizations of their ideas in various formats and for several reasons (Kaye et al. 2006). Most often, idea management is guided by improvised ad hoc assemblies of archives and tools, as idea management is not a skill which is specifically taught. Previous studies have found designers to purposefully avoid formalized explication of processes and knowledge, posing very high demands to systems that require them to do so (Shipman and Marshall 1999).

Externalization can be described as the active shaping of the world as an intellectual resource, and it is a core activity for most professional designers (Dix and Gongora 2011). In a more direct sense, externalization can be anything from verbalizing an idea to actively shaping it through interaction with the environment, for instance in the form of modelling or prototyping. In the tradition of cognitive science, externalization is considered any expression of computational offloading (Scaife and Rogers 2005) 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” (Kirsh 2009). Externalizations of interaction designers are particularly interesting in the scope of idea management, because interaction designers work with "materials without qualities" (Löwgren and Stolterman 2004) - or at least qualities that can be challenging to create accurate representations of (Dow et al. 2006). As a consequence, numerous tools are in play as ‘idea management tools’. In our study, we found, perhaps surprisingly, that interaction designers have very few follow-up questions when we ask ‘which tools they use to manage ideas’. This indicates that even if the processes are not standardized, idea management is a familiar activity for professional interaction designers.

2.2 Tools and the design process

In design research, tools often encompass both analog and digital tools. They can be distinguished by their role in aiding the designer’s creative cognition (Hollan et al. 2000; Hutchins 1995), rather than by their technical properties: “[t]ool] can denote a range of artefacts; and relative, in that it can be any artefact that is employed as a means to transform the situation. That is, an artefact becomes an instrument of inquiry when we use it as such" (Dalsgaard 2017). It
is recognized that tools play an important role in helping designers do much more than just give form to design artifacts; tools support design creativity and exploration by guiding perception and understanding of design problems and solutions, and by helping designers see, understand, explore, and experiment (Ibid.). Tools are parts of co-adaptive phenomena in which they help shape the designer shape their environment, meanwhile tools affect human behavior itself (Mackay 1990). In this section we will give an overview of related work of the influence of tools on interaction design practice.

While there is a general understanding and concurrence about the activities involved in creative design work, we have less of a vocabulary to describe how specific tools influence these activities in a frame of creative design. Howard et al. (Howard et al. 2011) describe the following roles of tools in creativity support: a) As a task framing tool during the analysis phase, b) As an idea generation tool during the generation phase, and c) As a selection or evaluation tool in the evaluation phase. However, it is widely recognized that creativity also happens outside idea generation meetings, when the designer is alone or during spare time activities (Amabile and Mueller 2008; Coughlan and Johnson 2008; Finke et al. 1992). Tools that are "phase-specific" therefore do not support longitudinal idea management.

Dalsgaard (Dalsgaard 2017) identified five qualities of tool support which contribute to our understanding of how tools affect professional design practice:

1. **Perception** (tools help designers perceive and understand the design situation and formulate the design problem),
2. **Conception** (tools help designers understand and articulate the problems they face as well as develop hypotheses about how to address these problems),
3. **Externalization** (tools allow designers to make imagined design solutions part of the world),
4. **Knowing-through-action** (tools allow new knowledge to be generated through acting with an instrument), and
5. **Mediation** (tools support mediation between actors and artefacts in a design situation and establish stable shared points of reference).

These five qualities express cognitive attributes that tools support through the design process. As such, they explain properties of existing tools which can be embedded simultaneously in the same tool, rather than isolated in different tools. A 'task framing tool' (Howard et al. 2011), for instance a mood board, can simultaneously support both perception, conception, externalization, and mediation.

While previous studies have shown very promising results in developing curation and ideation tools, often integrating analog tools with digital affordances, (i.e Dorta et al. 2008, Mendels et al. 2011; Lindley et al. 2013, Lupfer et al. 2016), none of these tools have been adopted into large-scale use. This may be due to such tools focusing on isolated "phases" of ideation, curation and idea generation, rather than long-term processes and seamless integration into other systems and tools.

Previous research in the role of tools has informed this paper in multiple regards. The work presented here is distinguished in two particular aspects: first, it offers a general theory of idea management processes in professional settings. Second, the analysis highlights and details the strategies taken by professional interaction designers to achieve creative goals.
3 METHODOLOGY

This paper presents a rich qualitative study based on a method of qualitative, semi-structured interviewing. Qualitative research can be described as enacting a local, action-oriented approach of investigation and applying small-scale theorizing to specific problems in specific situations (Berg et al. 2004). Some of the advantages of this approach are that the method is suitable for discovering influences on creativity and for capturing the complexity of organizational creativity. The method is less suitable for determining causal relationships of creativity and other factors, or for generalizing to other individuals (Amabile and Mueller 2008). Qualitative interviewing is an appropriate method for providing insights into objectives of interaction designers, rather than only behavior. A relatively small sample allows for thorough engagement with the data in a way where individual differences and distinctive approaches do not get lost in the general (Berg et al. 2004). That is, if a large number of designers use one tool to perform a certain activity, and a single designer uses a different one, it does not necessarily mean the one designer should be ignored. Rather, we might look to the one designer to be inspired to develop new and better systems because they may face the needs of the many ahead of time (von Hippel 1986).

3.1 Participants and interview form

We conducted semi-structured qualitative interviews with 20 professional designers, each interview lasting approximately one hour. The interviews were structured in topics corresponding to the activities central to idea management (as described in the background section): capturing ideas, managing ideas, retrieving ideas, and collaborating on ideas. We interwove factual questions (e.g. “Which tools do you use to…?”, “How do you…?”) with generative questions (e.g. “Take me back to a time when you…”, “Imagine the idea tool for…”). When relevant, we asked to see examples of the designer’s ideas. An overview of our interview guide is shown in Table 2.

<table>
<thead>
<tr>
<th>Table 2. Qualitative interview guide.</th>
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<tbody>
<tr>
<td><strong>Intro</strong></td>
</tr>
<tr>
<td>Intro 1: Can I ask you to state your name and affiliation, and that you are OK with this interview being audio recorded and used for research purposes?</td>
</tr>
<tr>
<td>Intro 2: What is your background in interaction design?</td>
</tr>
<tr>
<td>Intro 3: What kinds of interaction design do you work with?</td>
</tr>
<tr>
<td>Intro 4: How much of your time do you work alone vs. together with others when generating and developing ideas?</td>
</tr>
<tr>
<td><strong>Capturing ideas</strong></td>
</tr>
<tr>
<td>1.1 Which tools do you use to do capture your ideas?</td>
</tr>
<tr>
<td>• When you’re at work?</td>
</tr>
<tr>
<td>• When you’re at home?</td>
</tr>
<tr>
<td>• When you’re at “inconvenient places” (i.e. on a walk, in the shower, at yoga class etc.)?</td>
</tr>
<tr>
<td>1.2 Can you remember the last time you captured an idea? Describe what happened.</td>
</tr>
<tr>
<td>1.3 Imagine the ideal tool, in your mind, for continuously capturing ideas.</td>
</tr>
<tr>
<td>• What would the interface of this tool be like?</td>
</tr>
<tr>
<td>• What key features would it have?</td>
</tr>
<tr>
<td>1.4 Why do you capture ideas? What’s the end goal-product? And how does archiving contribute to that?</td>
</tr>
<tr>
<td><strong>Organizing ideas</strong></td>
</tr>
<tr>
<td>2.1 Where do you keep your ideas?</td>
</tr>
<tr>
<td>2.2 How do your ideas look? E.g. sketches, audio files, texts, image collections etc.</td>
</tr>
<tr>
<td>2.3 Which tools do you use to make them look this way?</td>
</tr>
<tr>
<td>2.4 Imagine the ideal tool, in your mind, for storing ideas so they are easy to find and use when you need them.</td>
</tr>
<tr>
<td>• What would the interface of this tool be like?</td>
</tr>
<tr>
<td>• What key features would it have?</td>
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</tbody>
</table>
4.1 Do you ever look at your old ideas?
• Why/why not?
4.1.a If yes: How do you use your old ideas for later projects?
4.1.b Take me back to the last time you went through an idea archive of yours. What did you learn from it?

3.1 Which tools do you use when you collaborate with others in generating/developing ideas?
3.1.a Why these tools?
3.2 Do you ever experience difficulty in representing your ideas so you can communicate them to others?
• If you think back to the last time you faced this situation: describe what happened?
3.3 Imagine the ideal tool, in your mind, for collaborating on ideas with your colleagues or team.
• What would the interface of this tool be like?
• What key features would it have?

<table>
<thead>
<tr>
<th>Table 3. Details about interview participants.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender, age, job description</strong></td>
</tr>
<tr>
<td>P1 Female late 20s. Works in a large IT-providing company in San Diego, USA. Focus on UX-design on one project.</td>
</tr>
<tr>
<td>P2 Male, mid 30s. Background in Computer Science. Has worked with game design but currently works in academia. Based in San Francisco, USA.</td>
</tr>
<tr>
<td>P3 Male, early 30s. Game designer at a medium-sized game development company based in Aarhus, Denmark. SCRUM-responsible for his team.</td>
</tr>
<tr>
<td>P4 Male, 40s. CEO of large, world-wide design company. Currently based in New York. Works with design strategy.</td>
</tr>
<tr>
<td>P5 Male, 40s. Freelance graphic and UX designer. Based in southern Germany.</td>
</tr>
<tr>
<td>P6 Male, mid 20s. Works as an interaction-/product-/UX designer at a design agency in Mountain View, California, USA.</td>
</tr>
<tr>
<td>P7 Male, early 40s. UX designer at a medium-sized design agency in Aarhus, Denmark.</td>
</tr>
<tr>
<td>P8 Male, early 20s. Product designer/interaction designer with a focus on software design and experience design. Based in bay area, California, USA.</td>
</tr>
<tr>
<td>P9 Male, 40s. Founder and CEO of medium-sized design company based in San Diego, USA. Background in graphic and web design.</td>
</tr>
<tr>
<td>P10 Male, 40s. Leading design strategy at a medium-sized design company based in San Diego, USA. Works closely with clients.</td>
</tr>
<tr>
<td>P11 Female, mid 20s. Experience Designer at a software company based in California, USA. Focus on visual design.</td>
</tr>
<tr>
<td>P12 Female, late 20s. UI and strategy designer for an app. Located in Copenhagen, Denmark, but collaborates with USA-branch. Background in visual design.</td>
</tr>
<tr>
<td>P13 Male, 30s. Freelance brand designer and artist. Based in San Diego, USA. Works a lot with space and wayfinding design.</td>
</tr>
<tr>
<td>P14 Female, late 20s. Interaction designer at an IT-provider based in San Diego, USA. Focus on interface design and service design.</td>
</tr>
<tr>
<td>P15 Female, late 20s. UX and UI designer at a large industrial company in Bjerringbro, Denmark. Background in sociology.</td>
</tr>
<tr>
<td>P16 Male, early 30s. Works as a UX designer in a Nordic, digital agency, Aarhus (Denmark) branch. Background in multimedia design.</td>
</tr>
<tr>
<td>P17 Male, mid 20s. UX and product designer (primarily mobile app) for a sharing economy-based startup company located in Copenhagen, Denmark.</td>
</tr>
<tr>
<td>P18 Female, early 40s. UX researcher and designer at Danish, Aarhus-based branch of a large, international e-commerce company.</td>
</tr>
<tr>
<td>P19 Male, early 20s. Intern UX designer at large international design company based in Aarhus Denmark. Studies digital design at university level.</td>
</tr>
<tr>
<td>P20 Male, early 30s. Industrial designer at small electronic product design company based in Aarhus, Denmark.</td>
</tr>
</tbody>
</table>
We interviewed 14 male- and 6 female designers (more information about the participants is shown in table 3). Participants were recruited via the authors’ personal networks, mailing lists, and Facebook groups for UX designers. The age span was between early 20s and late 40s, with experience in design ranging between 1 and 15+ years. We did not choose the designers based on their experience or demographics, but rather based on getting a varied sample of different types of designers. 20 interviews were enough to develop 'saturated' categories of information (Creswell 2013), meaning we could identify patterns of behavior which overlapped in all the categories of our framework.

Because interaction designers have such varied job descriptions and backgrounds (from sociology to computer science), we have chosen not to base our analysis on differences in the designers’ current job description. A designer with a background in graphic design may be more inclined to use, for instance, Adobe Illustrator, to develop sketches, but we have no way of distinguishing between whether this would be a difference in training or personal preference. We observed some patterns in preferences for tools, which seemed to correlate more with the designer’s training or education than their current job description. The preferences were related to preferred tools for development of ideas, however, more than to capture or organization of ideas. For instance, the application Sketch was a recurrently utilized tool for UX designers who designed interactive interfaces, but was not used for e.g. capture of ideas.

Interviews are inherently retrospective, and we are mindful of the fact that we can only report on what participants tell us and how they think or remember to behave. Therefore, we also asked each designer for a “tour” of their idea archives and examples of how their ideas looked. This method worked well to uncover tacit or forgotten knowledge, as it often brought up stories that the designer had not previously shared. As an example, designer P18 was walking us through her idea management system on her laptop and burst out: “Oh, right! I actually have a Slack channel with myself!”. We will discuss how the findings of our study may be expanded upon in the Discussion section.

Grounded theory-analysis

The interviews were transcribed and analyzed using a grounded theory-approach (Strauss and Corbin 1990; Creswell 2013; Gibbs 2018). We approached the analysis by first dividing the transcriptions into discernable chunks of meaning, and identifying open, descriptive codes (table 4).

Table 4. Categories identified during open coding.

<table>
<thead>
<tr>
<th>Head category</th>
<th>Sub-categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea forms and representations</td>
<td>To do-lists, visual vs. text, screen dumps, bookmarks, notes, sketches on paper, information, prototypes, talking as prototyping, analog-&gt;digital, digital-&gt;analog</td>
</tr>
<tr>
<td>Software</td>
<td>Evernote, reminders, Slack, PowerPoint/Keynote, Adobe Photoshop/Illustrator, Asana, Google Keep, Pinterest, tool personalization, one master tool, ideas for novel tools</td>
</tr>
<tr>
<td>Hardware</td>
<td>Sticky notes, paper, tagging, cloud, phone camera, phone dictation</td>
</tr>
<tr>
<td>Archives</td>
<td>Revisiting ideas, naming conventions, idea bank, inspirational materials, finding ideas, folder organization, forgotten ideas, desk area</td>
</tr>
<tr>
<td>Collective ideation</td>
<td>Decision making processes, ideation in a company, collaborating with a whiteboard, other tools for collaboration</td>
</tr>
<tr>
<td>Personal ideation</td>
<td>Ideation process, markers/tags to self</td>
</tr>
<tr>
<td>Representing ideas</td>
<td>Challenge of representing ideas, communicating ideas, flow of ideas</td>
</tr>
</tbody>
</table>
In the following axial coding, we moved towards analytic codes (Gibbs 2018), which identify and describe the central activities around the core phenomenon idea management. These codes are presented in the findings as a comprehensive model of idea management. From this model, the category 'strategies' (actions taken in response to the common phenomenon 'idea management') (Creswell 2013) is the basis of the framework of strategies for idea management presented in this paper.

4 FINDINGS

In this section, we will present first a grounded theory-model describing the core phenomenon 'idea management' exemplified with quotes from the participants in our studies. This model is based on axial coding of the interview data, and divided into the categories: causal conditions (factors which cause the central phenomenon), central phenomenon (a process or action, in this case idea management), strategies (actions taken in response to the core phenomenon), contextual and intervening conditions (situational factors, which influence the strategies), and consequences (outcomes from using the strategies) (Creswell 2013).

Secondly, we will present our other main contribution of the paper: a framework of strategies of idea management - that is, strategies that interaction designers take in response to the core phenomenon of managing ideas. In line with previous work (Kidd 1994; Shneiderman 2007; Bernal et al. 2015, Maudet 2017), we argue that the development of creativity support tools would benefit from an increased focus on the supporting the creator, rather than on the created product. In this vein it is important to understand not only what the designer does, but also why they do it. Our framework provides a detailed description of the explicit or tacit reasoning behind the activities involved in idea management in a frame of professional interaction design.

4.1 A grounded theory-model of idea management

![Diagram of grounded theory-model of idea management]

Fig 2. A grounded theory of professional idea management.
The theory of the core phenomenon and surrounding factors is shown in figure 2. The goal of a grounded theory analysis is understanding a process or an action involving several individuals, and in this case several tools (Creswell 2013). This theory thus explains how professional idea management is performed and supported over time, by tools, through actions and strategies taken by individuals, who experience individual outcomes. The contents of the model are described in detail in the following sections.

4.1.1 Core phenomenon. Figure 3 describes the activities involved in the core phenomenon, i.e. idea management. This phenomenon consists of activities of capturing, developing, organizing, retrieving, and sharing ideas. These activities correspond to descriptions of idea- and information management presented in earlier work (Barreau and Nardi 1995; Coughlan and Johnson 2008; Efimova 2009).

Capturing ideas equals externalizing the idea or a representation of the idea in an analog or digital form - the active shaping of the world as an intellectual resource (Dix and Gongora 2011). This can happen during design work or at other places and times: "Actually I was at lunch the other day, sometimes I use my mobile phone, but those are just for note taking purposes. I don’t draw, I don’t have any tools I would use to sketch an idea. But I didn’t have access to my mobile phone, so I used the back of the receipt. (...) I mapped out an entire solution on the back of a receipt. (...) it was exactly what I needed at that moment" (P9).

Developing ideas means expanding on the idea, whether that is contradicting it, reshaping it, or advancing it. It is a part of idea management, as the format of the idea often changes during this process - maybe the idea "moves" from a note on a receipt to a digital format. One designer (P5) described using a separate email account to manage his ideas, where each email thread represented a separate idea. If he pressed 'reply' to a thread, it meant he was contradicting the central idea, and if he pressed 'forward', it meant he was expanding on the idea.

Organizing ideas includes filing, storing, and rearranging ideas in a systematic fashion. Most of the study participants had developed an individual system for identifying working ideas from archived ideas: "...my structure of my files is that I have a version 1, version 2, version 3. So, I never delete anything. But I just put the latest file on the outside of my folder. And then that way I can always look back on my ideas and have a folder for inspiration" (P8). These systems would rely heavily on the individual designer and their memory, and does not always work for shared depositories of files.

Retrieving ideas equals finding stored ideas again. This can happen incidentally by browsing: "Every once in a while, I will find one [a notebook], and I’ll flip through it, and there’s some interesting things there. There’s this spark of something that actually came out and was handed off to someone else on the team." (P9) or deliberately by searching "I will go back to old ideas. One, for reference of the question of what did we do and why? The rationale of something, I guess it’s
sort of a portrayal. (...) The limitation is my phone space really. The times I go back is when there’s a question about why we did something, the way we did it or if we needed to go over the rationale for something’ (P6).

Sharing ideas involves any activity where another person than the designer is included, for instance during collaborative design sessions. The externalization of the idea usually serves and informational purpose (Dix and Gongora 2011), and the representation of the idea is central: "It can be difficult for me to understand when people say 'We'll just do this!' and then they make wireframes on boards, because it doesn't speak to me. An ipsum-text and some squares, it doesn't appeal to me. It's also because I'm so visually oriented, I need something more than just squares with X's. I always get upset if someone has designed something with ipsum, because then you can make everything look nice. Our titles will often be super long because it's the users who write them" (P18).

4.1.2 Causal conditions. A priori, the need for using tools to manage ideas stems from the limited cognitive abilities of the human mind (Scalie and Rogers 2005). But fear of forgetting ideas is only part of the story. Previous research has demonstrated how information management is influenced by value goals as much as resource accessibility (Kaye et al. 2006), and we confirmed this in our analysis.

There are external and internal causal conditions of professional idea management. This distinction is related to the notion of intrinsic versus extrinsic motivation of creative work: intrinsic motivation arises from the intrinsic value of the work for the individual themselves, and extrinsic motivation arises from the desire to obtain outcomes distinct from the work itself (Amabile 1993).

The interaction designers we interviewed described the following intrinsic motivational factors for using tools to manage ideas:

- **Fear of forgetting or losing the idea**: "I forgot what that meant [points to entry in Google Keep] (...) I just wrote it down and I don’t know what it was for. I’ll probably archive it later, but I’ll probably keep it there, just in case I might need it” (P8).

- **Maintaining and maturing a lifelong creative career**: As shown by Kaye et al. (2006), archiving and managing occurs for value-purposes as well as functional ones. For interaction designers, ideas and the representation of them are some of the most important skills they put to the table in a professional context. Depending on the individual designer, the use of idea archive has been shown to range from a problem-solving focus, where finished products and their working files inform the designer in similar cases, to an artisan design-focus, where ideas are explored and developed over extended periods of time with no particular goal in mind (Inie et al., 2018b). In the interviews of this paper, a majority of the interaction designers expressed the need to externalize and preserve their ideas for creative purposes beyond organizational due diligence: "Why do you capture ideas? I've never tried to forget an idea, so that's not the reason. I think it becomes tangible when you write something down, it's just like goals writing for yourself, it becomes tangible. You have to take like, 'Okay, but that's not even possible, so how would I make it possible?' So, you're obliged, you're making it something real. Everything starts with the thought, and then when you put it here it becomes a bit more tangible, and then (...) 'Oh my God, they implemented it." And then, "Oh my God a service technician is using it!" (P15).

Additionally, the designers were motivated by the following external conditions:

- **Organizational requirements (non-tool specific)**. Few companies require designers to share their ideas specifically, but most companies expect designers to store and share their working files, i.e. representations of ideas.
• **Communication and collaboration.** For the purpose of sharing ideas or continuously collaborating with others around the development of ideas, it is necessary for designers to be able to refer others to a reliable storage source of representations of ideas.

4.1.3 **Contextual and intervening conditions.** In our analysis, the relationship between the category 'causal conditions' and the category 'contextual and intervening conditions' is that 'causal conditions' describe the factors that lead to the activities involved in idea management taking place, and 'contextual and intervening conditions' are the influencing factors of how the individual strategies of idea management are chosen and performed. We identified the following contextual and intervening conditions of tool-use in professional idea management:

• **Available platforms, tools, and auxiliary tools.** What tools are available depends not only on what tools exist, but on which tools the designer knows about. Many of the study participants asked us to share the results of the study because they were curious to learn about the tools others use, that they did not know of. One designer said: "If I get hold of a really bad, pointy, stiff pen on a bad writing surface, right? It doesn't conceive any ideas in me whatsoever. If you get the right marker which glides in the right way on a whiteboard, you know, and makes a thick, fat line - that's what you need, right? That raises your productivity and your, like, creative desire. It's a total turnoff to get a ridiculous little pointy pencil you can only draw little crosses and checkmarks with, right? I think, like a musical instrument, if you give people a wrong violin, then - they can play it, but it won't be great art" (P4).

• **Personal preferences.** Which tools the designers preferred to work with depended, to a large extent, on how often they captured ideas, which representation the tools allowed them, and how the designer planned to utilize the idea later, a similar finding to previous studies of information management (Boardman and Sasse 2004). We have previously published an analysis of different strategies for utilizing archived ideas (reference anonymized for peer review).

• **Training, education and job function.** "Interaction designer" is a job description encompassing many different design tasks, and often employing people from different educational backgrounds. For example, we interviewed a designer with a background in sociology, and another with a background in computer science. Someone who is trained to use specific software tends to prefer the representations and auxiliary tools that this software allows. An example is that we saw that only the designers who had trained as graphic designers used, for instance, Adobe Illustrator to capture or develop ideas. This is an example of how the tool shapes the human action as a co-adaptive phenomenon (Mackay 1990).

• **Organizational requirements (tool-specific).** The difference between non-tool specific organization requirements and tool-specific requirements is whether the requirements are causal for idea management taking place, or whether they are intervening in the specific choice of tools. Both can be the case. Many professional designers are required by their workplace to use specific tools for e.g. security reasons: "I think that's something worth mentioning, um, security does change the way...like the things that we can use. We used to be big Evernote people and then it kind of just [...] They can’t be put under our security. It’s kind of like, things are confidential, and there’s always, like, hackers that can get in so there’s some things that we have to do, like, use sparingly, or use under the table and just use really smartly even though the tool itself is really helpful." (P11).
4.1.4 Strategies. Strategies describe the actions taken in response to the core phenomenon (Creswell 2013). A strategy is a high-level plan for how to obtain certain goals, in this case the goal of managing ideas. Therefore, it is central to identify the goals of managing ideas to be able to explain and define the strategies of doing so.

As an example, the strategy, or action taken, to capture an idea is highly influenced by the purpose of the capture. If the purpose of capture is to retain the idea, rather than to refer to it later, this purpose affects the strategy: "Do you normally go back and look at [your notebook] again? No, I have so many of these notebooks. And often times it’s more for me as a tool to just write it for retention versus recall. I don’t use it as much for recall" (P9).

Knowledge of the designer’s strategy can both inform and inspire the development of any tool to support the designer in achieving the underlying goal or objective. Therefore, our main contribution of this paper is the identification of a framework of strategies performed by interaction designers to manage ideas professionally: saving, externalizing, advancing, exploring, archiving, clustering, extracting, browsing, verifying, and collaborating. We will explain this framework and the goals of these strategies in more detail in a separate section of the findings.

4.1.5 Consequences. The consequences or outcomes of utilizing the strategies correspond to the interaction designer’s experience of the utilized tool.

- **Satisfaction with tool support.** If the interaction designer finds themselves satisfied with the tool’s support of the strategy they have chosen, they will most likely continue using the tool. The interaction designer may also expand their use of this tool to support other strategies than originally intended: "I started a couple of years ago to use an email account to capture my ideas because, then I had a Blackberry with a keyboard, which I already liked, [...] and then I started to think about "hey, why don’t I just make a photo of my sketches and send them to this account too", and so I started to use email. I wasn’t a conscious goal. It wasn’t a direct decision" (P9).

- **Dissatisfaction, abandoning tool.** If the interaction designer is dissatisfied with the tool’s support of the strategy, they might abandon the tool, and may or may not find a new tool or return to a known one: "I tried several tools. I tried pen and paper, I tried whiteboards, I tried it with Asana, I tried it with [company name], I tried several tools and, in the end, I was enthusiastic first moment, and after a couple of weeks I recognized that I already stopped to use all these tools. And I thought about a tool which is present everywhere and which is easy to use and which I can access from everywhere [...] and I recognized that email could do this stuff for me" (P5).

- **Dissatisfaction, continued use.** If the interaction designer is not overwhelmingly dissatisfied with the tool, or if they are prevented by lack of time, lack of available tools, or organizational support, to find a different tool to support their strategy, they may continue to use the tool. They may experience it as a pain point in their professional practice: "I use voice memos a lot now when I’m in the car, because that’s when I find, that, or when I’m running. Running is really difficult because I don’t like to stop to capture that thought, and I’m usually playing music on my device, and that’s something that I’m very conscious about when I run, and it becomes a repetitive thought, almost like a mantra if I think of something, and then I’ll write it down when I stop" (P10).

4.2 A framework of strategies for idea management

A strategy can be understood as a high-level plan with the purpose of achieving one or more goals under conditions of uncertainty. It is central to discuss the strategies and goals of the activities in more detail.
Different tools for capture are utilized because the goal of capture varies. Consider how this designer uses different modalities of the platform "pen and paper" for different purposes:

"What's the difference between the graph paper and the notebook - how do you use those differently? Notebook I take with me to meetings and I'm, just, general note taking. The notepad is more of actually sitting down and doing design work. (...) In the notebook that might be just, kind of... Just sometimes, you know, you just take notes just to highlight some things that you want to remember. Deliverables. You know, action items, stuff I need to, like, expand upon further later on or just some stuff you want to keep in your mind and that, it helps to just write down to remember better". (P3).

Because the goal of "not forgetting deliverables", is different than the goal of "actually doing design work", the strategy and tool taken are different. In this section we present a detailed description of each of the strategies we identified in our analysis: saving, externalizing, advancing, exploring, archiving, clustering, extracting, browsing, verifying, and collaborating.

4.2.1 Saving ideas. When the interaction designer saves ideas, they capture something with the intent to (be able to) return to it later. A widely used example of this is taking a picture of a whiteboard that contains representations of ideas. As a specific example, designer P2 had built an entire digital database for 'long-term ideas' - ideas, he wished to be able to return to and develop at any given moment in the near or far future. These ideas were captured purely in text, so he could use an NLP algorithm to search for keywords that were vaguely related to those in the actual text. Other examples of saving strategies are screenshots on a phone or laptop, sometimes with accompanying annotations: "If I see a great UI idea, I screen dump it and edit it with the pen tool. Sometimes it is, like, completely rough, and I don't think it makes any sense for anyone else but me" (P18). See figure 4 for an example of this designer's screen shot with annotation. The ideals of the saving strategy were a combination of the capture being quick and readily available, as well as the representation providing exactly enough information for the capture to make sense when looked at later.

Fig. 4. Designer P18 'saving' capture.

4.2.2 Externalizing ideas. By externalizing, we mean initial capture of ideas which serve informational, formational, transformational, or transcendental purposes, as described by Dix and Gongora (2011). While Dix and Gongora describe these terms in much more extensive detail, we will describe this strategy as any process of making internal processes (e.g. ideas) external (Ibid.). The main difference between this strategy in relation to the strategy of saving, is that the designer does not necessarily intend to return to the externalization again, but rather the process of externalizing is the goal in itself. In the words of Kidd (1994) "We may
have been fooled into thinking that knowledge workers write things down because they need an external memory store, whereas in many cases, it may be the graphological act itself which is important”. Externalizing ideas does not only entail writing or sketching. In fact, several of the designers in our study mentioned deliberately using their own voice as a mode of externalizing: “Typically, I’ll maybe sit in the car and reflect over something for 30 minutes, and during that half hour, maybe four or five things will emerge, which actually are like ‘Oops, there was something. That, I need to be able to return to’” (P7, authors’ translation).

Externalizing allows the designer to release some of their working memory (Kirsh 2009). Very often, the tools used for externalizing would be an analog platform - either some form of pen and paper or a whiteboard: “And those [sticky notes] will then be translated at some point but I’m constantly using... It has to be pen to paper first for my ideas to get flushed out” (P9). Several of the interaction designers in our study expressed that externalizing their thoughts in situ allowed them to remember something better without relying on the physical manifestation again. The ideal tools for the externalizing strategy were always described as having the least constraining properties possible, and often being analog: “As soon as you start making it ultra-concrete in [digital] wireframes, a lot of things emerge that one had not seen before. So, a development happens there. But I’d say the foundation is laid on paper” (P7).

4.2.3 Advancing ideas. Advancing the idea corresponds to the development of an idea with relatively specific objectives in mind. It may be the digitization of an analog sketch, which is developed into a more finished design artifact. While this development is happening, it is very common that new ideas emerge and that old ones are abandoned. The advancing of ideas was often described by our study participants as “actual design work”, which of course includes many processes of trial and error, conceptual detours, and discoveries of new properties. The primary goal of this strategy is, however, to bring a design idea closer to a finished artifact. Because our study subjects were in the business of interaction design, the tools involved in this strategy are usually digital. The ideals of tools for this strategy vary greatly with the individual designer’s personal preferences, background, skills, and workflow. Because the designer often has a more or less defined end-goal in mind, efficiency of moving towards that goal is an essential property: “Imagine an ideal tool in your mind (...). So, it would be something maybe with VR because then I could just ... Okay, now I’m really out there. But something where I could actually draw when I was standing here, so I’m interacting with the [artifact], I’m building screen by screen and I’m not, again, caught into a tablet. (...) And then I could just, like, "Okay, so I press this button and communicate." And then it would already know how the communication protocols between the [artifact] and this would work. So, it would just know, "Okay, so this would flow back and forth and this is how we get the right parameters here” (P15).

4.2.4 Exploring ideas. This strategy refers to the open-ended exploration of the idea, or different properties of the idea, without a particular goal in mind. Exploring is different from the strategy of externalizing in the sense that the designer explores an existing idea, rather than captures a novel one. In practice, the two are not completely discernable by observation, but the study participants were able to distinguish between working on idea A or idea B. The difference between exploring and the strategy advancing is the creative objectives involved: where the designer who is advancing an idea is focused on the efficacy that the tool allows, the designer who is exploring an idea is open to creative detours and open-ended browsing. A desired property often mentioned was the ability of a tool to provide different visualizations of the working idea: "I need a place to sketch things out. Something that doesn’t feel limited—something that I can have as much space as I need to keep growing my ideas, keep growing, like brainstorming. Of course, written text is always helpful as well, but I would say that if there could be a good balance between images, pictures, and text, that would be really nice” (P13).

4.2.5 Archiving ideas. Archiving describes the archival of ideas in a digital or analog storage facility, either deliberately or automatically. An example of an automatic archiving system is
the synchronization of a smartphone gallery to a cloud folder. The paramount property of this strategy is for the designer to feel confident in leaving the manifestation of the idea and trust that it will stay in this storage and be accessible if it becomes relevant in the future. The study participants described relying heavily on cloud storage for both personal and shared archives, but also on physical space to a large extent, echoing previous research (Barreau and Nardi 1995). At least two of the interview participants in our study referred explicitly to the role of physical space: “I write a lot of UI microcopy for work, so I always keep, like, certain things in it, like a certain area in front of my computer. Like, the rules that I follow for my microcopy are always right there (...) and those never go away” (P1).

4.2.6 Clustering ideas. After different ideas have been externalized, the interaction designer may spend time clustering or applying systems to the externalizations. Sticky notes are particularly popular for this purpose, but clustering may also involve going back to old archives and reorganizing files. When we asked designers to imagine novel tools for idea management, a very commonly expressed ideal was some form of a large, interactive interface which would allow them to consolidate and group various media forms: “if you had an invisible, I guess, interface, which would be great to have. Some sort of retinal display where you could move ideas around. So actually, it wasn’t a computer, it wasn’t a device, it was part of a biometric interface...Bringing it back to today, I really didn’t love Google, Google Drive. (...) If you’re not familiar with the structure, if you don’t have an idea of what filing system you’re going to use, then it can actually be pretty daunting because you start from somewhere and it becomes a real mess really quickly because you have lots of files without categorization file folders or structure. (...) I would love that intelligent interface to file my documents and thoughts without me having to think about it, so it’d be based on the content in there or the type of idea that I’m coming up with. (...) I spend a lot of time trying to order my thoughts” (P10).

4.2.7 Extracting. Under the activity of retrieval of ideas, the most commonly mentioned reason for returning to old ideas was to try to discern the rationale of previous design processes. When extracting, the designer is trying to find or identify a specific idea and the rationale or decisions surrounding it. The search itself can be performed by both browsing and searching (Boardman and Sasse 2004), but the objective is to find something specific: “I will go back to old ideas. One for reference of the question of what did we do and why? The rationale of something (...) The times I go back is when there’s a question about why we did something, the way we did it or if we needed to go over the rationale for something. Or if someone was held accountable for something and we don’t know who to hold accountable for it” (P6).

4.2.8 Browsing. The search strategy of browsing describes the process when the designer looks through old ideas without a particular goal in mind. ‘Old ideas’ can entail both ideas that the designers may have externalized themselves, or representations of others’ ideas that the designer has previously saved: “I took a picture of it and then uploaded it to Evernote for later usage. It wasn’t something that has anything to do with what I’m working on right now. But I found that adding it to this note is a really good idea because I might later on touch on something that has a part of it in it or in some way it will connect things for me when I get tasks later on. So, it’s very useful to have this [...] library of things that inspire me for whatever reason (...) So when I’m stuck or I need inspiration in some way, I’ll go into this...It’s basically this image base of things I’ve taken a picture of in some way, and I’ll just look through it randomly” (P12). A desired property of tools that support this strategy was the possibility of annotating, tagging, and commenting on the ideas - so the designer would spend less energy remembering why the idea was saved in the first place. This finding is parallel to the findings of previous studies, which have shown that designers wish to know the stories behind the saved artifact, rather than a "disembodied" representation of it (Herring et al. 2009; Sharmin et al. 2009).
4.2.9 Verifying ideas. Sharing ideas with the purpose of verifying them is different from actively collaborating on them. The interaction designers of our study described using slideshow software for collaboration purposes, but when we inquired further, it was very clear that slides were used to present ideas to other stakeholders, rather than to actively collaborate on generating or developing ideas. For tools supporting this strategy it is more critical to help communicate the idea correctly, than to allow for several people to contribute to the idea on the spot: “When presenting ideas, I find it most effective using a PowerPoint or a Keynote. The reason why is because people can only intake so much information, like if I showed them the entire Google Doc or something, they don’t know (...). But then when I arrange slides I try to get to like the main thing. And go from slide to slide to slide. So, I just present bits and pieces of information so it’s easier to digest” (P8).

4.2.10 Collaborating on ideas. Collaborating on ideas describes several individuals working simultaneously together on generation and/or development of ideas. The quality of tools to work as mediation (Dalsgaard 2017) is important during such activities. The most important property mentioned by our study participants was the ability of a tool to provide a comprehensive overview, while allowing all participating members of the group to contribute to the shared pool of ideas: “I would love a huge interactive touchscreen in my day where I could doodle, I could draw, I could swipe, I could write, I could pull up images from the net and having everything there at my fingertips. It’s not just having a touch laptop. It’s having a screen the size of a wall that you can be able to share or interact with many people at once. For overview and just ideation. I mean whiteboards and dry erase markers, I mean, sticky notes are great, but it’s pretty inefficient and you’re always referencing different things” (P10).

Table 5. A framework of strategies for professional idea management.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Strategy</th>
<th>Degree of certainty about goal</th>
<th>Desired properties of support tools</th>
<th>Primary tools and platforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture</td>
<td>Saving</td>
<td>High</td>
<td>Efficiency, availability</td>
<td>Phone camera, digital note taking software, pen and paper</td>
</tr>
<tr>
<td></td>
<td>Externalizing</td>
<td>Low</td>
<td>Freedom of expression</td>
<td>Pen and paper, whiteboard</td>
</tr>
<tr>
<td>Development</td>
<td>Advancing</td>
<td>High</td>
<td>Efficacy, efficiency</td>
<td>Design and UX software, pen and paper, whiteboard</td>
</tr>
<tr>
<td></td>
<td>Exploring</td>
<td>Low</td>
<td>Freedom of expression, different visualizations</td>
<td>Pen and paper, whiteboard</td>
</tr>
<tr>
<td>Organization</td>
<td>Archiving</td>
<td>High</td>
<td>Accessibility, reliability</td>
<td>Cloud storage services, computer folders, physical storage units, desktop</td>
</tr>
<tr>
<td></td>
<td>Clustering</td>
<td>Low</td>
<td>Different visualizations</td>
<td>Sticky notes, computer folders</td>
</tr>
<tr>
<td>Retrieval</td>
<td>Extracting</td>
<td>High</td>
<td>Accessibility, efficiency</td>
<td>Cloud storage services, computer folders, physical storage units, desktop</td>
</tr>
<tr>
<td></td>
<td>Browsing</td>
<td>Low</td>
<td>Providing inspiration, showing the core of the idea</td>
<td>Cloud storage services, computer folders, physical storage units, desktop</td>
</tr>
<tr>
<td>Sharing</td>
<td>Verifying</td>
<td>High</td>
<td>Correctly communicating the idea</td>
<td>Presentation software</td>
</tr>
<tr>
<td></td>
<td>Collaborating</td>
<td>Low</td>
<td>Freedom of expression, providing overview</td>
<td>Whiteboard, pen and paper</td>
</tr>
</tbody>
</table>

An overview of the ten strategies is presented in table 5. The strategies unfold the activities described in figure 2 and section 4.1.1. The table shows how each activity of idea management can be performed as a strategy of either high or low certainty about the outcome or purpose of
the strategy. Because interaction designers operate in scopes of both creative, open-ended discoveries and concrete problem solving (Inie et al. 2018b), there is a varying degree of certainty about the goals of their actions. This duality is simplified as the expression of two different strategies within each idea management activity, for instance saving and externalizing, which are both strategies for the activity capture.

Furthermore, the table lists the desired properties of tools to support these strategies as expressed by our study participants, as well as the tools and platforms which currently support them to the study participants. This does not mean that the list of tools is exhaustive of all tools used in idea management practices. We include the list of tools mentioned to give a detailed idea of how the strategies were described by the interaction designers who were part of the study in this paper.

5 DISCUSSION

There are many challenges to studying tool-use and creativity in professional settings, and many ways to approach this complex subject. The creative objectives of many designers are detailed and complex, and looking at strategies in single use cases provides us with a more comprehensive understanding of design practice. As an example, previous studies have shown a general preference in the activity retrieving information for browsing over searching (Boardman and Sasse 2004), but our data suggests that this depends on the purpose of retrieval. With this study, we have aimed towards gathering small-sample, deep knowledge and thereby establishing a rich foundation for understanding real-life practices. In this section we will discuss the implications of the work presented in this paper.

Firstly, the analysis presents descriptive knowledge about how interaction designers work. Even at a descriptive level, this knowledge is far from trivial, as it is inherently difficult to gather knowledge about idea management in organizational settings and outside the work environment (Coughlan and Johnson 2008).

Secondly, the paper presents a theory of professional idea management. The term ‘idea management’, is neither widely used nor well defined, but we argue that it is an area of great significance for the practicing interaction designer, and potentially also to a wider range of professions. Constructing, defining and discussing theories of processes is an essential basis for research, and thus the analysis in the paper advances a relatively novel research field.

Thirdly, the paper offers a framework to assist researchers in analyzing, understanding, and describing professional tool-use, based on strategies and goals of practicing interaction designers. This framework is useful for researchers as well as for developers of existing and novel creativity support tools in characterizing the role of tools and their support. Categorizing tools in terms of the goals they fulfill to interaction designers may also reveal which goals are not fulfilled using specific tools, or how designers modify tools to fit their purposes. For example, one designer (P18) had created a personal Slack channel with herself, which she used as a to do-list - because she would always open Slack as part of her work day. If we looked purely at the functions of Slack, the tool is designed for collaboration purposes rather than for individual idea capture. But if we consider the desired property in a tool for archiving (accessibility and reliability), Slack clearly fulfills these needs. Designer (P5) used a separate email account as both storage and development tool for his ideas. This is another use we might not expect from looking at the inherent functions of email as a tool. If we think of desired properties of a tool for saving, advancing, archiving, and retrieving, email is quite an obvious tool to fulfill these purposes.

Overall, the paper contributes to the discipline of research in professional interaction design. It is clear from the study that there is not one perfect tool for idea management, nor one standard
process or system. Interaction designers create their own assemblages of tools, methods, and systems that work for them exclusively. Even though each idea management system described in the study was unique, each system was internally coherent. One designer would not use Evernote to keep track of ideas for one project and Google Docs for the next project, for instance. They would adhere to some system that fit their individual needs.

The model offers an explanation and analysis of idea management processes - which is central if we wish to be able to develop tools to be process-focused rather than product-focused. Practicing interaction designers do not always work with a high certainty of the goal they are trying to achieve. Generating and developing design ideas involves a high degree of open-ended exploration and experimentation, and currently available tools do not always support this. Developing tools with a process focus might entail providing the interaction designer with open-ended, easily customizable interfaces, different visualizations, and continuously offering inspiration from external and archived resources of ideas.

Another example of how to use the framework is to deliberately facilitate one strategy at a time. We can aim to support the strategy verification by, for instance, by developing tools to propose different visualizations/representations of the same file, depending on the stakeholder the designer is presenting to. Or with the strategy of saving by developing tools specializing in different forms of tagging and annotation, to allow for rapid capture as well as easy retrieval.

Further studies should unquestionably be performed to expand upon our findings. Analyzing idea management strategies within one team of designers might yield a different result than within another team, because the strategies are affected by context and intervening conditions, as shown in the grounded theory model. The framework might, however, inspire the adaption of novel tools and novel processes of idea management.

5.1 Limitations and future work

The goal of this research was to generate knowledge for researchers and developers of creativity support tools to better understand and support real-world practices. One of the caveats of interviews, is that they report on what study participant say they do, rather than their observed practices. In the future, studies of mixed methods would expand upon the findings with the generation of more and new insights that were out of the scope of this thesis.

I have utilized qualitative interviewing because of its strength as a means of accessing attitudes and values that would not otherwise have been observable or discoverable (Byrne 2004). There are major qualities of the methodology (Amabile and Mueller 2008). Among these are the ability to generate new insights and hypotheses about causes and relationships and the appropriateness for studying organizational creativity with good ecological validity, that is, providing insights that are true to real-world practices. As with any research method, there are also caveats. The limitations of this small-sample work are that it does not allow for determining causal influences on practices, for testing of hypotheses about relationships between causal factors to be tested, or for broad generalizations.

Future research could expand the findings by combining qualitative interviews with, for instance:

**Longitudinal observations in the workplace.** Longitudinal observations of interaction design practices would offer additional deep knowledge of processes for idea creation, management and sharing. This type of study is promising for unfolding some of the findings, such as the context and intervening conditions that influence the chosen strategies.

**Screen capture and video recordings** of activities happening at the desktop in real time. To gather more detailed knowledge of tool-use, it would be extremely interesting to have access to
screen captures/video recordings of workstations over an extended period of time. Such studies would be less intrusive to the normal work practice, and could help discover tacit patterns or tool-uses. Ideally, such recordings would be combined with following interviews that allowed the researcher to ask clarifying questions. This type of study would be particularly interesting for discovering the correspondence between what interaction designers say they do and what they actually do. It would be a very promising avenue of research in terms of watching idea development over time, both on a short- and long-term scale.

Building and testing tools with a process focus. As described in the introduction, there is a potential in developing tools with a process-, as well as a product focus. That is, tools which support creative strategies in an unobtrusive manner. Future work would ideally be directed towards testing novel tools, and exploring how these might be beneficially adapted in professional interaction design practices. The framework of strategies for professional idea management we have presented in this article may inform the development of novel tools.

6 CONCLUSIONS
This work presents an extensive analysis of the activities and processes involved in professional, tool-supported idea management. We suggest that this analysis can benefit research into information management and creativity support tools by providing a deep, detailed understanding of real-world practices. Our findings allow us to characterize the idea management process in terms of relationships between the core phenomenon and its activities, causal conditions, context and intervening conditions, strategies taken in response to the core phenomenon, and consequences of using the strategies.

We identified a unifying theory of the core phenomenon of idea management: capture, development, organization, and sharing of ideas. We presented an analysis of this phenomenon as influenced by internal- (fear of forgetting, and maintaining and maturing a lifelong, creative practice) and external- (organizational, non-tool specific requirements, communication, and collaboration) causal conditions. We identified the context and intervening conditions of idea management as available platforms, tools, and auxiliary tools, personal preferences, training and job functions, and organizational (tool-specific) requirements. Our primary contribution of the theory was the identification of ten strategies, which are actions taken in response to the core phenomenon. These strategies were saving, externalizing, advancing, exploring, archiving, clustering, verifying, and collaborating. And lastly, we described the consequences of the strategies taken as either satisfaction with the support of the tool utilized, dissatisfaction and abandoning of the tool, or dissatisfaction, but continuation of using the tool.

Finally, we elaborated on the strategies, and illustrated them as a framework which might be used to analyze and describe specific tools based on how they fulfill certain strategies or objectives to the designer, rather than the tools’ inherent functionality. With this work, we hope to inspire both developers of novel creativity support tools as well as researchers in interaction design.

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HOW INTERACTION DESIGNERS USE TOOLS TO MANAGE IDEAS
AND WHAT WE CAN LEARN FROM IT

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