Information Professionals Going Beyond the Needful User in Digital Humanities Project Collaboration

Volkmar P. Engerer*

Department of Communication, University of Copenhagen,
Copenhagen, Denmark
E-mail: volkmar.engerer@hum.ku.dk

ABSTRACT

When information professionals deal with other disciplines in the course of digital humanities projects, they often assume that they are dealing with 'needful users' who have an 'information gap' to fill. This paper argues that the traditional view that information/knowledge is transferred from an information specialist donor to a domain specialist receiver is no longer appropriate in the digital humanities context, where the gap-and-search (or gap-and-filler) approach to information has given way to more direct, explorative engagement with information. The paper asks whether information science and the practising profession are ready for this paradigm shift and examines information science conservatism in two common collaboration scenarios, library support and digital development. It is shown that information science theory still assumes a traditional donor role in both scenarios. How information scientists deal with conservatism in practice is discussed in the example of the Prior project, in which the information science team exerted an ambiguous, hybrid approach with both conservative and non-conservative elements. Finally, two rather hypothetical answers are offered to the question of how information professionals should approach scholarly collaboration in the digital humanities context, where users have ceased to be supplicants. From a purely pragmatic perspective, information scientists need to shift their focus from information needs to research practices and the implications of these practices for digital information systems. More fundamentally, the emergence of digital humanities challenges information professionals to transform information systems designed for searching into digital objects that can be explored more freely by the digital humanities community.

Keywords: needful user, digital humanities, information professional, information need, information system, Arthur N. Prior

1. INTRODUCTION AND THEORETICAL BACKGROUND

This paper attempts to investigate the role of information science and information professionals in the emerging online academic communities called digital humanities. The digital humanities are by no means a clear-cut scientific discipline. Digital humanities scholars are concerned with many different issues, such as standardisation of digital representations through a 'scholarly mark-up language' (Flanders, 2012, p. 67), virtual research collaboration (Bos et al., 2008; Finholt, 2002) and crowd-sourcing in connection with editing and transcribing analogue material (Eggert, 2009; Rockwell, 2012). There have been many attempts to define digital humanities (see the collection of definitions in Terras, Nyhan, & Vanhoutte, 2013) and much work in the area focuses on presenting concrete digital projects and digitisation initiatives. These are supposed to exemplify the area in some way (Deegan & McCarty, 2012; Flanders, 2012; Hockey, 2012; Warwick, Terras, & Nyhan, 2012), but as they do not really tell us what the digital humanities are, it remains unclear what the term's intension is (Sabir & Engerer, 2019). For the sake of this paper, we can adapt the broad handbook definition by Flanders and Mylonas (2017, p. 1286), according to which digital humanities "includes the range of activities and projects associated with the use of digital technologies for humanities research."

Online research communication and collaboration (and their scientific study) are relatively recent phenomena, and are strongly connected with the rise of the networked personal computer and the world-wide web (WWW) (Tredinnick, 2007). The field takes a strongly applied and technological perspective on research communication and collaboration. Important strands of applied research include research into taxonomies and types of research collaboration infrastructures (Bos et al., 2008), the formulation of success criteria for online collaboration (Olson et al., 2008), design of evaluation procedures for collaboration projects (Ramage, 2010), and related issues such as ways of coping with sometimes challenging interdisciplinary digital communication and collaboration (Cummings & Kiesler, 2008). The technological strand identifies grid-computing, big science, data mining and dataspace (Elsayed, Madey, & Brezany, 2011; Finholt, 2002), coding standards and mark-up techniques (Eggert, 2009; Flanders, 2012), digital collaboration tools (Zaugg, West, Tateishi, & Randall, 2011), and others as the crucial factors in modern digital research environments. Contemporary online research collaboration is strongly associated with the digital humanities and the concept of the 'networked scholar.' The new digital academic infrastructures encompass ubiquitous online systems for research communication such as WWW-born research portals (Becker, Knackstedt, Lis, Stein, & Steinhorst, 2012), digital platforms for scientific collaboration ("collaboratories," cf. Finholt, 2002; Olson et al., 2008) and, more recently, 'cyber-infrastructures' in e-science (Borgman, 2007; Elsayed et al., 2011).

These research communication systems are well-studied interdisciplinary objects in the digital humanities and are investigated by researchers with diverse research interests and theoretical backgrounds. For example, there has been a psychological analysis of scholars' web blogging (Gurak & Antonijevic, 2012; for a more general account, see Wallace, 2001), socio-constructivist, system theoretic research into wikis (Kimmerle, Cress, & Moskaliuk, 2012; Notari & Honegger, 2012), and complexity theoretic modelling of online research teams as complex systems interacting on multiple levels (Vasileiadou, 2012). The very different conditions in the digital humanities have even prompted a rethink of a discipline's paradigmatic basis, as it is the case of a 'cyber-ethnography,' which redefines sociological inquiry and traditional ethnographic methodology in the new online environments (Robinson & Schulz, 2012).

Although it is sometimes somewhat unclear how the results of these various strands of research connect with each other and what their broader consequences for digital research communication and collaboration are, this is a promising and exciting, interdisciplinary field of inquiry. Investigations into research communication help us to understand how researchers interact with technology, with other researchers and the public and with information - often all at the same time.

It is therefore not surprising that both information science concepts, i.e., knowledge-related, stabilized, disciplinary concepts in information science, and more generally, informational concepts, i.e., phenomena in the real world that are usually related to information, are frequently referred to in collaborative projects and in the digital humanities in general. Informational concepts referred to in collaborative research include the notions of 'information need,' 'information overload' (Cummings & Kiesler, 2008, p. 113), and 'digital libraries' for research (Finholt, 2002, p. 79) as well as Borgman's concept of 'information infrastructure,' which highlights the information/data dichotomy in the context of modern research collaborations (Borgman, 2007, Ch. 3). Research on topics such as the accessibility of information, access points in collaboration platforms (Borgman, 2007, p. 2; Elsayed et al., 2011, p. 270), and questions of content and mark-up in digital information and websites (Eggert, 2009, p. 75) is also heavily informed by information science concepts. Furthermore, the idea of information as a shared, accessible, and

created commodity in knowledge collaborations (Kimmerle et al., 2012) has its roots in information scientific reasoning. Last but not least, information science theory emphasises the importance of tacit and presupposed knowledge in digital communication (Finholt, 2002, p. 96) and establishes the conceptual value of distinguishing between information and knowledge in the study of research communication (information is easier to mediate than knowledge) (Bos et al., 2008, p. 54). Information science must therefore be acknowledged as a major player in the digital humanities, and a theoretical understanding of research collaboration would not be complete without taking information science theory and knowledge into account.

This study explores the role of one dominant dogma in information science—the concept of the "needful user" in digital humanities—and how this concept manifests itself in digital collaborations information scientists are engaged in. The degree to which information scientists adhere to the needful user concept determines information scientists' conservatism, representing the extent to which needful user assumptions are implicit in informing professionals' behavior in professional contexts. The example of the Prior project demonstrates a hybrid approach to digital humanities collaborations in which both conservative and non-conservative elements coexist. I conclude with some more speculative considerations of how this hybridity or ambiguity regarding conservatism could be resolved and the ubiquity of the needful user could be overcome under the conditions of the digital humanities. The method applied is a conceptual analysis, which combines a deductive, top-down modelling of the knowledge transfer relationship between information scientists and research colleagues in the domain, and an inductive, bottom-up perspective that construes conservatism on a scalar dimension representing adherence to the needful user. I discuss, briefly, how conservatism has manifested itself empirically in the Prior project.

This project involves researchers working on the time logic of the New Zealand philosopher and logician Arthur Norman Prior working with information scientists affiliated with the Department of Information Studies, University of Copenhagen (Prior Project Group, 2017). One of the tasks of the information science group is to develop the Danish Prior websites associated with the project, enhance communication and collaboration between Prior researchers worldwide, and make Prior's unpublished manuscripts accessible in transcribed and digitised form. The Danish Prior Internet representation has been revised several times during 2018-2019, and one can inspect the results at http://www.priorstudies.org; however, this analysis refers to the website as it was before these improvements. This archived version of the website can be accessed at http://web.archive.org/

web/20070609124540/http://www.kommunikation.aau.dk/prior/index2.htm. The project group has reported elsewhere on some of the information scientific background to the project (Engerer & Albretsen, 2017; Engerer, Roued-Cunliffe, Albretsen, & Hasle, 2017) and the practical and theoretical issues it has raised (Engerer, 2019; Engerer & Sabir, 2020; Sabir & Engerer, 2019).

The paper is structured as follows: After an explanation of the powerful concept of the needful user and its inadequacy in relation to digital humanities in Section 2, the method is presented in Section 3 (modelling and connecting donor and receiver). Section 4 describes where donor and receiver meet, in 'encounter scenarios.' Section 5 then introduces and operationalizes (on a rather abstract level) the construct of conservatism using the heuristic tool of gap-and-filler questions. Section 6 discusses some reflections on conservatism/non-conservatism in the Prior project, an information science project collaboration with logicians, philosophers, and other academics. The analysis is summarized in Section 7 and concludes in the final Section 8 with some rather tentative proposals for information scientists to relate to collaboration in the digital humanities, beyond the concept of the needful user.

2. DIGITAL HUMANITIES AND THE CONCEPT OF THE 'NEEDFUL USER'

The concept of the needful user reflects a deep-seated, central premise of the information science tradition, namely the concept of 'information need.' The concept of an information need perpetuates a view of information system users as 'needy' individuals who should be urged to apply information seeking strategies (or seek professional assistance) in order to meet these needs (Batley, 2005; Beghtol, 1986; Borlund, 2013; Case, 2012; Cooper, 1971; Derr, 1983; Limberg, Sundin, & Talja, 2012; Wilson, 1981). In other words, information scientists and members from related vocations (information specialists, librarians, etc.) tend to approach users as "users with information needs" with a defined gap of knowledge that can be filled by the support of information specialists (librarians …). The needful user assumption has shaped the professional attitudes of information scientists since the discipline emerged, and it is inherent in much information scientific reasoning and theory building. It is therefore not surprising that contemporary collaborations in digital humanities are still, directly or indirectly, shaped by it (Stock & Stock, 2013; Tredinnick, 2006).

There is no doubt that the needful user concept is legitimate and has merits in many areas of information scientific investigation

and practical work. The information need scenario is by no means irrelevant or inappropriate; actually, the opposite is the case. The need for information is a basic human condition and the actions we take to obtain the information we need in collaborating groups and sometimes hostile or competitive environments are important (Sandstrom, 1994, 1999). However, in a digital humanities context the needful user concept seems somewhat dated as it invokes a whole set of traditional information scientific professional values that are no longer relevant or valid in the changed conditions of digital environments.

Digital humanities have radically challenged the environment of the needful user/researcher; in fact, researchers' relationship to information has changed (Wagner, Bratteteig, & Stuedahl, 2010; Warwick et al., 2012). In the digital humanities the traditional idea of information as 'information-about' (Beghtol, 1986), linked to the concept of information systems as secondary, supportive resources and encoded in searchable knowledge organising systems, has given way to the notion of information as a digital research object in its own right. Accordingly, information systems such as research databases (Hider, 2012) are no longer regarded exclusively as shortcuts to information that is external to the system or as 'signposts' to knowledge about the outer world; they are more and more viewed as explorable structures which lend themselves directly to research-related investigation. Researchers with questions that involve exploring datasets or networks of digital records (e.g., letters, films) are turning away from the objects to which the records refer (things, persons, places, etc.) and attending to information that exists exclusively in digital form. Film databases are perhaps a good example (Mohamad Ali, Smeaton, & Lee, 2011). Here access to the 'original' (the movie in question) is, in most cases, not only irrelevant but actually undesirable (and not even offered by the database). The original film does not, from the media researcher's perspective, give more, more relevant, better or more authentic information than its digital representation, the database record. On the contrary, the digital network, in which the records are embedded, is an enriched structure distinct from the structure of the film itself. Notions such as 'access to the document' or 'information on this film' are not the only ways to address one's research interests in a digital context. Consequently, researchers' motivations for engaging in information-related activities do not arise necessarily from traditional 'information gaps' they might have experienced; rather than having a specific need they are curious, experimental, and fond of discovery.

The image of the needful user is prevalent in information science and underlies much information science practice. Although there exists a tradition and strand of research in information science connected to the study of non-mainstream

"information encountering" and "creative" and serendipitous user behavior (Bawden, 1986; Björneborn, 2017; Erdelez, 1997; Foster & Ellis, 2014), the picture of the needful user is still implicit in the ways in which information science theory and information professionals interact with other scholars and disciplines in research collaborations, project environments, and other digital humanities platforms. A thorough understanding of how this view of researchers is shaping research collaboration enables us to make sense of the complicated interdisciplinary, collaborative relationships between information science and practitioners and scholars from other disciplines.

3. METHOD

3.1. Top-Down/Bottom-Up
My method is a combined top-down/bottom-up approach linking top-down theoretic-deductive reasoning (from which two scenarios, library support and digital development, are derived) to an empirical, bottom-up analysis of how conservative (this concept is discussed in more detail below) the two scenarios are. The conservatism of the two scenarios is illustrated by real world cases from the Prior project, a research project with which the author is involved (see below).

The top-down approach models the needful user as the recipient in a simple, unidirectional donor-receiver relationship between information science (information science knowledge and professionals mediating this knowledge) and the needful target-receivers of domain research (researchers) who are collaborating on a project. This scenario is explained in detail below.

The bottom-up analysis considers the scenarios in terms of their empirical conservatism and draws on examples from the author's involvement in the Prior project.

3.2. Modelling the Donor
How do information science knowledge, and the professionals who exercise and practice it as donors, link up with receiver-researchers in a single project environment? This was an important question for the Prior project. We needed to have a better understanding of the rather complex relationship between information science 'generalists' and their knowledge and 'hard-core' domain researchers from other disciplines (logicians and time philosophers). To this end, I will use a simple framework in which a unidirectional transfer relationship connects information science and information professionals (academic donors) with philosophical-logical research and researchers (academic receivers). This unidirectional transfer

represents an important aspect of the relationship of need, in which information professionals anticipate a user's information gap and thus trigger a transfer of knowledge from information science to the needful receiver.

The donor dimension comprises information science knowledge and the information professional mediating this knowledge as constituting elements. While information science knowledge characterises information science theory as a conceptual system, information professionals correspond to the concept of professional agents as individuals who know (bear this knowledge) and use and communicate it. Thus the information professional is conceived as a person equipped with competencies: He or she is not just a professional 'knower' or 'situated theoretician,' but is endowed with all the practical, methodological, and procedural skills appropriate to the profession.

3.3. Modelling the Receiver

As donors, competent information professionals relate to domain researchers in collaborative environments in complex ways. This complexity is due to the fact that domain research has a complex internal structure, in the sense that domain researchers in research environments typically act in different research 'modes' or take different 'stances,' as will be explained in more detail below (Engerer & Sabir, 2020). These modes are associated with distinct ways of relating to information and knowledge and are (often unconscious) orientations towards the various work situations that domain researchers might encounter during collaborative projects.

Researchers fundamentally engage in scientific knowledge-building and learning in the academic area of the project; they act in 'individual mode' (Engerer & Sabir, 2020). In individual mode researchers engage in the cognitive research objects of a project (concepts, propositions, relations, etc.) that are internalised in the researcher's knowledge system. The researcher's acknowledgement of knowledge gaps often initiates a learning process. The individual mode is characterised by 'individual information needs'; in other words, researchers basically relate to information and their own knowledge in a problematising way (Belkin, 1977; Calvert, 2015; Case, 2012).

The second mode I want to introduce is the 'project group mode,' which encompasses all kinds of research-related activities in a project environment (including those outside the cognitive sphere) (Engerer & Sabir, 2020). In project group mode researchers communicate and collaborate in accordance with their role and relationships with co-participants. The project group mode is rooted in a problem, but unlike the individual mode, the focus is on information gaps and needs at group level

(Kimmerle, Cress, Held, & Moskaliuk, 2010). The activities associated with project group mode are collective knowledge-building and reaching of joint answers. Equal access to project-relevant information and resources are critical to these activities, as is the establishment of common terminology, which is needed to enable the sharing of project-relevant knowledge (Lin, Fan, & Zhang, 2009; Shuhuai, Xingjun, Haiqing, & Jialin, 2009). The two modes, individual and group, broadly coincide with Mode 1 and 2 as defined by Engerer and Sabir (2020).

4. CONNECTING DONOR AND RECEIVER: ENCOUNTER SCENARIOS

Scholars typically act in both individual and group mode, often at the same time. They are devoted to learning and will analyse a difficult paper in depth and discuss it with departmental colleagues or the project group. Although it is completely natural for scholars to perform their roles without necessarily being aware of them or reflecting on them, it can be important for the information professional to acknowledge these roles in collaborative contexts. A feature of the needful user approach in information science is that domain researchers' professional modes of learning or communicating connect in significant ways to information professionals and their knowledge in collaborative contexts. Encounters between researchers and information professionals can thus be described in terms of 'encounter scenarios.' In these scenarios an information professional responds to certain properties of the domain researchers with whom he or she is collaborating. Beyond the more general professional components of an encounter scenario such as professional profile, object of engagement, and kind of activity (Engerer & Sabir, 2020), we have to acknowledge three more components that are more directly related to need:

- Construction of the domain's information need ('Identifying the gap by …')
- Method of locating knowledge to meet this need ('Identifying the filler by …')
- Areas of knowledge, i.e., information science knowledge to be drawn on ('Filler knowledge stems from …')

Methodologically, the scenarios are derived from properties of the receiver dimension, categorised in terms of

- Form of academic engagement
- Relation to information and knowledge

Scenarios thus provide the scripts for information professionals' responses to domain researchers operating in both individual

Table 1. Cross-classified receiver-donor dimensions and specification of two scenarios, library support and digital development

Receiver → (domain researcher)		Individual mode	Project group mode
	Academic engagement	Learning and knowing (knowledge-building)	Activities (communicating and collaborating)
	Relation to information and knowledge	Problematising of individual information needs	Problematising of information needs on project level
Donor ↓ (information professional/knowledge)	Encounter Scenario:	Library support	Digital development
	Professional profile: Acting as …	Research librarian	Information specialist
	Object of engagement: Working with …	People	Information systems (indexing, metadata, retrieval modules, interfaces, etc.)
	Kind of activity: Engaging in …	Communication & verbal interaction	Information systems development
	Construction of the need: Identifying the gap by …	Discursive elicitation of information needs in normal language	Identification of information systems that can meet a group's need
	Method of locating knowledge: Identifying the filler by …	Translation of user queries into controlled language	Identification of information systems types, which are pointers to information science knowledge
	Areas of knowledge: Filler knowledge stems from …	Reference interviews, library services, information literacy, etc.	Language control, indexing theory, interaction design, etc.

and group mode. They construe the relationship between the information professional and domain researchers as donor-recipient and categorise professional activity as a type of transfer.

Table 1, which is a heavily modified version of Engerer and Sabir (2020, p. 10), summarises the features of the receiver and donor domains.

When meeting domain researchers as individuals, information professionals respond to cognitive information gaps and needs of the individual researcher. In this scenario the information professional typically offers library support services such as verification of references (Goodwin & Parker, 2012; Li, 2009; Sharifabadi, 2006), execution of literature searches to address the domain researchers' specific topics or research questions (Edwards, 2007), and accessing full text material for project participants. In this scenario the information professional acts as a research librarian.

The library support response is closely associated with the reference interview, a well-established communicative methodology in library and information science (LIS) that uses verbal interaction and investigative communication strategies to elucidate the researcher's needs (Engerer & Sabir, 2020; Knoer, 2011; Ross, Nilsen, & Dewdney, 2002). In this scenario, researchers typically communicate their information need verbally (or, increasingly often nowadays, via the chat option offered at the library website) to the research librarian, who then translates the researcher's descriptions into a more machine-friendly and 'qualified' query composed of controlled terms

that can be acted on by the information system (catalogues, bibliographies, etc.) (Blair, 1992; Warner, 2007). This area has traditionally received much attention in LIS, for example, under the headings 'information need' (Calvert, 2015), 'reference services' (Barrionuevo, 2011), and 'information literacy' (Lloyd & Talja, 2010; Owusu-Ansah, 2005).

The digital development scenario applies to the interface between information professionals and domain researchers in the project group mode. This scenario is still concerned with problem-solving and knowledge-building, but at the level of project-specific information systems and communication platforms that can be accessed by all project participants. This means that filling an information gap is no longer treated as a problem-solving exercise for the individual researcher. Thus information professionals typically work with information systems and their main constituents - metadata, document records, retrieval modules, search interfaces, etc. (Chowdhury, 2010; Wallace, 2015). These systems and sub-systems are designed to facilitate collective knowledge-building and must therefore be meaningful tools for all project participants.

In the digital development scenario (cf. Engerer & Sabir, 2020) the information professional acts as an 'information specialist,' engaging both in more traditional, knowledge-related aspects of information system manipulation (indexing, information retrieval, etc.) and practical issues of project support such as providing relevant communication systems (Wallace, 2015). The information specialist supports a domain group's information

needs and assists the group by delivering distributed access to the project's information systems. This is achieved by implementing common domain language use and project terminology in these systems, both on the representational side of the system, for instance metadata (Chowdhury, 2010; Lancaster, 2003; Svenonius, 2000), and the output/input component, where domain researchers interact with the information system to retrieve relevant items of information (Baeza-Yates & de Araújo Neto Ribeiro , 2011; Ruthven & Kelly, 2011). The information specialist draws on established tools of knowledge organization systems (KOS) in information science such as indexing theory, language control, information retrieval, and interaction design. Information professionals are primarily concerned with domain language use, which informs both the description of project specific information items (bibliographic material, archival documents, academic events, etc.) and the processing of queries by project participants and other professional users of the information system in question. Thus the information specialist is also in one sense a language specialist.

5. CONSERVATISM

My approach models the needful user by positing a unidirectional relationship between the information science donor (abstract knowledge and the professional mediating this knowledge) and two levels of receiver (individual and group), in which an assumed information gap prompts a transfer of knowledge from the information science donor to the researcher-receiver. This formal constraint in the model reflects the attitude that information science supports the collaborating group of researchers and transfers information *to* them.

I now consider the bottom-up perspective and ask the conservatism question: How do traditional information professionals (now used as a collective term for research librarians and information specialists) and information science connect empirically with the needs of their individual and group clients? Conservatism is the degree to which information professionals align to a presumed information gap with their clients. This alignment is expressed by the answers given to two indicative questions: 1) What is the receiver's information gap? 2) Which information science knowledge must be drawn upon and transferred to fill this gap? I will refer to these two questions as 'gap-and-filler' questions and to the corresponding answers as 'gap-and-filler' information. The traditional approach, with its adherence to the concept of the needful user rests on addressing these two questions or at least assumes that they can be answered.

Here I will treat the concept of gap-and-filler information as a

heuristic and as an operational tool. Gap-and-filler information can be used to gauge the degree to which information science theory builds on needful user assumptions and the extent to which they are implicit in information professionals' behaviour in professional contexts. This is empirical conservatism. Easy and straightforward answers to the gap-and-filler questions in a given scenario indicate a high degree of conservatism in that scenario. In turn, ambiguities or an inability to provide straightforward gap-and-filler information is symptomatic of a less conservative approach. Conservatism is an empirical attribute of scenarios, where information professionals struggle all the time with gap-and-filler questions. In the following, I can only give theoretical and plausibility-based arguments for conservatism in the two scenarios. Empirical research will be required to substantiate my claims about the nature and degree of conservatism in the two scenarios.

The library support scenario provides a clear example of the conservative approach to research collaboration. Library service methods such as the reference interview are explicitly designed to provide a systematic, comprehensive analysis of the user's information problem. Research-reference librarians are trained to translate a user's approximate, colloquial expression of his or her needs into semi-controlled, topical language that can be mapped onto the library's knowledge organisation systems in order to retrieve user-relevant material (Knoer, 2011). The diagnosis of the information need (Question 1, gap) happens through direct communication (face-to-face or mediated) with the user. The identification of the relevant knowledge (Question 2, filler) is achieved by reformulating the user's need as a defined, unambiguous thesaurus expression that allows the appropriate information sources to be identified (Engerer, 2017).

If information needs are put forward and problematised as project issues, information specialists act at the level of digital development and interpret information gaps as issues connected with information systems. To meet project-level needs would then involve detecting the project-relevant information systems in a digital research resource (typically one or more websites) and identifying those which demand intervention in the light of the information need expressed by the group (or diagnosing the lack of an information system). Gap question (1) is therefore approached by moving from the level of websites to the level of information systems that need intervention (see the arrow 'Identifying the need' in Fig. 1 below). With regard to the filler question (2), represented by the 'Identifying the knowledge' arrow in Fig. 1 below, access to relevant information science knowledge is effected by determining the type of the information system demanding intervention (this idea was expressed for the first time in Engerer, 2019). Types of

information systems (e.g., bibliography, taxonomy) correspond to terms at the level of knowledge representation (Peters, 2009; Stock & Stock, 2013) and function as pointers to disciplinary knowledge. Information scientific terms such as *bibliography*, *taxonomy* enable the information professional to access the relevant domain knowledge. This knowledge can then be used to develop the information systems in question. This pathway, which has been presented in more detail in Engerer (2019), is visualised in Fig. 1 below.
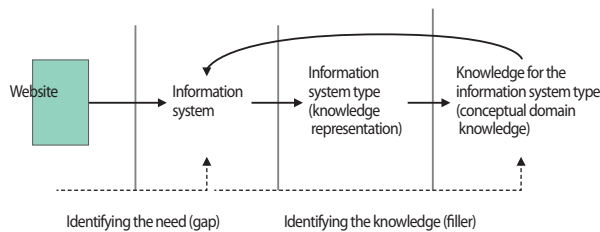

Fig. 1. From websites to information systems to types of information systems to type-specific knowledge and back to the information system.

What follows now is a discussion of conservatism in the Prior project, in which the author is currently participating. The discussion analyses how conservative the information science group's conceptualisation of the collaboration domain of philosophy and logic was - i.e., the extent to which it was based on the user-with-a-specific-need premise - and the extent to which more modern approaches crept into the group's work.

6. REFLECTIONS ON CONSERVATISM AND NON-CONSERVATISM IN THE PRIOR PROJECT

The Prior Internet Resources (PIR) have been analysed along the lines described by the project group (Engerer, 2019; Engerer & Albretsen, 2017) and six information systems have been identified and assigned to five distinct types of information systems (remember that this analysis refers to a now defunct version of the website). These types were used to identify and access relevant information science theory. The information system structure of the PIR is illustrated in Fig. 2 below.

Three of the six information systems are pure search facilities or knowledge organisation systems (two bibliographies, Nos. 2 and 3, and a taxonomy, No. 5) and are based on needful user assumptions. In contrast, the research portal component (No. 1) and the embedded full-text database (No. 4) are mixed systems, though still strongly aligned to search affordances and information needs. Only the Prior Virtual Lab (No. 6) is not primarily designed to support searches. Generally speaking, the present PIR are conservatively organised and structured, although there are some exceptions.

Because the information science group was involved in developing research infrastructure, it was clear from the start that it would need to become closely acquainted with the project group's way of working. This meant much more than learning about information gaps - the information science group had to learn about research practices, academic language, and academic culture in the domain. Consequently, the list of practices of the
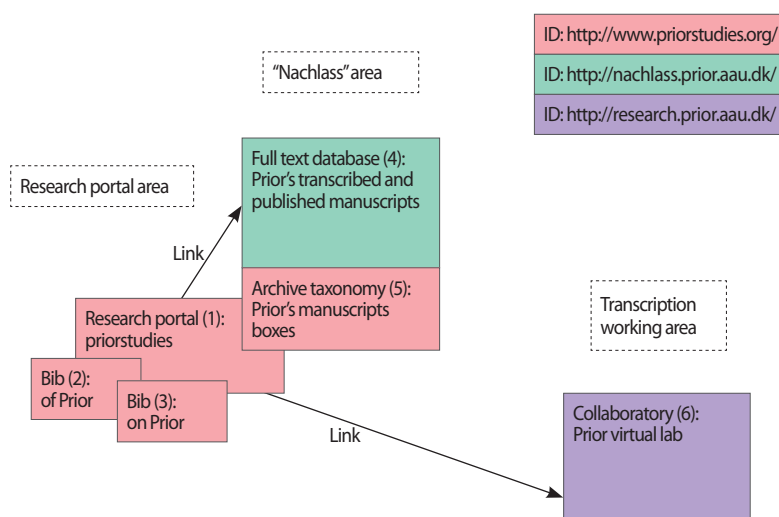

Fig. 2. General structure of Prior Internet Resources (as of summer 2017): six information systems representing five distinct information system types, implemented on three internet domains functioning in three areas. Reproduced from Engerer, J Inf Sci Theory Pract 2019;7:6-22; Engerer and Albretsen, Aalborg University Press 2017.

Prior project group was a rather haphazard mixture of need-related and typically ethnography-like items such as:

- the specific content and form of research questions put forward by Prior researchers;
- types of research questions that tend to be approved as worthwhile/legitimate by Prior researchers;
- preferred information resources of project participants; in practice these were Prior's handwritten manuscripts;
- Prior researchers' reasons for using these information resources;
- search and research techniques that complied with project norms and were executed in order to answer research questions that were considered interesting by the group;
- terminology issues, i.e., techniques for developing naming conventions for time-related logical objects that were specific to the project's research, introducing new terminology, and adapting it to the terminological system at a given point in time.

This brief list demonstrates that many of the research practices of the Prior project group went beyond solely addressing some kind of information need. Often the information science group was examining the Prior researchers' research practices and attitudes to information. Instead of trying to anticipate researchers' unpredictable information needs, the group strived to design an information structure that reflected the Prior researchers' practices.

In the case of Prior's Nachlass documents, mostly letters, this implied - perhaps trivially - that manuscript representations must as a matter of principle a) integrate terms used by Prior research, and b) make sure that these terms denote concepts (objects) that are meaningful to them. Indexing categories (sender, receiver, dating of letter, place, topics discussed, persons referred to, etc.) therefore needed to be grounded in the specific research questions of the project so as to offer relevant access points in expert search inquiries (Lancaster, 2003). Examples of directly project-related indexing categories in the Prior correspondence would include writers' references to their own and others' manuscripts and expressions of doubts or criticism of their own or others' work. The group discussed whether to include an indication of the logical notation used and references to other letters, historical events, or other logicians or philosophers. At this point we asked ourselves the question a librarian would ask at the outset: What is the correspondence about? All dimensions of the representational structure need to be solidly grounded in project research.

Although the group envisaged that there would be a transition from a purely need-inspired, conservative information architecture to an infrastructure that would permit for all types of research-related actions, explorations, and investigative practices, we assumed that information need and information systems would remain the primary objects of study. Search algorithms and retrieval technologies still have to be adapted to the specific information needs and preferred search strategies of the researchers. Prior research will approach retrieval systems differently from researchers in other domains and there will be individual differences in information needs even amongst Prior researchers. Hence the information science group adopted a semi-conservative approach, focusing on adapting search technology to anticipated information needs, but also on aligning document and data structures to the research practices of the project without necessarily considering researchers' information gaps. Without conscious intention the info science group followed a pragmatic path into digital humanities.

7. CONCLUSIONS

Taking the important role of information science and information professionals in research projects as a starting point, we observed that there is an underlying conservatism in information science - a tendency to preserve and perpetuate the needful user concept in collaborations in which information professionals are supporting other scholars from other disciplines. It was argued that this concept is no longer appropriate in the new digital humanities context, where the gap-and-filler approach to information has given way to research practices that involve researchers engaging more directly with information.

In order to explore information science's readiness for this paradigm shift at both the theoretical and practical level we modelled the needful user concept as a donor-receiver transfer relationship. In a top-down approach, information science knowledge is 'transferred' to the receiver dimension in the domain. Two distinctive scenarios in which this donor-recipient relationship is implemented were identified: library support and digital development.

A bottom-up analysis of the scenarios was carried out. This looked at the conservatism of the information scientific approach, operationalised as how easily two questions that are central to the needful user premise (What is the information need? How can it be satisfied?) could be answered. It is revealed that information science theory conceptualizes its practitioners (information science professionals) as strongly conservative donors in both scenarios, with an individual recipient (library support scenario) and with a collective recipient (digital development scenario). In both scenarios information science

has an underlying fixation on the two gap-and-filler questions.

The discussion on how the information science group on the Prior project performed in terms of conservatism was somewhat more ambiguous. There were no ambiguities in the handling of the library support scenario, to which the concept of individual information need is central, but the group's handling of digital development tasks was more difficult to parse. In this scenario the information professionals seemed to be guided more by the information practices of the researchers with whom they were collaborating than by their anticipations of specific information needs.

8. FURTHER PERSPECTIVES: THE NEW 'INFORMATION HUMANIST'

The project group clearly had some awareness that a shift was going on, that scholars were going from being information-lacking individuals to domain specialists who interact with information – to create, modify, explore, and study it. What does this shift, on a more general level, mean for information professionals? What should the role of information professionals be if users are not invariably coming to them with specific information needs? I want to conclude this paper with some more practical suggestions on what the future of information specialists in digital research collaboration could look like.

What I want to propose is that our new 'information humanists' need to elicit research practices and map them onto digital systems for research. My second answer is that information professionals should help to transform information systems designed for search into digital objects designed for exploration. Library catalogues designed solely to identify information in the external environment now seem to be obsolete in many spheres of research.

First, domain researchers in projects act as members of an academic community with value systems, practices, and routines of which they may not even be fully aware (Nicolini, 2013; Schatzki, 2001). The key question for the information professional is whether the digital systems used on a project correspond to the practices, workflows, and incentive systems to which the domain researchers on that particular project are committed (Christensen, 2016; Østerlund, Sawyer, & Kaziunas, 2011; Østerlund, Snyder, Sawyer, Sharma, & Willis, 2015). This question forces information professionals to shift away from meeting researchers' information needs and to take a more holistic view of how digital systems interact with other digital systems on the same website or with components on other websites (cf. Engerer, 2019).

When information professionals encounter their domain colleagues they combine knowledge of digital information systems with knowledge of how to observe, elicit, and identify existing research practices and align them with the architecture of digital information and communication systems. It is not a trivial task for information professionals working in the digital humanities ("iHumanists" in the terminology of Engerer & Sabir, 2020) to access and integrate this typically tacit knowledge (Falconer, 2006; Nonaka, Toyama, & Konno, 2000), as it does not manifest as an explicitly expressed information need. As researchers do not experience mismatches between academic practice and digital workflow as immediate, problematic knowledge gaps or unmet information needs, the information professional has to look for other indications of such mismatches. Typical domain researchers' responses to practice-technology incongruities are to choose an alternative (often less effective) method, to adjust the system so that it works after a fashion (but certainly not the way it should or could), or simply to drop a certain practice completely (Nicolini, 2013). A specific information science methodology from the pragmatic point of view could be domain analysis (Hjørland, 2002).

Second, aligning and adapting information and data structures to facilitate independent and creative exploration by domain researchers seems to be an emergent field of engagement for information professionals working in the digital humanities. This approach can be seen as a response to the fundamental changes in research objects that have taken place through the Internet. Taking a data-driven, digital humanities perspective on the role of information professionals, information structures are designed as both searchable (capable of being used to find information 'external' to the information system) and explorable.

One path in this direction could be the information scientific concept of an ontology. The move from traditional thesauri and classification schemes (Foskett, 1994; Miksa, 1994) to ontologies of knowledge domains coincides with the integration of semantic web principles into the description of data in WWW environments (Berners-Lee, Hendler, & Lassila, 2001). Moving from the lexical-terminological component (systems of interrelated words, i.e., thesauri) to a whole language with a built-in logic, a syntax and inference rules make it possible to derive information that is not explicitly contained in the descriptive terms themselves (Antoniou, Groth, van Harmelen, & Hoekstra, 2012). The advantages of ontologies for specialist users include improved options for exploring data, "semantic search" (King & Reinold, 2008, p. 22), more opportunities for serendipitous discoveries, and optimisation of search results

by using ontology-based search techniques such as Natural Language Processing (King & Reinold, 2008). All this can facilitate exploration, although there is more research to do in order to better understand which features of an ontology positively interact with explorative user behavior.

Building an ontology is therefore somewhat similar to mapping domain practices onto digital systems in the digital humanities, following, for example, Hjørland's (2002) domain analysis procedure. However, the ontology approach is narrower in scope, as it focuses on domain knowledge and only models the linguistic traits of the scientific community in question. Both methods - the domain mapping approach and the ontological - are intended to transfer tacit domain knowledge into the realm of explicit knowledge organisation, and both respect the linguistic form of this knowledge when modelling it in a knowledge system. Last but not least, both approaches transcend the group/project level and focus on the discipline as a whole - its traditions, norms, values, methods, and, in the case of ontologies, its language - rather than on ad hoc collaborations. For information professionals both the workflow-system approach and the utilization of ontologies in explorative contexts could be major steps towards the digital humanities.

To conclude, knowledge of the proposed scenarios and their conservatism potentials enable project managers to prioritise their engagement and allocation of funding resources and to decide on a solid basis which kind of contribution they might wish from information professionals. The criteria proposed here are essentially practical and therefore a suitable basis for making strategic decisions about a project. If it is the more conservative function, therefore employing the supportive functions of information professionals and librarians that are required in a specific research environment, then the two wh- questions are relevant: What exactly are the information needs? Where is the knowledge needed to meet them? If, however, a collaboration is more strongly embedded in a digital humanities framework, information professionals with the profile of an information specialist trained in the digital humanities ("iHumanist," cf. Engerer & Sabir, 2020) are the right choice. They combine methodological and personal competencies (observation, academic empathy, and domain analysis) with technological expertise in, for example, information architecture and ontologies. Regardless of whether information professionals are performing a more traditional, supportive function or working within a digital humanities infrastructure, their professional expertise and their knowledge will be indispensable to any collaborative project.

REFERENCES

Antoniou, G., Groth, P., van Harmelen, F., & Hoekstra, R. (2012). *A semantic web primer*. Cambridge: MIT Press.

Baeza-Yates, R., & de Araújo Neto Ribeiro, B. (2011). *Modern information retrieval: The concepts and technology behind search*. New York: Addison Wesley.

Barrionuevo, L. (2011). *Libraries for users: Services in academic libraries*. Oxford: Chandos.

Batley, S. (2005). *Classification in theory and practice*. Oxford: Chandos.

Bawden, D. (1986). Information systems and the stimulation of creativity. *Journal of Information Science*, 12(5), 203-216.

Becker, J., Knackstedt, R., Lis, L., Stein, A., & Steinhorst, M. (2012). Research portals: Status quo and improvement perspectives. *International Journal of Knowledge Management (IJKM)*, 8(3), 27-46.

Beghtol, C. (1986). Bibliographic classification theory and text linguistics: Aboutness analysis, intertextuality and the cognitive act of classifying documents. *Journal of Documentation*, 42(2), 84-113.

Belkin, N. J. (1977). *Linguistic and cognitive models of information and state of knowledge: Final report arising from a study visit overseas made to the U.S.A. 21 September-20 October 1976*. London: British Library.

Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The semantic web. *Scientific American*, 284(5), 28-37.

Björneborn, L. (2017). Three key affordances for serendipity: Toward a framework connecting environmental and personal factors in serendipitous encounters. *Journal of Documentation*, 73(5), 1053-1081.

Blair, D. C. (1992). Information retrieval and the philosophy of language. *The Computer Journal*, 35(3), 200-207.

Borgman, C. L. (2007). *Scholarship in the digital age: Information, infrastructure, and the Internet*. Cambridge: MIT Press.

Borlund, P. (2013). Interactive information retrieval: An introduction. *Journal of Information Science Theory and Practice*, 1(3), 12-32.

Bos, N., Zimmerman, A., Olson, J. S., Yew, J., Yerkie, J., Dahl,

E., & Olson, G. M. (2008). From shared databases to communities of practice: A taxonomy of collaboratories. In G. M. Olson, A. Zimmerman, & N. Bos (Eds.), *Scientific collaboration on the Internet* (pp. 53-72). Cambridge: MIT Press.

Calvert, P. J. (2015). *Information needs analysis: Principles and practice in information organizations*. London: Facet.

Case, D. O. (2012). *Looking for information: A survey of research on information seeking, needs and behavior*. Bingley: Emerald.

Chowdhury, G. G. (2010). *Introduction to modern information retrieval*. London: Facet.

Christensen, L. R. (2016). On intertext in chemotherapy: An ethnography of text in medical practice. *Computer Supported Cooperative Work (CSCW)*, 25(1), 1-38.

Cooper, W. S. (1971). A definition of relevance for information retrieval. *Information Storage and Retrieval*, 7(1), 19-37.

Cummings, J. N., & Kiesler, S. (2008). Collaborative research across disciplinary and organizational boundaries. In G. M. Olson, A. Zimmerman, & N. Bos (Eds.), *Scientific collaboration on the Internet* (pp. 99-117). Cambridge: MIT Press.

Deegan, M., & McCarty, W. (2012). *Collaborative research in the digital humanities*. Farnham: Ashgate.

Derr, R. L. (1983). A conceptual analysis of information need. *Information Processing & Management*, 19(5), 273-278.

Edwards, S. L. (2007). Phenomenography: 'Follow the yellow brick road'! In S. Lipu, K. Williamson, & A. Lloyd (Eds.), *Exploring methods in information literacy research* (pp. 87-110). Wagga Wagga: Centre for Information Studies, Charles Sturt University.

Eggert, P. (2009). The book, the e-text and the "work-site." In M. Deegan, & K. Sutherland (Eds.), *Text editing, print and the digital world* (pp. 63-82). Farnham: Ashgate.

Elsayed, I., Madey, G., & Brezany, P. (2011). Portals for collaborative research communities: Two distinguished case studies. *Concurrency and Computation: Practice and Experience*, 23(3), 269-278.

Engerer, V. (2017). Control and syntagmatization: Vocabulary requirements in information retrieval thesauri and natural language lexicons. *Journal of the Association for Information Science and Technology*, 68(6), 1480-1490.

Engerer, V. (2019). Information systems in interdisciplinary research: Analytic and holistic ways to access information science knowledge. *Journal of Information Science Theory and Practice*, 7(2), 6-22.

Engerer, V., & Albretsen, J. (2017). The Prior Internet Resources 2017: Information systems and development perspectives.

In P. F. V. Hasle, P. Blackburn, & P. Øhrstrøm (Eds.), *Logic and philosophy of time: Themes from Prior* (pp. 223-249). Aalborg: Aalborg University Press.

Engerer, V., Roued-Cunliffe, H., Albretsen, J., & Hasle, P. F. V. (2017). *The Prior-project: From archive boxes to a research community*. Paper presented at Digital Humanities in the Nordic Countries (pp. 53-57). Gothenburg: The University of Gothenburg, Department of Literature, History of Ideas and Religion.

Engerer, V., & Sabir, F. (2020). Information professionals meet Arthur Prior. *Journal of Librarianship and Information Science*, 52(1), 288-305.

Erdelez, S. (1997). Information encountering: A conceptual framework for accidental information discovery. In P. Vakkari, R. Savolalinen, & B. Dervin (Eds.), *Proceedings of an international conference on information seeking in context* (pp. 412-421). London: Taylor Graham Publishing.

Falconer, L. (2006). Organizational learning, tacit information, and e-learning: A review. *The Learning Organization*, 13(2), 140-151.

Finholt, T. A. (2002). Collaboratories. *Annual Review of Information Science and Technology*, 36(1), 73-107.

Flanders, J. (2012). Collaboration and dissent: Challenges of collaborative standards for digital humanities. In M. Deegan, & W. McCarty (Eds.), *Collaborative research in the digital humanities* (pp. 67-80). Farnham: Ashgate.

Flanders, J., & Mylonas, E. (2017). Digital humanities. In J. McDonald, & M. Levine-Clark (Eds.), *Encyclopedia of library and information sciences* (pp. 1286-1297). Boca Raton: CRC Press.

Foskett, D. J. (1997). Thesaurus. In K. Sparck Jones, & P. Willet (Eds.), *Readings in information retrieval* (pp. 111-134). San Francisco: Morgan Kaufmann.

Foster, A., & Ellis, D. (2014). Serendipity and its study. *Journal of Documentation*, 70(6), 1015-1038.

Godwin, P., & Parker, J. (2012). *Information literacy beyond library 2.0*. London: Facet.

Gurak, L. J., & Antonijevic, S. (2012). The psychology of blogging: You, me, and everyone in between. In J. Hughes (Ed.), *SAGE Internet research methods* (pp. 93-103). London: Sage.

Hider, P. (2012). *Information resource description: Creating and managing metadata*. London: Facet.

Hjørland, B. (2002). Domain analysis in information science: Eleven approaches - Traditional as well as innovative. *Journal of Documentation*, 58(4), 422-462.

Hockey, S. (2012). Digital humanities in the age of the Internet: Reaching out to other communities. In M. Deegan, &

W. McCarty (Eds.), *Collaborative research in the digital humanities* (pp. 81-92). Farnham: Ashgate.

Kimmerle, J., Cress, U., Held, C., & Moskaliuk, J. (2010). Social software and knowledge building: Supporting co-evolution of individual and collective knowledge. *Proceedings of the 9th International Conference of the Learning Sciences* (pp. 9-16). International Society of the Learning Sciences.

Kimmerle, J., Cress, U., & Moskaliuk, J. (2012). Wiki-supported knowledge building theory, research and application. In S. Bocconi, & G. Trentin (Eds.), *Wiki supporting formal and informal learning* (pp. 41-55). Hauppauge: Nova Science Publishers.

King, B. E., & Reinold, K. (2008). *Finding the concept, not just the word: A librarian's guide to ontologies and semantics*. Oxford: Chandos.

Knoer, S. (2011). *The reference interview today*. Santa Barbara: Libraries Unlimited.

Lancaster, F. W. (2003). *Indexing and abstracting in theory and practice*. London: Facet.

Li, L. (2009). *Emerging technologies for academic libraries in the digital age*. Oxford: Chandos.

Limberg, L., Sundin, O., & Talja, S. (2012). Three theoretical perspectives on information literacy. *Human It*, 11(2), 93-130.

Lin, H., Fan, W., & Zhang, Z. (2009). A qualitative study of web-based knowledge communities: Examining success factors. *International Journal of e-Collaboration (IJeC)*, 5(3), 39-57.

Lloyd, A., & Talja, S. (2010). *Practising information literacy: Bringing theories of learning, practice and information literacy together*. Wagga Wagga: Centre for Information Studies, Charles Sturt University.

Miksa, F. L. (1994). Classification. In W. A. Wiegand, & D. G. Davis (Eds.), *Encyclopedia of library history* (pp. 144-153). New York: Garland.

Mohamad Ali, N., Smeaton, A. F., & Lee, H. (2011). Designing an interface for a digital movie browsing system in the film studies domain. *International Journal of Digital Content Technology and Its Applications*, 5(9), 361-370.

Nicolini, D. (2013). *Practice theory, work, and organization: An introduction*. Oxford: Oxford University Press.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, 33(1), 5-34.

Notari, M., & Honegger, B. D. (2012). Wiki: An archetypical tool for collaborative learning in the digital age. In S. Bocconi, & G. Trentin (Eds.), *Wiki supporting formal and informal learning* (pp. 21-39). New York: Nova Science Publishers.

Olson, J. S., Hofer, E. C., Bos, N., Zimmerman, A., Olson, G. M., Cooney, D., & Faniel, I. (2008). A theory of remote scientific collaboration. In G. M. Olson, A. Zimmerman, & N. Bos (Eds.), *Scientific collaboration on the Internet* (pp. 73-97). Cambridge: MIT Press.

Østerlund, C., Sawyer, S., & Kaziunas, E. (2011). *Studying technologically dense environments through documenting practices*. Paper presented at 27th Egos Colloquium (pp. 1-28). Gothenburg.

Østerlund, C., Snyder, J., Sawyer, S., Sharma, S., & Willis, M. (2015). Documenting work: From participant observation to participant tracing. In K. D. Elsbach, & R. M. Kramer (Eds.), *Handbook of qualitative organizational research: Innovative pathways and methods* (pp. 391-400). London: Routledge.

Owusu-Ansah, E. K. (2005). Debating definitions of information literacy: Enough is enough! *Library Review*, 54(6), 366-374.

Peters, I. (2009). *Folksonomies: Indexing and retrieval in Web 2.0*. Berlin: de Gruyter.

Prior Project Group. (2017). *The primacy of tense: A. N. Prior now and then*. Retrieved February 2, 2020 from http://www.prior.aau.dk.

Ramage, M. A. (2010). Evaluating collaborative technologies: A simple method. In H. M. Donelan, K. L. Kear, & M. A. Ramage (Eds.), *Online communication and collaboration: A reader* (pp. 73-77). New York: Routledge.

Robinson, L., & Schulz, J. (2012). New avenues for sociological inquiry: Evolving forms of ethnographic practice. In J. Hughes (Ed.), *SAGE Internet research methods* (pp. 33-47). London: Sage.

Rockwell, G. (2012). Crowdsourcing the humanities: Social research and collaboration. In M. Deegan, & W. McCarty (Eds.), *Collaborative research in the digital humanities* (pp. 135-154). Farnham: Ashgate.

Ross, C. S., Nilsen, K., & Dewdney, P. (2002). *Conducting the reference interview: A how-to-do-it manual for librarians*. London: Facet.

Ruthven, I., & Kelly, D. (2011). *Interactive information seeking, behaviour and retrieval*. London: Facet.

Sabir, F., & Engerer, V. (2019). The prior eAchive as virtual research environment: Towards serendipity and explorability. In P. Blackburn, P. F. V. Hasle, & P. Øhrstrøm (Eds.), *Logic and philosophy of time: Further themes from prior* (pp. 201-230). Aalborg: Aalborg University Press.

Sandstrom, P. E. (1994). An optimal foraging approach to information seeking and use. *The Library Quarterly*, 64(4), 414-449.

Sandstrom, P. E. (1999). Scholars as subsistence foragers. *Bulletin of the American Society for Information Science*

and Technology, 25(3), 17-20.

Schatzki, T. R. (2001). Introduction: Practice theory. In T. R. Schatzki, K. Knorr-Cetina, & E. von Savigny (Eds.), *The practice turn in contemporary theory* (pp. 10-23). London: Routledge.

Sharifabadi, S. R. (2006). How digital libraries can support e-learning. *The Electronic Library*, 24(3), 389-401.

Shuhuai, R., Xingjun, S., Haiqing, L., & Jialin, C. (2009). From information commons to knowledge commons: Building a collaborative knowledge sharing environment for innovative communities. *The Electronic Library*, 27(2), 247-257.

Stock, W. G., & Stock, M. (2013). *Handbook of information science*. Berlin: De Gruyter.

Svenonius, E. (2000). *The intellectual foundation of information organization*. Cambridge: MIT Press.

Terras, M. M., Nyhan, J., & Vanhoutte, E. (2013). Introduction. In M. M. Terras, J. Nyhan, & E. Vanhoutte (Eds.), *Defining digital humanities: A reader* (pp. 1-10). Farnham: Ashgate.

Tredinnick, L. (2006). *Digital information contexts: Theoretical approaches to understanding digital information*. Oxford: Chandos.

Tredinnick, L. (2007). *Digital information culture: The individual and society in the digital age*. Oxford: Chandos.

Vasileiadou, E. (2012). Research teams as complex systems: Implications for knowledge management. *Knowledge Management Research and Practice*, 10(2), 118-127.

Wagner, I., Bratteteig, T., & Stuedahl, D. (2010). *Exploring digital design: Multi-disciplinary design practices*. London: Springer.

Wallace, P. M. (2001). *The psychology of the Internet*. Cambridge: Cambridge Univ. Press.

Wallace, P. M. (2015). *Introduction to information systems*. London: Pearson.

Warner, J. (2007). Linguistics and information theory: Analytic advantages. *Journal of the American Society for Information Science and Technology*, 58(2), 275-285.

Warwick, C., Terras, M., & Nyhan, J. (2012). *Digital humanities in practice*. London: Facet.

Wilson, T. D. (1981). On user studies and information needs. *Journal of Documentation*, 37(1), 3-15.

Zaugg, H., West, R. E., Tateishi, I., & Randall, D. L. (2011). Mendeley: Creating communities of scholarly inquiry through research collaboration. *TechTrends*, 55(1), 32-36.