

Annotation: from paper books to the digital library

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ABSTRACT

Readers annotate paper books as a routine part of their engagement with the materials; it is a useful practice, manifested through a wide variety of markings made in service of very different purposes. This paper examines the practice of annotation in a particular situation: the markings students make in university-level textbooks. The study focuses on the form and function of these annotations, and their status within a community of fellow textbook readers. Using this study as a basis, I discuss issues and implications for the design of annotation tools for a digital library setting.

KEYWORDS: Annotation, markings, study, digital library reading tools, annotation systems design.

INTRODUCTION

To mark in a book is enormously useful; it is also impractical in the paper library. Collections of digital materials can free readers from such constraints. Indeed, the digital library is a place where annotations are not only feasible, but also may become important adjuncts to the primary text, a place where we may (and are welcome to) write in books. The roles of reader and writer blur in this regime [8,13], but — in one of the many paradoxes of the nascent practice of electronic reading and writing — will every reader want to attend to annotated texts when she can start fresh? Likewise, will annotations that begin as personal markings ever transition into a public form?

Just how *will* annotation take place in the digital library? When we ask a question like this, we can think of annotation from at least two different perspectives. First, and most simply, we can look at the mechanics of annotation: how will we mark on digital materials, given our current practices and the affordances of the new medium? Second, we can look at

annotation as a highly developed activity, one that represents an important part of reading, writing, and scholarship. How do the markings people make on the printed page function? More abstractly, what is the relationship between the commentary, the reader, and future readers (a readership which may also include the original annotator)?

Of course, all annotations are not equal; they are created in the service of different activities¹, and with different expectations about audience and future use. An asterisk that a student pens next to a passage describing events that led up to the French Revolution, material that he believes will be covered on the final exam, is qualitatively different than the exclamation point that a reviewer marks beside a claim she doesn't believe in a paper she is reviewing for an academic journal. A co-author's longish note in the margin of a draft is easily distinguished from a published annotation on *Measure for Measure*.

Much of the current research on the annotation of electronic texts has centered on facilities to support public (or work group) commentary or collaborative writing; personal annotations on digital materials — realized in products like ForComment, Acrobat, Lotus Notes, and others — are seen as a simpler, special case of the more general problem of commenting on documents. CoNoter [2] and NCSA's HyperNews [6] are examples of annotation tools based on a model of annotation as public or work group commentary. ComMentor is an architecture that supports general annotation services along these lines [16]; annotations in this case are regarded as any kind of superstructural element — including notes, ratings, or paths — that a contributor might add to existing digital library materials to add interpretive value to them. In fact, a World Wide Web Consortium working group has formed on the topic of collaborative annotation to come to grips with the attendant issues and

1. We can view annotation as varying as much as reading itself; see Levy's discussion of the complex act of reading [10].

protocols necessary to add a general annotation facility to the Web [4].

Historically, other tools designed to support collaborative writing have taken an approach that views the changes co-authors suggest as annotations. Intermedia's InterNote facility used a notion of "warm-linking" that allowed a primary author to push an annotation down a link into the source document [1]. The PREP editor allowed a primary author to see a side-by-side view of multiple annotations anchored to the same place in the source document [14]. These creative approaches to displaying and working with annotations addressed observed problems in collaborative writing.

While we might think of collaborative or public annotations as subsuming personal or individual annotations, especially from an architectural or system design perspective, the practice that leads to their creation is quite different. If we look at paper books, we can see annotation as a personal device – one that plays into reading as a visible trace of human attention.

In this paper I explore personal annotations – their value to the annotators and to later readers, their functions, and the implications existing practice brings to the digital library. I do this through a study of annotations in paper books, a medium in which annotation tools and practice are well-developed (although certainly this does not reduce their capacity to change as reading and attention evolve, and new tools for marking like highlighters and Post-its come into play). This study reveals a set of issues and design implications for annotation facilities in a digital library setting.

ANNOTATION: A STUDY

To take a closer look at the practice of annotation, I performed a limited study of a particular type of annotators, college students, and a carefully-scoped set of readings, their required texts in a cross section of courses and disciplines. In this study, I examined the markings students made in their own textbooks – as they assimilated the materials, critically thought about the contents of a literary work, memorized formulae, worked problems, learned a new language, pieced together historical materials – in short, as they engaged in being students. I chose a university bookstore as the setting for this study, since it was a ready source of well-used books, uninhibitedly marked-up, in as many disciplines as we would find course offerings in a major university.

Why study university textbooks?

Looking at university textbooks offered the opportunity to collect annotations across multiple "identical" copies (that is, books that were part of the same edition). Examining

books from the same edition ensures that the pages are the same in size, weight, and texture of paper; that the margins are the same width; that the book offers similar places to write in the front and back covers; that the books started out as *materially the same*. Because it was possible to compare different copies of a given text, the form of the book became important, both in terms of the affordances it offered for writing and mark-up (an edition with wider margins might, after all, invite more extended notes), and in terms of function (a particular edition is apt to have had more comparable circulation in the used book system). In other situations in which one finds used books, it is rare to encounter such stacks of comparable texts.

The practice of marking in university textbooks is a familiar one. Universities generally require students to buy their books. Thus it is one of the places where marking in the texts is not actively discouraged (compared to, say, public secondary schools). In this case, the bookstore itself acknowledges the practice by ignoring the students' markup in its buy-back scheme. The books, regardless of condition or number or type of annotations, are all sold at the same price relative to new books, 75% of the new book price. Buying used books saves the students money (but not so much that those who covet a "fresh" copy are forced to buy used books).

We also can make assumptions about the role the books are playing in the readers' broader activities. University textbooks are used in a situation in which people must assimilate new (and possibly quite unfamiliar) material. This situation is, of course, only one of many in which people are asked to attend to material, and in some way demonstrate that they have expended some portion of their attention on it. Learning material presented in a textbook or primary work can be contrasted with other kinds of intellectual engagement. For example, much advanced scholarly reading is integrative or critical – a scholar may attend to a work with an explicit sense of how it fits in with other readings. An intelligence analyst may look at a news wire, noting in particular where it contradicts his or her standing beliefs. A reviewer may read an academic paper, and mark spots where additional references are needed, or where the novelty of the work is especially apparent. An educational setting, however, is a nice (and, more importantly, accessible) example of a situation in which sustained attention and close reading is necessary, and annotation of materials is encouraged.

Furthermore, the books are used in similar settings (courses, often taught by the same professor or set of professors) and annotated in similar material circumstances (in classrooms while the professor is lecturing, in dorm rooms while the stereo is playing, on lawns on sunny days in the midst of frisbee games). If there is something to be learned about

how the practice of being a student dictates the way the books are annotated, this setting should help us uncover it.

Study Setting

The study took place on the textbook floor (the basement) of a bookstore on the campus of a major university. About 7000 undergraduate students and 7000 graduate students attend this institution.

The study was performed over the course of the few days preceding and the week of the first week of classes. A steady flow of students milled around the bookstore with lists of books they would need for the semester's classes. Some students were purchasing books; others were selling books back so they would have enough money on hand to buy new texts. They came to the bookstore singly, in pairs,

and in exuberant large groups; they chatted with each other while they selected their textbooks – about classes, the vacation they were returning from, life in general, and the books themselves. It is to the last conversations that I attended most carefully.

By the end of the first week of classes, most of the used books were gone and the textbook floor of the university bookstore was once again placid.

Method

I first identified used copies (marked with a yellow tape on the spine) of a text of interest; I tried to pick textbooks with a sufficient number of copies of an edition to support comparison. In a few cases, I did not look through all the used copies (there were sometimes stacks and stacks of used

Title	Course Area.	# Exam'd	# Anno'd	Overview of notes
<i>Portugues Contemporaneo, Vol 2</i> (Abreu and Rameh)	Portuguese	10	(0)**	Only examined vocabulary section in detail, for annotations – none, even in heavily marked copies.
<i>Heart of Darkness</i> (Conrad)	History	8	4	Minor jottings.
<i>Riverside Shakespeare</i> (Evans et al.)	English	8	2	Unannotated copies appear unused. Many interpretive notes in 2 marked copies.
<i>Le Petit Prince</i> (St. Exupery)	French	14 (all)	4	Words, short phrases translated.
<i>Great Gatsby</i> (Fitzgerald)	American Studies	11 (all)	0	No markings, despite “well-used” character of the books.
<i>Calculus</i> (Hughes-Hallett et al.)	Mathematics	14	8	Light annotation, mostly pencil.
<i>Challenge of the West Vol. II</i> (Hunt)	History	NA	NA	Examined 4 copies in some detail. Watched order texts were bought. Most copies had selective highlighting.
<i>Basic Algebra One</i> (Jacobson)	Mathematics	4 (all)	2	1 w/light pencil throughout text, the other heavy use of yellow highlighter in the opening chapter.
<i>Decouverte Et Creation</i> (Jian and Hester)	French	10	(1)**	Only examined vocabulary section in detail, for annotations – uncommon, even in copies that had much marking in the rest.
<i>Portrait of Artist as a Young Man</i> (Joyce)	English	13 (all)	7	Some copies heavily annotated. Most used pen underlines and marginal notes. 4 had lists of important pages.
<i>Organic Chemistry</i> (McMurry)	Chemistry	NA	NA	Pencilled problem-working & interpretation. One copy with color-coded highlighting.
<i>Works of Mencius</i> (Lau)	Philosophy	11 (all)	10	Pen underlining is the dominant mode. Most copies heavily marked-up.
<i>St. Thomas Aquinas on Politics & Ethics</i> (St. Thomas Aquinas)	Great Works	20	19	At least 9 copies marked up by more than one student. Extensive marking in books. Evidence they paid attention to each other's annos.
<i>Maus: A Survivor's Tale</i> (Spiegelman)	History	9	0	No markings.
<i>The Color Purple</i> (Walker)	English	20	3	Very little marking; mostly lines of dialog have been underlined in pen.

Table 1: A sketch of findings by title and course area.

** The annotations of interest in these books were in the vocabulary section at the back of the books. The other portions of the texts were annotated mainly with translations.

books available for core undergraduate courses), but rather selected a stack of ten or twenty to examine. Unless they indicated a confusing trend, these copies were taken as representative. Wherever possible, I looked through all used copies of a text.

Assumptions

Naturally, a study of this sort is subject to many assumptions about events that have transpired before the books came to be part of the bookstore's used textbook collection. After all, I did not have the opportunity to interview any of the textbooks' former owners; I only had access to the textbook's next owners as they contemplated the stack of used copies on the shelf. Nor did I necessarily have access to the new owner of any particular copy I examined. I did, however, have access to the circumstances under which the books are bought and sold – the bookstore – and could observe and talk to employees working there and students shopping there.

Could I safely assume any markings in a book had been made by one owner? Any textbook may have had multiple owners (or have been borrowed and infelicitously written in). Most of the books I examined had clear signs of a single annotator – obvious handwriting uniformity, similarity of annotation style, a favorite pen. I made an effort to draw no unwarranted conclusions from ambiguous sets of markings. Textbooks may have also arrived at the bookstore from many other institutions; students may then have annotated the texts in classes other than the courses offered at this university. In fact, textbooks I examined were stamped with the names of other institutions or had tags from bookstores local to other universities. Of course, curricula vary, but I assumed some basic similarity across institutions.

How could I be certain that the books I examined were representative? Initially, I worried that the bookstore would, by policy, refuse to buy back books that were too heavily annotated, or marked in certain ways. After talking to the acting bookstore manager, I learned that the university bookstore buys back texts regardless of how much they have been marked up; they only reject books with missing pages, damaged bindings, or missing covers. This policy does not extend to law textbooks, which must be sold back to the bookstore in pristine condition. I did not, therefore, consider used law texts in my study.

FINDINGS

I examined fifteen different sets of used books, over 150 books in all. Table 1 summarizes the books used in the study. All the books selected were required reading for the courses in which they were used.

The findings are classified in two ways: first, by the *form* the annotations took in the textbooks, then by a reconstruction of the *function* of these markings derived from their form. A

close look at form should help us answer one of the questions we asked earlier – if we are to going to mark on digital materials, how will we do it? Understanding function should help us answer the other more far-reaching question – what roles might annotation play in a digital library setting? The analysis begins with form, since it is the readily observable aspect of the markings the students made in their books.

Form: Marking Characteristics and Marking Strategies

As I examined the used books, I took note of three different types of marking characteristics:

- *Was the annotation in the text, or was it in the margins or other blank spaces?*

Annotations that were in the text were markings that indicated a specific group of words (an *extent*), either through highlighting, through underlining, or through some other scheme for intermingling one's own notes with the text itself.

- *Was the annotation telegraphic – a personal, opaque coding – or was it explicit in meaning?*

Telegraphic annotations are markings that arise from personal systems of annotation; for example, some of the texts had asterisks in the margins. Explicit annotations are usually textual.

- *Was the annotation removable or had it become part of the materiality of the book?*

Removable annotations include devices like bookmarks (scraps of paper, candy wrappers), dog-ears (page corners turned down), and Post-its, as well as notes taken on separate pieces of paper tucked into the pages of a book. I will not dwell on this sort of annotation at any length, primarily because the focus in this study is on *markings on the book page*, not on removable media.

Table 2 shows examples of the annotative forms observed in the bookstore, categorized according to the first two characteristics listed above.

Not surprisingly, annotation form arises in part from the characteristics of the materials themselves, the imprints and the implements used to write on them. For example, the less expensive paperbacks (which typically are printed on non-shiny, ink-absorbing paper) are more subject to underlining than highlighting, since the highlighter bleeds through to the other side of the page (or even through to the following page). Pages formats with lots of blank space

allow students to write more expansive notes, work problems, or make up vocabulary lists.

Marking strategies. What should be of particular interest to us is how these materials shape the strategies for annotation. What is the fallout of having a particular kind of writing implement to hand? Or having a choice of many pens, pencils, and highlighters?

Using annotation tools (such as pens) demands a certain amount of attentional resource. As Thorngate suggests, making choices expends attention [17], in this case taking it away from the text and putting it on the local arsenal of writing implements. Thus, we would predict that using any one tool to mark on texts will involve a more seamless transition from reading to writing than switching among many marking tools.

This is borne out by students' markings. Students who use highlighters write fewer marginal notes than students who underline passages with pens. Since it is far more difficult to produce legible writing with a highlighter, students anticipating that they will write marginal notes may choose pens as their annotation implement; it may also be the case that if one has a highlighter in hand, one sighs and shrugs if one has a word or two to jot in the margins about a difficult or important passage.

Of course, there are exceptional counterexamples to the "to-hand" rule. In one of the copies of *Organic Chemistry* that I examined, the student used a color-coded highlighting scheme that seems to have required a great deal of attention. In this case, multiple highlighter colors were used to code types of information. What the types mean is, of course, not recoverable without consulting the annotator, but evidence that the coding is meaningful to the practitioner is found in places where he or she has retraced a given annotation to make it the "right" color.

The forms of annotation are also clearly shaped by disciplinary expectations and textbook genre. From Table 1,

we can see some clear patterns in types of markings and marking implements we have observed in various course areas. Pencil is the marking tool of choice in mathematics; complex philosophical narratives are subject to extensive mark-up in the form of underlines and highlightings; difficult works of fiction read in English classes abound with marginal jottings. In the next subsection, I begin to reconstruct the function of these markings from the observable forms and patterns I have summarized here.

Reconstructing function from form

It is difficult to fully reconstruct function from this kind of material evidence, the artifact that remains after the student has discarded it. It is impossible to know, for example, whether the student successfully completed the course; ever looked at the textbook after marking it up; or carried the book to class, session after session, dutifully following along with the lecture, favorite mechanical pencil in hand. Naturally, the full richness of the annotative circumstances – the practice as it occurs – is lost. My discussion is tempered with an acknowledgment of the incomplete nature of the artifacts I have in hand.

It is clear from our study, and from the history of reading and other studies of annotative practice [11, 15], that annotations do not serve only a single function; they serve a multitude of functions. In this discussion, I enumerate (and try to distinguish among) the most evident functions.

First, annotations are *procedural signals*, cluing in the student to where an assignment starts, what material is important (and as we will see, unimportant), and what material might require a second (or successive readings). Second, annotations are *placemarks*; they hold the quotes that are being reserved for the paper that the student will write at the end of the term, the chemical reactions and term definitions the student must memorize for the final, the theorem that is key to the proof in the homework assignment. Third, they are *an in situ way of working problems*. Fourth, annotations record *interpretive activity*, either from another reader (e.g. a professor's explanation),

Characteristics	Within-text	Marginal or blank space
Telegraphic	Underlining; Highlighting Circles and boxes around words and phrases	Brackets, angle brackets, and braces; Asterisks, and stars; Circles and boxes around whole pages; Arrows and other deictic devices to connect within-text markings to other marginal markings
Explicit	Brief notes written between lines, especially translations of words in foreign language texts	Short phrases in margin; Extended notes in margin; Extended notes on blank pages in the front of the book; Problems worked in margins

Table 2: Characteristics of annotations written on the books

or as the result of careful reading (the student has interpreted it him or herself). Fifth, and most elusively, these markings act as a *visible trace of a reader's attention*, a focus on the passing words, and a marker of all that has already been read (as if these words are now possessed).

Finally, the markings may just be incidental, *reflecting the material circumstance of reading*. Table 3 provides a rough mapping from form to function using exemplars of common forms; there is not always a one-to-one mapping from form to function.

Form	Function
Underlining or highlighting higher level structure (like section headings); telegraphic marginal symbols like asterisks; crossouts.	Procedural signaling for future attention.
Short highlightings; circled words or phrases; other within-text markings; marginal markings like asterisks.	Placemarking and aiding memory.
Appropriate notation in margins or near figures or equations.	Problem-working.
Short notes in the margins; longer notes in other textual interstices; words or phrases between lines of text.	Interpretation.
Extended highlighting or underlining.	Tracing progress through difficult narrative.
Notes, doodlings, drawings, and other such markings unrelated to the materials themselves.	Incidental reflection of the material circumstances of reading.

Table 3: Mapping annotation form into function.

Annotations as procedural signals. Students use annotations in anticipation of future attention – to designate reading assignments, responsibility for "knowing", and desire to reread. This function is even more dramatically illustrated when students mark in books to cross out sections, subsections, problems, and other document elements. This use of annotations suggests that the student is producing a custom version of the text to reflect the circumstances of the course. In one copy of *Organic Chemistry*, for example, various reactions were crossed out. Clearly this does not mean that the student thinks the reaction will no longer occur, but rather that the student doesn't need to worry about this portion of the text.

Annotations as placemarkings and aids to memory. Within-text markings that specify short extents (usually with highlighter, but sometimes with underlines or circles) seem to function as placemarkers, as a way of remembering or remembering to remember. Most of the highlighting in *Organic Chemistry* was connected with term definition and portions of the text that the student needed to memorize, like specific reactions (so the reaction was highlighted rather than the beginning or ending molecular configuration). In several of the literary works, for example *Heart of Darkness* and *The Color Purple*, it is likely that the markings (especially underlinings) record important passages and bits of dialog for later use in a paper or essay.

Annotations as in situ locations for problem-working. Students sometimes approach problems in context, at the time they are encountered, rather than deferring them and

risking a break in attention, or they work a problem near where the equation or theorem is presented in the text. The copies of *Organic Chemistry* and *Calculus* had more penciled-in marginalia of this sort than many of the other textbooks. For example, some of the pencilled-in annotations added worked-out substance, like electron spin, to in-line figures; various atomic symbols in schematized molecules showed evidence of counting marks (to figure out which valence electrons are available for bonding); in some places, elided hydrogens were drawn in; and markings were used to indicate action (or to help visualize action), for example, one student used the figures in the textbook to work out molecular rotations.

Annotations as a record of interpretive activity. Marginal notes, jottings, and interpolations record interpretive activity; in fact, our stereotype of writings in texts usually turn out to be interpretive annotations. In marked-up copies of the *The Riverside Shakespeare*, I observed three different kinds (and scopes) of interpretive notes; all three have counterparts in other types of textbooks. One kind noted interpretations of unfamiliar language, since Elizabethan English can be opaque to the reader; these notes refer to a single word or phrase. This form of annotation is also very common in foreign language texts. A second kind demonstrated interpretation of structure (noting names of famous scenes, for example). A third, and most common kind throughout my survey of literature texts, records interpretations of the work; for example, a marginal note in *Richard III* read, "Boy can't believe uncle is a killer." It is in interpretive markings that we may find both the sublime and

the silly, the insightful commentary, and the documented misreading. This type of annotation comes into play most strongly when we consider the value of annotations to prospective readers.

Annotations as a visible trace of the reader's attention.

Annotations become a visible trace of the reader's attention when the material is difficult and in narrative form; in other words, attention is easier to maintain if the material is relatively accessible. Hence, I saw far more extensive annotation of this sort in Joyce's *A Portrait of the Artist as a Young Man* or in *The Works of Mencius* than in Fitzgerald's *The Great Gatsby*, Walker's *The Color Purple*, or Spiegelman's *Maus*. Philosophy texts, with their oftentimes dense narratives, are particularly prone to page after page of highlighting or underlining.

Annotations as incidental reflections of the material circumstances.

Markings are bound to reflect circumstances that are entirely outside of the realm of the text, given that there is a world of distractions outside of the book. I encountered a few annotations incidental to the contents of the book; the book's pages became a convenient notepad that reflected the material circumstances of reading. For example, the marking "I LOVE YOU" appeared on an early page in a copy of *Calculus*. It was clear that the writer of the annotation was not referring to a particularly comely integral, but rather to another person.

It is interesting to note that one marked-up copy of *Le Petit Prince* had annotations in Arabic – not the fluid writing of an Arabic-literate person, but rather the awkward script of a student learning a new alphabet. This kind of annotation suggests that writing in a text may help repurpose it for a different circumstance than supposed (practicing two new languages at the same time). More importantly though, it reminds us that we can never fully predict where, when, why, or even how annotation will take place.

The status and value of these annotations

We think of these annotations in textbooks as personal (and, therefore, private). But when they reach the used book stack, they change to a public form. Are they useful? Are they distracting? Do they inhibit subsequent readings? I sought to understand how annotation changes the text by listening to the students as they selected their textbooks, and by watching the buying patterns as the used books gradually disappeared from the shelves. One illuminating conversation was overheard by the "Great Works" shelf. One student was instructing another how to assist him in finding the "right" used book to buy. He requested that the other look for books with writing in the margins, but without highlighting. The second student held up an example of a candidate text, and the first student corrected him, saying that he should look for books with long sentences, not just phrases. It was clear, then, that the

previous owner's notes had some value, but only if they were not so telegraphic as to be unintelligible.

To understand the students' exchange in the "Great Works" section, I examined copies of one of the books that was the object of their conversation, *St. Thomas Aquinas on Politics and Ethics*. I saw further evidence of this value in one of the numerous multiply-annotated copies. An early annotator had used pen underlining and marginal notes to record his or her interpretation of the work. The later annotator had not only highlighted selected text with a yellow highlighter; *he or she also highlighted some of the earlier annotations.*

Everywhere I looked there was evidence that *some* of these private markings were useful. The markings in *St. Thomas Aquinas* are by-and-large interpretive annotations. This type of annotation, and problem-working (a similar annotative function), are the least controversial in their value to students, either as subsequent readers or in subsequent readings. What of markings and notes that have been made in service of other functions?

As a very limited test of whether highlightings and underlines that have been made as place markers or memory aids make a text undesirable, I "planted" a set of the 4 most marked up copies of *Challenge of the West* at the bottom of the used book stack for the course, beneath copies that were not marked up at all. Interestingly, by the next day, someone had picked out one of the four and purchased it, even though there were minimally annotated copies still available. Other non-interpretive functions of annotation, then, do not always make a book less attractive.

I decided to look a little more deeply at this kind of marking to see what aspect of it might be the most valuable. I chose three copies of *Challenge of the West* with markings in the section headed "The Origins of the French Revolution, 1787-1789". If the underlinings and highlightings used in this way are of value to subsequent readers, there ought to be some consensus among different readers of the same materials about what is marked. The paragraph begins:

"Excitement greeted the long-awaited opening of the Estates-General in May 1789, but a crucial procedural issue remained unresolved: Would the deputies vote by order or by head? As in 1614, deputies had been chosen to represent each of the three orders, or estates: the First Estate, the clergy; the Second Estate, the nobility; and the Third Estate, everybody else, at least 95 percent of the population. In 1614 each order, or estate, voted separately, and each therefore had veto power..." (p.685)

The first annotator had underlined (in blue ink) "Estates-General in May 1789"; "First Estate, the clergy; the Second Estate, the nobility"; and "Third Estate, everybody else, at least 95 percent of the population." The second annotator had highlighted (in blue), "Estates-General in May 1789";

the third, (in yellow), "deputies had been chosen to represent each of the three orders, or estates: the First Estate, the clergy; the Second Estate, the nobility; and the Third Estate, everybody else, at least 95 percent of the population."

There is a consensus that this passage is important and a much rougher agreement on exactly what part of it is important. So if this marking is encountered by a subsequent reader, it will probably *shift function*; it will move from being a specific memory aid and placemaker to a signal, attracting the next reader's attention to this paragraph.

Now we direct our attention to the more problematic of the annotative functions: the underlinings and highlighting that are the visible traces of the student's attention as he or she reads difficult narrative. Another conversation between two students engaged in a similar in-tandem used book selection in "Great Works" is very revealing. "Highlighter or pen?" one asked the other. "Highlighter, definitely," the second replied.² This response points toward damage control, rather than value (especially since when I looked at the books they were trolling through, they were all well marked in).

I go on to ponder the fate of these markings in digital media, knowing that all forms and functions of annotation are not created equal.

SOME IMPLICATIONS FOR ANNOTATIONS IN THE DIGITAL LIBRARY

The university bookstore is an upbeat and lively place to learn about annotations. It is one of those rare places in which annotations are discussed, strategized over; a place in which books are rejected on the basis of where they've been, and the kind of company they've kept. What implications for digital libraries and digital materials can we draw from these markings in paper books?³

As a foil, I introduce a quote from Voyager's Robert Stein in dialog with hypertext writers and theorists Michael Joyce and Carolyn Guyer, and Sven Birkerts [3]. Robert Stein is in the midst of recounting his experiences reading books on a computer screen:

"One of the first things I read was the first several chapters of *The Portrait of Dorian Gray*. As I started reading various thoughts came to me and I wrote

several notes in the margin. Normally I hate to write in books; I do it but it runs against my training. Writing in the electronic book was completely different. Since I "knew" that there would always be a pristine version on the floppy disk the book came on, I was delighted to mark up the version on my hard drive with abandon. When I changed the text of a few sentences to bold to make them stand out for later reference, I suddenly realized that because I could personalize the text in a way that was meaningful to me (and that this could be done in a manner consistent with the aesthetic look of the book), I was reading more carefully and with more reflection than usual."

This quote reveals four important assumptions about personal annotations in the digital library that this study can readily call into question. The first two are most directly concerned with the observations of form; the second two arise from the reconstruction of the function and status of these markings:

- *Will annotations on digital materials be as rich in form as markings on paper?*

It is clear from our observations of form that annotations are informal, ad hoc, and take many forms. Will the ability to use the text-editing model Stein assumes here be sufficient? Probably not. The student markings were endlessly inventive. An underline gives way to a bracket which gives way to an arrow, which in turn gives way to a few scrawled words and an exclamation point as a single, fluid form. Informal, unconstrained pen-based sketching mechanisms like the Electronic Cocktail Napkin [5] may be a far more appropriate model for annotating materials in the digital world.

- *Will producing digital annotations require more attention than marking on paper?*

Once we demand a fully expressive means of marking in digital materials, we must be very careful of what we ask for. We may get it. As it stands, expressiveness can be limited by our choice of marking implements; as we have seen, a highlighter is not so mighty as the pen when it comes to writing notes in the margin. But switching midstream (picking up a new marker from our rainbow arsenal of highlighters, or even switching between our Cross pen and our Cross mechanical pencil) is distracting. How much attention is Robert Stein expending to switch from "annotate in the margin" mode (Look over from text. Grab pointing device. Select type-in point. Move hands to keyboard. Type) to "make the text bold" (Grab pointing device. Select the extent of the text. Find "bold" command or "bold" button. Apply). Will he still be engaged with the text after

2. It is easy to infer from this conversation that underlining is more disruptive than highlighting for new readings, rereadings, or successive attendings. The underlining may be sloppy and obscure portions of words, or it may simply interfere with reading to a greater degree.
3. Here I deliberately beg the question of digital materials that are simply printed out, and annotated as before. For the sake of brevity, I constrain my discussion to *digital marks on digital materials*.

he has interacted with it? This is perhaps an overstatement of the awkwardness of digital annotation, but it is difficult to match the seamlessness of writing in the margin and underlining the words. Digital annotation should be just this seamless.

- *Is the form appropriate to the function of the annotation?*

The parenthetical "and that this could be done in a manner consistent with the aesthetic look of the book" is one key to this question. One important aspect of annotative practice is that the markings are rarely consistent with the aesthetic look of the book; they are visually set apart from the published text. The second key to this question comes from the annotator's own understanding of the function of the marks he is making. Perhaps emboldened text is the best way to set off the words as a place marker. But if the annotation is lengthy, and will be the subject of what Michael Joyce refers to as "successive attendings" [7] – an observable habit of readers confronted with a surfeit of materials [12] – will Robert Stein's bold text inhibit this practice or support it? We have already seen that all markings are not equal in their functional capacity.

- *Finally, will Robert Stein really want a pristine copy of The Portrait of Dorian Gray once he's marked it up? Are his markings of no lasting value to himself or to subsequent readers?*

As is evident from the study in the bookstore, annotations (especially interpretive annotations and potentially placemarkers, just as Stein is taking the trouble to record) have unexpected value. So what will happen to private annotations in a digital work? If we were asked to classify these annotations at the outset of reading, certainly we (and Robert Stein) would say they were personal. Even as we completed our reading, we would not tend to publish them; after all, they are informal jottings, not formal commentary.

This being the case, most digital libraries, even those that are implemented with a notion of annotation, would simply give the next reader (or even the same reader at the next reading) a fresh copy of the materials. In the case of student textbooks, going digital may tend to remove the individual jottings done in the course of the normal day-to-day work of a student. Are these jottings important enough to worry about? In my effort to explore them, have I idealized them? Or does the

ability to always retrieve a fresh copy for one's own markings, devoid of the annoying scratches, lines, doodlings, and "I love you"s of the paper world, reflect more of the true function of personal annotation, a representation of the reader's engagement in the work?⁴

From a technological standpoint, versioning and other hypertextual mechanisms may help preserve both a fresh copy and the annotated work (given that the marks are *on* the materials, not linked to them). Will patrons in our digital collections be as thorough as the students I watched in the bookstore, thumbing through version after version – rotating through overlay after overlay – until they find just the markings they want?

Naturally, these are questions that studying paper books cannot really answer. A thoughtful implementation of a personal annotation mechanism in a digital library setting is necessary to carry this investigation forward. However, the study does suggest a strong set of design implications for new types of annotation facilities for readers working in a digital library setting, including support for:

In situ annotation, distinguishable from the source.

Readers like to write on the materials themselves – in the margins, in between the lines, over text, within figures. O'Hara and Sellen's study confirms this finding, and further reports that their subjects wanted their marks to be distinguishable from the source document [15].

Non-interpretive markings. Readers make many kinds of non-interpretive markings, including the elusive kinds of highlighting and underlining that mark progress through a difficult text as the reader focuses his or her attention.

Fluidity of form. Annotations on paper are highly individual in form; digital annotations should respect this fluidity. This finding argues against a palette of common symbols, colors, and pen types. Rather, it suggests a more freeform capability.

Informal codings. Several of the textbook annotators took care to develop personal systems of annotation in which symbols and pen colors meant something to the reader. These systems are necessarily informal, only adding as much overhead to the annotation activity as the reader feels is worthwhile.

4. Michael Joyce argues against the clean copy, fresh from CD-ROM, and for the interpretively augmented texts (created, in fact, by students) in his discussion of George Landow's In Memoriam Web in [7].

Smooth transitions between public and private annotations. It is hard to imagine private annotations becoming public again as they do in the used textbook section at the bookstore. Yet some of the commentary is indeed useful to future readers. A provision for seamless transitions between private and public forms of writing and the ability to request annotated versions of electronic materials – choose among them, or remove them – may help retain some of positive aspects the students found in buying used textbooks.

Integration with reading as an activity. Readers tend to annotate with the tool that is in hand; this finding suggests that annotation should interrupt reading as little as possible. O'Hara and Sellen's study confirms this: they found that annotation on paper was smoothly integrated with reading; on-line annotation (using a popular text editor) was distracting.

The final implication – support for a smooth integration of annotating with reading – is the most difficult to interpret from a design point of view; yet, it is potentially the most important. Until we, as system designers, get this right, it is likely that people will continue to annotate paper materials, even as they read materials in a digital library.

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