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Kickstarting creativity: supporting the productive faces of uncertainty in information practice

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Abstract

Introduction. Examines implications of research suggesting fast access to information may reduce the time needed for creative thinking and reflection. To support human thought through information provision, more opportunities to experience and work with imperfect information and to engage with ambiguities are needed.
Method. Four linked arguments are presented: (i) working through uncertainty and ambiguity is conducive to creativity; (ii) the time and effort associated with managing information can be detrimental to creative thought; (iii) in scholarly research there is increasingly less time to think; (iv) revisiting the concept of uncertainty in information seeking offers a creativity stimulation pathway.
Analysis. Ethnographic data about scholarly research practice and judgments about information in that context are used to illustrate some of the claims made.
Results. Respondents were as likely to find information on the Internet as from doctors, although several reported that they had no access to these resources. Many used the information they found to look after themselves or someone else, to decide whether to seek assistance from a professional and/or to make treatment decisions. A significant proportion of women reported that they did not discuss with a doctor the information they found.
Conclusions. Developing an awareness of and being in uncertainty is a critical condition in any creative endeavour.

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Introduction

We live in a time when access to information is seemingly easier than ever before. It is a world where expectations seem to be that we can, and need to, move as quickly as possible to the information specific to our individual need. While this is often a desired outcome, it often comes at the expense of the opportunity for exploration and discovery of new information. The capacity of Web-based, hyperlinked information to fulfil the aspirational imagery of works like Bush's (1945) essay about the potential of information to support human thought sits in stark contrast with Levy's (2007) concern about the destructive consequences of an information-intensive age leaving us with no time to think. This paper examines the implications of this contrast and points to research suggesting that fast access to information may be at the expense of the time needed for creative thinking and reflection. It suggests that if we are to support human

thought through the provision of information, we need to provide people with more opportunities to experience and work with imperfect information, to engage with ambiguities. Doing so, it will be argued, is an important precondition for creativity and innovation in any human endeavour. (The terms *creativity* and *innovation* are not formally defined in this paper but broadly fall within the scope of discussion of the Adelphi Charter (Royal Society 2006). The decision is consistent with the creative ecology portrayed by Howkins (2009: 9), who contends that creativity '*...can be described but not defined and indeed has always been conditional*'.)

This paper presents four linked arguments supporting the paper's premise about the need to make more space for uncertainty and ambiguity in our information and research practices:

1. working through uncertainty and ambiguity is conducive to creativity;
2. the time and effort associated with managing large quantities of information can have a detrimental impact on creative thought;
3. in scholarly research practice there is increasingly less time to think; and
4. revisiting the concept of uncertainty in information seeking offers a creativity stimulation pathway.

In presenting these arguments and the implications for information science, the paper draws on ethnographic data about scholarly research practice and judgments about information in that context to illustrate some of the claims made.

Valuing creativity and ambiguity in research practice

Creative practices of all kinds blend imaginative and analytical lenses. Getting the mix right can be quite a challenge, though we often do so without certainty about the how's and why's of our practice. Uncertainty is present in some shape or form throughout, but is far from a predictable quality. Knowledge work like scholarly research is one such form of creative practice where uncertainty figures in both the research and the information seeking processes. Research projects have a tendency to be ill-defined and open-ended, especially at the outset. Similarly, ambiguity and uncertainty can be a factor in judgments about the value of information encountered at various stages of a research project. Anderson (2006) discusses the value uncertainty provided to scholarly researchers for their investigations. Delving further into these findings led to an exploration of what Boholm (2003) refers to as an *anthropology of uncertainty* and *culture of risk*. Doing so invites one to speculate if developing an awareness of and being in the uncertainties of the everyday and of our practice is a critical condition in any creative endeavour.

Creativity and innovation are desired in many parts of our lives. Increasingly it is being valued in business, policy, science and technology as well as in the creative arts (see Howkins 2009). We value it in our children and in ourselves. The drive for innovative and cutting-edge research figures prominently in the aims of many universities and government programmes that wish to support the growth of their national industries and knowledge-generating institutions. Information technologies support the generation of knowledge by enabling rapid access and processing of information at a global level. However, new discoveries and innovation are also predicated on the creative and imaginative application of information encountered by researchers in the pursuit of their research goals. The Australian government's own discussion of research priorities, for instance, acknowledges the value of these qualities: *'Progress and wealth often derive from the unforeseen application of new discoveries'* (Australian Government Australian Research Council 2008). Nurturing opportunities for creative thinking in engagements with information systems can provide a key element for this research success.

If we are to encourage innovation in all sectors of our lives (individually and collectively), we have to be tolerant of ambiguity and uncertainty in our lives and in our society. We have to be able to see the productive potential of risk. We have to learn to manage risk and uncertainty rather than seek to avoid it altogether. We need to learn how to handle *imperfect information* about situations and how to reconcile with not knowing the outcome, all the choices or all the probabilities of particular outcomes in our own lives and in our society. From the perspective of information services, our systems and supports must be capable of helping clients as they journey through these uncertainties and ambiguities.

The concept of uncertainty figures prominently in library and information science. It is ever present in our information worlds. It is acknowledged as a persistent characteristic in information seeking, for instance, where Wilson observed that uncertainty:

> is, in effect, 'the ghost at the feast' since we may assume that much (perhaps most?) information seeking and retrieval are occasioned by uncertainty... [F]rom the perspective of the user, it is always there. (Wilson 1999: 265)

Uncertainty is, in fact, an unavoidable condition of our human existence. Eisenberg suggests that a primary challenge of being human:

> is living in the present with the awareness of an uncertain future... [L]ife is full of occasions where we must make

> important decisions with limited information. The fundamental indeterminacy of the future is an essential quality of human existence (Eisenberg 2001: 534).

Eisenberg is one of a growing number of researchers - from a diverse range of disciplines - suggesting uncertainty should be framed more positively. He speaks of uncertainty in relation to '*building a mystery*. The process of *'being in uncertainties'* is, such work would suggest, an important factor in creative practice. Lowenstein (1994) suggests that the act of satisfying curiosity (working through the mysteries so to speak) is pleasurable but not without risk. This paper expands upon earlier work showing that working through uncertainty was beneficial to scholarly research practices (Anderson 2006) to explore the link between uncertainty in both an anthropological and information science sense and creativity.

The concept of uncertainty in information science

Generally speaking, there is no singular way to define uncertainty or to locate it in relation to similar notions like ambiguity, doubt, vagueness or imprecision (for further discussion of various taxonomies of uncertainty see: Parsons 2001: Chapter 2). It is no different in information science research, where uncertainty takes on many different meanings. The focus in the design and evaluation of information retrieval systems, for instance, is often premised on reducing uncertainty. Information seeking research draws attention to the uncertainty in the experiences of the searcher, with discussion of the anxiety that can be associated with it and strategies for assisting people in this situation. One common thread across perspectives on this concept within library and information science however is the close link to judgments of information.

Increased interest in understanding how people work with these systems and with information more generally extended study of the embedded character of uncertainty in many aspects of information practice. Research in this direction, for instance, showed that information seeking can produce as well as reduce uncertainty and that in many instances, working with and through rather than avoiding uncertainty was a productive path (for further discussion, see Anderson 2009). It also became clear that rather than an inherent uncertainty, it is the perception of uncertainty that impacts on information practice.

Within scholarly research activities, working through uncertainty is a mediating strategy detectable at four levels of the ethnographic investigation reported in Anderson (2006):

- engaging with information requirements;
- immediate search;
- retrieval activities associated with search; and
- overall outcomes of task.

There was an embedded, interwoven quality to the expressions of uncertainty witnessed in this earlier research. It demonstrated that uncertainty and understanding intermingle, to the point that clarity about one aspect emerges while challenges surface about others. Earlier reports about this work (Anderson 2006) presented illustrations of spectra and degrees of certainty and uncertainty, relevance and non-relevance, and knowing and not knowing, present in the research and information practices of the informants. The desire to explore these findings further led to the present examination of the link between uncertainty and creativity.

The features of uncertainty in action reported in that earlier work that are of most significance for this paper include (the names anonymise the actual respondents):

> Judgments of partial relevance serving as a trigger for selection: *'It's not exactly on that topic, but it does help me in that kind of building a picture of - you know, what's the field like. So, you know it's a good thing to have…'* (Catherine)
>
> Both fascination and frustration being present at the margins of understanding about a topic (*horizons of understanding*): *'Again, where do you draw the line? There is a literature on mêmes and mnemetics and I'd be loathe to go beyond that unless I could see a particular relevance in an article to do that. So, I'm not going to do that with that one*'. (John)
>
> Dynamics of tolerating risk and uncertainty: *'I mean it might sound silly that over the space of five days the criteria can change, but... you know, the other pressures on my time are much more present and immediate and pressing and that sort of focuses my mind in a completely different way'.* (Catherine)

Tolerating rather than avoiding uncertainty figured prominently in these informants' information and research practices, which amplifies Kuhlthau's (1993) discussion about uncertainty in information seeking. Desirable uncertainty appears to emerge through the interplay between productive and seemingly unproductive forms of uncertainty. During the two-year lifecycles of these informants' projects that were part of the ethnographic investigation reported earlier, specific moments of innovation and breaking new ground appeared collocated with active engagements with the uncertainties manifesting themselves at that time. In this way, the experience of uncertainty played a critical role in the creative, innovative activity of the informants. More than accommodating uncertainty, their experiences illustrate how tolerating ambiguities and uncertainties might kickstart creativity. Later sections of this paper will return to these findings to provide illustrations of ways that the behaviour witnessed in this earlier research might provide a *creativity stimulation* (Bawden 1986) pathway.

Uncertainty and risk in the human condition

Moving through the stages of uncertainty in many situations plays a critical role in providing us with a sense of satisfaction and motivation. Risk taking at individual and collective levels propels us forward as creators, adventurers and discoverers. Intellectual curiosity drives discovery. Furthermore, at a certain point, too much certainty about a situation or about information is very counter-productive because it stifles us and can remove our creative side. This section of the paper builds on work from psychology and social anthropology showing that experiencing risk and uncertainty nurtures our creative and innovative practices.

Words like *risk* and *uncertainty* have permeated the media and even everyday conversations in recent times because of the global financial crisis and the backlash that has impacted on so many at personal and national levels. In this climate, there appears to be a tendency towards certainty and assurance in so many parts of our lives. Risks, it seems, need to be ascertained as reasonable and measured. Nevertheless, there is also growing evidence that even in such climates, we recognize that too much certainty is not what we are after either.

Boholm (2003) defines risk as a situation or event where something of human value has been put at stake and where the outcome is uncertain. This view shows the intertwinings between uncertainty and risk and illustrates that it has a very individual interpretation. Essentially, it is the perception of risk or uncertainty that is at issue. Both are socially constructed phenomena, intersubjectively produced and culturally located. Judgments of good or bad risk are in fact a matter of perception and perspective. Perception and social identity are powerful determinants for the tolerance of risk and uncertainty collectively and individually. Our sense of self and the way we wish to see ourselves in relation to particular social groups informs the way we approach risk and uncertainty. For instance, Eisenberg (2001) and Zaloom (2004) point to ways our sense of self can lead to productive forms of risk taking.

We can also see how perspective comes into play, because what I value may not be what you value and the degree to which I hold that value dear can change over time. When I have to put that to the challenge, maybe I will revisit the values previously established. The other aspect that is important here is that this is always a very everyday life type of experience. It is not something that is necessarily part of a catastrophe or an exceptional moment. This is something that we deal with in the every day and in that everyday sense we can have unexpected pleasures but also pain. This everyday uncertainty is an aspect that is very interesting.

The sense of control we feel we have or need has a great deal to do with how we perceive risk and uncertainty. The locus of control may explain why so many people consider flying riskier than driving, even though statistics would suggest otherwise. Conversely, when we can make the decision to push ourselves to the limit, in thrill seeking or adventure sports, for example, risk can become a fun or pleasurable experience. There are of course risks and uncertain situations that seem to have little creative potential: risks to family security (e.g.: job loss, housing concerns), to health (e.g., surgery, illness), or to personal security (e.g., crime, terrorism). However, even in these instances, judgments vary greatly with regard to where a particular individual draws the line in terms of threats to their security and acceptable risks. A review of research into terrorism threats, for instance, found great variance in terms of the perception of risk and potential terrorism threats within different communities at different points in time (Maguen *et al.* 2008).

Beck (1992) describes risk as a state between security and destruction. He is not suggesting that risk has to be negative but many current discussions drawing on his construct of the *risk society* tend to suggest that it is a pessimistic view because risk is a sign of trouble and trauma. The uncertainty that Beck appears to be talking about involves a lack of knowledge and challenges in terms of how information will become available and whether it can become available. Nonetheless, even Beck debates Beck in this point (Beck 2000). In some of his recent work he has taken issue with the pessimistic interpretation people have made of his conception of the risk society. He talks about the opportunities of the *'bads'* (Beck 2000: 226). So even in the bad there is opportunity and it is that opportunity that is worth examining in relation to links between creativity and human responses to uncertainty.

Boholm (2003) and Malaby (2002) suggest we need to view risk in more nuanced ways, as neither simply objective nor subjective. Risk

and uncertainty are linked - when something of value is at stake, uncertainty can relate to the chances of a negative outcome and the nature of the outcome itself. People work on ways to overcome, manage, or deal with the uncertainty and risk experienced in their lives on a daily basis. Malaby positions risk and uncertainty as an important element of our sociality: '*. . . it is through the engagement of indeterminacies, rather that their minimization or resolution . . . that one may socially demonstrate one's place vis-à-vis chance, and by extension, one's place in relation to others in the world*' (Malaby 2002: 284 as cited by (Christensen and Mikkelsen 2008: 113). This perspective is a critical departure from assuming risk is necessarily dangerous or destructive or that uncertainty needs to be avoided or eliminated.

Thus, we can see uncertainty as a fundamental experiential realm of human existence associated with tolerance and risk-taking. In fact, it is through the experience of risk and uncertainty that we learn to identify how much we can individually endure. While uncertainty or risk is not inherent, research suggests that when an individual threshold is reached, the negative emotions can overpower us. At moments when uncertainty and risk seem too much to bear, these powerful emotions diminish any opportunity for exhilaration and the pleasures of uncertainty (Wilson, et al 2005). This anthropological stance helps us to appreciate that everyday life is characterized by uncertainty - and that uncertainty can bring unexpected pleasures as well as pain.

Research in social cognition (Wilson, *et al.* 2005) draws attention to ways that uncertainty can prolong pleasure. We are highly adaptive in situations when we encounter new information; predictable or known elements become background so that our attention can remain uncluttered and prepared to deal with the unexpected. Wilson, *et al.*, explain that predictable events evoke less intense emotions than unpredictable events, which can lead to a pleasure paradox: we are driven to understand the causes of events in our lives in order to make them more predictable, but trying to make sense of positive events can also make them less enjoyable.

The attempt to make sense of the event (working to explain an event to ourselves) reduces the emotional power - positive as well as negative - of the event. In this way an extraordinary, attention-demanding event turns into one that no longer requires attention and consequently no longer triggers intense reactions. When we face the uncertain, we respond with intellectual curiosity and behaviours associated with making sense. Certainty reduces the pleasure associated with a positive event, but because this isn't often recognized by us in some circumstances we actually diminish the pleasure by looking for certainties rather than accepting the uncertainties that can actually prolong the pleasure. Wilson and colleagues (2005) speculate that we do not always resolve this paradox optimally because uncertainty is so often associated with anxiety, worry, and difficulty in adapting to new environments. This emotional response is one reason we often strive to reduce uncertainty in our lives. People who succeed in reducing uncertainty about traumatic events, for instance, do better emotionally and physically than people who do not. Writing or talking about it is often part of successful sense making in such situations. Clearly in a traumatic situation we want to do this; this human capacity to make sense speeds recovery. But what of the positive events that might bring pleasure and joy? Wilson and colleagues found that in situations where the ability to make sense of a positive event is inhibited, the pleasure surrounding an event could be prolonged. Sometimes a moderate amount of uncertainty is beneficial, but because notions of positive and negative are subjective to a degree, the intensity of the response varies. Each of us will interpret events differently; but managing and even tolerating rather than avoiding uncertainty is shown to be productive.

Risk reaps reward and so there are many examples of the productivity of risk in human practice. There are people who make the choice to actively engage with risk, some physical (e.g.: extreme athletes) and some economic (e.g., financial speculators). Zaloom explored the productive life of risk through fieldwork on the trading floor of the Chicago Board of Trade, a major global financial futures exchange. Zaloom describes the '*fine balance necessary to work with risk*' (Zaloom 2004: 382) and explains that it involves working with norms of risk management that are generated (in her context) on the trading room floor to the extent that self-definition and group-formation co-evolve: '*Active engagements with risk are a locus of self and space in contemporary economic and social life*' (Zaloom 2004: 384). Here we find a conundrum of risk and uncertainty and the mixed bag of perceptions of both across situations and cultures. The concept of risk can be understood as a framing device, allowing us to transform it from '*. . . an open-ended field of unpredicted possibilities into a bounded set of possible consequences*' (Boholm 2003: 167). Risk can be conceptualized and managed in different ways across communities, cultures, organizations. Looking at the productivity of risk draws attention to ways that some people see it fitting into their work and their self-defining behaviour.

As Eisenberg (2001: 534) suggests, mystery aids creativity: *'How we respond to the fundamental uncertainty of life shapes everything we do and is driven by how we think about our place in the world, our sense of identity'*. From this research we can see that emotionally, intellectually and physically, humans need some form of risk and uncertainty for motivation, interest, excitement and intellectual curiosity,. all of which are ingredients for innovation, creativity and imagination.

The role of creativity and unplanned information encounters in 21st century scholarly work

In the digitised and networked climate in which scholarly research is undertaken, the abundance of information and communication technologies available to provide efficient and effective access to potentially useful information can lead one to assume technical developments are a key element in research success. However, technical developments must go hand in hand with information strategies that can help researchers reach their full potential. Increasingly these critical information processes are shaped by systems and supports well beyond the control of the researchers affected by them. We are becoming aware of present and potential discontinuities between the tools being devised and our capacities for working with them in ways that best support human creativity (Levy 2007; Shneiderman 2002).

Scholarly research is a highly creative, interdisciplinary undertaking conducted in an increasingly diverse range of settings. A number of studies describe research work as growing increasingly fractured, distributed and diverse, in terms of tasks as well as location of practice (Agre 2002; Houghton 2003; Wright *et al.* 2003; Ylijoki 2004). Studies such as these have demonstrated that research work has changed because of greater use of information technologies. Herman (2001: 387) argues that while in the early 21st century the creative core of research activity remains constant, technological advances dramatically alter the processes and context of this work. His observations echo those of researchers in information science like Bruce (1996), Ford (2004), Levy (2007), Palmer *et al.* (2007), and Tenopir *et al.* (2003). As research continues to become more interdisciplinary, interactive and dispersed in nature, it becomes critically dependent on emerging computer and communication technologies.

The creativity associated with research relies on the effective provision, processing and manipulation of information at all stages of a project. However, even in Bush's 1945 essay we can find concern about the amount of time and effort involved in exploring and evaluating potentially useful information and the detrimental consequences such efforts might have on opportunities for creative thought. It is reasonable to assume that as information collections continue to grow in scale and complexity in the 21st century, these concerns are even more pertinent for us. Thus, we can see a long-standing concern about the impact that time and environment can have on creative efforts and original thinking. Bush (1945) writes about the desire to support human thought by facilitating access to all the information related to the matter at hand. Levy interprets Bush's memex as an attempt at automating the more routine aspects of information practice to free up more time for creative reflection (Levy 2007: 239, 248). Such a reading is in keeping with Ford's (1999) assertion that both convergent and divergent thinking are necessary for scholarly success.

Research is a creative activity described by Ford (1999), Bawden (1986) and Foster (with Ford 2003) as involving original thought, lateral thinking, and a certain amount of serendipity. Fine and Deegan (1996: para 5) define serendipity as '*. . . the unique and contingent mix of insight coupled with chance*'. Many key discoveries include such elements, in particular serendipitous or fortuitous discoveries or connections: the '*flash of insight when things come together*' (Ford 1999: 532). The literature provides numerous illustrations about serendipitous discoveries that have proven to be critical turning points in their respective fields (see. for example: Bawden 1986; Ford 1999; Foster and Ford 2003; Konecki 2005; Weeber *et al.* 2001). Such illustrations highlight the value across all discipline areas of serendipity and unplanned encounters with information for building connections, discovery and creativity.

Greater use of digital libraries has been found to limit the opportunities for informal explorations of information. Browsing, for example, has often played an important role in information seeking fields (e.g., Bawden 1986, Gup 1997; Levy 2007, O'Connor 1988, Toms 2000b) and is often associated with the unanticipated discovery of related items and ideas. Foster and Ford (2003), for instance, found serendipity emerging as an important aspect of how researchers encounter information and generate new ideas. Unfortunately, to avoid drowning in information we often end up cutting out this part of the search process. Filters and document rankings used to limit the enormous search sets available through globally networked databases have been found to reduce the number of paths available for discovery and connection building (Foster and Ford 2003: 323; Gup 1997). As Gup laments: '*We settle for information at the expense of understanding and mistake retrieval for exploration*' (1997: A52). Thus, ironically, increased access to information has in some ways closed the door on a key element of the creative process.

The interactional qualities of serendipitous and unstructured encounters with information play a critical role in all areas of scholarship: hard science as well as qualitative research (Fine and Deegan 1996; Ford 1999; Konecki 2005). Information systems that do not support such behaviour may have a detrimental effect on the nature of the creative practices associated with research work. Consider the following:

- The language used to describe concepts greatly impacts the connection building associated with creative thinking (Bawden 1986: 205). However, the general language and construction of conventional databases does not match the humanist's approach (Bates, 1996, 2002);
- Information retrieval systems favour convergent information processing, matching representations and looking for similarities between entities. However, the complexity of research and information practices leads to a non-linear, dynamic process that involves balancing divergent thinking with the convergence of ideas (Budd 2004:451; Ford 1999:528);
- Time pressures and workloads make it difficult for researchers to make time for "reflexive knowledge." (Ylijoki 2004). However,

when working with information systems, people do not always know how to articulate what they are looking for and may need time to articulate their ideas (Anderson 2000 and 2005);
- Academics often overlook serendipity or appear reluctant to admit to the role it has played in their research (Anderson 2003; Foster and Ford 2003: 335).

From such illustrations, it is possible to imagine that lost opportunities for serendipity, browsing and unstructured explorations could have alarming consequences for research creativity.

Levy points to a seeming paradox about our contemporary information practices: *'...that we are losing the time to look and to think at exactly the moment we have produced a remarkable new set of tools for scholarly investigation and communication'* (Levy 2007: 248). He suggests that this paradox is attributable to information cultures that privilege *'fast-time activities'* at the expense of the slower: *'Certain activities associated with education and learning - searching for information, collecting and superficially reviewing it - can be speeded up, while others - sustained reflection and contemplation - simply cannot'.* The intensification of such *'more-faster-better practices'* has destructive consequences for contemplative scholarship and for allowing the time so essential for creative reflection. In his examination of creativity in educational contexts, Claxton (2006) makes a similar argument when he points to the difference between thinking and acting quickly and thinking and acting slowly and the need to have the ability to know which kind of thinking to choose at any given time. Thinking and acting slowly, he suggests, is particularly crucial for supporting creativity in projects that are ill-defined and indeterminate in nature; an apt description of the information and research processes characterising many university projects.

Recent discussions about creativity place emphasis on the role of autonomy, openness to new possibilities and lifelong learning (Howkins 2009; Csikzentmihalyi 1997). Looking beyond the qualities of a creative individual to the creative milieu, Howkins points to diversity, collaboration, fluidity, fuzziness and emergent thinking as the systemic characteristics needed to support creativity (Howkins 2009: 42). Ideally one would find these qualities in the institutions where research is undertaken as well as in the information systems in use. Discussions such as those reported in this section remind us of the potential obstacles to working creatively in today's digital information landscape. In pursuit of more effective information systems, we are invited to ask: effective in relation to what? Supporting fast and efficient access to large quantities of (potentially) relevant information is not the same as supporting creative connection-building in relation to the information the system enables us to access.

Creativity and information systems

The interplay between information systems and the creative process has long been the subject of discussion in the information sciences. In his early work about ways information systems might support creativity, Bawden (1986) speaks of the difference between targeted and discovery practices. Ford (1999) discusses the implications of the different roles played by divergent and convergent thinking. Campos and Figueiredo (2001) present ways that software agents can induce serendipity.

Bawden (1986: 207) highlights eight aspects of information handling premised on observations about the conditions that aid research creativity:

- recognising or creating patterns;
- identifying analogies;
- interdisciplinary contact;
- dealing with false knowledge;
- identifying exceptions/inconsistencies;
- favouring chance;
- random stimulation of ideas; and
- temporary suspension of evaluation.

O'Connor writes about *'creative navigation'* as the exploration of the contents of a database *'...seeking a 'eureka' situation'* (O'Connor 1988: 204) where the discovery of new concepts, connections and syntheses are stimulated by browsing the attributes of the documents in the collection. This kind of navigation calls for the generation of alternatives to "shake up" the personal store of knowledge and judgment about the relevance of information. Bawden's (1986: 205) discussion of chance encounters flags the power of information potentially divorced from the problem at hand, which a researcher is unlikely to encounter if searching is restricted to closely-focused relevant information. For O'Connor such browsing is a necessary creative activity for people working "at the frontiers of knowledge" (1988: 205) where there is need for information environments that are '*...not anchored to existing knowledge or relationships*'. Thus, serendipitous discoveries are not matters of blind luck but rather a consequence of supporting the divergent thinking that enables a person to rely more on their own self-knowledge when working with document attributes (O'Connor 1988: 206).

Increasingly Web-based information systems have been able to make space for such serendipitous, unplanned information encounters. From Google's *I'm feeling lucky* feature and Web sites like *stumbleupon.com* through to the serendipitous information retrieval developments for digital libraries (e.g., Toms 2000a) and software agent prototypes like Max (Campos and Figueiredo 2001), we can find many illustrations of ways that Web-based systems can support unplanned, non-purposive information encounters. Similarly, the data-crunching systems used for large-scale collaborations and data-sharing have the potential to convert chaotic noise into meaningful signals. Schrage (2004) sees this as a way to increase the opportunities for inspiration that are critical for research innovation. He turns Pasteur's well-known aphorism on its head: rather than chance favouring the prepared mind, he contends that prepared minds favour chance. *'Innovators will spend less time designing clever experiments to generate data and more time scouring the data to generate hypotheses'* (Schrage 2004: 16). In many ways, Schrage's one-page snapshot about the value of data-driven statistical techniques is reminiscent of Bush's 1945 vision for information systems. However, cultivating chance and providing opportunities for inspiration through efficient data crushing is only part of the story.

Increasingly ubiquitous Web 2.0 features support the community participation, collective intelligence and knowledge sharing associated with a creative milieu. However in many ways, the dynamic, non-linear qualities of research work and the information seeking associated with it remain difficult to support and sustain. Finding the information is one thing, engaging with the content in ways that support the creative thinking that Bawden, Ford and Levy describe is not necessarily resolved with technological developments. As Levy (2007) most notably points out, the abundance of information potentially available for research work places the thinking time associated with new research directions at risk.

As Ford contends (1999, 2004), successful research inquiry requires both convergent and divergent thinking. Despite advances in system design (e.g., Eaglestone *et al.* 2007), supporting divergent thinking stills seems difficult for information systems to support. Toms (2000a), for example, groups the ways that people acquire information when working with digital libraries into three categories:

- through searching for information about well-defined and known objects;
- by looking for information about an object that cannot be fully described but would be recognised when encountered; and
- from serendipitous, accidental or incidental discoveries of an object.

The first category corresponds most directly with traditional retrieval. The associationist nature of Web engines, the capacities of *metacognitively aware* information systems (Gorrell *et al.* 2009) and tools facilitating online browsing as opposed to searching appear to have greater potential to stimulate creativity (e.g.: Eaglestone *et al.* 2007, Toms 2000a and b). Context-aware systems help support the remaining two, although as both Toms (2000a) and Campos and Figueiredo (2001) illustrate, the non-purposive qualities of serendipitous encounters present many challenges. In all these developments, there remains a tension between promoting sharing and access to abundant information and enabling the contemplation so valuable for creatively working with information accessed.

There remains a gap in our understanding of how we might balance the accommodation and support for the extemporaneous, fluid practices characterising creativity with the efficiency afforded by information systems and information management tools supporting searching and the '*high levels of planfulness*' (Gorrell *et al.* 2009: 457) equally important when working with information and ideas. Bawden (1986: 208) points to four kinds of information particularly supportive of the creative process:

1. interdisciplinary information;
2. peripheral information;
3. speculative information; and
4. exceptions and inconsistencies.

Such information is more conducive to divergent thinking because it is less likely to conform to the established understandings of the person exploring that information. In a traditional information system, these qualities would tend to be filtered out of material identified as relevant to an inquiry. Context-aware systems like those described in the works cited above succeed in remedying this earlier system limitation; but given the potential for gathering large amounts of information, it is still a challenge to juggle all the information that might be potentially relevant. In Anderson (2000, 2005), for instance, one of the informants struggled to strike the right balance between casting the net wide enough to exploit potentially valuable interdisciplinary and peripheral connections and narrowing his explorations and analyses sufficiently to reach his research milestones. Working with divergent information may be a valuable component in research work, but as digital information systems expose us to ever larger collections of potentially relevant information, it becomes ever harder to make time available for such contemplative scholarship.

When and how do we support both the convergent and divergent practices? Does supporting the convergent practices more often associated with targeted searching necessarily imply constraining the divergent ones more often associated with discovery and

creativity?

Expressions of uncertainty in information seeking: a creativity stimulation pathway?

There is no doubt that advances in digital information systems have enabled greater access to information on a global level or that they have increased our capacity to process large amounts of information efficiently. However, observations like Levy's (2007) that these increasingly efficient and crowded information environments leave us with "no time to think" leads us to speculate about the implications of this information system use for the creative information processes so often associated with research discoveries and the interplay with the way information is discovered, selected and used. The programmemed serendipity that Campos and Figueiredo (2001) describe supports the exposure to new information but what of the thinking time that is necessary to interpret and analyse potential connections provoked by these new insights? Supporting unplanned or accidental encounters is by the very character of such information practices difficult to embed in a programme or into human practice - nor should it be overly programmemed or planned. However, we can make time for such practices by finding ways that might make it easier to identify situations where it might be particularly fruitful for a researcher to make time for less structured information explorations or for information supports (system or human) to encourage such practice.

Can the uncertainty experienced by a searcher (or researcher) be a marker for a potential "creativity stimulation" pathway? In light of the findings reported earlier about uncertainty in scholarly research (Anderson 2006), it has been particularly interesting to revisit earlier research in information science about ways that information systems (and services) might stimulate creativity. Investigations of creative information processes by Bawden (1986), Ford (1999) and Eaglestone *et al.* (2007), for example, pursued the issue from a systems perspective. Levy (2007: 248) suggests that there is a need for more nuanced understanding of the different modes of thinking involved in scholarly work and ways that support for the non-creative dimension of thought might buy more time for creative reflection. The discussion in this paper is part of an ongoing investigation about the human and contextual dimensions of these processes, in particular ways that our creative practices and scholarly research might best be supported individually and institutionally. This paper extends the concerns of these earlier researchers by asking if the reduction of uncertainty (the generally accepted goal when designing an information system) is cutting off opportunities to deal with the divergent thinking found to be so important for scholarly success and research innovations.

As our information spaces grow increasingly crowded with digital access to greater amounts of information, does the time and effort involved in exploring, evaluating and working with this information privilege an established perspective and convergent thinking? Are we crowding out the opportunities for the sensemaking involved in divergent thinking? O'Connor briefly mentions an association between uncertainty and creative activity when he points to the findings from the psychologist Frank Farley that a creative person is one who '*. . . lives on the edge of uncertainty, thrives on novelty, and is tolerant of ambiguity*' (1988: 204). O'Connor does not discuss the matter any further other than to allude to the contrast between this human quality and the limitations of the retrieval systems of his time to support it in Table 1 (1988: 208). There is much left to be explored about this uncertainty and creativity connection in relation to our present information practices. The ethnographic research leading to the writing of this paper, for instance, suggests that the expression of *uncertainty* may provide clues to situations where supporting that individual's movement through uncertainty could be particularly fruitful.

Uncertainty and the potential for creativity at the periphery of understanding

This paper was in part prompted by an interest in the ways that people work with information at the periphery, the boundary between relevant and irrelevant, certain and uncertain, a central and a marginal interest. Anderson (2003 and 2006) illustrated that instances where informants moved from the known to explore the unknown were marked by feelings of uncertainty about information considered "marginal" or at the periphery of a topic area. Links to Bawden's (1986) discussion about the type of information required to kickstart the creative process appear particularly valuable for seeing how expressions of uncertainty in information seeking can provide opportunities for supporting people working with information at the margins of their understanding and embracing unplanned encounters with information.

Paying sufficient attention to information that may appear discontinuous with the matter at hand, Bawden argues, is invaluable for stimulating creativity (1986: 205-207). One way to make time for chance discoveries and lateral (or divergent) thinking might be to pursue information when there is some doubt about its relationship to the topic at hand or, in fact, to deliberately seek out such information (for instance, see discussion of DeBono in Bawden (1986: 207). Bawden (p. 214) makes the point that explorations of

peripheral and speculative material can be particularly fruitful aids to creativity.

This periphery is similar to what Schutz (1970: 10) refers to as the *'horizon of understanding'*. For Schutz, this horizon figures prominently in his discussion of relevance as a feature of our consciousness by which encounters with "new" information are related to what is already familiar to us. In determining the relevance of that information, we can see that engaging with uncertainties about that information is an important aspect of the process of making connections and understanding.

The experiences of relevance at this periphery can also be characterised by what Gendlin (2004) calls *thinking at the edge*. Claxton draws on Gendlin's technique as a way to encourage what he refers to as '*soft creativity*' and '*real-word kind of creativity*'. He makes the case for exploration at the margins of what one understands about a problem, suggesting that creative solutions involve '*...a softer, slower kind of groping for a way of articulating something that is currently, tantalizingly, beyond our linguistic grasp*' (Claxton 2006: 352).

If we extend this discussion of horizons and peripheries of problem areas to consider the process by which the line between what is *in* and *out* is continually drawn and redrawn, we can imagine the potential value in enabling deeper engagements with information judged at any given moment during the course of any search or research activity to be marginally relevant. Ford (1999: 538), for instance, speculated:

> There may indeed be some chemistry in failed high relevance which results in creatively useful information clustering in the middle ranks of best match searches. It is possible that a mid-ranked document has just enough (but not too much) relevance to aid creativity without being so totally unrelated as to be useless. (Ford 1999: 538)

Judgments about partially relevant material signal opportunities where divergent thinking needs more support.

Even if an individual item is likely to prove "marginally relevant," the ideas that are drawn to a searcher's attention through the review of the representations can serve a more important purpose. When the informants in Anderson (2003 and 2005) discussed their selection decisions and relevance judgments in situations such as these, they spoke about more than simply the ideas emerging from their reading and search encounters. They described ways that they imagined these ideas and texts fitting into their work. Through their engagement with citations, abstracts, and papers, they spoke about what they were learning about their topics and the ways these encounters helped them frame their research. One of the informants (John) often spoke about finding *central* issues covered in *marginal* documents where his instincts about the treatment of the issues covered in a work were significant enough to compel him to pursue the idea further. Thus, the boundaries of his understanding, and his topic of interest, would continue to widen. Thus situations where a searcher or researcher expresses doubt or ambiguity about the value of a particular search topic, the themes judged to be relevant to a research project or the insights encountered can serve as stimulants for creativity and innovation.

A complex but intriguing aspect of judgments at the margins of understanding is the role played by intuition in decisions to pursue information beyond that limit. Personal feelings or reactions to ideas considered (by a searcher) to be represented in a document or document representation are combined with clues or triggers to help work out how far to go with marginally relevant information. Through the process of bounding and rebounding an area of interest the informants discussed in Anderson (2003, 2010) create a sense of the potential significance for their research interests. The intuitive leap or hunch is acknowledged as a potential pathway to creative thinking (Ford 1999; Foster and Ford 2003). Gendlin's (2004) discussion about the value of *thinking at the edge* offers a way of understanding the support needed to help someone in such a situation convert intuitive understanding of the matter at hand into articulations of that understanding comprehensible by an information system or human intermediary. In such instances, we can also imagine how having more time to think about the matter at hand; more contemplative scholarship Levy (2007) might say, could help someone find appropriate words to convey that understanding and find the language that earlier researchers (e.g., Bawden 1986, Ford 1999) point to as an essential part of the system support for creativity.

Putting together what has been presented in this paper about the conditions that can stimulate creativity and the value of working through uncertainty suggests that feelings of uncertainty or ambiguity about the relevance of information might offer clues about a potentially rich associative trail that one might pursue or instances where taking risks to pursue an unplanned path might be particularly rewarding, especially if an intuitive sense about that information contributes to the curiosity factor (for more discussion, see Anderson 2010). Furthermore, there is evidence to suggest that thinking time as well as searching time will be needed to build the mystery that Eisenberg (2001) sees as so important for creative endeavours.

Closing comments: creativity and journeying through uncertainty

Given the cultural dimensions of risk and uncertainty, it is worth considering how uncertainty and risk might figure in the scholarly

research landscape, both in terms of the individual qualities of a successful researcher and in terms of the environments that would support and sustain creativity and innovation. John Keats is quoted as saying that artistic achievement is possible when people '*. . . are capable of being in uncertainties, Mysteries, doubts, without any irritable reaching after fact and reason*' (as cited by Wilson, *et al.* 2005: 6). Framing uncertainty as a potentially positive state, Eisenberg (2001) argues it is the essential ingredient for building the mystery that leads to creativity. As such works suggest, the process of "being in uncertainties" is an important factor for creativity and innovation however they are defined. Does this suggest that developing an awareness of and being in the uncertainties of the everyday and of our practice is a critical condition in any creative landscape?

By enriching our understanding of the value of working though uncertainty we begin to appreciate that thresholds exist along a certainty-uncertainty spectrum. Uncertainty helps us make sense of the world. For the informants in the ethnographic research drawn on in this paper, for instance, not knowing motivates them and compels them forward (Anderson 2000, 2003, 2006). However, too much *not knowing* can overwhelm and become unproductive. It can be detected in the frustration associated with communicating a message, information overload and risks, extending beyond what a person is prepared to tolerate at that point in time. At such a point, an individual might be said to be experiencing undesirable uncertainty. Anderson (2006) has shown that positive and negative forms (as experienced at any one moment) are inextricably intertwined but one key to working through any kind of uncertainty is developing a tolerance for it. To echo Boholm's contention, risk and uncertainty are extremely contextual. In fact, desirable uncertainty appears to emerge through the interplay between positive and negative forms in our individual practices. Thus, working with and through the uncertainties that we experience plays a critical role in creative, innovative activity.

Flow is found by journeying through confusion and doubt (Csikzentmihalyi 1997), suggesting that the time needed to work through and with uncertainties we experience in information seeking and in our research practices more broadly, should be extended rather than reduced. Exploring our approaches to creativity and uncertainty in this way sheds light on the relationship between information provision and creativity and on the way that information practices associated with creativity can ultimately aid the design of context-sensitive systems. Effective use of information systems is essential for working with complex clusters of information and for providing insight into *known* information worlds. However, there is growing evidence that the capacity to build on intuition and unarticulated insights, unplanned trails and discoveries as they unfold can be critical for success. Equally clear is the fact that by its very nature it is difficult to know how to create the sites of stimulation that will support such capabilities and opportunities. Findings like those reported above demonstrate that we must support both sets of practices: working effectively with information managements systems as well as taking risks on unplanned trails and insights as they arise in the complex information and research tasks inherent in scholarly work.

Is the abundance of information available for research through our growing digital networks putting our creativity at risk? From Levy's perspective it might appear to be the case. According to Claxton (2006: 359), engaging in *'slow, hazy thinking'* can be an essential precursor to what he calls *'full-blown creativity'*. Engaging in thinking about uncertain information or exploring our intuitive sense about marginally relevant information can therefore create conditions conducive to working creatively with information and ideas encountered in this process. Until recently the focus of information retrieval appears to have been more on effective and efficient management of information rather than making more space for experiencing uncertainty or ambiguity in our information or research practices. A key assertion of this paper is that risk taking balanced with pleasure and wonder is an important feature of research success. Supporting *thinking at the edge* of a researcher's problem space, making more time to work with information that is ambiguous or at the periphery of their topic of interest, may be a way to provide more opportunities for the contemplative scholarship that Levy (2007) calls for, which in turn can contribute to research creativity.

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