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Codex Ultor: Toward a Conceptual and Theoretical Foundation for New Research on Books and Knowledge Environments

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Introduction

This paper presents the conceptual and theoretical foundations for work undertaken by the INKE (Implementing New Knowledge Environments) research group, a large international, interdisciplinary research team, including over thirty-five researchers from more than twenty institutions. We have come together to study different elements of reading and texts, both digital and printed. The INKE team is comprised of researchers and stakeholders at the forefronts of fields relating to textual studies, user experience, interface design, and information management. We aim to contribute to the development of new digital information/knowledge environments that build on past textual practices. We have already articulated a foundation for identifying the characteristics of digital interfaces that respond to the expectations and needs of a broad constituency of professional, personal, and lay readers. The following paper presents the rationale for our research and the aims and objectives of the project.

Our work provides functional reading interface prototypes that have the potential to transform the way we engage with the digital materials, materials that comprise our personal and professional reading. To do this, our *Textual Studies* (TS) research responds to the need to better understand what components of existing textual artifacts are essential to represent in new digital objects and reading devices; our *User Experience* (UX) research identifies characteristics of user engagement with print and digital environments; our *Interface Design* (ID) research focuses on extending continuous reading and scholarship involving digital environments through interface; and, through iterative processes involving all research groups, our *Information Management* (IM) research builds prototypical digital reading interfaces that promote active reading patterns and draw on dynamically integrated collections of supporting materials.

1.0 Research Objectives

We are experiencing a paradigm shift in the way information is generated, disseminated, received, and preserved. For all our efforts since the rise of the Internet, we are still working to determine how best to design digital documents, and the systems that support them, that are functional and versatile in ways that enhance both the user experience and research possibilities. Although there have been many advances in digital textuality – the facilitation of hypertextual interrelation, the inclusion of multimedia content, the strategies that mimic the look and function of print, and the large database integration into research and reading environments – we recognize that the immediate need to design new knowledge environments that can expand the complexity of modes afforded by the digital text while attempting to meet the function and familiarity offered by print.

The root of this research problem was addressed initially by consultations held with funding from the SSHRC Strategic Research Cluster Developmental Grant program. Under the title "Implementing the New Knowledge Machine: Human Computer Interaction and the Electronic Book," these consultations drew together researchers and representative stake-holding research partners comprising interdisciplinary expertise from over ninety fields and sub-fields ranging from philosophy and cultural studies to visual communication design and robotics. As a result of these consultations, researchers concluded the mains reasons for the limitations currently found in electronic books and documents is the fact that they are still predominantly modeled on print-based textual forms. Research and development of such digital materials has chiefly focused on mimicking the look and feel of print – an approach founded on critical and textual models imported from print without understanding them fully. Hence, such work fails to capitalize fully on the technical possibilities of computational simulation. It also fails to take full advantage of computational possibilities for the use of text in dynamic reading environments where the reader is capable of controlling and modifying the format and content of the text as part of standard interaction with it (following McGann, 2001).

In order to achieve all the benefits of computation in these digital artifacts, our work suggested that research in this area must begin with a re-conception of core critical and textual models from the following perspectives: [1] the evolution of reading and writing technologies from antiquity to the present; [2] the mechanics and pragmatics associated with written forms of knowledge; [3] strategies of reading and organization within those forms; and [4] the computational possibilities latent in written forms and manifest in emerging technology.

Drawing on this foundation, our research group works towards an understanding of how best to combine the traditional strengths of print with the flexibility of integrated digital reading environments in order to take full advantage of the technical possibilities of the electronic medium. We seek to:

- document the features of previous textual forms as the context for implementing new knowledge environments;
- advance our understanding of how reading texts and using information is affected by digital, multimedia delivery;
- conceptualize new knowledge environments, and develop tools to produce accessible, flexible information architecture; to extend user control and/or affordances;
- to implement new visual metaphors and integrate social networking functionality;
- to create dynamic interface prototypes for new knowledge environments.

Our interdisciplinary research team will meet these objectives by using methodologies drawn from all disciplines represented, involving innovative research training and dissemination, and culminating in the release of prototypical digital reading interfaces and environments directly and through our partners.

1.1 The Importance of Prototyping as Research Activity

The process of prototyping in the context of our work involves constructing a functional computational model that actualizes the results of our research endeavor and, as an object of further study itself, undergoes iterative modification in response to research and testing. A prototype in this context is an interface or visualization that can be seen to actualize the theoretical foundations our work establishes, so the theory informing the creation of the prototype can itself be tested by having people use it (as per Rockwell and Sinclair; see also McCarty's discussion of modeling in this context). Computational prototypes such as those we propose as part of our work are distinct from production systems in that the prototype focuses chiefly on providing research-pertinent functionality within a larger framework of assumed operation (perhaps within the visual depiction of a fully-operational system, or perhaps in understood isolation from it); production systems require full functionality, and they are often derived from multiple prototyping processes. An example of a prototypical tool that performs an integral function in a larger digital reading environment is an experimental interface we call the Dynamic Table of Contexts (Figure 1; Ruecker; Ruecker et al.; Brown et al.), which draws on interpretive document encoding to combine the conventional table of *contents* with an interactive *index*. Readers use the Dynamic Table of Contexts as a tool for browsing the document by selecting an entry from the index and seeing where it is placed in the table of contents. Each item also serves as a link to the appropriate point in the file.
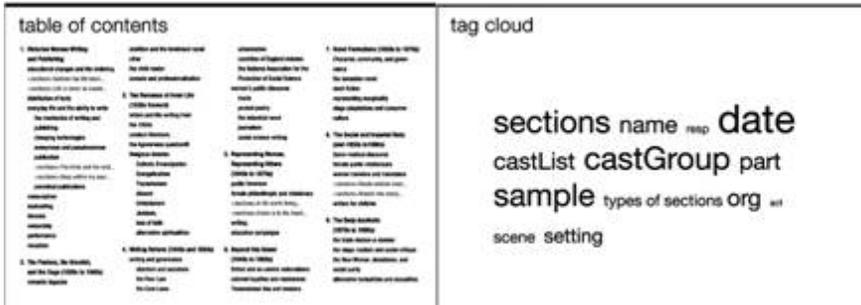
Figure 1: The Dynamic Table of Contexts is an experiment in combining the table of contents with an interactive index
created from interpretive XML encoding, shown here as a tag cloud.

The larger prototypes we propose to build in our research represent a complex of foundational textual forms, and their derivations comprise most professional and personal reading environments: the *scholarly edition*, such as those of the Internet Shakespeare Editions (ISE), the Folger Shakespeare Editions, and the Bibliothèque du Nouveau Monde (PUM), among others; the *academic monograph*, such as *Du papyrus à l'hypertext* (Vandendorpe); *poetry and creative fiction*, as represented in the Electronic Literature Organization (ELO) collections; and the *scholarly journal and essay collection*, such as those of the Public Knowledge Project (PKP; Willinsky) and the Blackwell *Companion to Digital Humanities* (eds. Schreibman, Siemens, and Unsworth). These prototypes also encompass a wide range of further text types: a digitized work (originally created in print); a born-digital work (created entirely in digital media, with no print source); a work with complex interpretive apparatus; an interactive work; a highly encoded work; works in different file formats; a Web-based document; work(s) in different genres; work(s) in French and English; and a dynamic document. All projects will draw materials from, and return results to, existing projects carried out by the research team and our research partners and representative stakeholders.

Collectively, our research is driven by the following questions:

How has reading changed since the rise of digital media, and how can the history of textual practices inform the future?

To answer this question we must understand "the human presence in *any* recorded text" (McKenzie 29), combining close study of material artifacts with interpretive inquiry into human activities (Howsam; McKitterick; Loewenstein). The same techniques of close reading and rigorous material study, long applied to print and manuscript, need to be extended to digital artifacts and online knowledge environments in all their multimedia forms (Liu; Kirschenbaum; Manovich). We will bridge the study of print and digital texts in order to develop a technical vocabulary for describing the salient features of digital texts — where *text* is understood to include, as McKenzie said, "*any* recorded text," in consideration of aspects of the full spectrum of multimedia. This vocabulary and its theoretical underpinning inform the work of the entire project, such that our prototyping activities take into account the material transmission of all such artifacts (manuscript, print, and digital).
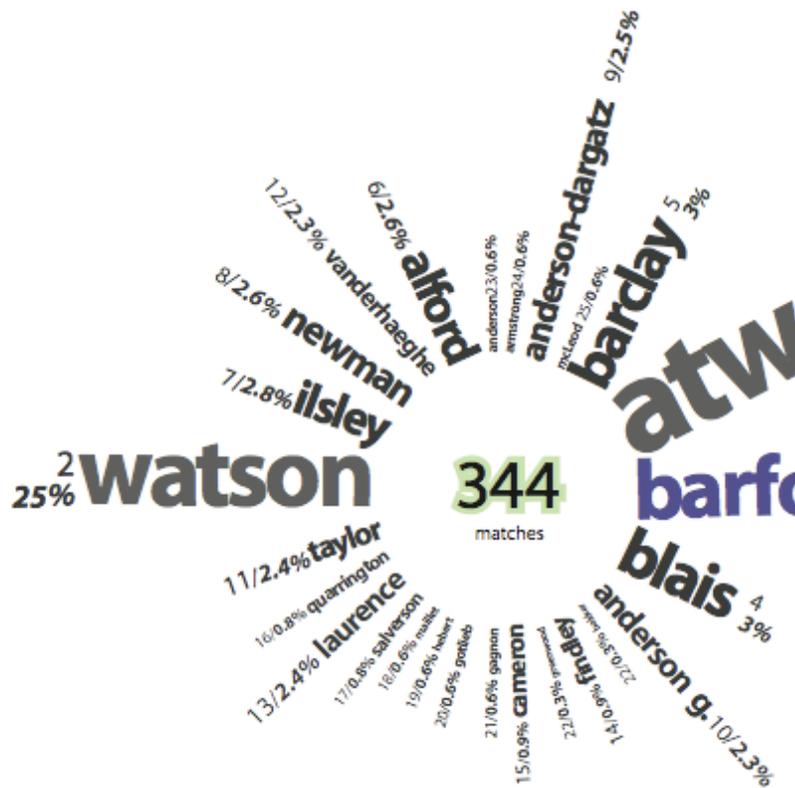
Figure 2: The Sunword visualization allows readers to compare, quickly, authors in a collection based on the metadata available for each author

How has our experience of information changed since the rise of digital technologies and the Internet?

Although reading is the key intellectual and cultural foundation of literate societies and the fundamental activity of scholars, we have little knowledge of how reading and the way we experience information is modified and extended in new media environments (Dobson & Willinsky; Warwick). In the early- to mid-nineties, humanities scholars expressed excitement about the possibilities of digital text, predicting that the experience of reading and information access would change fundamentally as a result of digital delivery and the integration of media such as sound, images and video (e.g., Bolter; Landow; Nunberg). However, such prophetic writings were not based on systematic research with users. Although there have been a number of studies with users from the perspective of interface design and software engineering, and several with readers of scientific literature (cf. Salmerón et al.), little progress has been made in understanding how digital media may affect readers' experience of literature and multimedia artifacts, both printed and digital (note, i.e. Lévy; Liu; Gervais; Vandendorpe; Douglas).

What new features can we design to improve digital information environments, and their interfaces, based on our knowledge of user needs, behaviours, and cultural contexts?

Given the emerging possibilities offered by new media, it still remains to understand and develop methods and models to: [1] extend reader control of digital texts; [2] develop and test prototypes that address issues raised by the printed page metaphor, and give readers and researchers better control of their activities by: revisiting the notion of page boundaries; devising experimental visual tools related to the scrollbar; designing advanced means of bookmarking and annotating; implementing new digital metaphors that may derive, for instance, from sculpture or visualization rather than from the codex book; and exploring possibilities for parallel displays and related tools (Schreibman, Kumar, and McDonald; see also TAPoR [Rockwell]); [3] create tools that merge reading culture with prototypes of social software; and [4] design prototypes that rethink and re-present genres of print material as well

as examine some of the emerging born-digital genres.

Theoretical models for representing textual material are in their early stages and do not fully accommodate the visual and logical dimensions of texts. The process of reading involves understanding not only the logical structure of content, as the Text Encoding Initiative (TEI) structure emphasizes, but also the integration of visual information provided by typography and the disposition of text (e.g. O'Donnell; Schreibman; Cummings; Gants); the layout of the text may help reading and visual memory, as one's ability to retrieve information depends in part on spatial cues consistent from one act of reading to another (Vandendorpe; Kirschenbaum; e.g. Kopac and Chiang). Further, rapid advances in computer hardware and software provide opportunities not possible even five years ago in the complex environments in which we work: consider larger screens, faster microchips, increased bandwidth, and electronic paper (Radzikowska et al.; Ruecker & Uszkalo) as well as new sensory modes of interaction (per Maclean). Given the emerging possibilities offered by new media, it remains vital to develop methods and models that rethink conventions of print material and examine emerging born-digital genres, such as e-literature, and consider how reading culture is affected by the rise of "social" computing environments, such as the popular Web 2.0 application *Facebook* and the Semantic Web environment presented by *Twine*.

How can we better design, or process, the data underlying and serving the needs of those using digital information environments?

A key problem posed by the electronic medium is that of finding ways to allow readers of digital materials to store, retrieve, share, annotate, and navigate information more efficiently than in the past (Schreibman, Guegen, and Roper). Traditional approaches dominate even the most current search resources, but they are proving insufficient for several key reasons: digital information is unstable; its volume doubles every three years (Lyman and Varian); and there is a profusion of data formats. Key strategies for addressing these issues do exist: the chief research challenge for archives or large corpora of texts is to provide means of organization and access to a radically expanding and heterogeneously formatted body of materials; the chief research challenge for individual artifacts is to provide contextual information for producers and consumers of dynamic reading environments. Our research combines the best of several knowledge management strategies: the speed and power of the search engine; deep textual-analysis methods used by the scholarly community; consistently encoded corpora in specific knowledge domains; and detailed user-recorded results provided by the social networking technologies of what are now known as "Web 2.0" tools (O'Reilly).

An example of a prototype representing an important, if small, approach to one aspect of this work is seen in our Sunword project (Figure 2), which shows author names organized on a circle with text size and location determined by reader-determined criteria. The goal is to display the content of a large collection by showing how authors differ from each other, using either basic criteria like number of titles or word count, or via more sophisticated factors available, such as citations or copies sold.

2.0 Research Methods

Our interdisciplinary program of research is organized around the convergence of four interrelated approaches, each represented by a group focusing on that area of inquiry: Textual Studies, User Experience, Interface Design, and Information Management. Together, our research activities fall into a number of key sub-areas with associated methodologies, as below:

2.1 Digital Textual Scholarship

To a textual scholar, a book is not an inert object left behind by historical change, but rather a nexus of physical materials, metaphors, human relationships, cultural preconceptions, and readerly interventions. Textual

scholarship at its best is therefore a synthesis of disciplinary approaches and methods. Over the twentieth century, the study of the material transmission of texts, and of human interactions with them, has been subject to the same specializing impulse that segmented much of the academy, especially in North America. By the end of the twentieth century, this tendency had resulted in a number of possible approaches, many of which did not communicate or even acknowledge the others' existence. In a discussion of the related new field of book history, Leslie Howsam schematizes three of the primary disciplinary divisions as: 1) history, which focuses on "agency, power, and experience" in relation to books, reading, and publishing; 2) literature, which focuses on the text as an object for interpretation, and takes the material and historical instantiations of texts to be partly constitutive of their meaning; and 3) bibliography, whose primary focus is on books and documents as artifacts that reflect the details of their manufacture (3-15). Another scheme we could use to explain the evolution of the study of the book is national. The French *histoire du livre* tradition developed out of the mid-twentieth century *Annales* school of historiography and brought a social-history focus to the study of books and publishing, placing these activities in a broad social context (Febvre and Martin; Darnton; Chartier). If traditional *histoire du livre* gave insufficient attention to the material complexities of books themselves, then its Anglo-American counterpart, the New Bibliography, may be accused of excesses in the opposite direction. Following the lead of A.W. Pollard, W.W. Greg, and R.B. McKerrow, and later Fredson Bowers and G. Thomas Tanselle, Anglo-American bibliography was resolutely empirical and narrowed the understanding of books to description of their physical reconstruction of their manufacture, and the hypothesizing of the manuscripts used as copy for printed books — often in service of an idealized notion of authorial composition in relation to the printing process, allegedly recoverable through the New Bibliography's arguably less rigorous editorial theory (overviews of this history are many, and all contentious; for representative accounts see Wilson; and Maguire).

The division between these approaches impoverished both of them. For example, bibliography is by nature a highly specialized discipline, which requires years of training and hours of painstaking labour to produce knowledge that often applies only to highly specified contexts. Although that knowledge can radically change our understanding of the nature of a cultural artifact — the Shakespeare First Folio, for example (Hinman) — bibliography has a difficult time with outreach to non-specialists. By contrast, other fields like media studies and intellectual history advance highly accessible narratives about the history of technology — Marshall McLuhan, for example, was interviewed by *Playboy* and made a cameo in Woody Allen's *Annie Hall* — but lack a technically rigorous vocabulary for describing their putative materials, treating a term like *book* as what computer scientists call a black box that encapsulates complexity. In a critique that would apply to McLuhan and his followers such as Elizabeth Eisenstein and Bruno Latour, Adrian Johns has argued that "cultural historians' appreciation of print has too frequently stopped short of the doors of the printing house" (Johns 42); conversely, Johns also notes that bibliographers "have often been too modest in their historiographical objectives" (Johns 42, n. 66). Given the raised stakes that digital technologies bring to the study of textual forms, and the temptation of an easy determinism in understanding those stakes (Bolter 19-20), the study of new knowledge environments must balance attention to big pictures with respect for arresting details. INKE's Textual Studies team, whose work is described below, proceeds on what David Greetham describes as a "belief in the disciplinary interrelatedness of all aspects of the study of the text of a book" (Greetham 2), and seeks to synthesize the best aspects of past approaches into a focused study of the historicity of manuscript, print, and digital texts alike.

INKE takes textual scholarship as one of its four top-level divisions for several reasons, all of which depend on the idea that what's past is prologue. Although past practices do not necessarily determine the future, the study of new text technologies in historical context can reveal patterns of cultural use and meaning that connect past and future knowledge environments on the same continuum. The orientation of the textual studies team is therefore closely aligned with the recent turn away from determinism, narratives of revolutionary change, and strict periodization in the history of technology (generally associated with the work of Walter Ong, Marshall McLuhan, and Elizabeth Eisenstein), and subsequent movement toward approaches that

examine long-term continuities and discontinuities, overlap between new and old technologies, and include the multiplicity of social and cultural effects that result (for example see Gitelman and the chapters in Thorburn and Jenkins). In addition to offering alternatives to outdated successionist models of technology and society, textual studies also gives INKE a vocabulary and set of methods for studying the particular. Many of the dominant accounts of new media repeat McLuhan's and Eisenstein's neglect of close engagement with primary source materials such as print and manuscript books from the periods about which they generalize, and thus have not done justice to the often idiosyncratic and even intractable particularity of human artifacts. As a discipline that links mechanical processes such as bookmaking with interpretive modes such as literary studies and cultural history, textual scholarship is fundamentally qualitative in its methods. The discipline shares in the humanities' distinctive idiographic orientation, generating knowledge from the study of particular cases, as opposed to the nomothetic tendency of the sciences to make generalizations based on broad but highly regularized data (Windelband). This qualitative, interpretive orientation enables INKE to study human activities like reading and meaning-making in methodological terms not available to traditional cognitive science. Finally, according to Greetham, "[t]extual scholars study *process* (the historical stages in the production, transmission, and reception of texts), not just *product* (the text resulting from such production, transmission, and reception)" (Greetham 2, emphasis in original). This attention to process enables textual studies naturally to extend its methods to digital texts, and, along with a corresponding attention to context, represents a fundamental methodological link between all of INKE's teams.
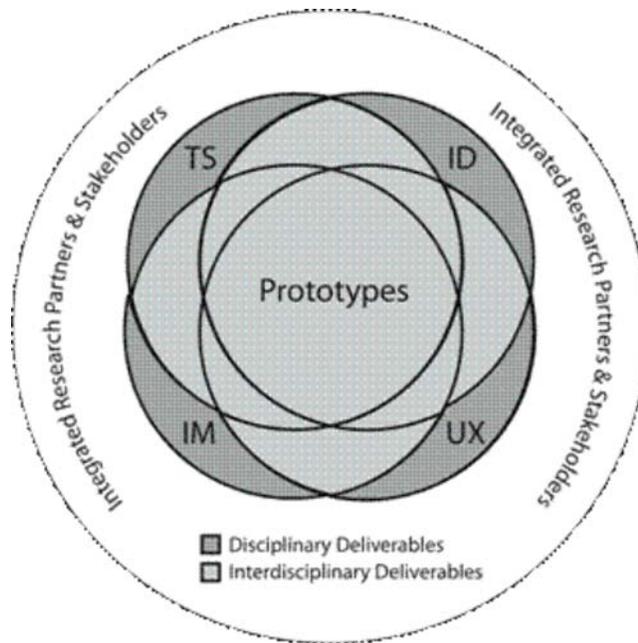
Figure 3: Our Research Collaboration. This diagram shows the four overlapping research groups integrated with our partners and stakeholders, together producing deliverables both for disciplinary and interdisciplinary venues, including prototypes

In order to understand how digital textuality will affect reading practices, the TS group will document the essential features of historical textual forms and their associated human practices. Documenting "the best of the past," as it were, will provide the essential vocabulary and theoretical framework for implementing new knowledge environments and for understanding overall changes in the human record. The emerging field of digital textual scholarship strives to emulate D.F. McKenzie's model of understanding "the human presence in any recorded text" (29). Following McKenzie, our objects of study

encompass artifacts like scrolls, newspapers, transcriptions of oral folktales, photographs, small-press periodicals, poems and plays in manuscript, electronic literature, video games, multiple versions of films, and unpublished archival materials. With such breadth in mind, the group brings to bear upon all manner of human artifacts, digital and analog: [1] *book history*'s interest in books as primary mediators of human relationships (Johns), and in the book as the text on a human scale; [2] *bibliography*'s focus on the complex relationship between *texts* as language and *books* as physical constructions (Greetham); and [3] *literary theory*'s sensitivity to the complexities of form, content, and materiality (McGann; Greetham; Cunningham; Best; Werstine).

The TS group will also connect the study of print and digital environments in order to develop a technical vocabulary for describing the salient features of electronic artifacts based on archival research into the history of book design, print production, and bibliography. This phase will also develop the multimedia focus inherent to *digital* textual scholarship (McKenzie; Kirschenbaum) by bringing together traditional bibliographic methods and new forms of digital narrative, such as electronic literature and video games. The resulting technical vocabulary will inform the prototyping activities of the other groups that will take into account the material transmission (both print and electronic) of texts. This phase of work will generate the group's earliest publications.

To document the complexity of our current textual forms, the TS group will also compile a *textual features knowledge base* (implemented online using open access software) that illustrates the features, technologies, and practices of transmitting knowledge in textual form. The repository will provide a complete set of facsimile exemplars of samples of type, columns, marginalia, tables, charts, volvelles (moving parts in books; Cunningham), indexes, pictures, title pages, and error-control mechanisms – all elements of the pre-digital information architecture of books, which our digital implementations must reconfigure. This knowledge will be gathered by archival consultation, as well as from bibliographic sources and from partners.

2.2 User Experience Evaluation

User experience research is concerned with understanding how people use information resources and systems, whether the information itself is in analogue (e.g., print) or digital form. It is important that we understand users of digital resources, what they need, what they enjoy doing, and how the use of information, printed and digital, fits into their lives. Without such study of users there is an identifiable danger that resources developed may be rejected by their intended audience (Jones and Williams). For example, almost a third of all publicly funded digital resources in humanities disciplines remain unused (Warwick). Yet we know that scholars use technologies if they fit well with what they do (Bates), especially if they save time or effort (Wiberley). This suggests that information resources need to be better designed to suit the needs and behaviours of their user population.

In discussing the question of how readers engage hypermedia spaces, Dobson and Willinsky (288-292) point to two extensive reviews of research in this area that report contradictory findings: [1] reviewing studies from 1999 to 2005 are Salmerón, Cañas, Kintsch and Fajardo (2005); [2] reviewing studies from 1990 to 1999 are Dillon and Gabbard (1998) and Unz and Hesse (1999). Contemplating such studies, Dobson and Willinsky note that it is clearly "difficult to synthesize this body of literature because of the range of variables" (290). For example, the types of digital resources employed in various studies differ greatly in terms of linking structures, the presence or absence of advance organizers, cues as to link direction, the extent of multimedia integration, and so on. Likewise, participant pools vary widely in terms of experience with digital media, content-area expertise, learning styles and preferences. Further, tasks assigned these participants range "from simple recall to complex analytical tasks such as essay writing" (Dobson and Willinsky 290), and study designs are diverse, ranging from extensive methods intended to lead to general statements about the population to intensive methods intended to illuminate behaviour and preferences within a particular setting.

The question of how to approach user studies in the context of the INKE project therefore has presented a challenge. The field of Human-Computer Interaction (HCI) has been highly involved in conducting user studies and in many ways dominates the field; however, as Cairns points out, HCI seems to function within a Null Hypothesis Significance Testing (NHST) paradigm and, in fact, "the standard of statistical reporting and analysis is poor. A large majority of papers have substantial problems, which means that their contribution to knowledge must be strongly called into doubt" (Cairns). Cairns suggests that HCI is not alone in this: "[i]t is well recognised within psychology and social sciences that there is a poor understanding of significance testing amongst students, teachers and researchers" (Cairns). Considering the range of possible methodologies, the problems with various approaches, and so on, INKE has elected to focus on the use-in-context approach that is common in studies within the field of library and information sciences and that is most employed in work with humanities users. This type of research emphasizes the importance of authentic reading spaces, such as libraries, offices, and homes, rather than laboratories. It also emphasizes the role played by the emotions and irrational affective aspects of users and the materials with which they interact (Hassenthal and Tracktinsky). We have elected to pursue this approach because ultimately the decisions that we take about how we use information, what and how we select, and how and where we chose to read are not always guided by rational cognitive processes, but by how we feel, and what we like and dislike about the information, the task we are undertaking, and the real context in which we find ourselves, whether physical or digital. The INKE approach aims to capture such information by employing a range of ethnological methods to explore quotidian practices of reading for a variety of purposes, scholarly and otherwise. The result of this research ought therefore to result in prototypes that are best fitted for use in the normal course of readers' lives and work.

In the information studies field, there have been numerous studies about the information needs and information seeking practices of humanities scholars (for example Barrett; Talja and Maula; Herman; British Academy; and Dalton and Charnigo). Stone's pioneering work showed that the range and types of material that humanities users need is much broader than that of other scholars. They require primary material such as printed books, manuscripts, images, sound recordings, and numerous different types of historical documents. They also require secondary sources such as monographs and journals. The date range of this material may span hundreds of years for primary sources, and classic secondary texts may be decades old. This is in contrast to much research in, for example, the sciences, which tends to focus on recent research (Stone). In 2002, Bates also carried out a series of studies of the way that humanities scholars find and use information, and these have been highly influential because they demonstrated that humanities users often create knowledge by reinterpretation, and synthesis of information that already exists, rather than through creation of new data. They also have an extensive understanding of their field, but may still choose to use references selectively, employing direct citation of work apposite to their argument rather than pointing to long lists of authors in the field. Such preferences are evident in dominant citation styles such as MLA (humanities) and APA (sciences and social sciences). Ellis also showed that humanities scholars tend to follow footnotes and references to find new information (chaining) rather than conducting keyword searches. Therefore, the kind of knowledge environment that is required by humanities scholars should differ from that designed, for example, for scientists. And yet, as Palmer and Neumann make clear, this is rarely taken into account in interface design. INKE research with users therefore intends to address the question of what kind of digital environments are appropriate for such needs.

The UX group will study the complex processes involved in engaging with and thinking about materials in print and digital environments, specifically with reference to the forms that comprise our focus, among them: the scholarly edition; the academic monograph, scholarly journal and essay collection; and electronic literature. We will derive requirements for, and subsequently test, the prototypes developed by our ID group. We will conduct studies with individuals engaging with humanities artifacts in a variety of contexts and for various purposes, such as study. These artifacts may employ one mode of representation (e.g. alphabetic language) or several (e.g., alphabet, icon, sound, image); they may be straightforward or complex in structure and may

contain marginalia, annotations and other forms of connected text. Each of these variables may modify cognitive and affective response, as demonstrated by empirical user studies in digital environments (Salmerón et al.; Unz and Hesse); readers may also adopt different physical stances and mental attitudes dependent on the formal properties of the text and the object of the reading enterprise (Grafton 183; Miall & Kuiken).

We will therefore employ a use-in-context approach, and study the broader context of user experience rather than isolated tasks (Attfield et al.). This is a form of ethnomethodology (Garfinkel) concerned with examining the complex ways in which people use and make sense of humanities artifacts in the context of their normal research and reading routines, and how they display this understanding to others. Participants will be drawn from among groups most likely to use the key textual forms comprising our study (as above) in partner and stakeholder contexts (including campus and K-12 groups). We will work with participants in naturalistic settings (for example an office or library rather than a laboratory) whilst they engage with various artifacts, print and digital. Our methods are informed by an holistic user experience approach (Hassenzahl and Tractinsky). This method emphasizes the importance of studying the affective and emotional aspects of behaviour as well as those that rely on rational cognitive decision-making. This method also recognizes that use of digital information environments is driven as much by how comfortable or enjoyable we find using them as the pragmatics of their utility. For example, humanities scholars are affected by feelings about physical environments (Rimmer et al.; Blandford), and report strong emotional reactions to different information spaces, both physical and digital (Warwick).

Studies will entail observation, interviews, talk-aloud commentaries, and analysis of user journals and diaries. During diary studies, we will ask users to keep a detailed record of their work over a period of time. The diaries will then be analyzed to identify patterns of behaviour, problem areas, and how participants make transitions between reading in physical and digital contexts (O'Hara et al.). This is vital, since humanists have sophisticated information skills and mental models of physical information environments, but they may find these difficult to apply to the digital domain (Makri et al.). Semi-structured interviews allow us to clarify how individuals use physical and digital information environments, and determine needs, preferences, and previous experience with such environments. For example, some humanities researchers are enthusiastic users of digital information (Duff and Cherry) but prefer generic informational resources such as web pages of libraries and archives, or online reference collections (see also Willinsky; e.g. Eberle-Sinatra) to the kind of digital object, which is comparable to a scholarly book (British Academy; Huxley et al.).

During observations, a researcher will sit with a participant in their normal environment and watch them as they use a printed document or digital resource. The researcher asks the participant to comment on what they are doing and the reasons for it. Such methods also explore any problems users may experience with digital environment, or anything that might deter them from using them, such as a confusing name, a challenging interface, or data that must be downloaded (Warwick et al.). We will record interactions with computer systems using software such as Camtasia and Morae, and use non-intrusive digital cameras and audio recorders to record behaviour.

Transcribed interview and written response data will be analyzed systematically employing qualitative data analysis software such as NVivo. This analysis will entail identifying and coding features in order to reveal patterns in the data, an approach described as numerically aided phenomenology (Kuiken and Miall). Video data will be examined using the video-analysis feature of Morae. This combination of ethnomethodological approaches will be supplemented by usability survey findings and quantitative analysis of the details of user sessions such as reading times, paths, and clicks per session. Our aim is to provide a rich understanding of how humanities users engage print and digital materials and how those materials might best be designed to meet their needs. We will undertake these studies in collaboration with the specific research partners listed below, and beyond.

2.3 Interface Design Prototyping

Prototype development can proceed in a number of ways, which are to some extent independent of the ways in which the prototypes are subsequently studied (see User Experience Evaluation, above). A traditional approach is to identify a weakness in an existing interface and suggest an improvement. This method has the advantage of providing the basis for comparing features between the existing system and the experimental revision. It is possible to couple this approach with user modeling based on goal orientation (Card et al.), where the designer couples features to goals then tests the capacity of the system to support the achievement of the goals. The disadvantage of a goal-oriented approach is that it can result in designs that are unnecessarily restrictive. It is simple in theory to identify goals, but not all human behaviours can be reduced to achieving goals (e.g. Sengers and Gaver).

Another strategy is to proceed iteratively through interactions with potential users of the system, using either user-centred design or participatory design methods (e.g. de Paula). This approach allows researchers to incorporate affordances that may not already exist in digital form, and provides a mechanism for adjusting the design through discussion and observation rather than consulting users at the beginning, thereby producing a design then testing it at the end. The disadvantage of this strategy is that there is not always a ready way to compare the new affordances to anything, which means that methods need to be used to study them in isolation. It is also possible to spend time developing features that may not prove to be useful outside the context of the particular users involved in the study.

A common variant of user-centred design is to produce an intermediate set of personas and scenarios (e.g. Pruitt and Grudin), which can be introduced into discussions to help keep the team focused and to communicate with other stakeholders about the direction that will be taken. These personas and scenarios may be invented from whole cloth by the design team or may represent an amalgamation of insights gained through other social science methods such as questionnaires or interviews. The disadvantages of user-centred design arise primarily when the users are involved as replacements for designers.

An alternative approach has been popularized by Gaver et al. , who develops and deploys "cultural probes" in the form of robust prototypes that are introduced into the lived environment of select study participants. These prototypes are often highly imaginative creations, such as memory cloth and the airplane tracker. By incorporating the designed object into their daily lives for weeks or months at a time, participants are able to provide insights into its actual use, as well as serendipitous affordances that may not have been previously identified by the designers. A related issue is what has been referred to as "affective design" (Jordan) or "emotional design" (Norman), where the intention of the researcher is to be able to support not just the intellectual activities of the user, but also accommodate the affective dimension. Examples include the work of Adrian Cheok, whose Mixed Reality Lab in Singapore has produced a number of innovations intended to support interactions between people and their pets, people and the natural environment, and children and their grandparents (Cheok et al.).

What all of these methods have in common is the opportunity to understand through making. If a prototype is more than just a set of features but in fact can be understood as the reification of a theory, then to build and test prototypes is to engage in a form of theorizing that is explicitly tied to the logistics of providing affordances for other people in the virtual environment. For the INKE project, we propose to make use of all of these strategies (and more) for prototype design.

The ID researchers will develop a variety of innovative interfaces in order to allow readers to work with digital artifacts. Our primary focus is on Internet platforms, sharing with our UX and TS groups an investigation of other devices such as e-paper, handheld devices, and wall- or desk-mounted touch screens, each of which affects the process of reading or viewing. However, these technologies are changing rapidly, so we have not tied our prototype plan to specific next-generation output devices. (For example, five years ago the use of iPods to watch movies would have been inconceivable, as would the

influence of gaming systems that have programmable text support and internet capabilities, the $100 laptop initiative [One Laptop per Child 2007], and the ubiquity of devices like the Blackberry [Research in Motion 2007].)
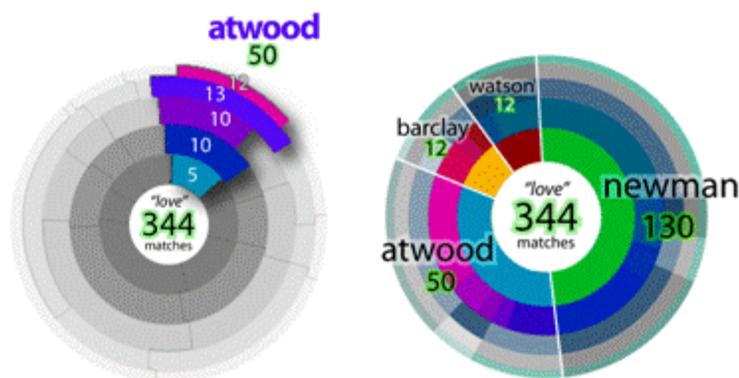

Figure 4: The Magic Circle glyph compares selected words as used by different authors in a collection. The reader can choose to see the usage divided by collection metadata such as date of publication, publisher, or any other metric available

To develop prototype interfaces, we will follow a research life cycle that begins by building on insights from colleagues in UX and TS. The ID group will create concept sketches for iterative review and feedback by research participants. The concept sketches will emerge in part from consultation with the other groups, and in part from our work on browsing and humanities visualization. (We distinguish humanities visualization from scientific visualization in that the latter deals primarily with numeric data, while the former emphasizes text and images as visual elements that can be adapted for innovative displays.) Members of the ID group have previously been responsible for over a dozen interactive prototypes (e.g. Ruecker; Schreibman et al.; Radzikowska et al.; Sinclair et al.; e.g. Best). These include systems that: create dynamic playback of dramatic texts for use by actors, directors, and students (*Watching the Script*); facilitate nuanced visual browsing of encoded text collections as well as individual documents (*Mandala Browser*); provide visual feedback to humanists during data mining (*Oil and Water Browser*) (Ruecker), and display parallel reading texts (*The Versioning Machine*).

Our proven design method includes direct user participation, with users consulted at every stage in the process. These methods range from practice user-centred design where readers are consulted at different stages in the process (but information gleaned from their responses is handled by the designers and programmers before the readers are consulted again) to participatory design, during which the research participants become active collaborators in the evolution of the design, and are among those present in the room while design decisions and programming choices are made.

We will develop and test a series of interface sketches and small prototypes that will converge into a larger working environment and give users access to the test-bed data. Our test-bed artifacts will fall into the four groups identified above, namely the scholarly edition, the academic monograph, the scholarly journal and essay collection, and forms of electronic literature. A simple example of a prototype for browsing collections in all four groups is our Magic Circle information glyph (Figure 4, above) that combines collection metadata (information about the collection) with low-level details about characteristic vocabulary, using lists based either on simple word frequencies or else more sophisticated measures like Dunning's Log Likelihood Ratio. Such work benefits considerably from the involvement of our stakeholding research partners.

2.4 Information Management

Our objective here is to provide ways for users to organize and access the expanding and diversely formatted body of digital material in ways that best serve their needs. One of the most significant contributions our work with all groups will make is to create prototypical information environments where a variety of related artifacts can be integrated and referenced, taking into account their data format and type (for example, text, sound or images). To this end, we will develop the informational underpinnings for four prototypical digital reading environments in the team's test-bed areas. Key initial work involves establishing collections of materials that will serve as contextual material essential for dynamic reading and viewing, through investigating and implementing corpus technologies necessary to build primary and secondary corpora pertinent to our reading environments, in English and French, in conjunction with our research partnerships. We will also automate the process of gathering and storing information so that it can be easily interrelated and retrieved (via metadata).
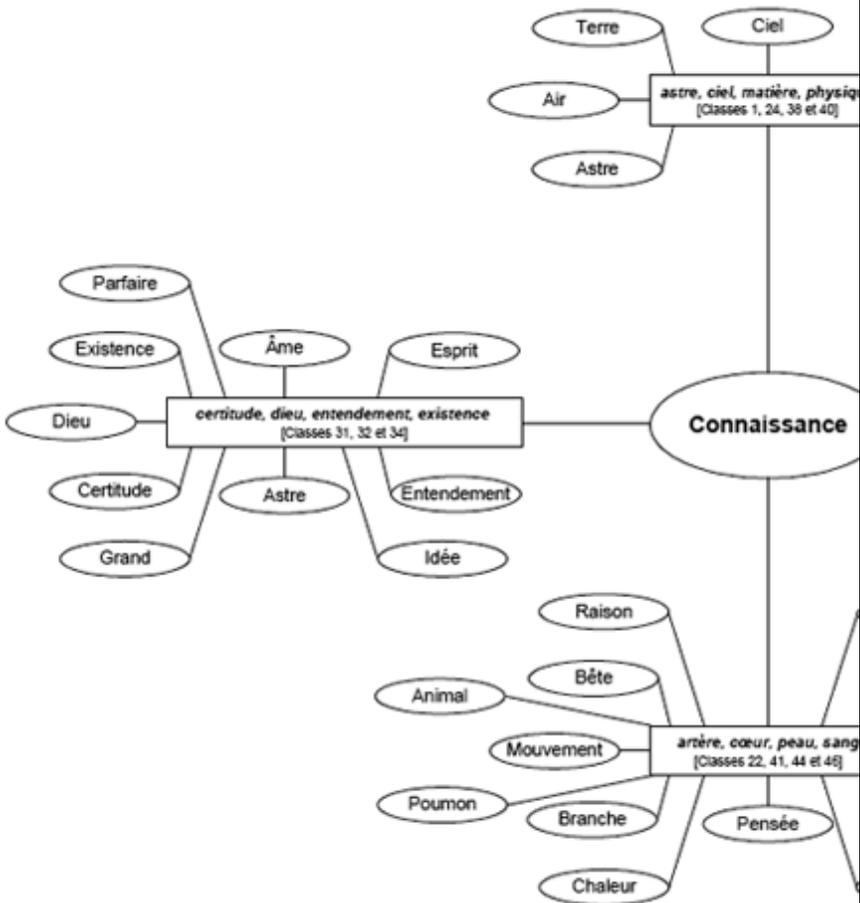

Figure 5: An example of thematic classification (Forest & Meunier 2005)

In document-centered dynamic reading environment such as we will prototype, a key research challenge is the provision of accurate contextual information to the reader in a timely fashion, such that it augments, rather than interrupts, the reading process. Our research seeks to combine the most responsive elements of several knowledge management strategies: the speed and power of the Internet search engine; deep textual-analysis capabilities (such as those explored by TAPoR [Text Analysis Portal for Research]); consistently encoded information sets covering specific knowledge domains (such as those provided by the TEI, Early English Books Online, Creation Partnership [EEBO-TCP], Canadian Research Knowledge Network [CRKN], and Proquest); and detailed user-recorded results provided by the collaborative social networking technologies. This research will require the development and adaptation of systems to: [1] facilitate navigation and dynamic interaction

with a text and its related primary and secondary materials; [2] allow dynamic updating of the primary and secondary materials; and [3] provide tools for interaction among readers – at the same time as relying heavily on established corpora as a foundation for reading engagement. We will adapt and create processing and analysis tools to navigate large corpora, integrating TAPoR tools and social networking tools (noted above; e.g. Sinclair), as well as tools to serve individual reading processes. We will also apply data-mining techniques (text clustering, automatic categorization based on machine learning algorithms, entity extraction, etc.) to digital reading environments. We will explore how data mining techniques used to search and gather data: [1] can assist the reading of digital documents using thematic maps such as the Sunword example above and in Figure 5 and [2] may be adapted to reading digital documents. (Key issues of pertinence to application in reading environments are captured in Agosti and Ferro; Bier et al.; Bowman et al.; Dourish et al.; Dumais et al.; Fox et al.; Gifford et al.; Golovchinsky; Kaplan and Chisik; Landoni; Marshall et al.; and Qayyum, among others.)

Corpora will be housed in several knowledge management systems, such as Fedora, and we will ensure that documents can be used in different information systems and are not tied to one corpus (this will draw upon partnerships with, among others, ebrary, Transliteracies, and CARL). This aspect of our work will also be informed by the work of indirectly affiliated stakeholders such as NINES (Networked Infrastructure for Nineteenth-century Electronic Scholarship), the Digital Library Foundation's Aquifer Project, IBM's Many Eyes Project, MONK (Metadata Offer New Knowledge), and SEASR (Software Environment for the Advancement of Scholarly Research).

Conclusion

This paper has presented the rationale for, and the theoretical and conceptual underpinnings of, the INKE research group. Building on the SSHRC Strategic Research Cluster Development grant "Implementing the New Knowledge Machine: Human Computer Interaction and the Electronic Book" (2005/6), our program of research contributes to the essential development of new digital knowledge environments that builds on the most effective textual practices of the past, and innovates based on our knowledge of readers and users in modern knowledge environments. Our team comprises leading researchers and partners in fields relating to Textual Studies, User Experience, Interface Design, and Information Management, and has already articulated a foundation for identifying the characteristics of digital textual interfaces that respond to the expectations and needs of a broad constituency of professional and lay readers. Necessarily interdisciplinary and international, and based in the humanities and social sciences, our group has already established pertinent networks, integrating research partners and stakeholders. Together, our work provides functional reading interface prototypes that have the potential to transform the way we engage with the digital materials that comprise our personal and professional reading. Our Textual Studies research responds to the need for understanding further what components of existing textual artifacts are essential to represent in new digital objects and reading devices; our User Experience research identifies characteristics of user engagement with print and digital environments; our Interface Design research focuses on extending continuous reading and scholarship involving digital environments through interface; and, through iterative processes involving all groups, our Information Management research allows the construction of prototypical digital reading interfaces that promote active reading and draw on richly integrated collections of supporting materials.

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