WORKSHOP REPORT:  
“STUDYING DIGITAL LIBRARY USERS IN THE WILD”

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JCDL 2005 WORKSHOP REPORT:
“STUDYING DIGITAL LIBRARY USERS IN THE WILD”

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Introduction
As DLs continue to mature into complex networked information and knowledge tools accessible to ever more diverse groups of users, library implementation and use are emerging as important research problems. How might we understand the ways in which the current generation of DLs are applied and used in real-life contexts today, and how might we apply our understandings to future generations of DL design?

Workshop Theme and Structure
This JCDL workshop was convened with the intent of supporting constructive dialogue amongst DL researchers involved in the qualitative analysis of DL use. The call resulted in the submission of a number of high-quality position papers which addressed a range of theoretical and methodological issues, and which were all highly relevant to the qualitative, naturalistic, and longitudinal study of DLs ‘in the wild.’ A total of eleven position papers were accepted, and these are available on D-Lib along with this workshop report.

Workshop participants were asked to treat DLs as sociotechnical artifacts (Bishop et al., 2003), that is as complex mixtures of people, practices and technologies, whose design, implementation and use brings together a wide range of sponsors, developers, users and technologies, in a range of institutional and social contexts (Bijker, 1995). The development of sociotechnical artifacts can be unpredictably influenced by social and technological contingencies (Bijker et al., 1987). If DL development is affected in the same way, then the identification and analysis of the dynamics of these contingencies and of how they affect the behaviors of DL users ‘in the wild’ (Hutchins, 1995) becomes a crucial component of overall DL design.

The workshop consisted of a series of panels and short presentations that focused on research methodologies that addressed the issue of sociotechnical complexity. Participants talked from their position papers, described ‘works in progress,’ and outlined case studies, the latter in particular providing excellent fodder for stimulating discussions regarding theoretical and methodological approaches, practical issues such as relationships with research subjects and sponsors, and general ‘tales of the field’ (van Maanen, 1988).

Several common themes and questions emerged over the period of the workshop, including:
- Flexibility of approach
- Archiving and sharing data
- Communication and intervention

Flexibility of Approach
Perhaps the most obvious theme of the workshops was the diverse range of research methods that participants had applied in their work. The main methods introduced are summarized here. (These brief sketches are of course incomplete descriptions of each participant’s research; see the archived position papers for more detailed accounts).

Adams, discussing tool implementation, described the use of grounded theory in studies of user authentication and privacy, and the introduction of DL technologies into clinical settings. She described how grounded theory had identified a number of unintended social consequences following the introduction of these technologies, especially in the social and institutional orders of the clinical settings. Notess, who also focused on the process of inductive model generation, provided a detailed description of the application of Contextual Design methods to the study of music DLs, and emphasized the need for such studies to become both more widespread and also more systematic within the DL community (for instance in the form of data and model sharing).

Buchanan et al., and Hinze (presented by Buchanan), discussed the methodological and practical issues, as well as the unexpected findings, that can arise when HCI research analyzes the fine grain of everyday user interactions. These researchers have analyzed news alert services, and the search needs of humanities scholars, and in the process they have questioned some common HCI assumptions regarding the ability of HCI methods to uncover what it is that the user ‘really’ knows about or wants from a technology. Particular care is needed here both in framing the research question(s), and also in applying these to the subjects.
Wolf, describing the early stages of research with several educational DLs, noted that a particular problem with user testing and evaluation is that many research subjects may not even have considered DLs as technologies in themselves (something which we, as researchers, can sometimes forget).

Speaking directly to ethnographic experience, the richness and complexity of real world practices was illustrated by Cunningham who described how ethnographic observations out of the laboratory, for instance in music stores and people’s homes, revealed how people used the containers of digital media (CD cases) to personalize their social spaces and also to communicate with one another. Weedman provided a wide-ranging review of a number of approaches that she has brought to bear on her field data, including the sociology of science, the sociology of art, STS, practice theory, and design theory, and she described how these have been applied to a series of different field sites, including image digitization projects and metadata design. Ribes, drawing on Actor Network Theory, described the complex sociotechnical ecology of ethnographic study itself, recounting several reflexive moments from his own ethnographic observations in a number of field sites when he realized that his presence within his field sites had triggered of a series of unintended social consequences within those sites. The conclusion to be drawn here is that the researcher cannot not have an influence on their site of study.

A number of participants described the use of computational tools to archive and analyze their data. Coding tools such as NVivo (www.qsrinternational.com) and ATLAS.ti (www.atlasti.de) were popular choices for the inductive coding and analysis of texts (such as transcripts of conversations, e-mail, threaded discussion, documents, etc.). Several researchers also described how they also used tools to parse (as well as to code) texts. Shumar argued for considering online technology users as being bound together in symbolic communities, constructed and mediated through discourse, an analysis that opens up DL research to a range of anthropological theory; and he studies the boundaries of such communities with Netscan, a tool that analyzes discussion threads and spaces. Khoo also described the use of computational text analysis tools, this time to identify the presence of regular patterns in spoken and written discourse, patterns that could point to the existence of differences in tacit understanding amongst different DL groups such as developers and users. Finally, Notess (see above) has used contextual design to generate models and diagrams of user behaviors that can then be used to inform design and also represented back to the users.

In discussion, the participants moved freely between their own theoretical and methodological ‘home territory’ and that of other participants, and they were quick to point out that each method had advantages and disadvantages, and that none is perfect for all locales and research questions. The juxtaposition of methods in discussion surfaced some common issues, including questions of scale, resolution and granularity, and the need to balance (where appropriate) macro and micro and inductive and deductive approaches. Here, pragmatic ‘tool box’ approaches that combined elements of different methods were often seen as appropriate responses to the granularity question - indeed methods such as contextual design can be seen as attempts to formalize such the tool box approach - although also noted was the danger that the use of individualized suites of methodologies could reduce the generalizability of research findings and also the sharing of data.

Another significant focus to emerge during the discussion was that of the importance of the notion of ‘practice’ to many theoretical and methodological approaches (for instance in the form of practice theory, communities of practice, etc.). An interest in practice, and the hands-on activities and know-how of actors in particular circumstances, often transcended (or, perhaps, united) disparate theoretical and methodological frameworks, and permitted an understanding of behaviours such as ‘pre-digitalization’ attitudes to new technologies, local adaptations of technologies, work-arounds, rejections of technologies, and so on. The notion of a ‘community of practice’ was mentioned in several presentations and discussions, pointing to the consideration of collectives of actors as defined by the things they do rather than by their ‘official’ organizational positions.

Archiving and Sharing Data

As was mentioned in the previous section, qualitative data analysis is increasingly supported by software tools such as NVivo and Atlas.ti, which allow for the inductive creation of codes by which data may be marked-up. These methods augment traditional qualitative data methods with digital technologies, and it was noted that this digital functionality is reproducing in the context of DL qualitative research the more general concern for data sharing and interoperability in scientific circles raised by the Atkins Report (Atkins, 2003). That is, while DL researchers may be collecting, archiving, and analyzing qualitative data in ever-increasing quantities, little is being done to enable data sharing across research communities.

This prompts the question of how we may archive and exchange our (digital) data, for example for historical record, for comparative and meta-analysis, or for future re-use. While software packages such as NVivo and Atlas can support collaborative and distributed projects, allowing the merging of coding categories, as
it stands there are no wide-scale efforts for the preservation and exchange of DL qualitative data. Further, the nascent state of our endeavors means that many aspects of such work are presently under-thought (issues of data accessibility, data security, and data privacy, for instance, remain to be worked on). In this regard, the cyberinfrastructure initiative has recently turned its attention to the social sciences, and research aimed at developing such tools will be hopefully be forthcoming in the future (see for instance http://vis.sdsc.edu/sbe/reports/SBE-CISE-FINAL.pdf).

Communication and Intervention

While qualitative DL research can provide rich descriptions of cultural practices and uses of technical artifacts, the complexity of these findings can make communicating them with diverse audiences such as DL developers, policy makers and end-users difficult. Additional framing is often necessary in order to present results. Two lines of discussion emerged regarding the question of communication: first, developing strategies for communicating with those not familiar with qualitative research, including the possibility of novel representational forms; and second, establishing forums to support communication amongst qualitative DL researchers, and between researchers and the outside world.

With regard to developing communication strategies, qualitative research needs to emulate quantitative research, which has traditionally used visual expression, such as graphs or charts. Visual representations have the advantage of quickly communicating large sums of data in synoptic fashion, and a number of visualizations have become standardized across fields, facilitating inter-disciplinary decoding (i.e. a bar chart). There is room here to develop similar representations for sociotechnical research. Here, researchers should not be limited to traditional representational mechanisms, but should also consider such forms as concept maps, social networks, organizational charts, etc.

With regard to establishing communication forums, there was a general feeling that qualitative DL research is often peripheral within the wider DL research community. To strengthen the position of such research, there is a need for a digital space for the archiving qualitative data, and the discussion of methodological and theoretical issues and case studies. Such a space would support the development of ‘toolbox’ approaches to DL research, permitting comparison of research sites and findings and supporting the emergence of more general theory and understanding. It should therefore present rich theoretical and methodological accounts, backed up by ‘thick’ case studies. Such a forum need not necessarily be limited to DL research, but could include examples of research into other information, communication, and knowledge technologies. It could also pay attention to and make contributions to sociotechnical and STS studies outside of DL research.

Following on from the workshop, several initiatives will therefore be undertaken to establish such a space and support the qualitative DL research community. The first step is the archiving of this report and the workshop position papers with D-Lib. We will also mirror these documents on a Plone server at the Digital Library for Earth System Education (DLESE: http://www.dlese.org/cms/qdl/). This mirror is expandable and editable, and researchers will be able to upload and archive papers, workshop reports, etc. in the future. The Plone site would therefore function as a repository for qualitative DL research ‘gray literature,’ and it is hoped that this function will prove particularly useful for researchers who do not have access to the resources necessary to generate formal peer-reviewed publications for DL conferences and publications. The site will also have wiki-like capabilities that will support the posting of announcements, etc. It is also planned to establish a qualitative DL research list, again on a server at DLESE, for announcements and the archiving of relevant documents.

Finally, a number of participants expressed enthusiasm with regard to holding a further workshop. Here, ECDL 2006 is a possible venue, which would afford European colleagues more opportunity to attend and present their research. A ‘traveling’ qualitative DL workshop is also a possibility.

Conclusion

The workshop position papers and discussions spanned a wide range of approaches. Rather than pointing up any weakness in the sociotechnical approach, this variety underlined the complexity of the research question(s) being addressed. The workshop also illustrated the creative possibilities inherent in dialogs between these approaches, as was evidenced in the lively exchanges that occurred during the various presentations.

Judging by the enthusiasm of the attendees, the outlook for qualitative DL research is favorable. Hopefully, as DL research in general matures, and shifts from technological development to deployment and use, DL stakeholders will become progressively more amenable to complex and situated analyses of use. DLs are community efforts, involving an enormous diversity of domains, and traditions of knowledge acquisition and management, and in the face of this diversity drawing on a full range of qualitative research approaches seems necessary and productive.
References


Introduction
During my research I have come to realize that effective system design and implementation requires more than understanding what the user is doing (tasks etc) or even what their cognitive processes might be. There is a need for a holistic approach to the users’ perceptual context and the social and organizational context for the design, development and implementation of systems. The holistic definition I refer to here is that of ‘emphasising the importance of the whole and the interdependence of its parts’. This means identifying the users’ emotional and social drives and perspectives; their motivations, expectations, trust, identity, social norms etc. It also means relating these concepts to work practices, communities and organizational social structures as well as organizational, economic and political drivers. This holistic approach has led me towards social theory with grounded theory as a methodology. However, issues of bias and validity are interesting points raised by naturalistic approaches as is the role of literature in the research process.

Grounded Theory Background
Grounded Theory (Glaser and Strauss 1967) is a social-scientific approach to theory building that can incorporate both qualitative (e.g. interviews, focus groups, observations, ethnographic studies) and quantitative (e.g. questionnaires, logs, experimental) data sets. The methodology combines systematic levels of abstraction into a framework about a phenomenon, which is iteratively verified and expanded throughout the study. The use of grounded theory methodology has diversified into two approaches; the classic version supported by Glaser (1976) and the Strauss & Corbin (1998) version. These variations are argued by Terence McCann and Eileen Clark (2003) as a sign that the method is maturing and developing as the domains of application widen. Nowhere is this more evident than in the field of information technology where the need for valid yet flexible research is essential.

A key strand of grounded theory is an understanding, as a researcher, of our own 'theoretical sensitivity' (Glaser, 1978). This term relates to the researcher’s personal degree of sensitivity or bias depending upon previous readings and experience, relevant to the area of study. The different approaches to grounded theory take different opinions on the role that this previous literature plays in the research process, which highlights some interesting points for further discussion during this workshop. Strauss & Corbin (1990, 1998) argue for a flexible approach to the use of literature in the identification of the research problem & support for emerging theory. Glaser argues that this can bias the researcher and that the literature review should only be conducted in association with the emerging theory (Glaser, 1992).

Grounded Theory Research Conducted & Methodological Issues Highlighted
My research has employed a very inter-disciplinary approach (e.g. social science, computer science, information science) and methodology (e.g. in-depth interviews, focus groups, observations, questionnaires, content analysis) over the past 8 years. Grounded theory is used as a foundation for generating valid theories through triangulating data from different sources.

Former research into the usability of authentication mechanisms for digital resources would initially appeared to relate to simple cognitive issues e.g. password memorability, secure password construction. However, questionnaire data led onto in-depth interview studies that a grounded theory analysis identified as a complex web of concepts at different levels of abstraction. An analysis of security literature and philosophical writings, such as Foucault, highlighted a security culture that is reliant on social pressures, withholding information under a ‘need-to-know’ principle that dramatically clashes with usability design principles. The research findings identified that poor communication between users and security departments (and visa versa) resulted in poorly designed systems and inappropriate user behaviours. In the worst scenarios a mutual distrust ensued between the user and security cultures. Without a review of the whole context including competing cultures and requirements appropriate design was found impossible to achieve.

Further research into users’ perceptions of privacy in multimedia communications identified that previous technology research in the field was often application specific and individually centric. My research reviewed users’ perceptions of privacy within its social context.
thus highlighting the different competing needs of the individual and the community which are often traded off against one another. An analysis of the relevant literature interwoven with the studies produced a privacy model to guide designers of multimedia communications. Ultimately although privacy is conceived of as an individual’s right to privacy, without a social context to be private from we cannot fully understand privacy.

Digital library research within the clinical and academic domains again highlighted the importance of social context. A grounded theory analysis of the clinical domain literature identified how social structures and work practices can be disrupted by technology implementation. Interlacing of this analysis with grounded theory research highlighted that DL technology can be perceived as a threat to senior staff members’ roles due to their poor training and support. Traditional organisational norms and roles were reversed by DLs allowing junior clinicians easier access to information than senior clinicians. Further research highlighted the importance of interactions between implementation procedures, communities of practice and high level organisational and economic directives.

Whilst previous literature has highlighted some of these issues our research has started to integrate these concepts that relate to both evolutionary and revolutionary design approaches.

Recent research – including a current full paper presented at JCDL’05 – has started to uncover not only complex contextual issues as various levels of abstraction but also how those concepts change over time. An analysis of the current literature and digital library design has highlighted missed opportunities to design for the temporal elements of users’ information requirements. Our identification of a users’ ‘information journey’ has identified further opportunities for digital libraries to supporting users changing needs.

Grounded Theory allows for a complex interleaving of various data types and literature when developing theories through incorporating various levels of abstraction. Although, it is clear that previous literature and research can be biased in its approach to specific problems. However, to assume that as researchers we cannot ourselves remain unbiased by this research is under-estimating our research capabilities. Ultimately it is important to understand and not be governed by previous research but to be informed and judgemental of it. This reveals that although a reductionistic approach can provide pieces of the whole jigsaw puzzle we need to see the ‘whole picture’ to work out where they fit in. This is often complicated by the fact that this picture is, like a movie, a continually moving target.

References


**Usability Challenges in Digital Libraries for the Humanities**

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**Introduction**

Humanities scholars represent a highly skilled set of users who use libraries and archives intensely throughout their work. In comparison with scientific and mathematical academics, the intellectual skills of humanities researchers more strongly emphasise skill with words, at the expense of abstract notation and logic. This may result in particular problems, shared with a wider range of users, where current digital library interfaces demand the use of formal notation to achieve effective results. We are investigating the specific interaction and usability problems faced by these users in their use of digital libraries, both to illuminate their specific needs and the problems created by the technical skills required by current information retrieval technologies.

Of the existing studies of humanities users, some have focussed on the users of a particular subject – e.g. historians [2]. Others, such as Wiberley [3, 4] have taken a more general view, of humanities scholars as a whole. Many of these studies have been qualitative, and studied users over a longer period of time, and their broader information seeking skillset. However, a number of key works pre-date the ubiquitous internet, and so are dated. In addition, it is not clear how the broader lessons and insights obtained translate into specific technical design constraints for the developers of end-user digital libraries.

Our own research backgrounds include both the technical side of digital libraries and human-computer interaction. Thus, we approach this challenge from two complementary perspectives – technical and human-centred. This is reflected in the studies that we are undertaking, and the particular insights that we wish to obtain. We aim to close the current gap between the general knowledge obtained to date and the finer detail required to engineer successful DL systems.

**Current Research**

We have undertaken an initial study of eighteen humanities academics at the University of Waikato in New Zealand. There were two goals for our study: first, to identify the general pattern of information seeking presently used by the academics with digital libraries, and how this differed from their use of physical materials; second, to detect any relationships between the different forms of humanities search terms listed by Marchia Bates [1] and the results returned by the same search terms.

Discovering the broader information seeking pattern of a participant reflects the general problems of investigating user's behaviours over long spans of time: e.g. obtaining consistent data in terms of coverage and accuracy, and the work required to process the data obtained from any study.

The other challenge was obtaining ‘natural’ search terms and criteria to understand what the normal experience and approach of our academics was. To achieve this, we conducted a semi-structured interview, in the course of which we invited the participant to demonstrate their use of digital libraries by re-enacting examples of their recent information seeking. This gave the opportunity to obtain insight into the participant’s own approach and information need, rather than the artificial constraints of a laboratory based study. We encouraged the use of familiar digital libraries and searching tools to illuminate the individual's tactics in use, as they recalled particular searches that they had performed recently. This approach proved to be effective in getting an insight into the query terms, needs and expectations of each person.

**Findings**

Our initial findings have confirmed the idiosyncratic nature of the information needs of many humanities academics – and any single document or work can be interpreted and used by scholars from different disciplines, traditions and areas of study. Creating systems that match the richness and variety of user interests is a challenging task, especially as users’ information seeking strategies are often primitive. Furthermore, when a new library is being created, identifying the needs of future users is problematic, especially in the case of the digitisation of specialised libraries. This is a consequence of the wide variety of goals and strategies that users can bring to the same corpus of documents.

Simple tasks – such as retrieving a specific paper where the author and title details are known – provide few difficulties. However, user strategies may involve tracking chains of citations, persons, places or events through different documents and libraries, and at present these techniques map poorly onto the library interfaces, and prove repetitive and tiring at best.
We have found that part particular forms of seeking prove predictably ineffective for humanities users, even when the semantic meaning of their search is, in human terms, well defined. A key example of this is the case of discipline terms as search terms. These technical phrases often prove extremely poor discriminators when used naively to search library and archive catalogues – and the advanced search criteria that would make them effective are seldom used by humanities academics. Thus, terms that Bates [1] indicated had meaning and precision do not, in fact, have those properties in the context of information retrieval.

**Future Work**

We now face the challenge of eliciting the skills of our target users, and finding matches between their strengths and the capacities of information retrieval systems. Unfortunately, humanities users have a limited vocabulary to express their information seeking strategies, so studies will have to be carefully designed to successfully articulate the underlying logic of their seeking. Digital library systems have a long way to go before they will support the broad range of approaches to finding documents that humanities academics deploy in physical, traditional libraries, and may never provide the extrinsic values that researchers of history and literature place on physical material.

**References**


PEOPLE AND THEIR MUSIC

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Introduction

Since 2002 David Bainbridge (University of Waikato), J. Stephen Downie (University of Illinois at Urbana-Champaign), and I have been trying to find out what people do with music, and what they would like to do. The motivation for this work is to inform music information retrieval (MIR) system development—to suggest functionality and to explore useful ways to organize music collections within MIR software.

MIR, as the name suggests, has emerged out of Information Retrieval. Although scattered bits of work have been conducted on music retrieval systems over the past 30 years, it is only recently that these bits have coalesced to form a research field (the first MIR conference was held in 2000, and it’s since become a yearly event). The Information Retrieval influence has meant that the focus of much of the research has been in supporting search, primarily known item searches. The question that this raised for the three of us was whether there were other music activities that were being neglected. To move towards an answer to this question, we have been focusing our efforts on examining what people actually do with their personal music and with public music collections. We are particularly interested in behaviors that can, or should, be supported in a music retrieval system; we also choose to focus on the everyday behaviors of people with music that they personally enjoy, rather than, for example, the specialist needs of music professionals.

Our Approach

Our work has mainly been qualitative and ethnographic. We combine a variety of techniques—interviews, participant observations, query analysis—to gain as rich a picture as possible of music behaviors. To date, our work has included:

• analyzing music queries posted to Usenet News [1] and to the Google Answers ask-an-expert service [2]. These queries are rich examples of music information needs—the postings are in natural language and aren’t constrained by query languages or any preconceptions about the types of information that could be asked for. The most interesting insight from this work was that people want all sorts of music-related documents: they want lyrics, information about the artist, pictures, guitar tablatures, and a host of other document types. An MIR system should support users in locating a far richer set of documents than simply ‘the song’ as an mp3 file.

• watching what people do in music CD stores [3]. A CD store is, essentially, a publicly accessible music collection, and seeing what people do in these stores might give us ideas about how people would want to interact with a publicly accessible MIR system. The most significant lesson learned from this exercise is that people do a LOT of browsing with music. Browsing has not been well supported in MIR systems, relative to searching, so this observation has opened up a new set of possibilities for us in MIR design. Browsing can be useful in bringing music to one’s attention for possible purchase, but can also be a simple pleasure in and of itself—not surprisingly, people enjoy interacting with music.

• finding out how people organize their personal CD collections [4], again with an eye to finding ideas for personal digital libraries of music. This research confirmed observations from earlier studies, including the importance of the visual aspects of a collection. The visual is particularly important with personal collections, as people want to ‘show off’ their collections to others, or use the visual aspects such as CD cover images to quickly browse collections.

• gathering descriptions of why people hate particular songs [5], in the guise of an online survey where people nominate a song for ‘the worst song ever’ and then explain why they hate it. The idea here is that music recommender systems are beginning to be based on music psychology research into music preferences. Music dislikes, however, haven’t been studies in nearly as much depth. We’re trying to find features that can be used in a music recommender system to try to filter away songs that users are probably going to dislike. Some of the characteristics that cause people to loathe a given song are idiosyncratic (for example, the song might remind them of a former spouse). Other features are more amenable to inclusion in an MIR system; for example, songs with simple, repetitive lyrics and rhythm are particularly susceptible to being hated.

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Toward a theory of music information retrieval queries: system design implications. Proceedings of the


DIGITAL LIBRARY EVALUATION: A LONGER VIEW

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When an animal bred in captivity runs, flaps or slithers into the wilderness for the first time, scientists do not simply wave goodbye, wish it well and move on to the next project. Usually the animal is tracked and observed for a long time thereafter—the point of release is where the research really begins. However, this has been less true for grant-funded digital library projects. Administrative and institutional barriers tend to confine evaluation to the funding period when the system is being designed, and when its uses and effects can only be guessed at. In this short paper I will discuss a digital library project in environmental science where some of these evaluation issues arose, the value of eliciting narrative data from users, and some ways to take better advantage of existing but underused mechanisms for long-term evaluation of digital libraries.

Viewing information technologies and society as inextricably co-determined makes it necessary to gather data both on the design process and on how the finished systems are used by people—often in quite unexpected ways. Iterative design and formative evaluation are ways to introduce user feedback into ongoing design (Borgman et al. 2001), but while these strategies can serve as an effective translation layer between users, designers and builders, the focus is on how an evolving system might be used. How it is actually used can be more accurately determined when the system is in the wild, when the designers and their formal evaluation instruments have gone away.

Digital libraries are social entities. They tell stories about a culture, a science, a place or a time, through the items represented and organized in the collection, and in use, they help generate new stories as well. Manovich (2001) has advanced the idea of database and narrative as two ends of some continuum; both structure information, but where a database aims for access, a narrative aims for psychological immersion in the story. From an institutional standpoint, digital libraries are rarely ends in themselves. The social missions of the funding organizations—the stories they wish to tell—often drive the creation of digital libraries, but how well a finished system supports the mission can’t be fully evaluated until the digital library has had some time to develop a user base.

This line of research began with a participant observation of the design of a digital library of environmental science collections. Funded by an Library Services and Technology Act (LSTA) grant, the project involved diverse designers, content, metadata and institutional participants (Gazan 2005). As one of the participants in the environmental science digital library noted, “Part of the art of grant writing is interpreting vague language in a way that lets you do what you want to do,” or in other words, making project proposals and achievements dovetail with the mission and goals of the funding agency. These goals included outreach and evaluation, so a usability component was included in the grant proposal. My initial role in the project was to develop the instruments and conduct the evaluation.

Understandably, digital library designers tend to create evaluation instruments that demonstrate in a measurable way the work they’ve done, a tacit statement of the value produced for the grant funds received. For example, the design of the interface, the appropriateness of descriptive metadata, and user success at canned search tasks are classic evaluative measures. However, in an analysis of the Perseus Digital Library (PDL), Marchionini (2000; p. 328) writes:

“Operational data are powerful components in a chain of inferences that address impact but the PDL evaluation illustrates the value of anecdotes and ‘stories’ that illustrate new effects, i.e., how DLs augment existing capabilities with new ones. These augmentations garner public support for a DL and should not be underestimated in assessing impact...Integrating multiple views is more naturally done with narratives than summary statistics and integrating these forms of evidence can aid in assessing complex change.”

In the evaluation, statistical and demographic data were not hard to come by. Observation, interviews, document analysis, narrative analysis and social network analysis were effective ways to construct as complete a picture as possible about the interactions of the designers. But the usability component needed to be completed at the same time as the digital library, in time for the results to be included in the final LSTA grant report (though the exact LSTA grant regulations vary by state, most LSTA grantees must submit a final grant report within 15-30 days of project completion). Participants in the usability study were evaluating a still-evolving system, and had to project potential uses into their responses to open-ended interview questions. By the time they might integrate the collections into their
professional lives, and perhaps surprise themselves with unexpected dimensions of usefulness, the evaluation would be long over.

This is certainly not to say that there is no such thing as continuing evaluation of grant-funded digital libraries. But the mechanisms for long-term evaluation are usually little more than Web forms or e-mail links, not organic components of the digital library. In practice, designers are more concerned with present and future digital library projects than with continuing evaluation of those of the past. Digital library researchers have an opportunity to conduct this longer-term research, to question and reveal the impacts of digital libraries as social entities, and to apply the resulting knowledge to future projects.

The good news is that in some situations, a mechanism for longer term evaluation already exists. For example, the State Library of Ohio’s LSTA grant process makes use of a “year-after” evaluation form (http://winslo.state.oh.us/publib/lstayraft.html), which includes questions such as “Did the project produce any unexpected results?” and encourages narrative (“Please provide a success story of how your project has impacted someone’s life or had a positive impact on the community.”). This is precisely the sort of open-ended data collection instrument that can reveal how a digital library is actually being used—but even this document is only the length of a one-page questionnaire. Subsequent research will attempt to evaluate the usefulness of this and other longer-term evaluation instruments, and how they might be expanded.

While longer-term evaluation should include quantitative data such as transaction logs and perhaps a list of external sites that link to collection content, evaluation instruments should also be open-ended, designed to encourage narrative expressions of unexpected use, the kind of data that reveal to funding agencies the real impact of their grants. Iterative digital library design philosophies have always had at their core the sense that user input should feed back into ongoing system design. I propose here simply a wider iterative design circle, one that allows for more naturalistic data about longer-term use to be fed back into future systems.

In sum, lessons learned that will be explored in future research include an increased emphasis on:

- linking findings more directly to the higher-level goals of funding agencies

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ISSUES IN USABILITY STUDIES FOR ALERTING IN DIGITAL LIBRARIES

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Introduction

Alerting Services inform users of Digital Libraries about new or changed content of their favorite Digital Library collection, or about new documents discussing a topic they are interested in. The users define their interest in form of subscriptions; the alerting service filters new or changed documents against all user subscriptions and notifies the users about matches found. To define their subscriptions, users may, e.g., select a journal from a list, or a topic from a classification. Few services support the definition of Information Retrieval type queries, or advanced combinations of queries and metadata selections.

In recent years, Alerting Services have been installed for several proprietary libraries such as the ones offered by Springer [1] and Elsevier [2] or the ACM Digital Library [3]. The scope of these services is restricted to the publisher’s documents; they provide only restricted expressiveness and functionality. The main focus of these services has been the delivery of TOC information and email notification about selected scientific publications.

Support for alerting in open Digital Library Projects is sparse; one of the rare alerting service examples is integrated into Greenstone’s open digital library software [4,5]. Few independent services have been proposed (e.g., Hermes [6], Dias [7]). The functionalities within both types of service (open and independent) differ widely, addressing interesting issues such as advanced subscription definition, interoperability, openness, and information integration from different providers.

Our recent user study (reported in [5]) has shown that users of digital libraries are interested in receiving notifications about a variety of events, such as new documents at a particular server, or music files that adhere to certain specifications or new software releases. Users are also interested in receiving the notifications via different channels, such as news-feeds (e.g., RSS), email, or a personalized webpage. To the best of our knowledge, no evaluation has been done to study the user’s interaction with an alerting system for digital libraries. So far, no study has addressed the questions of either the

(1) successfullness of different alerting methods for long-term user information needs, or

(2) usability issues and usefulness of alerting services for digital libraries.

In this paper, we study the reasons for this gap, and discuss challenges arising for analysis and study of the two questions.

When studying users’ needs and usability issues in alerting, a multitude of issues arise. These are especially pronounced in alerting in the context of digital libraries as a means to fulfill long-term information interests, where omissions do not become immediately apparent (different to the observation of a power plant).

We group the identified issues into the three aspects: (1) users, (2) system design, and (3) longitudinal study. Examples of issues for each of the aspects to be addressed are given below; we will focus particularly on the user aspect.

Aspect: User issues

- Awareness of (long-term) information need: Usability of alerting in digital libraries cannot be studied if the users are not aware of their long-term information needs. Over the last years, users have become accustomed to search or browse to address short-term information needs. Alerting services can also provide useful information here, especially in the case of highly dynamic information sources. But the value of alerting will mainly become apparent when searching over a longer time period. This needs a different approach to information seeking from the users: an analysis of their interests in a wider context and on a higher level of abstraction. Users might need to be encouraged to contemplate their information needs and to specify them to the alerting system.

- Ability to express (long-term) information need: It is more challenging to define a useful query that will be continually executed over a long time period than a search query. No immediate results may support the specification; the user cannot develop the specific query form in a dialogue with the system. Thus, a conceptually successful user subscription for alerting might fail due to wrongly defined query terms. Internal support for query definition in the alerting service (such as automatic query generation from previous searches) might only capture short-term information needs and evaluations would often only analyze the quality of the query-algorithm but not the usefulness of the alerting to the user.
• **Awareness and notification methods:** When the alerting system discovers information of interest, the user has to be made aware of it. The notifications sent to the user have to reach them in the right context of their work, in the right format to be useful, and in a way that supports a long-term satisfaction of the information need. That is, the right information has to reach the user in a way that they feel the information need was fulfilled and they are able to utilize the information within in their work context. The impact of the notification methods on the long-term user behavior would have to be measured: short-term satisfaction might not lead to utilization of the information gained.

• **Alert management by the user:** Users have different methods to manage alerts that they receive. For example, they might store email alerts in a separate folder, which is never to be looked at again; or they might include and annotate a received bibtext reference into their literature database, so that it is ready to be used. The importance here lies in the incorporation of received alerts into the users’ work processes, which may differ greatly.

• **Psychological impact of the alerts on the users:** In the context of a recent study [8], we learned that some users feel uncomfortable receiving alerts. They perceive a heightened work pressure and feel an expectation to perform better (i.e., read more, research more, and know more). It remains to be analyzed if these users are less likely to use an alerting service or if it inspires them to act upon the alerts received. When evaluating the quality of the alerting service, these aspects have to be taken into account.

### Aspect: System design issues

• **Subscription interface and interaction design:** As known from HCI studies, the design of the user interfaces has a great impact on the usability of the alerting system. Subscriptions might be created from previous search queries, based on browsing results (notify me about new documents similar to ‘this’ document), or by observing a users work space (notify about documents similar to the ones that are there already). In addition, users may have to be encouraged to enter new fields (similar to recommender systems). Offering interfaces that support a creative and playful information-need discovery might provide help for some users. The effects of the interface design are often only studied in short-term contexts (e.g., can the user find the right button?) but not in the context of long-term user behavior and satisfaction.

• **Presentation and content for delivered alerts:** Similarly to the previous point, the presentation of the notification is of crucial impact. For example, presentation of document information in a format that is wide spread and easily integrated, such as bibtex and endnote. Note that the access to the notifications and storage of the given references does not give indication about the usage of the information given. Easier access for storage might also lead to less impact on the user (such as, save and forget). Thus the information might have to be offered in different formats – to capture the user’s interest and to allow easy storage.

### Aspect: Longitudinal study issues

• **Studying long-term effects of alerting without interfering:** The impact of alerting lies in the quality of the information and in the user’s awareness of the given information. How does one study long-term awareness? The user cannot be questioned during the study directly, as this approach would interfere with the work process and may change the overall result. Thus, a diary-like approach might not mirror the effects of the alerting service without the study: Naturally, being asked to reflect about one’s awareness of a topic interferes with ones awareness. A reflective study at the end of a longer period (such as months or years) might not be able to fully capture the work process. Conversely, the fact that a user did not use the given references directly, does not allow conclusions about the user’s awareness or the quality of the references. The users might have been inspired to further searches or different work tasks. The fact that no notification was received could be seen by a user as a success (e.g., when testing for competitors).

• **Cross influences of work methods and alerting system:** The usage of an alerting system might positively influence a user’s work experience. As explained above, the user’s information seeking behavior and the expectations as to what constitutes a successful usage of alerting and the resulting notifications may differ widely. Cross influences between alerting system and work style might be seen as inspiring by the user (e.g., discovery of new options and ways of thinking and working) or as a distraction (e.g., users might interact in the way the system was designed to gain best results). In all cases, the system design, usage, and personal style interact with each other, and an independent study that allows for systematic analysis of the system becomes harder.

### Summary

The aspects highlighted above give a brief introduction into the issues that one faces when attempting a usability study of alerting systems that goes beyond a simple short-term interface study. Note that the aspects
mentioned are not independent but are interlinked and interfere with each other during a study.

The overall questions remain of how to ascertain the user satisfaction for such a system, i.e., what would be considered a successful long-term user/system interaction and how can this be measured.

References

[1] Springer Link Alert – Service Homepage at springerlink.com/alerting


**Technological Frames and Language-Games: Understanding Tacit Knowing**

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**Introduction**

Tacit knowing (Polanyi, 1983), also called tacit knowledge, is a form of knowing that shapes our interpretations of and actions in the world but which at the same time is hard to describe to other people. In this paper I outline some of the knowledge and communication issues that can arise when groups with different forms of tacit knowing interact in the process of digital library development and implementation. I am interested in exploring whether these groups should arrive at a common understanding in order to proceed - and if not, what level of agreement is necessary - and, finally, how agreement of any kind can be constructed when tacit knowing is not directly articulated in discourse.

**Theorizing Tacit Knowing: Technological Frames**

Broadly defined, tacit knowing consists of the knowledge we have of how to do something in a learned, coordinated fashion, without paying specific attention to the individual components of the task itself. It is a coordinated, gestalt way of understanding how to do something, rather than a description of the components of that something; think here of the differences between action and description in such cases as riding a bicycle, driving a car, performing a piece of music - or using a digital library. Tacit knowing has recently been theorized by organizational theorists as tacit knowledge, and placed in opposition to explicit knowledge (see e.g. Nonaka & Takeuchi, 1995).

Tacit knowing can include assumptions regarding the functionalities of technologies; that is, some of our understandings of what a technology does may be tacit. These understandings do not have to reflect actual functionalities. While we can become familiar with a technology over time, when we are faced with a new technology we often have to guess its capabilities, projecting from our understanding(s) of similar existing technologies. Often, this strategy works (a recumbent bike functions much like a road bike, for instance, despite looking very different). Sometimes however new technologies that appear to replicate existing technologies (for instance in the way that cell phones appear to work in the same way as land-line phones) may function in different technological ways, in which case applying existing understandings to new technologies can be confusing.

Tacit knowing can also include assumptions regarding the social and political uses of a technology. For instance, studies of groupware implementation have described how technology implementers can see groupware as creating new work practices, boosting productivity, and decreasing stress amongst users, while the users can see groupware as adversely affecting productivity and increasing stress, often because the introduction of the groupware can involve the structuring of existing work practices and social structures, accompanied at the same time by a steep learning curve.

Given that users’ tacit knowing is both constituted by and constitutive of the local practices of users, it is not surprising that technology implementation can be a far more complicated and contingent process than developers account for. In practice we continually improvise, adapt and repurpose technologies in novel ways to achieve our aims (Suchman, 1987). This dimension of user behaviour has been known and theorized about for a while, and I have found particularly useful here Orlikowski and Gash’s (1994) model of ‘technological frames’ which asserts that people have to make sense of [technology]; and in this sense-making process, they develop particular assumptions, expectations, and knowledge of the technology, which then serve to shape subsequent actions toward it. While these interpretations become taken-for-granted and are rarely brought to the surface and reflected on, they nevertheless remain significant in influencing how actors in organizations think about and act toward technology.

These taken-for-granted interpretations are ‘frames of reference,’ ‘built-up repertoire[s] of tacit knowledge that [are] used to impose structure upon, and impart meaning to, otherwise ambiguous social and situational information to facilitate understanding.’ In relation to technology use, technological frames are thus ‘the assumptions, expectations, and knowledge [organizational members] use to understand technology in organizations [including] not only the nature and the role of the technology itself, but the specific conditions, applications, and consequences of that technology in particular contexts.’ Where multiple technological frames exist among different groups in the same setting and these frames differ significantly, ‘organizations are
likely to experience difficulties and conflicts around developing ... and using technologies.’ Such difficulties and conflicts have been reported by Orlikowski and Gash for instance in the case of the introduction of LotusNotes into a large corporation.²

Identifying Tacit Knowing: Centering Resonance Analysis

Researchers such as Orlikowski and Gash use ethnographic data to identify tacit knowing. I also use ethnography, augmented with the recording and transcription of naturally occurring conversation and the archiving of electronic communication, and the machine analysis of these data. This method has several advantages. First, I have reviewed field notes in the light of recordings and realized how much I had missed or misinterpreted in the notes; second, digital recorders now permit clear sound recordings which can be digitally archived and sent over the Internet for quick transcription; third, much organizational communication now occurs on bulletin boards and in e-mail; and finally, this method can significantly increase the amount of data collected and processed. In the case of research with the Digital Water Education Library (DWEL) I recorded and transcribed workshops, meetings, and telephone conferences; archived e-mail exchanges and bulletin boards; and collected project documents (Khoo 2004, 2005).

To analyse these data I have been working with Centering Resonance Analysis (CRA; Corman et al., 2002), a computational tool that assumes that semantic meaning in discourse is centered in noun phrases, and that meaning can thus be mapped by measuring and quantifying the frequency, distribution and clustering of noun phrases within discourse. CRA generates spreadsheets and .gifs of noun frequency and distribution that point to the underlying semantic content of texts, and which can be used to identify differences in the discourse of various groups.

However, if tacit knowing is not directly represented in discourse, how may it be identified through a computational analysis of the same discourse? To answer this question I have to turn to the CRA results of my research with the DWEL project, which revealed that two of the groups in the project – the project PIs, and a group of educators – used distinct, non-overlapping vocabularies when they talked about digital libraries. The project PIs, who had a relatively large amount of digital library knowledge, talked about various digital library system components and architectures, while the educators, who had a relatively small amount of digital library knowledge, talked about digital libraries as ‘black boxes’ used in the classroom.

What is notable about these differences is that while they were expected before the project began, and while they were addressed at the start of the project in three days of workshops intended to address and bridge them, they persisted after the workshops, even when the PIs were under the impression that the differences had been resolved and the educators had acquired an understanding of digital library systems.³ In other words, the PIs thought that they and the educators had reached agreement, when in fact they continued to disagree.

This observation finding reflects Banks and Riley’s (1993) case study of discussions on management practices between American and Japanese managers of a multinational corporation, in which the managers continued to make culturally specific assertions even when they appeared to be in agreement. Banks and Riley hypothesized that both groups of managers had tacit, cultural models of management that they were either unwilling or unable to abandon in discussion. In the case of the DWEL project therefore, I argue, similar tacit and cultural differences were present, this time between the PIs and the educators, even when they two groups were under the impression that they were in agreement. This suggests in turn that tacit knowing may well be expressed in discourse; however this will be in a form that is transparent and unapparent to the speakers.

Addressing Differences in Tacit Knowing: Language-Games and Boundary Objects

In such circumstances, how may different forms of tacit knowing be mediated and organizational members brought ‘to the same page’? Organizational communication researchers often recommend ‘more’ and ‘better’ communication as means of bridging the ground between different groups and knowledges. However, what this communication might consist of is often not detailed; and also ignored is the fact, noted above, that tacit knowing in itself may not be easily rendered in communicative terms.

Another problem here is that some theorists of tacit knowledge – such as Wittgenstein (2001) (‘language-games’ and ‘forms of life’), Giddens (1984) (‘practical consciousness’), and Ehn (1988) (‘language-games’) - hold that different forms of tacit knowing may on occasion also be incommensurate (Kuhn, 1970). From this point of view different forms of tacit knowing may

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² Similar phenomena from a range of theoretical perspectives have been reported by range of other researchers including Barley (1986), Bijker (1995), Heracleous and Barrett (2001), and Bower and Star (1999). I have found Orlikowski and Gash’s concept of the technological frame to be particularly useful, both as a lens for analysis, and also for presenting the results of analyses to outside parties, who seem to find the technological frame concept easy to apprehend.

³ The PIs were in fact surprised by the gaps in vocabulary between them and the educators later demonstrated by the CRA.
frame (measure) the same concept in irreconcilable ways. If this is the case how may groups with different forms of tacit knowing work together?

To briefly address (although not to resolve) this issue, I introduce here Wittgenstein’s concept of language-games. Wittgenstein’s terminology should not be confused with ordinary definitions of ‘language’ and ‘game’. By language, he refers to practices that describe and make sense of the world (in this sense his definition of ‘language’ approaches a cultural one; c.f. Geertz, 1973). By game Wittgenstein refers not to formal rule-based games such as chess or football, but to playful, creative and improvised activities, such as children’s games, or a solo game of throwing a ball against a wall. Language-games can therefore be thought of as improvised yet persistent sets of interpretative cultural practices produced, reproduced, and mediated through communication and other practices.

While two groups may appear to an observer to be playing the same language-game, Wittgenstein argues that these groups need not necessarily understand that language-game in the same way. He provides the example of two groups of children playing a game of trains. The first group knows what a train is, while the second does not; but the second group can copy the first and appear as if they are playing at trains. From the standpoint of this position paper, two groups with different technological frames can appear to an observer to be working with the same technology, while at the same understanding it in radically different and perhaps incommensurate ways.

How may the differences between two groups and their language-games be addressed? Giddens (1984), citing Wittgenstein, argues that because all groups practice language-games, they are therefore aware at some level of what language-games are, and can in principle construct new language-games between them. Ehn (1988) echoes this idea in his theory of work-oriented technology design, in which he suggests that the differences between developers’ and users’ language-games can be addressed through these two groups working together on the construction of a new language-game of design-and-use. In other words the parties concerned have to become reflexively aware that (a) they are playing language-games, (b) others may have different language-games, and (c) that they have to locate and articulate both their own and also new language-games in order to play with others.

How does one learn to articulate one’s own language-game, especially the tacit dimensions of that game?

Wittgenstein refers elsewhere to the process of ‘reminding,’ that is, of an active effort to remind oneself of what one already knows tacitly (and here again his use of ‘reminding’ suggests that one may possess tacit knowing that one has forgotten how to articulate).

How may this active reminding be encouraged? Giddens (1984) refers to a similar process in terms of encouraging one’s research subjects to become social scientists who then become aware of their reflexively situated positions. This suggests that training one’s research subjects in the use of the tools for eliciting the knowledge of research subjects - rather than just making them the subjects of those tools - may in turn pay dividends (in other words, the tools should be applied by the subjects to themselves, rather than by the researcher to the subjects). In the case of the DWEL project, for instance, in order to surface their own tacit knowing, the project PIs engaged in the design of a series of concept maps - graphical illustrations of knowledge domains in which the nodes represent concepts and the edges semantic relationships between those concepts (Novak, 1998) - that represented the project both to the educators but also to themselves (see Khoo 2004, 2005 for further details). Supporting a creative reflexivity on the part of DWEL developers helped therefore to ‘remind’ them of what they tacitly knew, and also helped them to mediate their understandings of digital libraries to the educators; and mediating these understandings resulted in turn in improved project communication and productivity.

Summary

Different groups involved in the development and implementation of digital libraries may have different tacit understandings of digital library technologies. These differences can negatively digital library project organizational communication and processes. A communication-based ethnographic approach based on

- the digital archiving and analysis of organizational communication;
- a theoretical analysis including technological frames and language-games; and
- interventions based on helping various groups to remind themselves of what it is they tacitly know

can help in identifying, unraveling and addressing some of the different forms of tacit knowing to be found amongst the various groups involved in digital library projects.

References


4 Wittgenstein also at times associates language-games with ‘forms of life,’ which again can be taken as a reference to cultural practice.


USING CONTEXTUAL DESIGN FOR DIGITAL LIBRARY FIELD STUDIES

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Introduction

Contextual Design (CD) is a popular human-centered design method from the field of information systems design [1]. CD practitioners conduct focused field observations, validate or adjust their interpretations in discussion with participants, and use diagrammatic work models to represent, analyze, and communicate findings. The work models also guide the design of new or revised systems.

Recently, CD has been at least partially used in the study and design of digital library systems [2] [3] [4] [5]. However, CD has not been consistently applied, and few work models have been published. The question remains unexplored: how helpful can CD be in the study and development of digital libraries? Might CD make it easier to design digital library systems that are broadly useful? Is it possible that CD models could be effective as a standard language for comparing digital library user contexts? Apart from its potential practical uses, might CD also be valuable as a methodology for descriptive research? The purpose of this paper is to introduce CD briefly, illustrate its use in two examples drawn from actual field studies of digital music libraries, and to assess its utility in field studies of digital library use.

Contextual Design Described

Contextual Design developed as a systems design method rather than as an academic research method. The full CD process includes six steps:

1. Contextual inquiry – interactive observations of people doing real work in their normal contexts. The observer watches the activity, forms explanations of what is happening and why, and then tests these hypotheses in discussion with the person being observed.

2. Work modeling – the design team hears a verbal account of the contextual inquiry session and puts the reported data into formalized work models. Work models include flow, sequence, culture, artifact, and physical. A running list of brief “work notes” is also kept.

3. Consolidation – data from multiple observation sessions are combined, yielding a holistic picture of work practice. Individual work model types are consolidated, and the work notes are organized into an affinity diagram.

4. Work redesign – using a visioning and storyboarding process, the team generates ideas for improving the work practice.

5. User environment design – the functions and structures needed by the redesigned system are expressed in a detailed architectural model.

6. Paper prototyping – a series of transformations are applied to the user environment design to create testable paper prototypes, which are taken back to the field and put in front of users. Data from contextual prototype interviews are folded back into the design process.

Although CD is not based explicitly on a set of theories, like any design process it reflects beliefs about work and about design. I have elsewhere [6, pp. 83-84] identified several broad principles given here in slightly abridged form.

1. Context. Work data are largely embedded in a context. To get at those data you have to examine the context. Apart from this examination, the data are not trustworthy.

2. Partnership. The contextual inquiry and paper prototyping steps of CD involve users in design as expert partners. This improves design and facilitates acceptance.

3. Visualization. A key strength of CD is the diagrammatic representation of data and design throughout the process, which helps keep designers grounded in customer data.

4. Iteration. CD is not strictly linear. Paper prototyping assumes design iteration is necessary and leads to refinement of the work products from earlier phases of the process.

It is worth noting that the first principle, context, clearly springs from an Activity Theory perspective. In fact, Beyer and Holtzblatt acknowledge their debt to Activity Theory [1, p. 444]. Activity Theory offers an approach to thinking about work that Contextual Design embodies in a design process.

As a design process, CD helps teams address the following questions.

• What work is going on in a given environment? Why?
• What cultural forces are at work in the
environment, and how do they shape the work practice?

- How is the work practice structured, by role, by time, and by location?
- How are artifacts used in the process of accomplishing the work?
- What breakdowns are occurring in the current work practice? How can the work practice be improved?
- How well do proposed improvements fit existing contexts?

**Usage & Results**

Our own work designing the Variations2 digital music library [7] has primarily made use of the early steps of CD. We conducted two separate CD studies using contextual inquiry, work modeling, and consolidation. Our use of these data for work redesign and paper prototyping has been more *ad hoc*.

**Study 1**

Our first use of CD is described in detail elsewhere [6]. Five researchers (4 graduate students in an HCI class and myself) each conducted contextual inquiries with undergraduate music students, each of whom were using the online audio reserve system, Variations (the predecessor to Variations2) in the Indiana University Cook Music Library. The researchers worked as a team to create and consolidate the work models. We then brainstormed ideas for improving student work practice, created prototype designs, tested those prototypes with students, and modified our designs. Although this was a class project, the results were presented to the Variations2 design team and did influence the design of Variations2. For example, in our observations we noted students’ need to listen repeatedly to a small section of audio. Variations2 now permits students to define their own excerpts.

**Study 2**

Our second study using CD is partially described elsewhere [5]. In this study, I conducted 14 contextual inquiries with graduate voice students, mainly at the music library but also in some of their other learning contexts (voice lessons, rehearsals, classroom). After the inquiries, I did limited work modeling and model consolidation. I used the findings in design discussions with the Variations2 team. The findings from contextual inquiries were influential in feature and prioritization discussions with the development team. For example, I observed several students having difficulty determining the duration of an audio track. They need this information for recital planning assignments, where the recital has to fit within a narrow time window. In our design of Variations2, we put the track duration adjacent to each track so this important information was not hard to find.

**Assessment**

Contextual Design offers significant benefits to designers of digital library systems. Its strongest benefit is the disciplined way in which it connects designers closely with those whom their systems will serve. Too often developers make unwarranted assumptions about how users will want to use their systems, basing those assumptions on personal preference or on the system’s technical capabilities. CD helps ground design in real work practice and offers tools for validating designs throughout the design processes. Clifford Lynch writes of the need to design from such a grounded understanding.

Ultimately, we are going to have to develop information retrieval and management systems that actually empower the user in his or her day-to-day activities, and those systems are going to require an understanding of which systems the user employs and why and when each system is utilized. It will require a holistic view of user behavior, both as an individual and as a member of multiple workgroups and communities (and an understanding of how these workgroups and communities overlap and relate to each other). [9, pp. 213-214]

Contextual Design can provide this holistic view.

Another benefit is the richness of the data yielded by contextual inquiry. Although we have used other tools for field research, such as surveys and system logging, these latter methods often leave us with more questions than they answer. Contextual inquiry allows us to ask *why* users do something, right when they do it, in the place where they do it. Knowing users’ motivations—the intents that drive their activities—is very important data for system designers.

A challenge of CD is that it requires one to figure out who one’s users actually are, locate them, and convince them to participate. For digital library projects such as ours, this has not been difficult. We have a large local user base who has been willing to participate in exchange for small incentives such as gift cards. Other digital library projects may not have such easy access to a known, willing population. Another challenge of CD is that, if you use the full process, it has a fairly steep learning curve and requires a large resource investment. However, a recent book [8] describes lighter-weight approaches to CD, and we have been able to derive significant value for a small investment by picking the steps that appeared most applicable.

Qualitative research methods often lack standardized ways to present results. For example, it can be difficult
to compare findings from two ethnographic studies. A possible advantage of CD work models is that they can provide a more formalized language for representing qualitative fieldwork data. Even in our own two studies, we were able to compare consolidated sequence models to identify similarities and differences in the kinds of activities undertaken by the undergraduate and graduate students. Digital library technologists sometimes assume it is adequate to build systems to deliver a specific media type such as journal articles, art images, or streaming audio. But without comparing usage of those materials by different stakeholders, we cannot be sure the interface to the delivery system should be the same for everyone. Likewise, by comparing work practice across various types of media, we may find opportunities to use the same technology with different types of media.

Apart from its potential practical uses, might CD also be valuable as a methodology for descriptive research? It is primarily the first three steps that might be helpful: contextual inquiry, work modeling, and consolidation. The current difficulty is that these steps, while fairly well specified, are not defined rigorously enough to be employed consistently. This is not unusual for a design process, where adaptability is desired. To become a research method, the constructs expressed in the work models need operational definitions, and the inquiry, modeling, and consolidation processes must be defined in such a way as to guarantee reproducibility of results. Despite this lack, it is worth considering whether the CD models in particular might be a useful first step towards a more standardized, comparable language for specifying qualitative fieldwork results.

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References

Introduction

A new space for social science is opening within large-scale technical projects such as cyberinfrastructure and information infrastructure building more generally. These endeavors are framed as complex and ambitious combinations of information technology enactment, science research goals, and the bringing together of diverse communities. This framing has opened an opportunity for the participation of science and technology studies (STS) not only as researchers, but also as participants in the creation of collaborations, standards, metadata languages, ontologies, ‘best practices,’ &c. But within STS intervention – the contribution of the analyst to the field of action – itself remains a controversial and under-explored subject. In this position paper I describe three empirical sites of investigation which also double as sites of intervention. I use these cases to first elaborate on the understanding of intervention within STS – not as a problem of objectivity, but of political action – and then outline three experiences I have had with interventions in these projects. I conclude that interventions, while complex, are opportunities to refine empirical understandings of fields sites, for developing grounded theory and for enriching methodologies of action.

Three Cases - Three Positions

I am currently involved in three information infrastructure development projects, each of which stand as independent research sites, but which are also tied together through a comparative study of their interoperability strategies (Ribes, Baker et al. 2005). In each of these three projects a different position emerges for social science research, thus producing three kinds of interventionist politics.

GEON, the geo-sciences network: GEON is a five-year cyberinfrastructure development project for the broader geo-sciences. It is a collaborative project between information technologists and earth scientists to build and deploy high-end IT tools: computing, visualization and knowledge mediation. The project is nationally distributed, with its technical core at the San Diego Supercomputer Center, and includes PI’s from multiple institutions and disciplines. I was brought on to this collaboration as a ‘social informatics researcher’ at project inception (2002), with the explicit goal of facilitating relations between domain and IT practitioners. This research is primarily ethnographic and via document collection. All GEON participants are aware of the nature of the social research project, and have discussed its development with me throughout the years through formal and informal conversations. I have also conducted more official feedback presentations to the GEON group, and to the National Science Foundation’s project review team.

LTER, Long Term Ecological Research: LTER is a collaboration of American ecologists with the goal of creating interoperable datasets which match the length of environmental timespans. This research network includes 26 sites, distributed across the nation, and drawing together many disciplines related to ecological research (including biologists, geologists, information managers, and human geographers, to name a few). The project was initiated in 1981, and has gone through several iterations of funding renewal, identity shifts, and growth. Data collection for the social research project is primarily through document analysis, ethnographic investigation at a single site of the research collaboratory and of larger planning meetings; primary access is granted through an information manager. The scope of LTER quite large, and the vast majority participants are unaware of our research project. Interventions have been substantially limited to the primary investigation site at the Scripps Institute for Oceanography, and has included such activities as organizing ‘information studies’ reading groups, publications in the LTER newsletter and informal discussions with participants.

OI, Ocean Informatics: OI does not yet exist as a formal organization. It is a loose collection of information managers and ocean scientists at Scripps. As a nascent endeavor participation is relatively informal and goals continue to shift: broadly stated OI is organizational formation with the intention of strengthening the information infrastructure for scientific research. This is a study in ‘collaboration readiness’ (Olson and Olson 2000) -- the preparatory work of forming working relations between participants. My participation in this project comes close to transcending the ‘investigator’ role as I am a collaborator at multiple levels of engagement, including planning events, reading groups, continuous developmental feedback – research involves documenting the unfolding and maturing of the participant relations, technical decision-making and organizational ties.
Inherent Intervention and the Act of Intervention

In this section I would like to quickly distinguish between naïve objectivism and interventionism as it understood in the pragmatist traditions of social research. Within the sociological adoptions of pragmatist philosophy (e.g. symbolic interactionism and actor-network theory – ANT) scientific investigation, or inquiry of any kind, is always already understood as an intervention. Investigation is a the deployment of tools -- ideational, technical or practical -- in relation to the object(s) of inquiry (Hacking 1983). Emergent elaborations of meaning and knowledge is the result of this placing-in-relation (Hickman 1990). For the sociologist this notion of intervention always places the investigator within the field of action, thus rendering moot critiques of maintaining objective separation: intervention is inherent.

But within the field of Science and Technology Studies (STS), interventionism has come to take-on an additional meaning: what in the social sciences is usually called participant observation, a social researcher who partakes in the development of the research object. From this perspective intervention becomes problematic not as ‘a question of objectivity’ but as a kind of political act: what is it to contribute to, assist even, the site of investigation? STS often takes on questions such as the relationship of science to the state (Shapin and Schaffer 1985); the work that categories do (Bowker and Star 1999); and the epistemic and moral consequences of information organization (Vaughan 1999). Investigations of large-scale information infrastructure building, such as cyberinfrastructure, inevitably raise these questions for the STS oriented researcher. Far too large to chew in this paper, I include them as ‘contexts’ for understanding the broader concern that informs a more detailed analysis of interventions in this position paper.

More practically then, leaving aside the question of objectivity and instead focusing on consequences means carefully considering the participation of a social scientist as acts of intervention. In what follows I describe three occasions in which I contributed back to the communities in which I partake, and which I investigate. These narratives of intervention are the ‘stuff’ of politicized STS questions, writ small.

Three Odd Tales of Intervention

Acts of intervention are local. While at times they can be planned, or at least outlined, often they are ad hoc opportunities emerging in the moment. Furthermore, interventions are experimentalist actions, resulting in further elaborations of meaning but also unintended outcomes. In the first two narratives the particular circumstances of intervention were relatively unplanned, in the third a more conscious action is described – conversely, the first two cases are tales of effects on my objects, whereas the third is of how an intervention re-shaped my understanding of the research field.

In GEON my formal feedback to the group has been in my capacity as a social researcher, focusing on IT-domain relations. These interventions have served as theoretical elaborations, providing conceptual frameworks for informants’ experiences. A more surprising intervention occurred approximately thirty six months into the project during an internal re-organization. As a formal organization GEON has built itself up from the ground up, there are no professional managers or an independent administrative body. The re-organization involved the creation of topically oriented sub-groups and regularized weekly meetings for the development of particular aspects of the information infrastructure: a systems group for hardware and grid development, a geographic information systems team &c. In response to what I saw as significant organizational formalization, I suggested that ‘organizations require coordinating and communication mechanisms to ensure that the work and progress of sub-groups is available to the larger body.’ The response that followed was quite unexpected. The suggestion of co-ordination and communications mechanisms was received quite well; meanwhile the term ‘organization’ received heavy resistance. It was the earth-scientists present at this meeting who reacted most strongly: to them ‘organization’ was a term from business, open to management and financial concerns, whereas they understood GEON as science, as research. Meanwhile the information technologists were relatively comfortable with the term, holding closer ties with IT businesses, but also understanding ‘organization’ as a general term not necessarily tied to the private sphere. What resulted was a small debate between domain earth scientists and information technologists: my intervention became a resource for a discussion of GEON’s identity and its future as a planned entity. This intervention had the unexpected result of inciting discussion about ‘what is GEON’ and the role of considered organization and management in building cyberinfrastructure for the geo-sciences.

One LTER intervention has been the formation of a reading group which brings together information managers, scientists and social scientists; readings are selected to broaden participants’ understanding of methods for producing interoperable datasets, they includes articles drawn both from computer science and social science. One of the early readings was my own article, co-written with Geoffrey Bowker, on the process of developing ontologies within GEON (Ribes and Bowker forthcoming). Ontologies are software technologies to enable ‘smart searches’ or integration of
multiple databases. These technologies are well established within the business sphere as part of ‘knowledge management,’ but have only recently been introduced within scientifically oriented circles; in recent years ontologies have become particularly ‘hot,’ gaining substantial cachet as an approach to data integration. In contrast, LTER has been through a long-term process of developing and adopting the Ecological Metadata Language (EML); metadata standards are another approach to interoperability (see Millerand forthcoming). For various reasons, this long-term effort to standardize data has recently come under question within LTER and the technically savvy have been eying the currently favored ontologic approach. At the reading group it became apparent that our article was interpreted as endorsing ontologies, but in writing the article our purpose was not to promote ontologies but to outline the methodological details of this particular approach. I proceeded to dedicate substantial effort to framing ontologies as one approach amongst many, each with particular practical and organizational commitments. While initially we had understood the intervention – sharing this social science article – as an introduction to processual understandings of interoperability development the more significant and unplanned intervention was to reframe ontologies as a particular approach, rather than simply in terms of technological progress. Thus the particular intervention was a sort of categorical leveling, contrary to the bubbling hype surrounding ontologies I attempted to encourage an agnosticism to the available strategies of interoperability: ontologies become one amongst a range of possible approaches.

Within OI my role is closer to a participant, than observer. Much of the work has been assisting in familiarizing ocean scientists at Scripps with their human and technical infrastructure, such as the information managers, the technologies of interoperability and organizational commitments necessary for planned projects. The domain sciences have often considered information technology as a ‘mere tool’ to accomplish scientific ends. With the growth of large-scale projects such cyberinfrastructure it is becoming progressively more difficult to consider IT as ‘means’ – information managers are becoming experts in their own right, shifting from completing the ‘to lists’ of scientists, to organizing for technology adoption and long term data curation. Information managers are a substantial repository of knowledge about scientific datasets, and this knowledge is crucial for the integration goals of cyberinfrastructure. I am most familiar with the GEON case, which is an explicit collaboration between domain and information technologists – information managers are far less prominent in GEON than in OI. For months I had simply equated the information managers of OI with the information technologists and computer scientists of GEON. It was only after close collaborations with the information mangers that I began to shape the categories of my analysis and understand information mangers as an independent group of practitioners. The result of my interventions with OI, has been an new reflexive understanding of the particular structure of GEON which is understood as domain-IT collaboration, leaving information managers significantly on the periphery.

Conclusion

In this paper I have argued for an understanding of intervention as a considered act, rather than as a challenge to objectivity. The act of intervention is not, however, de-problematic. Rather it must be considered a form of political action. It is significant to conclude with some generalizations about these cases of intervention:

First, is the emergent quality of activity: in each case, it has been a somewhat surprising set of circumstances which have constituted the intervention, and in turn a surprising outcome. Aside from contribution back to informants, interventions are opportunities for testing understandings of the field site, and to refine grounded theorizing. To pose outcomes of interventions as surprising is not an excuse to recklessness, but rather a call to careful reflection, before and after the fact.

Second, interventions are not simply acts upon the subjects of research, but are in turn sources for the development of new knowledge. My work in OI has significantly enriched my analysis of GEON and future projects by adding an important group category: information managers. In introducing the term ‘organization’ to GEON I developed a more nuanced understanding of what GEON was to the geo-science participants. From the LTER reading group I received a new reading of my own article and how it may play into technical choices made by readers.

Thirdly, the astute reader will note an agnosticism towards the consequences of intervention by a social scientist on the social or technical dimensions of a project. While in the first narrative the consequences are traditionally ‘social: a shift in GEON’s understanding of itself as an organization; the second example approaches a ‘technical’ intervention: the problematization of hierarchies of one particular technological approach over another. The agnosticism towards divisions of the social and technical espoused by ANT (Latour 1993[1919]) is more than a fancy theoretical perspective but a noteworthy methodological resource for action.
References


ETHNOGRAPHY AT THE MATH FORUM
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Hybrid Worlds: Social Cyberspace, Imagination and Identity

My work has been primarily involved with the study of online educational communities and particularly most of my work has been with The Math Forum, an NSF funded digital library and one of the premier online communities for math education. My research at The Math Forum has focused on teacher communities and the ways teachers use The Math Forum to extend their face-to-face networks creating hybrid groups that overlap between physical space and virtual space. In this work I have suggested that teachers’ imagination of community is transformed through their work online and with it their potential for learning (through informal means of professional development) and their sense of professional identity and efficacy (Shumar & Renninger 2002). Through this work Ann Renninger and I have developed a methodology for studying online educational communities that involves triangulation across several types of data, i.e., participant observation, in-depth interviews, online questionnaires, and logfile analysis.

From the work with The Math Forum I have suggested that digital libraries like The Math Forum are a new form of resource that we have begun to call interactive digital libraries. These interactive digital libraries involve social activity and uses that go way beyond the normal, use, re-use, search and browse functions assumed by many in the digital library world. The Math Forum has been a pioneer in leveraging these new activities by doing things like building collections out of traces of interaction between users, encouraging individuals to become lead participants in the community, developing hybrid activities that involve face-to-face interactions combined with virtual interactions, creating workshops and special events to take lead teachers and developers and help build out collections, etc. Recently I have begun to work with other digital libraries and online communities to expand the base of this research done at The Math Forum.

My work secondarily has moved to designing systems for learning. I am the PI of the Online Mentoring Project, an NSF funded project that has been developing curriculum for pre-service teachers to have a “pre-field” experience. Teachers learn to mentor students in the online mentoring environment and then they mentor live some of The Math Forum’s Problem of the Week students (an online challenge problem service where kids submit answers to math problems and then get a mentored reply online). This online mentoring environment is designed to be used in a face-to-face math education class. I am also co-pi on the Virtual Math Teams (VMT) project a project that is studying and designing online collaborative problem solving environments for math. The VMT project presents interesting challenges for an ethnographic approach to research in digital libraries. The focus of my presentation at the workshop will be on the work with VMT.

The work discussed above is a sample of some of the main work I have done at The Math Forum. There are several strands of theory that I have used throughout this work. First I have drawn on classic European social anthropology to make an argument about the nature of communities and the ways that boundaries work between social groups.

Theoretical framework

Boundaries and the cultural construction of community

Building on the work of Barth (1981) and Cohen (1985) and Shumar and Renninger (2002) it is suggested that communities, modern or traditional are based upon symbolic boundaries. If symbolic boundaries are the things that define communities, the attachment and belonging to those entities must be understood as socially produced and are often reinforced through rituals and other symbols. What is critical then for the definition of community, from an analytic point of view, is an understanding of the ways boundaries work and the forms of attachment and connection experienced by social actors.

Contemporary anthropological thinking tends to see community as a complex set of overlapping boundaries. Smaller more subtle boundaries are often only seen by insiders to the group and the larger external boundaries are often seen by outsiders. These boundaries are tied up with the symbols of belonging and attachment and thus community and culture are closely related and share the same complex structure. These boundaries are something that are manipulated by social actors and are often contested, leaving the community as more of a patchwork of connections and discourse about those imagined connections.
**Imagined communities**

Social imagination is the process by which groups of people understand the symbolic boundaries that define community, sub-groups in a community and the relationship to other communities. This suggests that all communities are virtual in the sense that they are the product of social imagination and must be defined symbolically (Anderson, 1991). It also suggests that the distinction between virtual and physical to which some point may more accurately represent a continuum of community types rather than two forms of community.

While some have suggested that Internet communities may be less deep and involved more surface forms of attachment and belonging (Nie & Erbring, 2000; Kraut, et. al., 2000), it is also the case that the Internet has made the experience of hybrid forms community more possible than in the past. What the Internet has done is not brought us virtual community, but allowed for a greater flexibility of forms of interaction and symbolic communication and that has stretched the realm of possible imaginations of community. There is greater “virtualism” to Internet based communities. This has on the one hand meant that many online groups are very surface and there is a thin connection to the group with weak attachments and not much of a sense of identity and belonging tied up with those groups. In those instances it certainly would be fair to say that “this is not an online community”.

**Social semiotics and discourse**

The imagination of community is not only a cultural process but one that is semiotic in that it relies on particular signs to do specific work of framing how we understand the boundaries of a community and what constitutes membership in that community, what the rules of behavior are etc. There is often an official discourse that defines what membership is in a particular community. That discourse can be contested by various groups who vie for community membership and control.

**Culture**

Discussions of culture have also tended, like discussion of community have tended to be tied up with issues of boundary. While earlier discussions of culture identified a simple boundary and identified all within that boundary as homogeneous, more recent models have specified overlapping sets of boundaries and pointed to heterogeneity that is intertwined with homogeneity. More contemporary models of culture have drawn on Deleuze & Guattari’s (1987) notion of the rhizome. A rhizome has structure and pattern. It also has diversity and a separation of parts. So within a culture or community there may be many sub-groups, alliances, overlapping boundaries, differences that make up the whole. This more dynamic structures may lead to conflicts, hybrid identities and newer forms of dynamism.

Classic problems of difference and identity, which are part of all cultures, are compounded by the hybrid collaborations of people and groups that are possible in virtual spaces. Poster (2002), reflecting on the possibilities of the Internet, suggests,” Culture has lost its boundary”(p. 1). He points out that debates about the determining role of technology in the development of culture miss a very significant point. The Internet constitutes a space, “which encourages practices and which, in turn, serves to construct new types of subjects” (p. 3).

**Cognitive and emotional aspects of shared practices**

What constitutes culture beyond the complex semiotic structure of overlapping boundaries and continuities implied in the rhizome is the shared practices that members of particular communities share in and the ways the practices develop and evolve. This shared material plane of existence leads to what Bourdieu (1977, 1980) has referred to at habitus – “a set of durable, transposable dispositions”. The shared nature of this set of practices and the process of “transposing” them led Lave and Wenger to the development of the notion of “communities of practice” and idea of “legitimate peripheral participation (Lave & Wenger 1991, Lave 1993). Also cognitive anthropologists have suggested that habitus constitutes a model for rethinking the relationship of the external to the internal or culture to mind in that these regular forms of practice then will tend to produce schema within social actors where shared ideas, models and plans for action can be identified (Holland, Lachicotte, Skinner, & Cain 1998, Kirshner, & Whitsom, 1997, Strauss, & Quinn, 1997) I would also argue that this internal external issue with culture also involves an affective dimension where unconscious desires find expression in particular idioms that are meaningful within a particular shared context (Paul, 1990 Winnicott, 1971). Finally these shared practices and the cultural ideas associated with them lead to particular forms of consciousness that are shared across a group of people in a specific context.

**Methodology**

There are several methodological challenges to working with interactive digital libraries such as The Math Forum. First and most complex is the question of how to envision the boundaries of such a complex hybrid world created by complex online groups. Over the last several years I have been working with Marc Smith, a sociologist at Microsoft research, on this problem. Marc has developed a tool called “Netscan” which allows one to do a social accounting of online discussion groups. Further they have developed
visualization tools that allow one to “see the shape” of online discussion groups. This tool goes a long way toward giving one the contours of particular kinds of communities and allows one to think about sampling issues such as who to interview, whose pattern of discourse to analyze etc. Netscan gives one a look at one kind of online interaction and it is part of what I would refer to as the social mapping process. Also social interactions, cultures and communities, take place within some social geography. Getting a sense of that social geography and how it informs the practices within the social space is a critical ethnographic task for any ethnographic work. With digital libraries we have tended to use a combination of tools like Netscan, online surveys, and participant observation (where possible) to get a sense of the overall contours of the community and what might constitute the groups within that social space.

From that general understanding of the social space we have then used interviews and again more participant observation to get a better sense of the specifics of what groups are doing, how their practices in the digital library relate to other activities in which they are engaged, and how these activities inform their consciousness. This work pays careful attention to the way hybrid worlds are particularly constituted by social actors and the ways boundaries and border crossing are informed by the tools and technologies that digital libraries offer.

**Virtual Math Teams (VMT)**

In my presentation at the workshop I will focus on our current project VMT. In this project we are working on developing synchronous chat spaces where students can work together to solve math problems. The goal of this would be to create a service that was as automated as possible where students could come, join a group, and get an opportunity to do collaborative problem solving together. Short term goals are to think about the ideas of social role and positioning in order to reflect upon what constitutes a good group, and to develop a robust chat environment for this kind of math problem solving.

Because of the nature of this project, it has tended to lead us to Conversation Analysis (CA) as a way to analyze the experimental chats that we have been doing with the project. But CA allows for only a very limited range of analysis of the specific work of conversational interaction. The larger frame of context within which students are doing the chats and their cognitive and emotional reactions to the work are more up in the air. I have been thinking about ways to read the chat “symptomatically” in order to create hypotheses that could be tested in other ways to give us some of the larger frame within which the students are doing the chats.

**References**


DESIGNERS, CLIENTS, AND KNOWLEDGE PRODUCTION

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Introduction

A technical system may be viewed as a locus of knowledge production. Knowledge grows through the design process, as the designer constructs new solutions to problems. Donald Schon (1983, 1990) describes a conversation between the designer and the materials of design, an interaction in which the designer makes a move – either with the actual artifact or with a sketch or other representation of it – and the artifact “talks back,” providing the designer with new information about actions and outcomes, which then shape future moves. Knowledge also grows as features of the new system are communicated to the designer’s professional community and becomes a part of the general knowledge base. Users may use a technical system explicitly to find information, and in the process not only add to their own personal knowledge, but find unexpected ways to use the system, which may then be communicated to other users. All such newly created knowledge moves, to a greater or lesser extent, out of the original situation and into new situations where it is accepted, modified, or rejected through additional interactions between people, things, and surrounding situations.

Theory

Works from three fields have been particularly useful to me in studying designers and users of various technological systems – sociological studies of science, technology, and art, practice theory, and design theory. Many of these are classics that still have generative value 30 or 40 years later, despite changes in rhetoric.

Sociology of Science, Science & Technology Studies, Sociology of Art

Design and use of technology can be studied as intellectual work analogous in some important ways to the conduct of science and other creative work.

Communication is central to the social context of intellectual work. Various studies have shown that informal communication is essential to the growth of knowledge. Herbert Menzel (1962) described the importance of informal, hallway-type conversations, in which scientists test arguments before they’re fully formed, ask questions, and get others’ reactions to half-baked ideas. Derek de Solla Price was the first to identify a stable pattern of informal networks by means of which the most productive scientists in a field are reasonably in touch with everyone else who is contributing, and through them with most of the rest of the field. He called this inner circle an “invisible college.” Hagstrom (1965), Coser (1965), and Kadushin (1974) also found that almost all the ideas developed by various groups of thinkers either resulted from interaction with others in the field or were first tested out on them. Everett Rogers’ (2003) classic work on diffusion of innovation is often useful in explaining the social and material factors which influence the adoption of a new technology. Knowing who talks to whom, and what they talk about, can contribute a great deal to understanding the processes of system design and use.

Bruno Latour’s Science in Action (1987) is a rich source of provocative ideas about the way science is done, and the relationship between the way it’s done and what we consider to be legitimate scientific knowledge. An example of the thread of Science & Technology Studies that is known as a “laboratory studies,” it presents the work of science as writing texts that will withstand the assaults of a hostile environment, and creating allies through translating the scientist’s interests into forms that will address others’ interests in order to enroll them in the construction and defense of the scientific fact. All of the STS literature explores the role of social structure in individual cognition, stressing the importance of the interactions between people (or interests) and the tools of work and the situations in which the work is done.

Several excellent explorations of the role of tools – why some tools are chosen and not others, how tools influence the way work is done, how the work influences the tools – can be found in Clarke and Fujimura’s The Right Tools for the Job (1992). James Griesemer’s chapter in this book, for instance, argues that tools are not merely material constraints upon the intellectual work done, enabling some activities and prohibiting others, but that selecting and using tools is itself theoretical work.

The idea of knowledge as social construction rather than the product of an individual’s genius is present in sociology of art as well. Becker (1981) and Wollff (1981) explore the ways in which the creation of works of art is inseparable from such social and material factors as the buying and selling of paper, the education of printers, the sweeping of stages, the reactions of critics and audiences, and earlier art.
**Practice Theory**

The label “practice theory” is applied to a variety of approaches which focus on “people’s actual, daily, embodied activity, often including skills, tacit knowledge and presuppositions, as well as their interaction with others and with material and other resources” (Van House, 2003).

The emphasis on the situatedness of all work practice allows practice theory to be combined easily with social studies of intellectual work. Lave (1988, p. 1) argues that “arrangements of knowledge in the head” are socially organized and not divisible from the social world outside an individual’s head; cognitive work (such as design, or the use of technology) should be studied as “a nexus of relations between the mind at work and the world in which it works.” Suchman and Trigg (1993, p. 196) describe the work of researchers in artificial intelligence as “skilled improvisation, organized in orderly ways that are designed to maintain a lively openness to the possibilities that the matters at hand present” (1993, p. 146). Tools interact with situations; they are not fully determined entities which are applied to situations. The process of work itself shapes the possible outcomes, and the means can’t be separated from the ends.

**Design Theory**

Much of contemporary design theory reacts against Herb Simon’s (1973) argument that any problem, no matter how complex and recalcitrant, can be broken down into smaller, well-structured, solvable problems. Donald Schon has been particularly influential in arguing that such decomposition is more often impossible than possible. Schon’s research (1990) indicates that such a rational, rule-based model often fits the later stages of design but does not reflect the reality of the early stages. Designers do their work in a world of uncertainty, instability, and uniqueness, and what they actually do is to make and remake their ideas about the design, carrying on an ongoing “conversation with materials.” Bucciarelli (1994, p. 123) also stresses the messiness of design work – design is by nature “an uncertain and creative process. In every design there is an opportunity for creative work, for venturing into the unknown with a variation untried before, and for challenging a constraint or assumption, pushing it to see if it really matters. Uncertainty both allows participants to exercise their creativity and ensures that there will always be unforeseen outcomes.” Schon points out that designers can never make a move which has only the effects intended; “each move is a local experiment which contributes to the global experiment of reframing the problem,” (1983, p. 101) and the design professional is engaged in a reflective conversation with the artifacts and situation of the work.

One particularly useful idea from the design literature is the recognition that the original determination that a problem exists and is in need of a solution shapes the subsequent design process. Lave, mentioned above (1988, p. 42) writes that problem solvers choose “whether to have a problem or not, and the specification of what constitutes the problem.” Boland (2002) asserts that “a problem representation structures the problem space with elements of the problem and its potential solution, and is the most potent explanation for if and how a design problem will be solved.” As Schon (1983, p. 40) argues, the central task in design is to set the problem – “defin[ing] the decision to be made, the ends to be achieved, the means which may be chosen. In real world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials of the problematic situation which are puzzling, troubling, and uncertain. When we set the problem, we select what we will treat as the ‘things’ of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed.”

There is design involved in users’ information seeking behavior as well; a user sets a problem and designs a strategy for finding elements of the solution. Searching – the selection and employment of tools for solving the problem – has been described by Kuhlthau (1993) as a process of constructing information. A researcher brings to a collection a question which is an anticipation of the possible shapes of an answer; this anticipation guides her initial queries, and interaction with the documents retrieved leads to adjustment of the anticipated answer shapes. A better understanding of the relationship between problem-setting and the process of constructing a solution would involve the interactions of individual cognition, the choice and use of tools (information systems), and the changes in knowledge resulting from the encounter between the user’s existing knowledge and knowledge as captured in documents retrieved (Weedman, 2005).

**Methods and Settings**

In this section, I will describe my own research questions which have come from these theoretical approaches, and the methods I have found useful to address them.

The first study concerns cultural rather than technological artifacts; I’m citing it here because the method used is readily applicable to technology settings. In research on cultural gatekeepers – publishers, reviewers, and scholars of literature – I used social network analysis to ascertain the kind of communication that supported their work practice (Weedman, 1992). In a questionnaire, I asked questions
about various aspects of their work, and then three
direct questions: with whom did they talk when they
wanted to “think out loud” about their work, with
whom they talked when they needed to sort out their
thoughts about their work, and whether people inside
or outside their own profession were most frequently
a stimulus for their thinking. I had also asked about
publications – books and journals – that were
influential on their thinking.

Social network analysis is a tool for studying
communication patterns (Wasserman et al., 1994).
There is network analysis software available which
creates a matrix for all the respondents in the study,
and maps the communication between them. Social
network analysis has been used to diagnose problems
in organizational behavior, to study distributor/supplier
relationships, to study community, and in many other
settings.

I looked at technology more explicitly in a study of
computer mediated communication in the middle
1980s (Weedman, 1991, 1999), when it was new.
Discussions of users and technology has often been
quite deterministic, and most of what was being
published at that time asserted that email and
discussion boards were information lean media, causing
depersonalization because of the lack of body language,
facial expression, and vocal intonation; researchers
asserted that electronic media changed how human
beings communicate. It seemed to me much more
likely that people would take technology and find
unexpected ways to use it for their own purposes than
that they would be confined to a very limited range of
practices. I studied a computer mediated conference
(something like discussion threads, but more
sophisticated) that was initiated by a group of graduate
students.

In this case I combined a survey of the participants in
the conference – both posters and lurkers – with a
content analysis of 18 months of the transcript from
the conference. The content analysis was based on a
taxonomy of professional socialization issues that I
developed based on the literature of the field. The
results showed that the students were using the
conference to simultaneously enter and construct the
social world of their chosen profession during the
course of their school experience. The survey data
explored the daily embodied work of professional
socialization – the interactions between the technology,
individuals, and social setting.

In a small study of image digitization projects
(Weedman, 1999), I used questionnaires to gather
information (N=15) followed by interviews with eight
of the respondents. Rogers’ (2003) 5 factors which
influence technology adoption worked quite neatly to
explain why some people take on the challenge of
initiating a digitization project while others do not.
Observability had a strong impact. Awareness of other
digitization projects had created a sense of inevitability
about the technology. Trialability was also an important
factor – the equipment needed is relatively low cost,
and it’s not difficult to identify a small, discrete part of
an image collection which can serve as a pilot project.
Complexity was a factor working against the initiation
of digitization projects – imagebase projects involve
copyright law (about which there are a variety of
conflicting opinions), image manipulation techniques,
large amounts of storage, time, data structures, and
vocabularies. Many of these aspects are not yet a well-
established part of the professional knowledge base.
Relative advantage is Rogers’ fourth factor, and it often
worked against adoption; slide libraries have gotten
along with rigid filing systems, small labels, limited-
access lightboxes, and projectors for decades; there is
little incentive for a change which will affect existing
teaching practices. Unexpectedly, the ability to provide
increased subject access which came with database
technology appears to be a more revolutionary
innovation in visual resource collections than
digitization. Users have always had images available
to examine, and the change from a slide drawer to a
monitor is one of improved convenience rather than of
change in the practice of their work. It is a much
greater change to go from providing access by country,
time period, and creator (which requires the user to
know in advance what artist’s work is wanted) to
providing access by subject. Subject metadata
describing the content of an image allows a user to
search for the unknown rather than for the known.

A current study of metadata design – subject metadata
specifically – also combines questionnaires with a
smaller number of interviews for a mix of quantitative
and qualitative data (Weedman, forthcoming). I posted
queries to five professional listservs, asking for people
who had done vocabulary design for image collections
and were willing to participate in the project. Thirty-
four respondents completed questionnaires, which
collected descriptive information about their subject
metadata. I’m now in the midst of interviewing a subset
of the respondents, using the design literature reviewed
above to ask about the process of metadata design –
the cognitive, intuitive, and emotional dimensions of
the work, uncertainty, the occurrence of conversations
with the materials of design, and the relationship
between the problem setting process and the ultimate
form of the product.

Both these studies revealed a healthy tension between
professional standards and local practice. Each
professional must solve the problems of innovation in
the context of a specific organization with needs and
expectations which have evolved over time. The
growing knowledge base which is codified in the
published literature and standards of a field may or may not be instantiated in its individual members. Reciprocally, new local knowledge sometimes does and sometimes does not move beyond the walls of the institution, becoming available to others. These two components of the professional knowledge base stimulate, modify, and constrain each other, leading to yet more knowledge growth.

In a study of image use, I conducted a 2 1/2 hour interview with a sociologist who studies the history of built environments – canals, gardens, etc. (Weedman, 2002, 2005). The subject described three ways of using images for her historical research – as tools for thinking, as tools for investigation, and as tools for remembering. The strongest impression that emerges from reading the transcript of the interview is the variety and strength of the verbs the subject used to describe her use of images; the heart of the data analysis was a fine grained discourse analysis focused on these verbs. Information contained in images is not resting there waiting to be found. Rather, images form a sort of ground or territory for the work of constructing questions and answers. Her discussion of searching for images in a collection was inseparable from her discussion of using them. A new description of browsing searches emerged from the analysis, distinguishing between different kinds of searching based on the interactions with the documents encountered. One kind of search is for pre-existing information which the searcher hopes to locate within documents; another kind, as described by this subject, is a search for information which comes into existence as the searcher retrieves documents and uses them (Weedman, 2002, p. 381).

The final project I will describe here (Weedman, 1998) is a study of a collaboration between designers and users of computer technology. In this project, I was a participant observer and used questionnaires and interviews to gain additional data. Sequoia 2000 was a collaborative, multimillion dollar research project in which a team of earth scientists served as a client group for a team of computer scientists. Both groups were university faculty and researchers. At the problem-setting stage of the process, it appeared that the needs of the two groups were complementary and would create a stable foundation for the collaboration. The computer scientists were at the end of a major development project and looking around for a new problem to solve, while the earth scientists had major data handling problems that required advances in computer technology. In fact, the meanings that these incentives had for the participants were more complex than was initially understood. The study explores the structure of the incentives present in the project, the effect of differing work practice within the two disciplines, and the balance of costs and benefits of participation. Costs to users were much higher than expected, particularly at the points of requirements analysis and testing, and the benefits were defined primarily by the computer scientists. The conclusion of the research was that there are asymmetries inherent in the user-designer relationship that destabilize collaboration, and that a fundamental task of project management is the structuring of incentive to support an alignment that on its own is neither balanced nor stable.

Conclusion

These studies of knowledge growth through the design and use of various technologies draw on a theoretical approach which gives importance to the interactions between people, artifacts, and situations. The processes of growth are multivariately messy. Innovation often takes place without clear-cut goals and objectives; rather, there may be only a sense that this is something too important to ignore, or an opportunity may present itself which must be responded to. Whether the initial goals are clear or not, they serve to define the solution. Subsequent interactions between the people, artifacts, and situations will often shift the problem definition, and various kinds of “back talk” inform the process. Advances are uneven. Each individual solves the problems of innovation in a specific context, both drawing on the existing knowledge base and contributing to it as he communicates his own experiences.

References


Price, Derek de Solla and Beaver, Donald deB. Collaboration in an invisible college. American Psychologist 21, 1011-1018.


UNDERSTANDING FACULTY NEEDS OF DIGITAL RESOURCES AND LIBRARIES
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Theoretical approach

Use of a particular type of technology or resource is notoriously difficult to study. There are many different dimensions to use, and this complexity cannot be captured using a single research method. We are using a multi-method approach that will allow us to triangulate our research methods and our sources of data. Our approach begins with qualitative focus groups of faculty. The protocol is designed to allow themes to emerge based on responses to questions regarding digital resource and digital library use. This will be followed by a large-scale quantitative survey to give us an over-arching picture and identify broad trends, but such an approach will give us few details of the mechanics of digital library use because answers will be limited by the nature of survey responses. The qualitative survey supplements the quantitative data from focus groups and interviews of faculty to describe the process whereby faculty come to use libraries and what they perceive the obstacles and opportunities to be. This can be correlated with observations on real behavior like those described in Manduca, et al. (2005, D-Lib Magazine, doi:10.1045/may2005-fox) to examine what digital libraries provide, how faculty would like to use resources in digital libraries, and how faculty actually use digital libraries.

Methodological Approach

To grasp the full complexity of the nature of faculty use of digital libraries and to counter any potential weaknesses in any individual methodology, we will employ three different, yet complementary, methods to gather the data for this study.

1. Focus groups and interviews of science, technology, engineering, and mathematics (STEM) faculty
2. A national survey of higher education faculty
3. Usage tracking of SERC and MERLOT STEM materials by target faculty

We are conducting focus groups with faculty from a range of higher education institutions across the country, from community colleges to research universities, with broad representation across the STEM disciplines. The focus groups are being held at representative institutions. The protocol for these groups asks participants to describe how and when they attempt to locate and use the materials they find for instruction, if and how they share information about teaching with their colleagues, and what roles communities of practice in which they participate assist their gaining and sharing teaching expertise.

Information gathered in these groups will be used to form a survey to be delivered nationally. Results from both the focus groups and survey will be shared with all National Science Digital Library (NSDL) projects and with the wider digital library community, and can be used now and in the future to understand the needs of users and to understand and overcome barriers identified by non-users.

We believe that these data will serve as a baseline for the long-term monitoring of the growth of faculty use of digital libraries that can be correlated with usage tracking to understand user behavior. In addition, the survey will be offered to allow other projects (including those targeting continuing education and K-12) to modify and use the survey to collect data on their target audiences and better serve them.

Research Questions

While the use of digital resources for teaching and learning by higher education faculty has increased, the growth of the use of collections of materials does not appear to have kept pace with early expectations. This has the potential to make the cost of creating and maintaining these collections difficult to justify into the future. To increase the pace of utilization digital libraries must better address the needs of a wide audience of users, and not just for the relative few users who have been involved in their creation.

Specifically our research attempts to address these primary research questions:

1. What are the characteristics of online collections that make them useful for teaching?
   Given the increased use of the web by faculty as a source of materials for teaching, where do digital libraries add value above and beyond standard web searching strategies? And, beyond increasing awareness of the existence of organized collections of digital resources, what can be done to make collections valuable throughout the teaching cycle (course design, implementation, evaluation)?

2. How do faculty employ materials in useful collections?
What types of materials are faculty looking for, and how would they like to use them? What kinds of support are required to allow faculty to make full use of these materials throughout the teaching cycle (course design, implementation, evaluation, revision)?

3. How are collections, resources, and services best aligned with faculty work patterns?

What implications do faculty use patterns have on digital library construction and organization?
Can we align digital library practices with the demands of their roles as scholars?

While all these questions are framed in the positive form, we have considerable interest in factors that discourage use, the formatting and delivery mechanisms of materials that are not of value to instructors, and barriers that arise that make libraries not useful to the way faculty work.

**Introduction to Sample Populations**

Past research by the investigators has examined usage by faculty in specific STEM disciplines: Engineering (McMartin), and the Geosciences (Manduca and Iverson). In this study, we have to date conducted focus groups with faculty from a range of STEM disciplines from a research university, a public comprehensive university, and a liberal arts college. We are currently arranging similar focus groups at additional institutions including community colleges and institutions serving underrepresented populations. The survey will take advantage of the partnerships within the MERLOT consortium, but will also look to institutions outside that framework. While the focus group protocol was limited to STEM faculty, the survey will not be exclusive to that population for both logistical reasons (it is often difficult for institutions to limit lists by discipline), and for comparison of STEM vs. non-STEM faculty. Also by faculty, we are including undergraduate instructors both in tenure and non-tenure tracks.

**Issues Arising From Preliminary Research**

While it is too early to generalize our results from the focus groups, we are getting some enlightening answers and many more questions.

One issue that we are encountering with our current protocol is not that there are widely varying understandings of digital libraries, though that certainly exists, but that there are frequently individuals who have never thought about digital libraries as a concept or as an entity. This presents a challenge for the portion of our study attempting to determine properties of effective digital library services and practices. This is requiring us to carefully reexamine our focus group protocol.

The participants are having interesting discussions that raise questions such as: when in the teaching cycle are they searching for materials? What kinds of materials (formats and levels of granularity) would they like to find? Under what circumstances are they using the materials? How do they envision peers participating as a community in surrounding digital libraries? And, how important is peer review of the educational resources found in digital libraries?

We are beginning to see patterns of faculty motivation for use of the web in instruction and the criteria they use to sharpen their search strategies, evaluate resources, and revisit what they consider to be good. While not surprising, there are differences in resource use between the participants who primarily use online materials and those who both create and use resources. Finally, time is commonly marked as a major factor that limits adoption of digital library resources, and we are just beginning to get a picture of the complexity that is reflected in the simple statement, “I don’t have time.”

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**Annotated Research Findings of Interest to DL Researchers**

Brody, P., M. Markland and C. Jones. (2003). Linker:


A report from JISC projects looking at integration of course management systems and the library. They also found that Google was the primary stop for faculty and even when they integrated links to digital libraries into the course management system while faculty had high awareness of the resource only 30% used it in their teaching.


This study that monitors use of the starting point digital library. It discusses how the design of the library was influenced by user needs and preferences, and, in turn, that user centered design can impact the users’ teaching.


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Faculty Use of Course Management Systems is a key findings summary of how faculty members use course management systems for teaching. It includes discussions of methodology for investigating faculty use of technology for teaching and factors that encourage and discourage adoption of new technology. The full study is available to Educause-ECAR member institutions.