

Notation and Annotation of Structured Data: The Interactive and Annotative Behaviors of Musicians

Dissertation Prospectus
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Purpose of Study

Recently, numerous scholars in the field of Information Science have published studies concerned with various user groups' annotative behavior, viewing annotations as a kind of by-product of user interaction with a text. Marshall (1997) analyzed the annotation patterns of university student's textbooks and developed a framework for analysis (1998); Shipman et. Al (2003) worked on the annotations of law students' legal-briefs in preparation for mock courts; Wolfe (2000) looked at the effect of annotation on students' writing abilities; Cunningham & Knowles (2005) reviewed the annotation behaviors of professionals upon conference proceedings; and Luo et. al (2005) explored the ways in which annotations assisted librarians with the process of cataloging websites. Most of these studies were prepared and carried out with specific goals: the development of useful tools designed to allow innate user interactive and collaborative behaviors, like writing in the margins, or "annotating" digital documents to be more feasible than currently realized. Although we are only beginning to recognize the full potential of digital annotation, the development of blogs, technorati "tags," and wikipedia, are steps in the right direction, allowing people to identify, augment and alter web content almost at will. With tools like wikalong, purple slurple, and Flickr's "note" tool, web users can also declare their opinions, state their views, or simply comment on web pages either privately or in public.

The development of these tools owes much to previous work in annotation studies but there are at least three areas that annotation researchers haven't, as yet, explored. First, there have been no studies describing the annotative behavior of users interacting with highly structured data. A study focusing on this type of data would be useful because it is inherently digital, and we currently have very little idea about how people interact and deal with this data at the practical, individual interaction level. Statistical, GIS, and astronomical data are typical examples of highly structured data; but computer programs themselves also fall into this group.

Second, there have been no studies on the annotative behaviors of those users interacting with symbolic, notational data. Almost all of the current annotation studies have concentrated on text in one way or another, although there has been some focus on image and video annotation. A study dealing primarily with annotation of symbolic, notational data would be beneficial because this type of data tends to have collaborative functions. Research in this area would be valuable not only for tool development but

also possibly for development of a theory of collaboration, which would be very useful in advancing to the next generation of collaborative Internet technology. Examples of this type of data include: music and dance scores, architectural plans, and dramatic scripts.

Finally, there have been no studies on those annotation systems that are symbolic, formalized, and highly structured; like editors' marks, for example, or many of the annotations found on musical scores. There are a number of reasons why research in this area would be worthwhile; the most notable being that "highly formalized and structured" is what computers do best. Because there's very little "handwriting" support in existing computer hardware and software, and it's difficult to anchor typewritten text to specific spots on a digital document, highly structured, formal, and symbolic annotations might be the most promising digital annotation technique given current computing capabilities. While highly structured and formal annotations are narrowly applied in analog realm (I can only think of those two examples), it might be possible to develop more general functions for them in the digital realm if we were able to come to a deeper understanding of how humans create and use them in their natural context.

There are three areas in need of attention, then: structured data, symbolic notational data, and formalized annotations. The purpose of this research project is to study these three areas, to explore, describe, and characterize a highly structured, symbolic *and* notational data source, which is annotated using highly formalized and symbolic annotations. This miracle data type is: the musical score, which is largely non-textual, highly structured and notational, and annotated with formal and often symbolic markings. In addition to providing valuable insight into the annotative behaviors of users interacting with notational, symbolic data, this research will also clearly benefit the music information science community, acting essentially like a user study of musician's interaction with the score. Understanding musicians' annotation behaviors will hopefully influence music digital library development, and may lead to better interfaces, more contextually relevant retrieval systems, modified digitization and digitized score preservation policies.

Research Questions and Objectives

Because a musical score is essentially a set of rules or instructions for how an group of musicians should perform a given piece, this research will focus on the process of learning (rehearsal), performance, and representation of a variable product. This research seeks to gain a fuller understanding of how a variable work is realized and particularized; and how users' interactions or interpretations, as evidenced by annotations, affect the final product. Tangential objectives are related to the concept of authenticity or reliability in performance, the relationship between annotation and collaboration, and the role annotation plays in providing context for more meaningful retrieval.

Specific research questions include:

- How do musicians interact with their score? Does the nature of that interaction change over time? Does it change with intention? Does it change with skill level?
- What is the nature of musicians' annotations on the score?
- Do the annotations have value? If so, how so? If not, why not?

Research Design

The design of this research project is qualitative in nature. To say one is doing “qualitative research” infers an assortment of philosophical positions, methodological tactics, and analytical procedures. Morse (Morse, 1994) summarizes the cognitive processes involved in qualitative research; he believes that, regardless of the specific approach, qualitative research involves:

- *Comprehending* the phenomenon under study;
- *Synthesizing* a representation of the phenomenon, which accounts for linkages and relationships within its pieces
- *Theorizing* the how and why these relationships appear the way they do; and
- *Recontextualizing* the new knowledge.

The chief data collection methods of qualitative research are through observation, interviews, and data analysis.

Theoretical Framework

There are two theoretical frameworks supporting this research, which, put together, I term the “ethnography of annotation” model. The first is the ethnography of communication model, a subset of discourse analysis, and the second is an annotation framework, which combines Marshall’s annotation’s dimensions of use (1998) with MacMullen’s typologies of annotation research (2005).

Ethnography of Communication

One of the most common flavors of qualitative research is *ethnography*, which seeks to understand human behavior within its own social setting. Closely related, the ethnography of communication model uses anthropological methods to study verbal interactions in their own social setting (Hymes, 1964), and tries to understand, as completely as possible, from as many different viewpoints as possible, the ways people interact with each other, their environment, and their technologies. The basic unit of analysis in the ethnography of communication model is called the “communicative event,” and meanings are conveyed through “speech acts” (Searle, 1969), which can either be defined as a command, a request, or a recommendation among many other options.

Ethnographers of communication use traditional qualitative methods of participant observation, interviews, and document analysis as their research tools (Saville-Troike, 2003), only differing in the level of immersion the researcher attempts, and the depth of information the researcher tries to contemplate. Implementation of this approach need not be exact; the model provides valid data whether the researcher is trying to understand the customs and behaviors of residents of the Boa Islands (Hymes, 1985), or the context of children's information seeking behaviors (Solomon, 1991).

Observation

Observation is an essential component of the ethnography of communication model. Observations are useful for a number of reasons. They can provide the basis for starting the research, they help familiarize the researcher with participants and the existing methods and procedures of communication; they help formulate introductory descriptions and explanations; they provide focus and structure for subsequent interviews; and observations ultimately provide an opportunity to build strong and robust foundations for thinking about and describing the research topic.

In order to get a deeper understanding of how musicians interact with their score for the purpose of successful performance, I will observe rehearsal processes randomly throughout the rehearsal cycle. I will attend rehearsals at the beginning of the process, when the musicians don't necessarily know the piece they're working on, through to the end, when they have learned their part and are more comfortable with the piece.

Interviews

There are different types of interviews in qualitative research: structured, generally recognized as questionnaires; semi-structured, in which the interviewer has a list of questions he or she wants to cover but which also allow for a certain amount of divergence from the script; and open-ended, in which there might be one or two themes that the interviewer wants to talk about, but generally follows the lead of the interviewee (Weiss, 1994). In a strictly instituted ethnographic study, interviews, as such, are generally open ended and deep. This will not be a strictly instituted ethnographic study.

Hitchcock and Hughes (Hitchcock & Hughes, 1989) prefer the semi-structured interview format because it allows the interviewer to further develop and expand upon particularly interesting responses, and in the best-case scenario, develop a kind of relationship with the participant; where negotiation, discussion and expansion of responses can occur. The semi-structured interviews should to be organized so that the participants, while answering specific questions, feel free to augment the conversation with what they consider valid, if uncovered, information. Additionally, while the "semi-" ness of semi-structured interviews allows a level of freedom in questions and responses, the "structured" part provides a means to ensure consistency across interviews.

Interviews in this project will be very important. After the rehearsal/performance cycle has ended, I will conduct interviews with as many people involved in the process as possible (see “sampling” section, below). The interview questions are listed in Appendix A, and are based on the annotation framework set out by Marshall (1998) and MacMullen (2005).

Annotation Framework

Marshall’s annotation framework (Marshall, 1998) provides a powerful construct for thinking about and studying these artifacts of interaction (figure 2). She identifies annotations as “reflections of a reader’s engagement with a text,” which may or may not prove valuable after the reader has finished his or her commitment to the text.

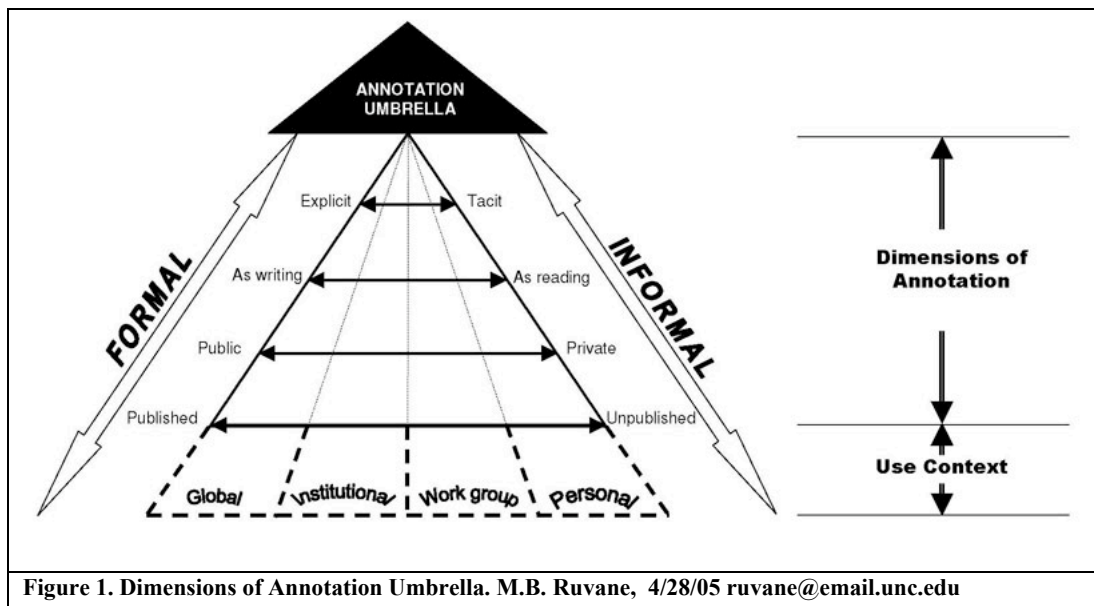


Figure 1. Dimensions of Annotation Umbrella. M.B. Ruvane, 4/28/05 ruvane@email.unc.edu

There are two primary dimensions in Marshall’s framework: Formal and informal. *Formal annotations* are often metadata-like, explicitly defined and meant for public discussion. They have long-term, permanent value, and are not tied to a specific reading or context. They’re formally written and often can be regarded as a form of public authorship. *Informal annotations* are tacit, meaning they’re personal; their meaning is ambiguous to someone other than the annotator. They’re primarily a reading by-product, and are meant to be private. They often have transient value, meaning they’re only useful while the reader is actively engaging with the text.

The context of annotation production and use ranges from *global* to *institutional* to *work group*, to *personal*. Generally, the more formal the annotation is, the broader its context of use. For example, a Variorum Shakespeare edition would be considered a highly formal annotation of a published work, with

a global context of use. Handwritten notes on a college textbook would generally be considered informal annotations with a personal context of use. It is conceivable, however, that an annotation could be informal but with a broad context of use or highly formal with a personal context of use.

Annotation Typologies

In addition to Marshall's "dimensions of annotation," MacMullen (2005) has developed a general typology for annotation research, based on Buckland's typology for information (Buckland, 1991), which I intend to follow. He sets out three areas for exploration: annotation-as-process, annotation-as-thing, and annotation-as-knowledge.

Annotation-as-process (AP). By studying the processes by which annotations are created, sustained, and utilized by both human and non-human entities, we can come to a greater understanding of their value. These processes range from informal personal annotation behaviors to automatic annotation techniques to organizational workflows, which influence annotation behavior.

Annotation-as-thing (AT). This is the study of the different physical realizations of annotations, their properties and attributes, both alone and in relation to the information objects to which they are linked. The study of *AT* also analyzes an annotation's ability to function as another type of information object in another use context, and with interoperability across contexts. For example, something that might be an annotation in one context might be operationalized as a piece of metadata or index term in another.

Annotation-as-knowledge (AK). This refers to the intellectual component of annotation, distinct from its physicality. Annotations convey knowledge and meaning, and the study of *AK* focuses on uncovering those meanings.

Research Framework & Design – Final Comments

This qualitative research project is focused on grasping the intricacies of communication between a musician and the work he's performing, seeing annotations as a by-product of that communicative event. The ethnology of communication model provides a framework with which to consider the communication aspect, and the annotation model offers a structured way to approach the annotations. For example, the interview questions are strongly influenced by the annotation typologies described above. Questions relate to: the context and process of an annotation's creation and use, the physical characteristics of annotations, and the knowledge necessary to create and read these domain-specific objects. The categorization of specific annotations will be based on both the annotation dimensions defined by Marshall, and the ethnography of communication model. Annotations will be divided into a formal / informal dichotomy, with attention given to its dimension of use, while concurrently being analyzed as communicative events, speech acts, and/or as evidence of breakdowns in communication.

The qualitative nature of this research ensures a deep understanding of the issues involved, with an emphasis on examination of processes and meanings. Typically, qualitative methods produce a lot of detailed data about a small number of cases, and provide a depth of detail through direct quotation, precise description of situations and close observation. The great strength of qualitative research is that it attempts to depict the fullness of experience in a meaningful and comprehensive way.

Sampling

The data I will be collecting comes in the form of observation notes, interview transcripts, and annotated musical scores. In order to ensure comprehensive data collection, I have developed a framework consisting of two levels: user mode and skill. The first level, the musician mode, has three parallel sublevels: composer, conductor, and musician; each equally important, and based on what I call a "hierarchy of interest:" A *composer* is primarily interested in creation and transforming his "aural vision" to notated form to ensure reliable performance. In this research study, only the composers' published annotations (like expressive marks) will be considered. A *conductor* is primarily interested in interpreting a score for expressive purposes, and is charged with the responsibility of organizing and leading the orchestra to produce authentic performances. Conductors mark up their own score, and often annotate musicians' parts for individual instruments or performers in the orchestra. Finally, *musicians* are primarily interested in interpreting their part for performative purposes. Musicians almost universally annotate their parts, generally marking up sections that are difficult or interpretable in some way. The second aspect of the collection framework focuses on the skill level of the users. I identified three levels for this study: amateur, pre-professional, and professional.

There are two notes on the data collection framework: First, because this study is focusing on the interactions of people working with structured data, specifically the Common Notation System, it will be necessary to collect data from users for whom reading music is a non-issue. Rock and jazz musicians often do not read music, so their annotation behaviors may be fundamentally different from those of musicians for whom interaction with a score is second nature. This requirement limited this study's user base to orchestral musicians, but interesting future work could be done on musicians who do not read music. They're often still interacting with structured data, although it's in a different, much less structured form. The second note concerns the presence of a leader in the musician groups from which I will draw my data. Because I am interested in exploring the interaction behaviors of musicians with the work they're performing, I thought it necessary make a distinction between people who interact with and interpret music directly (conductors and musicians who work without a conductor: a quartet for example), and those musicians who are performing someone else's interpretation (musicians in an orchestra).

I will collect scores from musicians either after the last performance of the work, or towards the end of the performance cycle in order to ensure the richest possible data. When scores are collected, I will also conduct interviews with participating musicians, asking questions regarding the processes and context of their specific annotation behaviors (see “interview” section, above).

Table 1. User Groups Directing Data Collection

1A. Professional Composer (published score)		
1B. Professional Conductor	2B. Pre-Professional Conductor	3B. Amateur Conductor
1C. Professional Musician (With Conductor)	2C. Pre-Professional Musician (With Conductor)	3C. Amateur Musician (With Conductor)
1D. Professional Musician (NO Conductor)	2D. Pre-Professional Musician (NO Conductor)	3D. Amateur Musician (NO Conductor)

Document Content Analysis

Once the data have been collected, it’s then necessary to analyze it in a systematic way. Typically, the documents analyzed in qualitative research include all documents related to the research, in this case: interview transcripts, observation notes, and annotated music.

The purpose of content analysis is to develop a valid framework in which it’s possible to make reproducible inferences from the text. Becker & Lissmann (1973, quoted in (Mayring, 2000), have identified two levels of content appropriate for analysis: primary and latent. Primary content includes the themes and main ideas of the text, and latent content includes any contextual information within the text.

Qualitative content analysis focuses on the empirical and methodological analysis of texts within their context of communication. These methodological and empirical rules recall the advantages of quantitative content analysis, and there are a number of specific procedures involved in robust method:

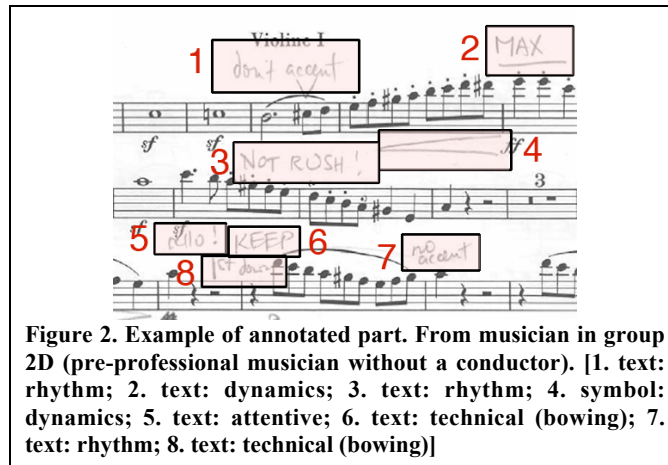
- *Model of communication*: before beginning analysis, the researcher should decide which part of the communication are under analysis; how the interviewer’s preconceptions and biases might influence data collection and the interaction between researcher and research participant; and the context of text production and reception.
- *Category Development*: The documentary material must be analyzed in a consistent manner, following procedural rules.
- *Category Application*: The categories of analysis should be based on the research questions, and refined by the process of analysis.
- *Reliability and validity*: The content analysis procedure seeks to be valid across different researchers. There are various methods to ensure this.

Category Development and Application

Category development is an enigmatic process. “How categories are defined...is an art. Little is written about it” (Krippendorf, 1980). Mysterious though it might be, categories should be closely related to, and developed in terms of, the text. Essentially, the purpose of this process is to develop criteria for analysis, derived from: theoretical knowledge of the issues at stake, the research questions, and the text itself. Based on these criteria, the researcher works through the text and develops categories. The categories are revised and reduced within a feedback loop, and checked for reliability.

The categories developed for this research project are based on a pilot project completed in 2004, conducted in order to ascertain the general nature and quality of annotations, and to make certain that the primary researcher had enough knowledge to properly complete the project. Exploration of the annotations on the pilot study scores revealed that there are two types of mark-up: structural, and content-based. At the structural level, there is the demarcation of bars and phrases. At the content level, there are three types of written notes: *textual*, where the musician has actually written a word in the margins; *symbolic*, where the musician has written non-textual symbols; and *numeric*, where the musician has placed numbers above or below notes for fingering or timing instructions. Content-level annotation is the most common type found so far. The purpose of both textual and symbolic annotations falls into six categories: 1) timing / rhythm, 2) emotive / mood, 3) technical, 4) dynamics, 5) articulation, and 6) attentive.

The above-mentioned annotations are informal. Musical scores also have formal annotations, which are composer created, and are printed on the published score. These instructions are generally expression marks defining dynamics, tempo, and articulation, for example. These instructions are not, by the layperson, commonly considered to be annotations – but whereas pitch, for example, is generally deemed non-negotiable or command-like, the expressive marks are more like recommendations, which can be variable depending on musician skill, and context of performance. Because these published composer annotations are prevalent in Western music, it would be impractical to categorize every one of them. However, because it will add to comprehension of annotative behaviors, I will attempt to categorize the intention of the object a musician annotates. See figure 2.



Each annotation will be categorized in four ways: 1) whether it is structural or content-based (most annotations are content-based; it will be assumed they're content-based unless otherwise defined) 2) whether it's textual, symbolic or numeric 3) the purpose of the annotation; and, if appropriate, 4) noting whether the annotated element or concept is a command or recommendation. Categories three and four might be redundant, but might nonetheless be illuminating. For example, in figure 2, annotation #2 (“MAX”) is a textual note on dynamics, and is related to annotation #4 (<), a symbolic note on dynamics. Both of these notes are related to the formal composer annotation “ff,” an abbreviation of “fortissimo,” which means “very loud.” While they are all communicating the same concept (= “get loud here”), I believe pointing out these redundancies will be valuable for characterizing the annotation and interaction behaviors with structured data.

On a related note, if it's possible to find a computer program that can handle it, I would like to categorize relationships between annotations (in the previous example: #2 and #4 repeat the same information, and reinforce the message of the formal annotation “ff”).

Reliability and Validity

The validity and reliability of qualitative research depends on the researcher's skill, sensitivity and training in the field. In addition to good planning and theoretical backing, there are specific methods a researcher can perform to ensure data validity and reliability. These methods are related to data collection (triangulation, attention to negative cases, and “fair dealing”); project description (comprehensive project documentation, reflexivity); and findings verification (respondent validation). The design of this project has taken all of these points into account in order to ensure the validity and reliability of the findings.

I am trying to ensure comprehensive data collection by triangulating three different methods of data collection (observations, interviews, and document analysis) with three different musician modes (composer, conductor and musician) at three different skill levels (amateur, pre-professional, and

professional). The only problematic point is that I am only collecting data from musicians who can easily read (and interact with) musical notation, so can not generalize to other kinds of musicians, like those who play rock and jazz. While this does call into question the universal applicability of the project's findings, I do not think this issue will negate their validity because the primary research question is related to how musicians interact with structured data, as exemplified by the score. If a musician can't read a score, they can't interact with it in a way appropriate to this study.

In an attempt to ensure comprehensive project documentation, I am attempting to document every step and motivation of the research process. Because research methods inevitably influence the research subjects, it's fundamentally important to clearly state the process and researcher preconceptions in relation to data collection and analysis. By the end of the research cycle, the researcher should be able to account for the evolution of the simpler classification systems of the research questions into the more sophisticated coding structures of data analysis; and the subsequent development of these coding structures into the clearly defined concepts, explanations, and theories generated by the data. This written account should give the reader sufficient data and documentation to judge whether the data adequately support the researcher's interpretations and whether the researcher and the research process have unduly influenced each other.

Before publicly releasing the final product, I will seek out selected project participants' reactions and opinions to my findings. I intend to provide an "executive summary" type of document that participants can review and comment upon. I'm in the process of developing a questionnaire that will record their reactions to research processes, subsequent findings and theories, discussion points, and possible applications of this work. Their reactions will be incorporated into the findings, and/or will comprise part of the dissertation's discussion section.

Timeline

I am hoping to defend the full dissertation proposal the first week of October, and to finish collecting data by the middle of November (data left to collect: pre-professional conductors, pre-professional and amateur musicians without a conductor). Concurrently with writing the proposal and collecting the data, I'll be transcribing interviews and observation notes. Data analysis will begin in early December 2005, and I'm giving myself three months to complete the data analysis. By the end of February 2006, I should complete my data analysis, and start writing, delivering a final draft of the dissertation to the committee by April 15, with a defense in late May or June 2006 and graduation in August.

Appendix A: Interview Framework

Contextual Questions

- Use context(s)
 - In what domain contexts do annotators annotate (domain, sub-domain, industry, work environment)?
- Instantiation context(s)
 - {individual,small group,large group}?
 - {formal,informal} processes?
- User context(s)
 - In what roles/job functions do annotators annotate?
 - In what rank do annotators annotate?
 - In what roles/job functions are annotations used?
 - In what rank do users use annotations?
 - Demographic characteristics of annotators and users
 - Skill-set characteristics of annotators and users
- Motivation
 - Why are annotations created? [big picture: memory aid, intellectual linkage, disambiguation]
 - What values are perceived as being gained?

Process Questions

- Creation
 - Is training required to create annotations?
 - Can someone unfamiliar with the system understand the annotation? Is there short-hand or coding involved?
- Authority
 - Who/what creates the annotations?
 - Who/what manages the annotations?
 - Is the annotation voluntary or mandated?
 - Are annotations reviewed for accuracy, timeliness, completeness, etc.? If so, for what characteristics and attributes are reviewed? Using what criteria?
- Use
 - What is done with the annotations? How are they used and by whom/what? What processes take annotations as input or produce annotations as output?
 - Is the annotation part of an intermediate step, or an end product?
 - Is the annotation private or public (organizational scope of use)?
 - Are there any ethical concerns regarding the use of the annotation?

- Time
 - When in the life-cycle of the underlying object is the annotation created?

Object Questions

- What form(s) do the annotations take?
- Is a standard format or style used?
- Is a {controlled vocabulary, domain-specific ontology} employed for terms used in annotations?
- Would storage in a different {format, media} allow {higher levels, different kinds} of {functionality, utility}?
- Is an annotation viewed as another type of information object in other contexts or under other conditions (e.g., as metadata)?
- Is the annotation permanent or transient?
- How is the relationship between object and annotation instantiated? Is the annotation stored separately from the underlying object?

Knowledge Questions

- Is this knowledge related intellectually to that within other areas of this work?
- Does this knowledge have utility for other activities?

Bibliography

- Buckland, M. K. (1991). Information as thing. *Journal of the American Society for Information Science*, 42(2), 358.
- Cunningham, S. J., & Knowles, C. (2005). *Take note: Academic note-taking and annotation behavior [Poster]*. Paper presented at the Joint Conference on Digital Libraries 2005, Denver, CO.
- Hitchcock, G., & Hughes, D. (1989). *Research and the Teacher: A Qualitative introduction to school-based research*. London: Routledge.
- Hymes, D. (1964). Introduction: Toward ethnographies of communication. *American Anthropologist*, 66(6, Part 2), 1-34.
- Hymes, D. (1985). Language, memory and selective performance: Cultee's "Salmon's Myth" as twice told to Boas. *Journal of American Folklore*, 98(390), 391-434.
- Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*. Beverly Hills: Sage.
- Luo, L., West, D., Marchionini, G., & Blake, C. (2005). *A study of annotations for a consumer health portal [poster]*. Paper presented at the Joint Conference on Digital Libraries 2005, Denver, Colorado.
- MacMullen, J. (2005). *Annotation as process, thing, and knowledge: Multi-domain studies of structured data annotation* (No. TR-2005-02). Chapel Hill, NC: University of North Carolina, School of Information and Library Science.
- Marshall, C. C. (1997). Annotation: From paper books to the digital library. *JCDL '97*, 131-140.
- Marshall, C. C. (1998). Toward and ecology of hypertext annotation. *HyperText* 98, 40-49.
- Mayring, P. (2000). Qualitative content analysis [28 paragraphs], *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research [Online Journal]*.
- Morse, J. M. (1994). "Emerging from the data": The cognitive processes of analysis in qualitative inquiry. In J. M. Morse (Ed.), *Critical issues in qualitative research methods* (pp. 23-43). Thousand Oaks, CA: Sage.
- Saville-Troike, M. (2003). *The ethnography of communication: An introduction* (3rd ed.). Malden, MA: Blackwell Publishers.
- Searle, J. R. (1969). *Speech acts: An essay in the philosophy of language*. Cambridge [England]: Cambridge University Press.
- Shipman, F., Price, M., Mashall, C. C., & Golovchinsky, G. (2003). Identifying useful passages in documents based on annotation patterns. *7th European Conference on Research and Advanced Technology for Digital Libraries, Trondheim, Norway*(August 17-22).

- Solomon, P. (1991). *Information systems for children: Explorations in information access and interface useability for an online catalog in an elementary school library*. University of Maryland, College Park, MD.
- Weiss, R. S. (1994). *Learning from strangers: The art and method of qualitative interview studies*. New York: Free Press.
- Wolfe, J. L. (2000). Effects of annotation on student readers and writers. *JCDL '00, San Antonio, Texas*, 19-26.