Ideation as an intellectual information acquisition and use context: Investigating game designers' information-based ideation behavior

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Abstract

Human Information Behavior (HIB) research commonly examines behavior in the context of why information is acquired and how it will be used, but usually at the level of the work or everyday-life tasks the information will support. HIB has not been examined in detail at the broader contextual level of *intellectual purpose* (i.e. the higher-order conceptual tasks the information was acquired to support). Examination at this level can enhance holistic understanding of HIB as a 'means to an intellectual end' and inform the design of digital information environments that support information interaction for specific intellectual purposes. We investigate *information-based ideation* (IBI) as a specific intellectual information acquisition and use context by conducting Critical Incident-style interviews with ten game designers, focusing on how they interact with information to generate and develop creative design ideas. Our findings give rise to a framework of their ideation-focused HIB, which systems designers can leverage to reason about how best to support certain behaviors to drive design ideation. These findings emphasize the importance of intellectual purpose as a driver for acquisition and desired outcome of use.

Keywords: information behavior, information-based ideation, context, game design, creativity

Introduction

There has been a gradual shift in Human Information Behavior (HIB) research – away from understanding how people acquire and use information isolated from the work or everyday-life tasks for which information is sought and towards a more holistic view where the "*context-laden nature of information behavior seems to be taken as a given"* (O'Case and Given, 2016, p.360). However, there is still a need for a 'much fuller' understanding of context (Bates, 2010), beyond the task level, including of the relationships between behavior and context (Fidel, 2012). While HIB's scope includes the integration of acquired information with pre-existing knowledge to forge new understandings or generate new ideas (Bates, 2010), to our knowledge HIB has not been examined in detail at the broader *intellectual purpose* level (i.e. the higher-order conceptual tasks the information was acquired to support). This can enhance holistic understanding of HIB as a 'means to an intellectual end,' provide an enriched understanding of *why* people do what they do with information, and inform the design of digital information environments that support information interaction for specific intellectual purposes.

This research investigates *information-based ideation* (IBI) in a specific intellectual information acquisition and use context. IBI involves generating and developing new ideas to encourage creativity, by finding and making use of information (Kerne et al., 2008; 2014). IBI is undertaken through *information interaction*: engaging with information-rich environments (often, but not always digital) to find and make use of information. While information interaction can be undertaken for a variety of intellectual purposes (e.g. questioning existing or creating new knowledge), in IBI, information is acquired specifically to drive *ideation* (Kerne et al., 2008).

This study considers ideation as comprising the divergent activities of producing and exploring a variety of ideas (idea generation) and the convergent activities of evaluating, selecting and elaborating ideas (idea development). IBI is a specialist type of *ideation-focused* information interaction, where examining relationships between information found can lead to the generation and development of ideas: *"the essence of creativity"* (Kerne et al, 2008, p.461). We use the term 'IBI behavior' to denote information behavior undertaken for the purpose of supporting ideation (i.e. ideation-focused HIB).

Previous HIB research has focused on understanding designers' information acquisition and use behavior, resulting in a greater understanding of IBI in the process. Furthermore, existing IBI research has provided some insight into designers' HIB as a by-product. However, little HIB research has focused on understanding IBI behavior specifically, or in detail. This is important for the Human-Computer Interaction (HCI) field which has identified the need for qualitative investigations of IBI activities to feed the design of digital information environments that better support creativity and to connect disciplines in the investigation of these activities (Kerne et al., 2008; 2014). It is also important for the HIB field: partly for understanding the HIB of a rarely-studied group (game designers) and for enriching understanding of designers' ideation-focused information behavior, but mostly for demonstrating the usefulness of understanding information acquisition and use at the intellectual purpose level: a broader contextual level than is usually examined.

Critical Incident-style interviews were conducted with ten game designers, focusing on how they interact with information to generate and develop creative design ideas, with the aim of examining their IBI behavior in detail to enrich understanding of ideation as an intellectual information acquisition and use context. Our findings give rise to an empirical framework of their ideation-focused HIB, which designers can leverage to reason about how best to support certain behaviors to drive idea generation and development.

Next, we discuss previous studies that provide insight into how designers interact with information and review existing digital information environments that support design ideation. We then discuss the method used in detail and present our framework, discussing it in relation to previous work. Finally, we discuss the wider implications of our work, focusing on the importance of understanding HIB in the context of the intellectual purpose information is acquired for. We introduce a conceptual 'purpose model' of information acquisition to support this discussion, which emphasizes the importance of intellectual purpose as a driver for acquisition and desired outcome of use.

Background: Designers' HIB

We review existing studies of designers' HIB, encompassing their information-seeking, encountering and use behaviors and existing digital information environments that support design ideation. We synthesize literature from Information Science and HCI and discuss information-based ideation as it relates to HIB. This is a first step towards connecting two disciplines with a shared interest in informing the design of digital information environments that encourage creativity.

Understanding HIB is essential for designing useful digital information environments (Vakkari, 2008). Vakkari calls for *"case studies on mechanisms that connect information behaviour with the activities generating it and with the use of tools for supporting that behaviour."* Our research connects HIB with ideation as an intellectual activity driving it and informs the design of information environments with a strong ideation focus, the need for which has been identified across disciplines (Makri and Warwick, 2010; Kerne et al., 2014).

Information interaction is fundamental to the creative design process (Medaille, 2010). When addressing design problems, designers examine relationships between information found, often resulting in new ideas (Kerne et al., 2008). Ideation is both an intellectual driver for and outcome of information-seeking (Makri and Warwick, 2010); the need for original and useful ideas (without knowing beforehand what they will be) spurs information-seeking which, in turn, supports ideation and creative designs. As ideation is a cognitive process (Finke et al., 1992;

Hernandez et al., 2010), and therefore intangible, it can be considered an intellectual (rather than physical) outcome of creative design. Ideation manifests itself in tangible creative design products, which reify the ideas generated.

Designers' information acquisition behavior

Information-seeking is undertaken throughout the design process, but particularly when generating alternative design ideas (Hemmig, 2009; LeClerc, 2010; Miller, 2014). During this process, designers are often *"looking for inspiration more than satisfying specific information needs"* (Sharmin et al., 2009, p.2374). This type of information-seeking has been labelled 'inspirational search,' where designers' understandings of what information is required and the information found is 'intelligible but not predictable' (Hill et al., 2016, p.3). During inspirational search, designers are acutely aware they 'don't know what they don't know' (Hill et al., 2016). Information-seeking for idea generation is therefore characterized by an evolving understanding of the design problem and associated information needs, which becomes more concrete as they identify and fill their Anomalous States of Knowledge (Belkin, 1980), often through exploratory search (White and Roth, 2009). Designers' exploratory information-seeking can result in the acquisition of sought or unsought information, both with potential to inspire (Mougenot et al, 2008, Makri and Warwick, 2010).

Designers' 'inspiration hunt' (LeClerc, 2010) involves extensively seeking visual information, particularly images and video (Mougenot et al, 2008; LeClerc, 2010) that is not directly incorporated into designs, but used *indirectly* to fuel idea generation and development (Laing and Masoodian, 2015). It is not intrinsically 'inspirational,' but can become so after it has been understood and incorporated into the designer's interpretation of problem and solution space (Gonçalves et al., 2016). Information-seeking can be tailored to aesthetic tastes of clients, end-users and the design market, to ensure distinctiveness (Laing and Masoodian, 2015). This tailoring is useful, but not essential for encouraging creativity during design ideation (Laing and Masoodian, 2016).

As well as actively seeking information, designers frequently *encounter* potentially useful information unexpectedly (Hemmig, 2009; LeClerc, 2010), often during exploratory searching or browsing (Mougenot et al., 2008; Makri and Warwick, 2010). Encountering is particularly useful when generating (rather than developing) ideas; 'Loose' searches can serve a brainstorming function, potentially resulting in acquiring information *"the designer did not have in mind but that are inspirational…"* (Mougenot et al., 2008). Designers not only 'experience' encountering, but *rely* on it spurring idea development (LeClerc, 2010). Therefore, just as ideation is a key driver for information-seeking, encountering is an important catalyst for ideation. Our research enriches understanding of both information-seeking and encountering during design ideation.

Designers' information use behavior

Information use involves physical acts, such as annotating text, and cognitive acts, such as incorporating information found into the person's existing knowledge base (Savolainen, 2009). Just as information-seeking and encountering can support ideation, so too can use. The knowledge gap-filling approaches of Belkin's ASK (1980) and Sense-Making (Dervin, 1998) acknowledge new ideas as a possible beneficial outcome of information use. However, information use research has not traditionally focused on how people 'use' ideas triggered by information acquisition (Savolainen, 2009). This has largely been left to creativity researchers in HCI. There is scope to expand the boundaries of 'information use' in this regard, ideally defining them more clearly in the process.

Curation of personal information collections, and subsequent review to spur ideation, is particularly common among designers (Webb et al., 2013; Kerne et al., 2014; Laing and Masoodian, 2015). Curation involves conceptualizing, finding, choosing and synthesizing information to generate and develop new ideas (Kerne et al, 2014). It therefore incorporates aspects of information use *and* information-seeking. Curation can encourage idea generation through iterative cycles of collection, reflection and interpretation (Webb et al., 2013). Curation facilitates the *creative cognition* (Finke et al., 1992) of relationships between collected information (e.g. clippings and annotations). Creative cognition posits that our minds alternate between generative and exploratory processes and characterizes creative thinking in terms of how these processes are employed or combined. For example, a designer may generate initial ideas by combining familiar and new concepts, then examine the ramifications through seeking related information. Observed curation behavior patterns include arranging, connecting, synthesizing, mapping, grouping and sequencing information (Lupfer et al., 2016). Curated information is often shared with clients and colleagues, to aid idea expression and communication (Laing and Masoodian, 2015).

Information use can be considered both a process and outcome (Kari, 2007). The use process can be driven by lower-level intents, such as better understanding a topic area (Savolainen, 2009) or, we argue, by higher-level intents, such as ideation. We are unaware of prior work that has conceptualized ideation as an aspect of information use. However, use has been discussed in terms of knowledge creation (Kari, 2010), which can potentially be driven by ideation.

Information-based ideation

When ideation-focused, information acquisition and use can be regarded as a means of facilitating *information-based ideation* (IBI). IBI *"focuses on creative processes that are meaningful to people as they engage with information"* (Kerne et al, 2014, p.41). While the scope of IBI extends beyond information interaction, it focuses primarily on *"how people generate and develop new ideas as they work and play with information"* (p.7). IBI complements (and is claimed to incorporate) existing information-seeking theories, including Sense-Making (Dervin, 1998) and exploratory search (White and Roth, 2009). We investigate game designers' IBI behavior; the ideation-focused information behavior they undertake when interacting with information. This encompasses the information-seeking, encountering and use behaviors driven by ideation with the aim of encouraging creative outcomes. These creative outcomes can be considered as outcomes of information use.

Existing IBI environments

The need to support ideation in digital information environments has been recognized (e.g. by Kerne et al., 2008; 2014, Hernandez et al., 2010; Laing and Masoodian, 2015) and several environments have been designed to this end. While the features and functions supported provide some guidance, more design-based research is needed to determine how best to implement ideation support. Most existing environments have been designed based on a conceptual understanding of IBI, but not always on an empirical understanding of users' IBI behavior, which can ensure future design is shaped by and shapes future behavior.

Existing digital information environments often integrate information-seeking and use, supporting ideation through curation. For example, Webzeitgeist (Kumar et al., 2013) supports finding design patterns and trends on the Web, allowing the creation of dynamic collections that demonstrate certain design characteristics (e.g. a specific visual layout).

Several environments support browsing own or others' designs, encouraging ideation through examination of previous solutions (e.g. Pearce et al., 1992; Chan et al., 2015; Lupfer et al., 2016). Some also support movement from design examples to new ideas. For example, OpenIDEO (Chan et al., 2015), a crowdsourced innovation environment, explicitly tracks connections from designs to sources of inspiration, storing citation links. While supporting serendipitous discovery is rarely stated as a design aim, some ideation environments facilitate information encountering through exploration (e.g. Lindley et al., 2013).

Many existing environments facilitate information use through sketching, often integrated with information-seeking. For example, SketchStorm (Lindley et al., 2013) supports sketching in a central canvas while streaming Web images based on submitted queries and from the designer's personal collection. IdeaMâché (Lupfer et al., 2016) also supports sketching, alongside visual arrangement and transformation, lightweight annotation and cloud-based sharing. It supports information-seeking through the creation of *rich clippings* consisting of visual Web clippings, supplemented by relevant metadata to support re-finding.

Research gap

The research gap presents itself at multiple levels; the first is understanding the HIB of a rarely-studied group: game designers. Filling this gap represents a minor contribution, as their HIB was similar to other design disciplines. The second is better understanding designers' *ideation-focused* HIB. This represents a larger contribution, as an enriched understanding of how information interaction facilitates ideation can inform the design and improvement of ideation-focused digital information environments. The third is demonstrating the importance of ideation as an intellectual information acquisition and use context. This is our major contribution and paves the way for future research that examines HIB in a variety of intellectual contexts that can influence information acquisition and use.

Understanding game designers' information behavior

While there is a growing body of research on designers' information and ideation behavior, little research has examined *game designers*' HIB and none, to our knowledge, has done so with a specific ideation focus. Although Miller (2014) asked game design students to discuss a recent information-seeking episode, most chose examples related to learning specific game development software rather than creative design examples. We provide insight into the HIB of this rarely-studied group, noting similarities with other design disciplines.

Understanding designers' information-based ideation behavior

Existing studies provide only limited insight into the breadth and depth of designers' IBI behavior. Some have examined designers' general HIB, which has resulted in a greater understanding of their IBI behavior in the process. For example, in our observations of design students' HIB (Makri and Warwick, 2010), many of the behaviors displayed were ideation-focused as although we asked the students to undertake self-chosen information tasks, all chose tasks related to the creative design projects they were working on. This motivated us to take a deliberate ideation focus in this study. A broad understanding of IBI behavior can inform the design of digital information environments that support information-seeking and use throughout the ideation process. Other work (in HIB, HCI and Design Studies) has provided in-depth understanding of specific aspects of IBI behavior, such as the role of visual information (e.g. Herring et al., 2009, Laing and Masoodian, 2015; 2016) and digital curation (Linder et al., 2014) in design ideation and the use of physical and digital information sources (Mougenot et al., 2008) and sketching (Buxton, 2010) to support ideation. A detailed understanding of IBI behavior can help ensure digital information environments provide comprehensive support for important ideation-related behaviors.

Ideation as an intellectual information acquisition and use context

While it is now common to understand information acquisition and use in the context of the work or everyday-life tasks that drive it, we are unaware of previous studies that demonstrate the usefulness of understanding information acquisition and use at the broader *intellectual purpose* level. 'Context' and 'use' have become prominent strands of HIB research. However, they are rarely discussed together, despite task context influencing both information-seeking *and* use behavior. Examining HIB at the purpose level can provide a more holistic understanding of information acquisition and use and a more focused understanding of information interaction in specific intellectual contexts (in this case ideation). This can ensure

digital information environments are designed with the purpose of information interaction in mind.

Method

Data collection

We conducted semi-structured interviews with a purposive sample of ten designers from a London video game design company. These comprised four Graphic Designers, two Concept Artists, a Motion Graphic Designer, an Animator/Motion Graphic Designer, a Storyboard Artist/Motion Graphic Designer and a Visual Interface Designer. Although their job roles straddled art and design disciplines, we refer to the participants collectively as *game designers.* We interviewed game designers as they engage heavily in ideation and information interaction to support it. We interviewed across job roles to aid generalizability and did not note any organizational culture or practice bias. While basic HIB processes might be transferrable across contexts (O'Case and Given, 2016), in-context HIB studies have limited generalizability (Fidel, 2012). As our findings complement and enrich those from other design disciplines, we only claim generalizability across *design* disciplines.

Each interview lasted around forty minutes and took place in the designer's regular workspace. After explaining the study's purpose and obtaining informed consent, we established rapport by asking questions about the nature of the designer's job and the role of creativity and information interaction in it. The main interview was based on an adaptation of Flanagan's (1954) Critical Incident Technique (CIT), which involves asking people to provide recent, memorable examples of experiences in order to elicit concrete (rather than abstract) detail. We asked for examples of finding information on the Web to support design idea generation or development. The designers discussed their chosen example in detail, using the Web (and any physical or digital design artefacts they created) as 'props' to aid the discussion. They were requested not to try 'reconstructing' previous information interaction, as re-tracing their steps would be difficult. Instead, they were asked to use the Web to help explain rather than recreate their example. Screen and audio were recorded. During the interview, the researcher did not ask specific questions but instead asked opportunistic, probing questions to check assumptions and elicit more detail. For example, when D10 stated a design goal of aligning the shapes in the client's company logo with the elements of earth, wind, rain and fire, the researcher checked her assumptions by asking whether each element would be assigned a representative color (e.g. red for fire). She elicited more detail by asking D10 how he came up with this alignment idea and what he did afterwards.

CIT has been successfully adapted to understand information behavior (Savolainen, 1995; Marcella et al., 2013). Marcella et al. (2013) note CIT has been inconsistently applied, calling for it to be 'used in a thoughtful manner.' We tried to be thoughtful in our adaptation by following Flanagan's (1954) advice: We ensured the interview was grounded in clear aims and objectives; our aim was to understand how game designers interact with information to generate and develop ideas. A key objective was to elicit recent, memorable examples of this through our interviews. Our interviews were also discursive, conversational and participant-led. They were transcribed promptly so the details were 'fresh in the mind' of the researcher. To avoid data collection bias, we explained we wanted to gain as clear and accurate understanding of participants' behavior as possible (to discourage them from omitting, altering or embellishing details). We also regularly tested assumptions by questioning in a humble, non-assertive manner.

Data analysis

A grounded approach to data gathering and analysis was followed, supported by Qualitative Data Analysis tool ATLAS.ti. We 'listened to the data' from the ground up; identifying and categorizing important behaviors.

Our approach was based on key principles of Grounded Theory (GT). Firstly, it was cyclic; after conducting each interview, we transcribed it verbatim, analyzed it, and used emergent findings to inform the questions we asked in subsequent interviews. For example, our first interviewee (D1) stated his creative ideas often came from previous project experience, but it is useful to look beyond previous experiences. We asked subsequent participants about the role of previous experience in idea generation, resulting in the creation of 'interpreting' (information in light of previous experience) as a behavior category. Secondly, it involved 'constant comparison'; we compared emergent findings with those from previous interviews and with the literature on designers' information and ideation behavior. For example, when participants mentioned creating personal collections we compared how and why they created them across participants, and in relation to existing literature. This does not undermine an inductive, grounded approach provided the literature is not used as data per se, but to stimulate thinking about the properties and dimensions of data (Corbin and Strauss, 2015). Thirdly, our approach involved method triangulation as our interviews incorporated an observation component. We also regularly checked assumptions with interviewees and maintained an attitude of skepticism, which Corbin and Strauss (2015) argue is especially important when researchers adopt categories from previous literature (which we did for some of the behaviors identified).

Although we followed key principles of GT, we did not identify a 'core category' to discuss all other categories in relation to. Instead, coding ended once a comprehensive set of behaviors was identified. This approach is supported by Grounded Theorists (e.g. Strauss and Corbin, 2015) and is commonplace in grounded approaches that inform design (see Ellis, 1989; Makri et al., 2008; Makri and Warwick, 2010). While it did not create a 'Grounded Theory,' our approach did result in theory generation: an empirical framework of information behavior in a specific ideation context and a conceptual model of intellectual purpose as an information acquisition and use context.

Findings

The game designers demonstrated IBI behavior when working on design briefs: documents that explain the project purpose and scope and describe, primarily, the type of product to be designed and motivation for designing it. Insufficiency of information on a design brief necessitates information acquisition (Goldschmidt, 2014). The information behaviors they undertook are listed and defined in table 1. These constitute a framework that details *what* designers do when interacting with information to support design ideation, *how* (the various ways they undertake each behavior) and *why* (their rationale for doing so). Unlike previous information behavior models (e.g. Ellis, 1989; Makri et al. 2008), which discuss behavior separately from its task context (and therefore separately from the broader intellectual purpose the behavior aims to support), our framework describes information behavior undertaken specifically for the purpose of *generating and developing ideas*. We use *framework* rather than model as it is more aptly describes a collection of distinct behaviors. Behavioral 'models' (e.g. Ellis, 1989; Makri, et al. 2008) have, so far, not captured relationships between behaviors (e.g. activities involving multiple behaviors), which might make *model* the most suitable term.

The behaviors are split into two groups; information *acquisition* and *use* behaviors. While there is some overlap, these groupings reduce complexity. Some behaviors (e.g. 'externalizing' and 'unblocking') are closely-tied to ideation and cannot be understood outside this context. Others (e.g. 'immersing' and 'communicating') can potentially be understood in other contexts, but are discussed in an ideation context.

Information acquisition behaviors
Seeking*. *Looking for useful information by searching or browsing for it to generate new or develop existing ideas.*
Encountering. *Coming across useful information unexpectedly to generate new or develop existing ideas.*
Monitoring. *Acquiring information to keep up-to-date with developments and trends to spark new and evaluate existing ideas.*
Examining*. *Looking at information in detail to determine if it helps encourage new ideas or develop existing ideas.*
Immersing. *Immersing oneself in information to trigger as many new ideas as possible.*
Unblocking. *Employing strategies to 'unblock' counter-productive thinking to encourage the generation of more ideas.*
Information use behaviors
Interpreting. *Interpreting acquired information in light of previous experiences to decide whether and how to develop a particular idea.*
Collecting. *Creating and reviewing personal collections of acquired information to support developing catalogued ideas and generating new ideas during review.*
Externalizing. *Expressing ideas generated during information acquisition in external form to support idea evaluation and drive further idea development.*
Communicating. *Discussing design ideas with colleagues and clients to support idea evaluation and drive further idea development.*

Table 1: Framework of the IBI behaviors undertaken by the game designers. *Seeking and examining are not discussed due to space restrictions

Information acquisition behaviors

Encountering

The game designers not only sought information to support ideation (e.g. by searching or browsing for it) but also stumbled upon it, leading to the creation of new mental connections and ideas:

> *"You can see another user's board on Pinterest and it can lead you on a path, an unexpected path…It's kind of how the world works, how ideas work. It's how you arrive at these connections."* (D2)

Serendipitous information encounters can spur creative professionals' idea generation and development (LeClerk, 2010; Makri and Warwick, 2010). However, to our knowledge, how encounters contribute to design ideation has not been examined in detail.

While Herring et al. (2009) note a distinction between designers finding information during *active search* (when looking for something in particular) or *passive search* (when not looking for anything in particular), this distinction was not clear-cut in our findings; designers regularly encountered information during active seeking, but this was often information they were not specifically looking for.

Erdelez (1999) originally proposed a narrow definition of encountering as *"looking for information relating to one topic and [finding] information related to another"* (p.25). This definition has been subsequently expanded to include three types of finding useful information unexpectedly, when: 1) looking for information on something else (i.e. only partly or seemingly-unrelated to the information found), in line with Erdelez's definition, 2) looking for information, but not anything in particular and 3) not looking for information at all (Makri et al., 2017). Makri and Warwick (2010) found architectural and urban designers experienced the first type, while

our game designers experienced all three, and all served to drive ideation. Examples of each type follow.

***Fleas, frogs and Frogeye Sprites**: Encountering information when looking for information on something else.*

D8 was looking for information to generate ideas for designing a robot game character. As the design brief stated the robot should jump and run, D8 decided to look for 'things that jump' on Google Images, to inspire his design. He narrowed his concept direction to fleas and frogs and looked for information on the anatomy of frogs and, in particular, how they jump:

> *"It was mainly looking for how the legs work. That's what I was looking for. But I also ended up looking at the frog's face. I thought 'aww it's so cute'. That's probably when I realized that frogs, not fleas should be the way forward."* (D8)

D8 then focused on parts of a frog's face and searched for 'frog eyes'. He came across images of the 'Frogeye Sprite' car manufactured by Austin Healey, with prominent headlights intended to resemble frogs' eyes (figure 1).

***Figure 1: Austin Healey Frogeye Sprite car (Wikimedia Commons, licensed for reuse)***

The designer remembered he had previously seen this car when he worked in a petrol station as a teenager and made a mental connection between the car's 'big round eyes' and those of a frog and between the metal design of the car and that of a robot. This helped inspire the final robot design, which incorporated a metallic look and big, round eyes (figure 2).

Figure 2: The final robot character design, inspired by the Frogeye Sprite car

***Something Victorian**: Encountering information when not looking for particular information.*

D9 was designing a poster for a third-person shooter set in an alternative history London in the Victorian era and was looking for diagrams to inspire his to poster design. He wanted the poster to feature a gun and incorporate a technical drawing style. He searched Flickr for 'Victorian diagrams,' but was not looking for a particular diagram type or Victorian style element. He found several Victorian invention diagrams and noticed they incorporated inventor stamps and signatures. He also incorporated these in his poster design (figure 3), as he felt they made the poster more 'believable' and authentically Victorian.
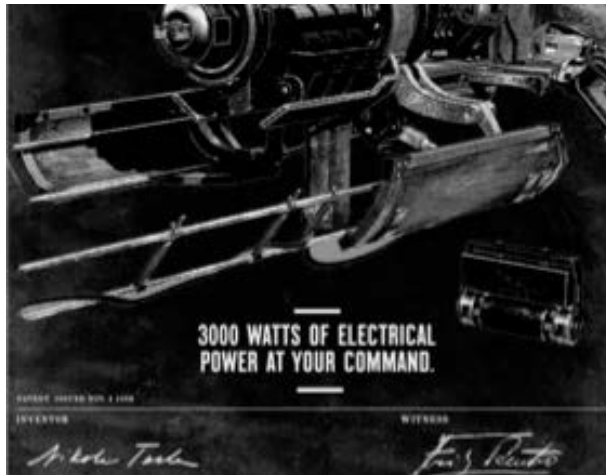
Figure 3: The inventor stamp and signature D8 used in his poster design

The sports drink robot: *Encountering information when not looking for information at all.*

D1 was also *working on the design of the robot game discussed earlier, which was intended to look "very futuristic and high-end"* (D1). While visiting Amsterdam, he entered a supermarket. He was not looking for information or design ideas, but something for dinner. He noticed the distinctive packaging of a sports drink, not because the packaging looked particularly futuristic or high-end, but *"because the color palette was fantastic"* (D1). He photographed the packaging (figure 4) and thought *"'wouldn't it be great if the robots in my game were colored like these drinks cans?'"* (D1). He designed his game using similar colors.

Figure 4: The sports drink packaging that inspired D1's robot character design

Creating value from encountered information often requires considerable effort (Makri et al., 2017) which can restrict the types of encountering examples collected in HIB research to those

that have not fully come to fruition. These examples concretely demonstrate how encountered information can drive idea generation and development. They also demonstrate the connection between encountering and ideation; André et al. (2009) argue that insight is a desired intellectual effect of encountering. In this vein, insight can be regarded as both a determinant and outcome of encountering; it is required to make mental bisociations between information found and an existing task or interest (Makri et al., 2017) and can occur as a result, manifesting as new ideas.

Monitoring

The game designers highlighted the importance of continually staying updated with current design trends and broader industry knowledge:

> *"'It's probably one of the most important characteristics of a designer in any industry: to have broad industry awareness, not only of their discipline but of the entertainment industry as a whole."* (D1)

They frequently monitored sources related to their own personal design interests in their spare time and even when they did not need to find information for a current project:

> *"I've got many personal things I like… character design, inspiration type, infographics… Sometimes in my spare time I just browse Pinterest to see what I stumble upon"* (D2).

Monitoring was often achieved through regularly browsing 'favorite' information sources, including blogs, videos, image-based social media and digital design magazines. Regular browsing has been identified as a type monitoring in several studies, including of visual designers (Mougenot et al., 2008) and game designers specifically (Miller, 2014). As we focused on understanding *digital* information behavior, we did not observe the common activity of browsing physical design magazines (Hemmig et al., 2009). Browsing was often without a particular aim, which sometimes resulted in *encountering*.

Monitoring was also used to determine whether an idea was truly creative, or whether it (or something similar) had been previously implemented. For example D6 was considering incorporating double A lettering in a game logo. She was aware the Automobile Association used 'AA' as an acronym, but when browsing existing 'AA' logos, discovered it was also an acronym for Alcoholics Anonymous and decided not to use it due to its strong association with existing brands.

Immersing

The designers did not simply look for information to support ideation, but *immersed* themselves in it; rather than seek a small amount of 'relevant' information, they sought as much as possible, even if loosely-related. They wanted to expose themselves to multiple idea triggers, ensuring their thinking remained unconstrained. The information sought was usually visual (images and video), but sometimes textual.

To support immersion, they made extensive use of image and video search tools (e.g. Google Images and Vimeo, industry blogs and visual social networking tools such as Pinterest and Behance). Social functionality supported designers in identifying and following topics and people related to their projects, and to their broader design interests. This, in turn, exposed designers to more, and more diverse information streams. Immersing themselves in information through exploration was common. D5 commented exploration *"opens you up to stuff that you wouldn't necessarily go searching for straight away"* (D5), while D10 explained the importance of exploring information, by following paths between metadata:

> *"If I find an interesting video, it's useful to dig into who directed it. Because then you can look for other things that director's done. If you like the style of the director, you*

can follow up. Or the studio. And you can be like 'oh I like that Analogue made this, they're a very good studio' and you can find other videos they have made." (D10)

D1 described visual information as the 'seeds' for his ideas and explained exposing himself to lots of information could increase opportunities for unexpected encounters. Similarly, D3 explained her information-seeking strategy when generating ideas was to *"see as much as you can"* (D3) and collect useful information by building personal collections (discussed as 'collecting'). While Laing and Masoodian (2015) found graphic designers were concerned about 'getting lost' in the exploration process, this was regarded as positive by our designers:

> *"I like to use Pinterest because you can get really lost in it… collecting things until you think you've had enough, and then you get back to real life and put these images together and look through them." (D2)*

Unblocking

Almost all designers regularly made connections between information found and their design projects. However, they often had deadline pressures and this could cause them to become stuck in a counter-productive mindset, where new ideas were *"blocked or limited by one's current thinking"* (Bates, 1979, p.281). This is known as 'design fixation' (Kerne et al., 2014).

They adopted a range of 'unblocking' strategies. Some involved disengaging from the research process and 'making mental space' by conducting a different activity, such as going for a walk (D8), showering (D1), listening to music (D1) or watching films (D2). Others involved continuing to engage with the research, but shifting focus away from actively trying to fulfill the design brief (e.g. by browsing with no particular aim for information that might inspire the design). D10 described browsing to *"see whatever people in industry are doing"* when he felt 'blocked.' He explained *"the more you are exposed to something, the more chance you will unexpectedly come across something,"* highlighting the role encountering information can play in 'unblocking' creative thinking.

Designers also 'unblocked' by deliberately looking for information that would *not* be useful for fulfilling the design brief, to spark ideas about what *might* be useful. This is reminiscent of the 'reversal' technique advocated by de Bono (de Bono, 2010). Looking for 'non-useful' information allowed designers to alter their thinking in the hope of gaining a new perspective on the brief. D1 described this activity as trying to find information in a 'different way.' D9 referred to it as 'doing the reverse' and 'opposite gathering':

> *"Sometimes looking for images is not to pick some part of the elements to use. Instead, something you don't want to be used. Opposite gathering."* (D9).

Information use behaviors

Interpreting

All designers reported interpreting information in light of their backgrounds, previous work and design interests (especially trends). These influenced designers' decisions on whether and how acquired information should inform their designs. Designs were influenced by *"the stuff you learn along the way, the people you work with, similar projects you've worked on in the past, the Art History course you take in the evening and your interest in the subject generally"* (D5). The finding that prior knowledge influences information interpretation supports the views that meaning is constructed by individuals rather than intrinsic to information (Vakkari, 2003) and that ideas come from prepared minds rather than individual 'aha moments' (Sharmin et al., 2009).

D2 unpacked the concept of 'fiesta' to help him design a logo for an open gameplay event. He made several word associations, including 'food' and 'sunshine.' When asked how he thought

of these words, he stated *"it's from past experience, or I've seen it in a film. You just remember certain visuals and use them to justify your design theme"* (D2).

D9 explained how his previous experience studying Victorian history and watching documentaries helped him generate a new idea for a game set in an alternative history London in the Victorian era:

> *"I remembered things I'd read from the past and watched in theatre productions from the Victorian times. It's like leaning over time, from school or from watching documentaries. You just absorb information as you go along."* (D9)

While previous findings (e.g. Westman, 2009) have highlighted the importance of personal knowledge and experience in image search, our findings highlight their importance for influencing IBI behavior.

Collecting

All designers reported creating text and visual information collections, using various methods; saving onto a computer, server, or the cloud and sharing on social networking sites. They wanted to catalogue the information to support future idea generation:

> *"I am always looking at the things that excite me and interest me. Then I put them away and catalogue them for future reference."* (D1)

Idea generation has been identified as a particularly important reason for designers creating personal collections (Sharmin et al., 2009). Personal collections supported idea development in current projects, future projects, or often both:

> *"Save things you like and they are quick starts to how you might approach a future project. It's really a starting point. And sometimes a finishing point."* (D1)

The designers often reviewed their personal collections to spark new ideas (echoing previous findings: see Herring et al., 2009; Sharmin et al., 2009; Makri and Warwick, 2010). They organized collections by creating folder and sub-folder hierarchies.

Social image curation tool Pinterest was used by most designers and described by D1 as a *"great online scrapbook."* It allowed them to create image collections that they shared with other designers and clients and stored for use in future design projects. They used Pinterest to access their personal collections from different locations and on different devices. They also used it to re-find images, re-organize their collections and group images for use in client presentations. This complements findings from a study of Pinterest use (Linder et al., 2014), which found users collected and curated images to drive *everyday life* design activities (such as renovating one's home or dressing in a particular style). Combined, these findings suggest the importance of personal collections in supporting IBI behavior.
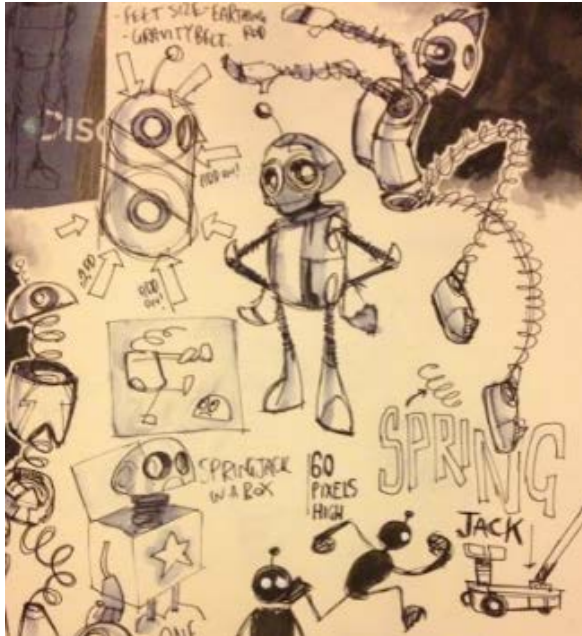
Externalizing

When the designers explored ideas for fulfilling briefs, they created external artefacts (notes and sketches) to offload their thoughts. This is known as 'external cognition' (Scaife and Rogers, 1996) and has been noted as a means of establishing a 'creative sensibility' amongst designers, both supporting *and* representing the ideation process (Vyas et al., 2013).

Externalizing often began by writing down important concepts related to the brief, *"pulling the brief apart and pulling out the key words"* (D9). This helped the designers to generate more and more varied ideas, think around topics in a structured manner and make connections between ideas:

> *"I write 'festival' and you kind of just go 'what do you think of?' and say 'tents' and then 'food' and then you go 'what kind of food?' It's getting all the words out of your head quickly. Just whatever you are thinking."* (D2)

Externalizing design ideas also helped remind designers of important information they recorded previously, supporting them in tracing back their thoughts and progression. An example externalization is shown in figure 5, depicting D8's ideas for designing a cartoon robot game character (see figure 2 for final design).

Figure 5: D8's sketches and notes to support the design of a cartoon robot character

Sketching as a form of externalizing initial design ideas was commonplace and is widely documented (Buxton, 2010; Goldschmidt, 2014). Sketches serve as 'external memories' for design ideas (Goldschmidt, 2014) and provide visual cues for further associative thinking. They are important for exploring partial design solutions; cognitive advantages include the ability to create flexible visual representations quickly and fluently, utilizing minimal cognitive resources (Goldschmidt, 2014). Sketching is also central to the 'C-Sketch' technique (Shah et al., 2001), an alternative to brainstorming that involves designers sketching visual solutions to a design problem, then passing their sketches sequentially through the design team, each member adding their own contributions. C-Sketch has been found to encourage idea generation in general, and *unblocking* (Shah et al., 2001).

As well as a memory aide, externalization was also used by designers as a deliberate means of *forgetting*, to spur further ideas and to avoid constraining their thinking. Offloading thoughts allowed the designers to put aside previous ideas and 'free the mind' to generate new ideas:

> *"If you've gone through the process of drawing something or writing it down, you will remember it clearly. But also, weirdly, I'm able to forget it. So that frees up my brain."* (D8)

The designers used concepts they externalized as query terms to support searches. D4 explained conducting searches around concepts he identified helped him 'understand the feeling' of the concepts:

> *"Anything to get my head in the same place as what it is I am designing… studying it, reading it, looking it up on Wikipedia, reading about other people's reaction to it or looking at photos."* (D4)

Externalizing not only occurred at the beginning of the design process, when generating initial ideas, but also later in the process (once initial ideas were exhausted and additional ideas needed). This happened by conducting text and image searches. D1 used online thesauri to trigger new potential ideas and information-seeking directions:

> *"I first search for everything that comes into my head. When I run out of ideas, I will use the thesaurus and this will open up another track in my mind. Then I can start sketching lots more ideas down."* (D1)

D1 provided an example of thesaurus use to generate ideas; he explored the concept of 'art' and had previously thought of visual art: paint, paint brushes etc. His thesaurus search for 'art' returned the synonym 'craft,' which provided a new way of thinking about art and led to the creation of new logo design ideas:

> *"Craft tends to make me think more of blacksmith, anvil or hammer. Crafting is still within the Arts, but it's a new way of thinking about them."* (D1)

Communicating

The designers communicated their design ideas with colleagues and clients using *mood boards*, *style frames* and *sketches*, all popular design presentation forms (Lucero, 2012; Goldschmidt, 2014; Laing and Masoodian, 2015).

Mood boards were usually created by graphic artists, often incorporating images from personal collections and the Web to illustrate different styles, colors pallets and typefaces. Sometimes personal collections evolved into mood boards. They were created primarily to communicate design ideas to colleagues and clients, but also to support idea development:

> "*We will put together a reference document so that we can show to the client that this is the kind of thing we want to make, but also for us to refer back to."* (D1)

Both of these functions are noted by Lucero (2012), who found mood boards served key roles of *framing* the scope and parameters of the design task, *aligning* stakeholder visions, supporting reasoning about seemingly conflicting or contradictory ideas (*paradoxing*), supporting different abstraction levels (*abstracting*) and *directing* future design directions.

The motion graphic designers used style frames to communicate their artistic direction for design concepts when working on videos or animations to clients. Style frames are important high-level frames in a moving image, intended to illustrate the look and feel of key scenes. The designers used visual artefacts such as mood boards, style frames and sketches to reify design ideas and as springboards for sharing personal knowledge and experience.

Communication with other designers was also important when undertaking solo projects; sharing visual artefacts and bouncing design ideas off colleagues helped designers develop existing ideas and generate new ones, by tapping into the broad range of expertise available:

> *"Sometimes when you have an idea, it may not be a really good one. But when you show it to others, they may have a different interpretation and that might take some part of your idea to another level."* (D8)

Communicating has been identified as important in previous studies of designers' HIB; Makri and Warwick (2010) identified information sharing, often using social media, as an important form of informal communication among designers. Information sharing has also been identified as integral to collaborative design (Poltrock et al, 2003).

Discussion

Value of considering intellectual purpose

HIB studies often examine information behavior in the context of the work or everyday-life tasks that drive it (O'Case and Given, 2016), but rarely at the broader contextual level of *intellectual purpose* (i.e. the higher-order conceptual tasks the information was acquired to support). This study examined ideation as one type of intellectual purpose. Others, with potential for future research, include knowledge creation, updating, synthesis and evaluation.

This study serves as a template for identifying purpose-focused behaviors that are strongly-tied to the intellectual tasks they were undertaken to achieve. While the behaviors identified are not new (they are widely-discussed in the creativity literature on ideation), several (such as immersing, unblocking and externalizing) are seldom discussed in the HIB literature. This study also provides fresh, purpose-focused understandings of information behaviors that *have* been previously discussed in the HIB literature (e.g. encountering, monitoring). This particular 'theoretical lens' can provide new insights into how previously-identified behaviors can support specific intellectual purposes. This builds bridges between HIB and IBI fields which, despite sharing the aim of informing design, have not cross-fertilized to their full potential.

This research also demonstrates the close interlinkage between context and use, as it is the intellectual purpose of acquiring information that often dictates its use. Considering intellectual purpose as both a type of acquisition *and* use context moves beyond regarding people as 'information-seekers' or 'information users,' to regarding them as *information designers* (Savolainen, 2009), who find connections between, sculpt and flexibly wield acquired information to identify and fill their knowledge gaps. This research considered the *intellectual purpose* of filling knowledge gaps.

Understanding designers' IBI behavior is also important for informing the design of next-generation digital information environments that place intellectual purpose at the center of design; rather than decide whether and how to support behaviors independent of intellectual purpose, designers might ask themselves, for example, how best to support information immersion for the specific purpose of driving design ideation. This allows designers to consider supporting HIB for a holistic intellectual purpose, rather than in isolation of purpose or with only task purpose in mind. While it may not be possible to directly support cognitive tasks in digital information environments, as existing IBI environments demonstrate, it *is* possible to provide functionality that *indirectly* support them; encouraging rather than 'creating' creativity.

'Purpose' model of information acquisition and use

This study enriches understanding of ideation as an information acquisition and use context and of acquisition and use more broadly. The implications of our findings give rise to a 'purpose' model of information acquisition and use (figure 6), where the intellectual *purpose* of the information tasks undertaken is represented as an important *driver for acquisition* and a *desired outcome of use*. Further work is required to validate the model in IBI and other purpose contexts.
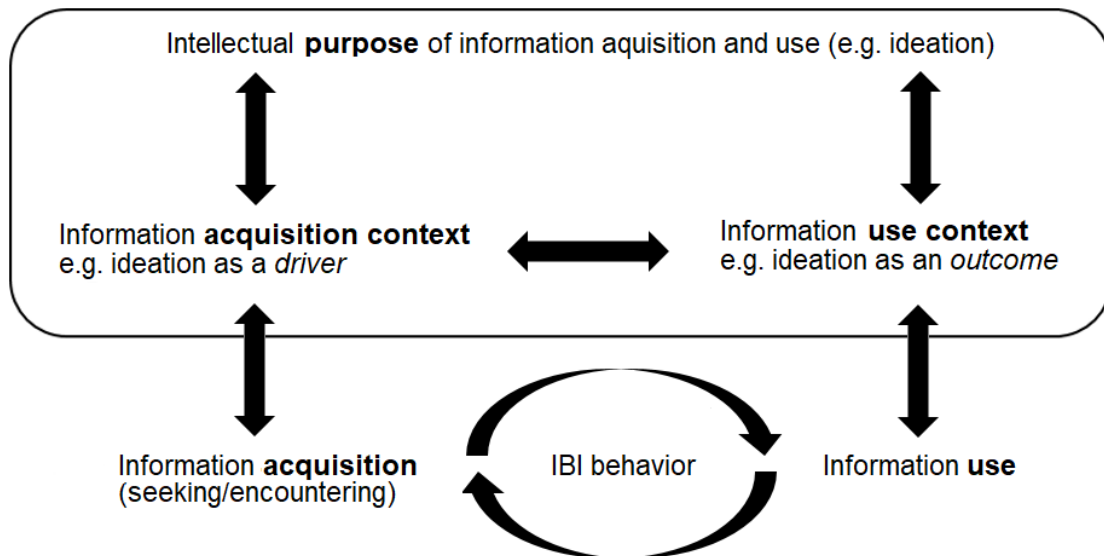
Figure 6: 'Purpose' model of information acquisition and use

The intellectual purpose of information acquisition and use shapes and is shaped by the contexts of these activities, which also comprise the nature and constraints of the information task and the nature of the outputs to be created from the task. Intellectual purpose is presented as an over-arching concept that influences and is influenced by the contexts surrounding information acquisition and use. While purpose can potentially be considered a *type* of acquisition and use context (and therefore integral to context rather than over-arching), it is presented separately to emphasize its importance.

Information acquisition and use contexts are considered as *connected* rather than separate, as the intellectual purpose that drives acquisition is also a desired outcome of use. The acquisition context *drives* acquisition behavior but the information acquired can also shape user's understanding of the acquisition context (e.g. by spurring them to re-think assumptions made earlier in the design process). The use context dictates the desired *outcome* of use and how the information is used can also shape the user's understanding of the use context (e.g. ideation might highlight the potential for knowledge creation by combining information or ideas).

Information acquisition behavior, which encompasses both active information-seeking and passive information encountering, drives use. But also outcomes of use can inform subsequent acquisition (see 'IBI behavior' loop). This partly reflects the dynamic, evolving nature of information acquisition and partly the strong relationship between acquisition and use, where use can identify additional knowledge gaps that can be addressed through further acquisition.

IBI behavior, representing an example intellectual purpose of the information tasks undertaken, occurs at the interface and at the heart of acquisition and use. It is a product of the information acquisition and use contexts and the broader intellectual purpose that helps define these contexts. IBI can both drive and facilitate information acquisition and the resultant ideation is a desired outcome of information use.

Our findings and the 'purpose' model emphasize the importance of intellectual purpose as an information acquisition and use context. The model can be used as a starting point for HIB researchers to reason about and further examine: 1) the role of intellectual purpose as an information acquisition and use context, 2) the interplay between information acquisition and use contexts and 3) the influence of specific intellectual purposes on information acquisition and use behavior.

Conclusion

This study examined game designers' information behavior, with a specific focus on how they find and use information to generate and develop creative ideas. A framework of game designers' HIB when interacting with information for the intellectual purpose of ideation, grounded in empirical data, was presented, enriching understanding of designers' ideation-focused HIB. Systems designers can use this framework to reason about how best to design new and improve existing digital information environments to support ideation. Doing so can encourage and nurture creativity during the design process and, in turn, spur the development of truly novel products and services. A 'purpose' model of information acquisition and use was also presented, based on the implications of our findings. Our findings and the model emphasize the importance of intellectual purpose as a driver for information acquisition and desired outcome of information use.

Our main contribution is an expansion of 'context' in HIB research to incorporate intellectual purpose as an important type of information acquisition and use context. Examining HIB at this broader contextual level can provide a more holistic understanding of information behavior and a more focused understanding in specific intellectual contexts (in this case ideation-focused behavior). We call for HIB researchers to examine other intellectual purposes (e.g. knowledge creation, consolidation, updating or evaluation) and for systems designers to put the intellectual purpose of information acquisition and use at the heart of their designs.

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References

André, P., Teevan, J. and Dumais, S.T. (2009). Discovery is never by Chance: Designing for (un) Serendipity. In *Proc. Creativity and Cognition* (305-314). ACM.

Bates, M.J. (1979). Idea Tactics. *JASIS*, 30(5), 280–289.

Bates, M.J. (2010). Information Behavior. *Encyclopedia of Library and Information Sciences*, 3, 2381-2391.

Belkin, N.J. (1980). Anomalous States of Knowledge as a Basis for Information Retrieval. *Canadian J. Information Science*, 5(1), 133-143.

Buxton, B. (2010). *Sketching User Experiences*. Morgan Kaufmann: NY.

Chan, J., Dow, S.P. and Schunn, C. (2015). Do the Best Design Ideas (Really) Come from Conceptually Distant Sources of Inspiration? *Design Studies*, 36, 31-58.

Corbin, J. and Strauss, A. (2015). *Basics of Qualitative Research.* London: SAGE.

De Bono, E. (2010). *Lateral Thinking.* Penguin: London.

Dervin, B. (1998). Sense-Making Theory and Practice: An Overview of User Interests in Knowledge Seeking and Use. *J. Knowledge Management*, 2(2), 36-46.

Ellis, D. (1989). A Behavioral Model for Information Retrieval System Design. *J. Information Science*, 15(4-5), 237–247.

Fidel, R. (2012). *Human Information Interaction*. Cambridge, MA: MIT Press.

Finke, R.A., Ward, T.B. and Smith, S.M. (1992). *Creative Cognition: Theory, Research, and Applications*. Cambridge, MA: MIT Press.

Flanagan, J. (1954). The Critical Incident Technique. *Psychological Bulletin*, 51, 327–358.

Goldschmidt, G. (2014). Modeling the Role of Sketching in Design Idea Generation. In *An Anthology of Theories and Models of Design* (433-450). Springer: London.

Gonçalves, M., Cardoso, C. and Badke-Schaub, P. (2016). Inspiration Choices that Matter: The Selection of External Stimuli during Ideation. *Design Science*, 2, e10.

Hemmig, W. (2009). An Empirical Study of the Information-Seeking Behavior of Practicing Visual Artists. *J. Doc.*, 65(4), 682–703.

Hernandez, N.V., Shah, J.J. and Smith, S.M. (2010). Understanding Design Ideation Mechanisms through Multilevel Aligned Empirical Studies. *Design Studies*, 31(4), 382-410.

Herring, S.R., Chang, C.C., Krantzler, J. and Bailey, B. P. (2009). Getting Inspired!: Understanding how and why Examples are Used in Creative Design Practice. In *Proc. CHI,* 87-96. ACM.

Hill, T., Charles, V., Stiller, J. and Isaac, A. (2016). "Searching for Inspiration": User Needs and Search Architecture in Europeana Collections. In *Proc. ASIS&T*, 53(1), 1-7.

Kari, J. (2007). Conceptualizing the Personal Outcomes of Information. *Information Research* 12(2), paper 292.

Kari, J. (2010). Diversity in the conceptions of information use. *Information Research*, 15(3) colis709.

Kerne, A., Smith, S., Koh, E., Choi, H., Graeber, R. (2008). An Experimental Method for Measuring the Emergence of New Ideas in Information Discovery. *IJHCI* 24(5), 460-477.

Kerne, A., Webb, A.M., Smith, S.M., Linder, R., Lupfer, N., Qu, Y. and Damaraju, S. (2014). Using Metrics of Curation to Evaluate Information-Based Ideation. *TOCHI*, 21(3), 14.

Kumar, R., Satyanarayan, A., Torres, C., Lim, M., Ahmad, S., Klemmer, S.R. and Talton, J.O. (2013). Webzeitgeist: Design Mining the Web. In *Proc. CHI*, 3083-3092. ACM.

Laing, S. and Masoodian, M. (2015). A Study of the Role of Visual Information in Supporting Ideation in Graphic Design. *JASIST* 66(6), 1199-1211.

Laing, S. and Masoodian, M. (2016). A Study of the Influence of Visual Imagery on Graphic Design Ideation. *Design Studies*, *45*, 187-209.

LeClerc, A. (2010). Seeking Serendipity: The Inspiration Hunt of a Creative Professional. *Faculty of Information Quarterly*, 2(3), 1–8.

Linder, R., Snodgrass, C. and Kerne, A. (2014). Everyday Ideation: All of my Ideas are on Pinterest. In *Proc. CHI,* 2411-2420. ACM.

Lindley, S., Cao, X., Helmes, J., Morris, R. and Meek, S. (2013). Towards a Tool for Design Ideation. In *Proc. BCS HCI*, 14-24.

Lucero, A. (2012). Framing, Aligning, Paradoxing, Abstracting, and Directing: How Design Mood Boards Work. In *Proc. DIS*, 438-447. ACM.

Lupfer, N., Kerne, A., Webb, A.M. and Linder, R. (2016). Patterns of Free-Form Curation: Visual Thinking with Web Content. In *proc. ACM MM*, 12-21.

Makri, S., Blandford, A. and Cox, A.L. (2008). Investigating the Information-Seeking Behavior of Academic Lawyers: From Ellis's Model to Design. IP&M, 44, 613–634.

Makri, S. and Warwick, C. (2010). Information for Inspiration: Understanding Architects' Information-Seeking and Use Behaviors to Inform Design. *JASIST*, 61(9), 1745–1770.

Makri, S., Ravem, M. and McKay, D. (2017). After Serendipity Strikes: Creating Value from Encountered Information. In *Proc.* ASIS&T 54(1), 279-288.

Marcella, R., Rowlands, H. and Baxter, G. (2013). The Critical Incident Technique as a Tool for Gathering Data as Part of a Qualitative Study of Information-Seeking Behavior. In *Proc. ECRMBMS*. Guimaraes, Portugal.

Medaille, A. (2010). Creativity and Craft: The Information-Seeking Behavior of Theatre Artists. *J. Doc. 66*(3), 327-347.

Miller, O. (2014). Collecting Library Resources for Video Game Design Students: An Information Behavior Study. *Art Documentation*, *33*(1), 129-146.

Mougenot, C., Bouchard, C., Aoussat, A. and Westerman, S. (2008). Inspiration, Images and Design: An Investigation of Designers' Information Gathering Strategies. *J. Design Research*, 7(4), 331-351.

O'Case, D. and Given, L.M. (2016). *Looking for Information: A Survey of Research on Information-Seeking, Needs and Behavior*. Emerald: NY.

Pearce, M., Goel, A., Kolodner, I., Zimring, C., Sentosa, L and Billington, R. (1992). Case-Based Design Support: A Case Study in Architectural Design. *IEEE Expert*, 7(5), 14-20.

Poltrock, S., Grudin, J., Dumais, S., Fidel, R., Bruce, H. and Pejtersen, A.M. (2003). Information-Seeking and Sharing in Design Teams. In *Proc. SIGGROUP,* 239-247. ACM.

Savolainen, R. (1995). Everyday Life Information-Seeking: Approaching Information-Seeking in the Context of "Way of Life". *LISR,* 17(3), 259-294.

Savolainen, R. (2009). Information Use and Information Processing: Comparison of Conceptualizations. *J.Doc.*, *65*(2), 187-207.

Scaife, M. and Rogers, Y. (1996). External Cognition: How do Graphical Representations Work? *IJHCS,* 45(2), 185-213.

Shah, J.J., Vargas-Hernandez, N.O.E., Summers, J.D. and Kulkarni, S. (2001). Collaborative Sketching (C-Sketch): An Idea Generation Technique for Engineering Design. *J. Creative Behavior*, *35*(3), 168-198.

Sharmin, M., Bailey, B.P., Coats, C. and Hamilton, K. (2009). Understanding Knowledge Management Practices for Early Design Activity and its Implications for Reuse. In *Proc. CHI,* 2367-2376. ACM.

Vakkari, P. (2003). Task-Based Information Searching. *ARIST*, 37, 413-464.

Vakkari, P. (2008). Trends and Approaches in Information Behaviour Research. *Information Research*, 13(4), paper 361.

Vyas, D., van der Veer, G. and Nijholt, A. (2013). Creative Practices in the Design Studio Culture: Collaboration and Communication. *Cognition, Technology and Work, 15*(4), 415-443.

Westman, S. (2009). Image Users' Needs and Searching Behavior. In Goker, A. and Davies, J. (Eds.). *Information Retrieval: Searching in the 21st Century*. Wiley: NY.

Webb, A.M., Linder, R., Kerne, A., Lupfer, N., Qu, Y., Poffenberger, B. and Revia, C. (2013). Promoting Reflection and Interpretation in Education: Curating rich Bookmarks as Information Composition. In *Proc. Creativity and Cognition*, 53-62, ACM.

White, R.W. and Roth, R. A. (2009). Exploratory Search: Beyond the Query-Response Paradigm. *Synthesis Lectures on Information Concepts, Retrieval, and Services.* 1-98.