Turning the Page on Navigation

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ABSTRACT

In this paper, we discuss the findings of an in-depth observational study of reading and within-document navigation and add to these findings the results of a second analysis of how people read comparable digital materials on the screen, given limited navigational functionality. We chose periodicals as our initial foil since they represent a type of material that invites many different kinds of reading and strategies for navigation. Using multiple sources of evidence from the data, we first characterize readers' navigation strategies and specific practices as they make their way through the magazines. We then focus on two observed phenomena that occur when people read paper magazines, but are absent in their digital equivalents: the lightweight navigation that readers use unselfconsciously when they are reading a particular article and the approximate navigation readers engage in when they flip multiple pages at a time. Because page-turning is so basic and seems deceptively simple, we dissect the turn of a page, and use it to illustrate the importance and invisibility of lightweight navigation. Finally, we explore the significance of our results for navigational interfaces to digital library materials.

Categories and Subject Descriptors

H.3.7 **[Information Storage and Retrieval]**: Digital Libraries – *User issues*; H.5.2 **[Information Interfaces and Presentation]**: User interfaces – *Evaluation/ methodology.*

General Terms

Design, Documentation, Human Factors, Performance.

Keywords

Electronic periodicals, navigation, reading, browsing, encountered information, field study, complex documents.

1. INTRODUCTION

In an ideal world, software and devices for reading digital library materials would let readers annotate, clip, search, gather, and interact fluidly in ways that not only captured the affordances of paper, but also transcended paper's limitations. These capabilities, implemented broadly and uniformly across genres, would allow readers to use the digital materials in ways they would find

familiar, useful, and even compelling. Any type of reading – from leisure reading to extensive research to collaborative use of collections – and its attendant forms of interaction would be supported.

A number of research projects have been framed according to this vision. As a result, hardware and software have been developed specifically to support reading and interaction on digital devices [15]. In this context, much has been made of how one presentation mode – paper or screen – might be better than the other, but we feel it is important to pay careful attention to the advantages of each. Paper has many affordances that digital materials do not [16] and digital technology offers many possibilities that can go beyond paper [14]. For example, people summarizing a set of documents can move readily among and within the documents on paper [12] and classics students reading online texts in Perseus can look up unfamiliar ancient Greek words easily, without leaving the source text [9].

However, as often as this vision of on-screen reading is adopted, it is also pared down when the research leaves the lab and goes into real use. Pragmatic constraints are introduced: time and cost limitations on software development; the installed base of hardware; publishers' business and legal concerns; and so on. In these situations, the question then becomes: what is sufficient? What functionality meets the needs of a core set of readers, the expected reading situations, and the target genre of materials? If this is indeed our vision, what portions of it are essential?

In this study, we turn our attention to navigation, both as it is realized by paper and as it may be minimally implemented as simple page-turning and link-following. We use periodicals as our initial foil; they represent a type of material that invites many different kinds of reading – including browsing, skimming, flipping, and glancing – and a variety of strategies for navigation. From there, we can speculate on how our findings may apply to other genres of materials, other types of reading, varying levels of reader commitment, and information seeking as well as information encounter. We can also identify further questions that need to be pursued to support these generalizations.

The specific question we are addressing – what kinds of navigation are necessary to read and browse digital materials – has been answered to some extent in a very practical way: people are increasingly willing to read at least some of the periodicals they receive regularly in digital form [10]. Furthermore there is a clear recognition that archives of periodicals are an important digital library resource and offer a distinct advantage over paper archives. But the same people who have switched to reading online periodicals and recognize the value of digital archives would still claim the experience of reading an electronic periodical is different, and possibly less pleasant and efficient

than reading the comparable periodical on paper. It is this gap we are exploring.

In this paper, we discuss the results of an in-depth observational study of reading and navigation and add to these the results of a second analysis of how people read comparable digital materials on the screen, given limited navigational functionality. Thus we have two windows onto navigation: one on readers' normal practices of making their way through physical magazines and the other on readers using a minimalist interface to make their way through comparable digital magazines. These two situations will enable us to winnow down which aspects of physical documents are fundamental to reading and navigating effectively, and which aspects seem to be less essential, or more readily replaced by compensatory types of digital functionality.

2. APPROACHES TO NAVIGATION

What exactly do we mean by within-document navigation? If we take the question in its most literal sense, the answer seems obvious. Navigation is the way in which people get from one page to another (or, more generally, from one point in a linear flow to another). When we read a paper magazine, we usually turn pages forward and back, sometimes several at a time. We might open a magazine to a random place, or where it falls open by virtue of how it has been assembled or how drop-out cards have been inserted. We might use the Table of Contents to find a specific article or feature, or we might rely on our knowledge of the magazine's usual structure to find our favorite feature. Or we might even go off looking for the story that is featured on the cover, an article a friend has told us about, or an interesting advertisement we remember from a past issue.

But what of visual navigation within pages, when one's eyes stray to an inset photo or an ad in the leftmost column? Or folding a page so that only one column is visible? Or opening up a two page spread? Is that essentially the same as looking at the two pages in sequence? What do we make of the physical interactions with the magazine when a page is being turned – for example, the way some people stick their finger under the top outer corner of a page well in advance of turning it – is that a trivial or important aspect of navigation?

We ask these questions in a genuine way. It is easy to imagine that considerable effort may be put into making a digital form more paper-like if certain aspects of paper are essential to reading. For example, Chu and his colleagues have responded to the British Library's "Turning the Page" system [1] by simulating the actual physics of page turning and the visual feedback offered by the physical act [3]. Others have focused on the effects of navigation rather than the act by representing digital wear and tear on the materials [6]. Still others have introduced physical motion as a means of initiating navigation through digital materials [5]. As yet another alternative, others have focused on developing hardware for more effective physical control of scrolling or techniques for moving through a document very rapidly in an effort to recapture the navigation associated with skimming [7][17].

Thus navigation introduces subtle notions of physics and physicality, the interplay between the functional structure of a document and its visual layout, and the different styles of reading and browsing that may take place under a more generic rubric.

3. STUDY DESCRIPTION

The observational study focused on three in-depth cases of magazine reading. Participants videotaped themselves reading a current issue of a weekly magazine when and where they normally would. We subsequently viewed the videotapes to log different kinds of reading-related activities, including navigation, manipulating the medium (e.g. folding back a page so only two columns of text are visible), and lapses of attention (e.g. talking or sleeping). We also captured peripheral activities like reaching for a drink, shifting position, and face or head-scratching, as well as the way the participant held the magazine (e.g. one-handed or two?). In these logs, we noted whether the study participant was scanning or merely glancing at a page, what page he or she was looking at, and what article, feature, cartoon, or advertisement was the apparent focus of the participant's attention. In short, we made every effort to fully describe the reading sessions so we could return to particular portions of the videotape that exemplified different kinds of navigation or physical interaction with the magazine.

So our cases would be relatively comparable, the three readers in the study were chosen because they were regular readers of the same magazine, the *New Yorker*. We were aware that the magazine's genre would have a profound effect on how it was read, so for this study, we wanted all three readers to approach similar material. Furthermore, we were hoping for readers with a similar level of commitment to the magazine; thus we decided to recruit participants that were either regular readers or subscribers. Naturally, each reader has his or her own agenda, so we were aware that any given issue of the magazine would contain articles and features that would range from extremely compelling to being of little interest. Participants read the magazine how and where they normally would. One participant read in bed every night before he fell asleep; another read the magazine on a cold Saturday afternoon on her living room couch; and a third read sitting on a recliner in his living room. Participants operated the video camera themselves after we had set it up for them so their reading would be as normal as possible. Figure 1 shows the three study settings.
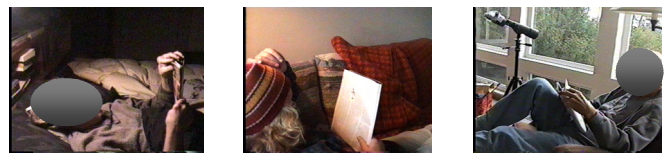

Figure 1. Study settings for in-depth reading sessions

We conducted interviews both before and after each reader read the current week's issue of the magazine to better understand how the videotaped sessions related to the participant's own characterization of his or her practices and to validate our interpretations of what we had seen. The interviews were conducted in the participants' homes; both background and follow-up interviews were semi-structured and open-ended. We audiotaped and transcribed the interviews and photographed the reading setting to help put the videotapes into context.

In the background interview prior to the main portion of the study, participants were asked about their reading practices, what else they read, and other general questions. At that time, we also instructed the participants in how to use the video recorders and set up the camera for them in a position that seemed likely to capture a usual place the person read. We assured them that we

were interested in seeing how they normally read the magazine, and emphasized the importance of just doing whatever they usually did. Despite initial fears about blank tapes or potential camera problems, our participants all turned out to be adept at self-recording.

After we had viewed the videotapes of the participants' reading sessions, we returned for a second round of interviews. These follow-up interviews were broken into three segments. In the first segment, we used the newest *New Yorker* (we made certain participants hadn't looked at the current week's issue) as a means to elicit more information about their reading practices by having them talk aloud as they went through the new issue. This enabled us to further investigate whether the extensive recordings we had collected represented the participant's normal practice. The second segment of the follow-up interview involved viewing portions of the videotape with the participant; this allowed them to clarify ambiguous or confusing portions of the data and to validate some parts of our interpretation of their actions [2]. For example, we might use this means to find out why the participant initially paged quickly through an article, and then returned to the first page and began to read carefully. For the final segment of the follow-up interview, we showed the participants a prototype electronic *New Yorker* with a tablet computer-based magazine reader. We handed them the prototype (with an unfamiliar issue of the *New Yorker*) and again urged them to talk aloud as they looked through the electronic magazine.

To provide a provocative contrast to our in-depth case studies, we also logged videotapes of free reading sessions, each about 20 minutes long, in which eight participants in a second study read or browsed two electronic magazines on a tablet computer in a lab as part of a usability study. The two electronic magazines, an issue of *Esquire* and an issue of the *New Yorker*, were prepared in such a way that they duplicated the physical layout and appearance of the magazines. The participants in this portion of the study were recruited because they claimed to be familiar with the magazines and were occasional readers of either or both; they were also familiar with the tablet computer. The user interface to the electronic magazines was very simple: the participants could use hardware buttons or a pen and software buttons to move one page forward or backward, or to bring up a menu that would allow them to jump to either the Table of Contents or to specific articles by title. Few other functions were implemented at the time of the study. Figure 2 shows a sample page of the electronic magazine and the reading setting.
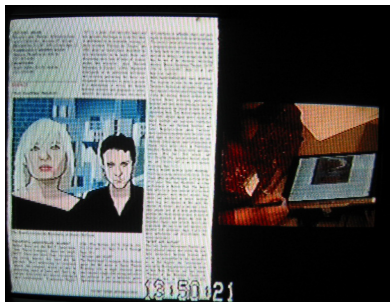

Figure 2. The digital *New Yorker* and the reading setting

We logged the usability lab reading sessions in a way that allowed us to make some rough comparisons across the two different studies with the caveat that the situations were not entirely comparable, but that some aspects of the data would allow us to identify areas for further inquiry and to answer some simple questions.

4. THE IMPORTANCE OF NAVIGATION

Just how important is within-material navigation? There are several perspectives that we might want to take to answer this question. One is to qualitatively assess how much time readers spend actually reading as opposed to scanning material, glancing at pages, interacting with the magazine itself (for example, by folding pages or clicking on links), or even becoming distracted (for example, dozing off or talking to someone who has come into the room). A second way is to take a coarse-grained navigational perspective and ask what the reader's principal activity is on each page that they see; this perspective allows us to answer the question of what is going on between each turn of the page.

To answer this question, we coded the data from both kinds of videotapes, our in-depth recordings of study participants reading the physical *New Yorker*, and the second set of eight recordings of the reading sessions in which participants in another study read a digital equivalent. We used multiple sources of evidence from the videotapes to distinguish among some rough, readily discernable categories: reading (proceeding linearly through the text), scanning (skimming or letting one's eyes wander over a printed page), or glancing (quickly appraising the material, getting a gestalt). Certainly we could make finer-grained distinctions with measurement tools such as eye-trackers, but this would require sacrificing the basic aim of letting our participants read the *New Yorker* as they normally do.

If we assume the first perspective and examine how the participants in our in-depth study spend their time going though a new issue of the *New Yorker*, reading dominates. In fact, given this general situation – a committed reader, a genre that is oriented toward long, general interest articles, and reading that is neither time constrained nor task directed – it should be no surprise that most of a reader's time is devoted to what would unarguably be considered reading. The data do not disappoint. The three readers spent anywhere from 70% to 84% of their time reading. Scanning was the second most common use of time (ranging between 4% and 21% of the time), and glancing third (consuming from 2% to 4% of the total time) for all three readers. But what of the eight readers who were given the equivalent digital magazine in a time constrained situation in the usability lab, and hence were likely to have been less committed to the material? While there was considerably more variation, only two readers spent less than half their time reading, and three spent more than 84% of their time reading (so even more than our readers in a natural setting). Similarly, six of the eight readers spent a greater proportion of their time scanning than glancing. Given our first perspective – time – it is no stretch to say that reading dominates and that navigation is a secondary phenomenon.

But now let's consider the data from the second perspective, what is happening between each turn of the page. What the data demonstrate is that on any particular page, a reader is likely to be doing something other than reading, and that in the light of this less committed engagement, navigation comes into far greater prominence. On paper, all three readers actually read considerably fewer than half of the pages they encountered; in fact the

percentages of pages read ranged fairly evenly from 18% to 43%. In the digital situation, the numbers are even more telling – even given the short period of time, only 2 readers read most of the pages they encountered; from the tape, it is evident that they were immediately engaged by one or two articles, and spent much of the time reading those. The other six navigated more and read less, their reading rates ranging from 9% to 30% of the pages they encountered. In fact, they were far more apt to glance at a page and move on. Thus navigation becomes far more visible and prominent when it becomes apparent that most pages aren't really read in the most literal sense, but rather taken in more briefly. Although we use these rough percentages to argue here, watching the videotapes makes this point about the prominence of navigation more viscerally – it is readily evident that within-document navigation is very important until the reader is actively engaged in reading something.

Notice too that this study represents readers and reading at a far point in a continuum: more than other magazines and long documents, the *New Yorker* is edited to be a magazine for more attentive readers who are familiar with the authors and features; here, we would expect to see more reading and more straightforward navigation, not less. What we saw in the data is that navigation is a significant part of reading longish, complex material. Navigation will be even more important to the person using materials casually, browsing a new topic or reading very quickly. As it is, difficulties with navigation may account for the desire to read long documents as hardcopy or for the perception that reading on the screen is less effective than reading on paper. This confirms a related qualitative assessment of navigation reported in [12].

5. STRATEGIES AND PRACTICES

In this section we describe what we observed in both reading situations, physical and digital. We first report on our more detailed observational records of people reading the physical magazine – their navigational strategies and how these strategies are realized in practice. We then give a brief account of how the readers approached the electronic periodicals, paying close attention to how some of their navigational practices resemble and differ from those of the readers of the paper *New Yorker*. These characterizations reveal an aspect of navigation on paper that merits special attention: lightweight navigation (unselfconscious seamless movements out of the linear flow of the text and back in again). We use a specific instance of turning the page to illustrate the subtlety and complexity of lightweight navigation. We also discuss some other coarser-grained navigation related findings that were revealed by the differences between navigating the paper and digital magazines.

5.1 Navigation strategies

Since we have three extended cases of people making their way through the magazine, it is interesting to contrast how they did it. In this case, we had three different sources of data to triangulate: each participant described how they thought they read the magazine during the pre-interview; the videotape gives us a least one example of reading the magazine to the extent that they normally would; and during the post-interview, participants talked aloud as they went through a new issue of the magazine.

Jay. In the pre-interview, Jay, a long-time subscriber, describes planning his reading by deciding which articles he'll want to read,

either by looking through the Table of Contents for familiar authors or interesting topics or, less frequently, by leafing through the magazine quickly.[1] He reads a variable amount of material in each issue, guided by his interests, but he cites the movie reviews as a feature he reads regularly and the fiction and the poetry as magazine elements that he seldom reads. He describes this usual practice as he talks aloud during the post-interview:

> "The very first thing I always do is find the Table of Contents. … And so normally I can find it in just a couple of pages. And then what I do is turn down the corner. Because I constantly will flip back to the Table of Contents."

As Jay narrates his progress through the Table of Contents in the *New Yorker* he's just received the day of the post-observation interview, it is evident that he uses his knowledge of the magazine and its contributors to plan his course, which he corroborates with bits of advice from other trusted media sources and friends:

> "Annals of Law by Jeffrey Toobin. Well, just the fact that Jeffrey Toobin wrote it, I'm going to read it. He's an absolutely wonderful legal writer. And this one's about the collapse of Martha Stewart's defense. Oh! Well, I just heard Terry Gross mention that she's going to have Jeffrey Toobin on talking about this article. And so, this reaffirms that the *New Yorker* has really good stuff in it. And I certainly know that I always like Jeffrey Toobin."

Interestingly, the article's title seems to be less help to him than these other kinds of metadata; this is likely to be particular to the magazine's genre and Jay's long term relationship to the magazine itself.

He often starts with the movie reviews at the back of the magazine, a feature he finds using both the Contents and the normal position of the feature in the magazine:

> "The Table of Contents said it was page 102. I know from experience that the movie review is almost always the very last thing in the magazine. Except they oftentimes will have a cartoon page on the very, very back of the last page. But it's almost always the very last thing in the magazine. So I know it's page 102. But I will start by just going to the very end of the magazine and flipping back. And it usually takes me a couple of flips and I'm at page 102."

From there, he describes selecting an article from the Table of Contents and finding it via the page number. He reads the descriptor line and then a bit of the article to see if it meets his expectations; if it doesn't, he stops and returns to the Contents page to find the next article he wants to read. He reads cartoons if he encounters them in his reading, although at one time he used to read them all.

This strategy is confirmed by the videotapes of Jay reading the *New Yorker* each night before he falls asleep. He's quick to find the Table of Contents, and he's equally facile at finding his favorite feature, Current Cinema, by its position near the end of the magazine. He does not look through the entire magazine, and

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[1] When questioned further, Jay actually begins by grooming the magazine – taking out the advertising inserts and drop-out cards that will get in his way later.

sometimes quickly abandons articles he's selected to read. He does, however, sometimes look ahead when he's finished an article, and when he does, he encounters other features and advertisements along the way to the "next" article on his reading agenda. This bit of serendipitous exposure to parts of the magazine that extend beyond his planned reading will figure into our discussion of the differences between the precise navigation of ePeriodicals and the slightly looser way that even planned navigation functions on paper. For example, he narrates how he gets to a desired article on page 50:

> And I'm just going to skip to page 50. One of the great things about the *New Yorker* is that every page that's not an ad [has a page number], well, this one doesn't. But initially, they all had a page number. And this page doesn't have a page number. … Okay, this page says page 55. I'll back track. 51. 50. Which begins with a gigantic picture, so of course I'm going to look at the quote under the picture first for Homecoming Queens.

Gene. Gene characterizes his own reading as progressing straight through the magazine, from cover to cover, reading and scanning variably as articles catch his attention (or not) and as time permits:

> "It depends on my time schedule for the day – I have two modes of reading. The one you've seen me do now is the hurried mode. And on the other hand if it's a rainy Sunday morning, the unhurried mode, I'd read as I go."

He uses the Table of Contents as a preview to the magazine. It usually does not alter his course through the magazine's pages, but rather sets his expectations. If he is interrupted while he's reading, he simply bookmarks where he has left off, and resumes reading at that point. He also might undertake his linear scan, then return to articles he plans to read in more depth.

In the course of looking through every page, he sees his first priority as catching all the cartoons: "The cartoons come first. So I have to service the cartoons." Even if Gene is engaged by an article that piques his interest, he interrupts himself to read an encountered cartoon: "Oh, immediately after I flip the page [in the middle of a *Talk of Town* story], I'm gonna read the cartoon before all else."

In the videotaped sessions, it is evident that Gene does a substantial amount of scanning and partial readings of articles. He characterizes this pattern as intentional – that partial reading is part of his strategy for approaching the weekly magazine. During the talk-aloud portion of the post-interview, he describes this approach as he goes through several sequential articles, the first, a one-page article, and the second, a much longer story:

> "'Financial Page.' I'll read the first paragraph. This starts out about Michael Eisner at Disney. This is a continuing tragedy of corporate mismanagement. So I might read this, or scan it. Um. [turns page] 'Letter from California. An anxious [sic] young mayor takes San Francisco.' Since I used to live in California, I'll read enough of this just to know what's going on in the city."

At first blush, it seems that this is a very linear page-by-page progression through the magazine, and that if it weren't for the cartoons, Gene would be able to finish a partial reading of an article and skip to the start of the next. However, his reading practice also admits a certain amount of serendipity.

For example, while he's reading the Table of Contents during the talk-aloud portion of the interview, he refers to a profile of sculptor Maurizio Cattelan: "I don't care about 'Profiles' probably. He's a 'subversive sculptor', so that's – I'll just look at the photograph by Richard Avedon, because they're nice photographs. When I get there." Then, when he reaches the start of the article, he re-affirms his earlier stance, "I've never heard of this artist. And the title is 'The Prankster.' And this face is completely distorted. This is not a subject that would attract me." But when he finally reaches the photographs that illustrate the article, he tells us: "This [the photos] got my attention. … So now, by virtue of [the photos], I might read the first paragraph. Otherwise I wouldn't." Thus his linear progress through the magazine has been interrupted as he backtracks and begins to read the long article.

Gene also characterizes a slightly different reading and navigation strategy for some kinds of articles; this is a strategy in which he simply scans to notice elements that stand out, as a name would. For example, as he turns to a music review, he says:

> "I don't know anything about pop music. I should because we're always stumped in the *New York Times* crosswords by the pop music characters. I do know Beyonce is an important character who appears in the crosswords. So I may get a few names out of it. But that's about it."

Constance. Although Constance confessed that the videotaping has slightly altered her larger strategy, the talk-aloud portion of the post-observation interview reveals that she is more likely to flip randomly through the pages, looking at things that catch her eye, until she becomes deeply engaged with a particular feature or advertising supplement.[2] For example, it seems that she usually flips until the magazine falls open to a poem, which is one of the things she enjoys reading. When asked how she finds the poetry, she tells us:

> "I was just flipping through. It's often right in the middle. They often have something that seems to be just about right in the middle of the magazine. I don't know if they planned it that way or it just happened like that."

Her navigation strategy is also guided by her knowledge of where particular features appear in the magazine. She refers to the often-humorous content that appears on the last page of the magazine,

Like Gene, Constance looks at the Table of Contents ("I like to see who wrote stuff"), but does not necessarily use it for navigation. In both cases, the Table of Contents provides an awareness of what's to come and an overview of what's in the magazine more than it contributes to navigation.

Despite the fact that Constance went through the magazine more or less from front to back, she presented a sense of being less methodical than the other two readers – she did not plan like Jay, nor did she give us the sense that it was important for her to cover the ground of what was in the magazine. Rather, it seemed that she hoped to run into her favorites, in particular book ads, book

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[2] During the videotaping, Constance read the magazine from front-to-back, although within any given feature, she probably read as she normally would (i.e. she didn't feign engagement when she wasn't particularly interested). The talk-aloud portion of the post-observation interview and some reading she did off-tape before she got home seem more indicative of her normal practice.

reviews, fiction, poetry, and cartoons. Of the three, Constance seemed to rely most on attributes of paper navigation such as where the magazine fell open and the relative position of features.

5.2 EPeriodical navigation

EPeriodicals are electronic versions of paper magazines. The layout and on-screen appearance is very similar to the original paper magazine, including the advertisements.[3] Electronic versions of two magazines were used to gather data in this secondary study: the *New Yorker* and *Esquire*. Both magazines publish longer articles and short fiction; they also run features that appear in each issue, for example, the *New Yorker's* Talk of the Town or *Esquire's* Man at his Best. Participants were already familiar with the ePeriodicals user interface, the tablet computer, and were at least occasional readers of one or both of the magazines. They were videotaped during a 20 minute free-reading period; as Figure 2 shows, one stream captured the display on the tablet computer; a second camera was focused on the participant.

Navigation in ePeriodicals is necessarily limited by both hardware features and software functions. ePeriodicals were implemented to make page-turning easy: Readers were offered two ways to turn the page forward or back; they were able to choose between using hardware buttons on the side of the tablet computer and software buttons that could be selected using a pen. In practice, some participants preferred to use the pen and others the buttons. Three used the pen exclusively, three others mostly relied on the hardware buttons, and the remaining two shifted between the two. Observation revealed that the choice between the two did not seem to affect their reading (except for occasional breakdowns when readers found the software buttons difficult to select), so we will not focus on this aspect of tablet/ePeriodical usability.

The second mode of navigation offered by ePeriodicals was a jump, implemented as either direct links from the Table of Contents that could be selected using the pen, or from a menu that listed brief squibs from the articles' or features' titles. The menu also offered readers the ability to return directly to the Table of Contents or close the magazine. Little else was implemented, so the interface was bare-bones and unobtrusive. None of the readers had significant usability problems with jumps.

The way we coded the data allowed us to get a rough idea of the relative use of each of these modes of navigation. Individually and collectively, the most common navigational action by far was to turn the page forward. Less common was use of jumps, and less common still was turning the page backward. All but one of the readers adhered to this general navigation pattern (one reader turned back more frequently than using jumps). The collective data is shown in Figure 3 to suggest the relative prominence of the various acts. Beside it, we have the data aggregated from our three readers on paper; because the relative frequencies are so similar, we use the chart as a convenient visualization.
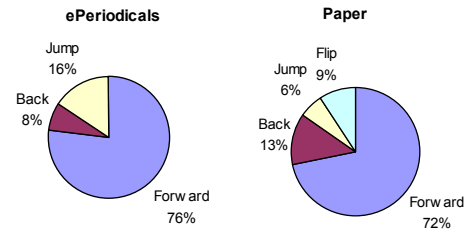

Figure 3. A rough characterization of within-document navigation in ePeriodicals and on paper.

Thus we can show through time codes and counts of different navigation acts that most of the readers spent the overwhelming majority of their time reading and a substantial proportion of their navigational acts consisted of paging forward through both forms of the magazine. If these general patterns are the same, where do the important differences lie? We turn our attention to a particular type of navigation, what we refer to as *lightweight navigation*, a kind of action that does not move the reader forward in actually reading a linear stream of text; in fact, the reader is seldom aware of performing these actions, but we have found them to be very important.

5.3 Lightweight navigation on paper

Much of our discussion so far of within-document navigation has focused on the navigation that takes place when pages are turned or flipped with the idea of "moving forward" (or sometimes backward) through the magazine or locating a desired article or, more generally, the next thing to read. It is on this basis that we have compared the experience of reading so far. Yet there is another significant phenomenon that we observed in our repeated viewings of the videotapes of people reading the paper *New Yorker*. In fact, a number of the segments that we reviewed with readers in our post-observation interviews represented instances of this phenomenon: the lightweight navigation that occurs either when people reach a particular page, or when they move within an article in a way that is so unselfconscious that they aren't apt to remember it later. There are four important types of lightweight navigation that we observed when people read on paper:

- *Narrowing or broadening focus by manipulating the physical magazine;*

- *Letting one's eyes stray to a page element out of the textual flow;*

- *Looking ahead in the text to preview or anticipate; and*

- *Looking back to re-read for context.*

While we observed slight variations for each of our participants in the kinds of within-page page navigation that they do, these four types of very lightweight maneuvers are common.

Narrowing or broadening focus.

Often readers narrowed their focus to a particular portion of the page or broadened their focus beyond the page by manipulating the magazine itself. Using the videotaped sessions, we observed the others moving the magazine to a new position that would be oriented toward seeing the top or bottom of the page. One reader, Jay, tended to fold his *New Yorker* down to one or two columns, both to make the magazine comfortable to hold and to focus his attention:

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3 Each ePeriodical included a few interactive ads in addition to conventional advertising. They did not figure strongly in the reading experience we observed, although several participants were engaged by their novelty on first encounter.

"I always fold back the page. Wherever I am, I want to get my reading space as little as possible. And folding it back, and having it like this [rolled so only one column is visible] requires two hands. But that is often the way I read. If I'm in bed, like you saw me [on the tape], oftentimes I will get lazy, and I will roll it across the column that I'm reading like this. Just because that's a real one-hand thing. ... Then that whole column is right before my eyes and I can just do that, and this [gestures how he folds/rolls the magazine]"

Broadening focus usually came about as an organic part of the physical act of page turning. Figure 4 shows a sequence of actions incorporated as part of a physical page turn. The interesting thing about the sequence is that the focus is broadened only briefly, then narrowed back to the page being read.

Broadening focus may also be done in a more deliberate way, to take in a photo or illustration that spans more than a page, or to retain reading context across pages.

Letting one's eyes stray to a page element out of the textual flow

Magazine pages may be complex, laid out in multiple columns with different kinds of elements coming together. Some are related – an uncaptioned graphic or a captioned photo that illustrates the text – and some are not, for example a cartoon or advertisement. A reader's attention is often lured away from the basic flow of an article to another element on the page. Readers either succumb to this kind of interruption as part of the basic experience of reading a magazine or handle it by explicitly allowing their attention to be diverted, then fluidly moving back to the original focus. We observed this type of self-interruption in videotapes of each of our participants. Jay expressed this tension during the post-observation interview. Note that he talks about the experience the same way regardless of whether the distracting element is related to the article or not.

"It's just that in my mind I can't start reading text when in my vision there's a gigantic picture that I have yet to process. So I want to get the picture out of the way, so that as I'm reading the text I can just say, 'I've been there. I know what the picture is.'"

"I might have read the cartoon. I've got this thing, if there's something in my field of vision distracting me from my article, I want to get rid of it. And my way of getting rid of it is to look at it and read the caption, or if it's a cartoon, to read the cartoon. Not because, 'Oh, I think this is a great cartoon.' Then, my mind can just totally block it out. And I can't do that [block it out] somehow until I've done that part."

Much of Constance's lightweight navigation was visual – a page element would attract her attention, and she'd look at it, hopping from element to element, then back to what she'd been originally distracted from. When asked why she'd shifted her focus from one ad to another and back again in an advertising supplement about books, she said:

"Oh, the color of this [referring to a Judy Blume ad], but then I realized it was children's stuff. And it doesn't interest me. I think I was just [clears throat] reading this more thoroughly. I may have noticed that subliminally, but I didn't really take in what it was, and when I realized

they were children's books, I mean, I have never read her, but it just doesn't interest me."

Gene is more strategic about shifting his focus than the other two readers. He is willing to shift his focus to a cartoon during what he'd consider to be a "high priority" short article in Talk of the Town about ballistic missile defense:

"For a long period of my life, I've followed ballistic missile defense. Both from a technical and political point of view. So I would stop and read this whole thing… Before I do anything more. Because this one is a high priority … [turns the page] And then we get to a cartoon, so this takes precedence… Immediately after I flip the page, I'm gonna read the cartoon before all else."

Looking ahead in the text to preview or anticipate

One characteristic of many *New Yorker* articles is their length. Readers often look ahead in a paper magazine without much conscious thought. They are looking for answers to questions like, 'how much more of this article is there? Is it worth continuing?' To do this, they may scan ahead, skimming the remaining text very quickly, or they may look for a sign that they are almost finished reading the article. The following are examples from our post observation interviews with Gene and Jay, respectively, in which Gene is skimming ahead, and uncertain that he wants to read the rest of the article, and Jay is looking for the black diamond that signals the conclusion of the article:

"I've read some of this, and I've tentatively said, 'do I want to go further?' To answer that question, I'm hitting the top lines of some more [of the article] over here."

"But the *New Yorker* always puts a little black diamond at the end of an article. And so I know just the minute that you had me turn this over, 'oh, it ends right on this page'."

Sometimes this type of lightweight navigation simply involves skimming or scanning the current page, but we also observed cases in which a reader turned ahead a number of pages, checking how much is left to read. For example, in the middle of a lengthy article about British scientist David Kelly, Jay scanned through the article's seven remaining pages, first skimming the text very quickly, then looking for the black diamond, and finally returning to the page he was originally reading.

Looking back to re-read for context

In the same lengthy article, we also observed Jay turning back a page. When we asked him why he'd done that (after viewing the videotape with him), he told us:

"So something has made me re-read something that I just read. Now that happens to me. And I'll think, 'oh, oh, they've just referred back to something.' And so I'll go back and re-read it. What often happens to me is an article will have a lot of names in it, and … it'll keep mentioning somebody, and I think, 'Oh, who the hell was that?' And so I'll go back, scan for their name, until I don't see their name any more, and then figure, 'Okay, they've got to introduce this person.'"

Sometimes this kind of quick re-reading is the result of a very casual initial reading. A reader's attention naturally waxes and wanes in the course of an article, and sometimes the reader returns to a page for a second go at the text. In this case, Constance has

inexplicably gone back a page, and when we ask her about it in the post-recording interview, she tells us:

> "You know, if it's something [clears throat] I missed a detail. Or I might've been double-checking… I was maybe double-checking a little fact that was mentioned in the beginning that I had glossed over."

In our inquiries, it's clear that this practice of flipping back a page (or glancing back at it while still maintaining a position on the current page) is a very unselfconscious act. Readers seldom remember that they did it, and when faced with evidence that this is what they did, they are hard-pressed to recall exactly why they went back.

5.4 Turning the page as lightweight navigation

Our videotapes of people reading on paper reveal that turning a paper page in the midst of reading a long article commonly is a complex combination of lightweight navigational activities. This seamless combination readily disappears from even the most sophisticated digital page-turning simulations of hardbound books [1][3], yet paper page turning may have an important function.

Let's look a page turn in a step-by-step fashion. Figure 4 shows Constance performing the following sequence:

(a) She finishes reading the first page of a long review of Bob Woodward's *Plan of Attack*; she had narrowed the focus to this page when she began to read the article.

(b) She reaches for the magazine's binding in preparation to turn the page.

(c) She flips the magazine to the opposite page, which is graphic she was already aware of; when she'd turned to start the article she'd had the magazine open to 2 pages.

(d) She grabs the corner of the graphic page so she can turn it; note that she can take in the humorous graphic while she's readying herself to turn the page.

(e) She's partially turned the page, but is still looking at the graphic.

(f) She opens the magazine to a two-page spread once again, the next two pages she's planning to read, giving her a brief glimpse at the broader context and telling her that the book review continues beyond the next page.

(g) She folds the loose left-hand page (the one she'll read next) under the magazine. This allows her to maintain a grasp on the magazine while she continues to look ahead.

(h) She turns the magazine over using both hands (presumably to keep the pages together). Note that she can continue to see content on one or both pages while this flip is in progress.

(i) She narrows the focus to a single page so she can continue reading the review.

(j) She positions the page so she can read holding the magazine comfortably with one hand (periodically she uses the hand that's not supporting the magazine to scratch her head, pet the cat, or pick up her drink).

The time that has elapsed is six seconds. In these six seconds, Constance has performed an entire complex sequence of lightweight navigational acts, acts that she may only be partially aware of. At first blush, six seconds seems like a long time to spend turning a page (or two pages, if you count the intervening graphic); in a comparable situation (a text flow interrupted by a whole-page ad or graphic), ePeriodicals readers spent about half as much time. But functionally the page-turning act was nowhere near as rich.

On the other hand, we can find examples in which turning paper pages significantly interrupts reading. The videotapes reveal that our study participants regularly spend time smoothing out pages, recovering from page turns in which two pages are grabbed rather than one, or recapturing a page that has escaped their grasp.

Thus we are faced with a balancing act when we compare turning a physical page with turning a digital page. Turning a digital page is relatively efficient, but the reader briefly loses contact with the text; it's often a fundamentally discontinuous event (with the exception of 3D simulations as in [2] or [3]). But more importantly, the reader loses the opportunity for all of these lightweight navigational actions – there is no incidental exposure to the broader context by glancing briefly at a two-page spread, no chance to narrow focus, and no chance to do all of the subtle look ahead that is possible when a page is turned this way. But it's by no means obvious that we want to preserve all of the physicality of page-turning itself.

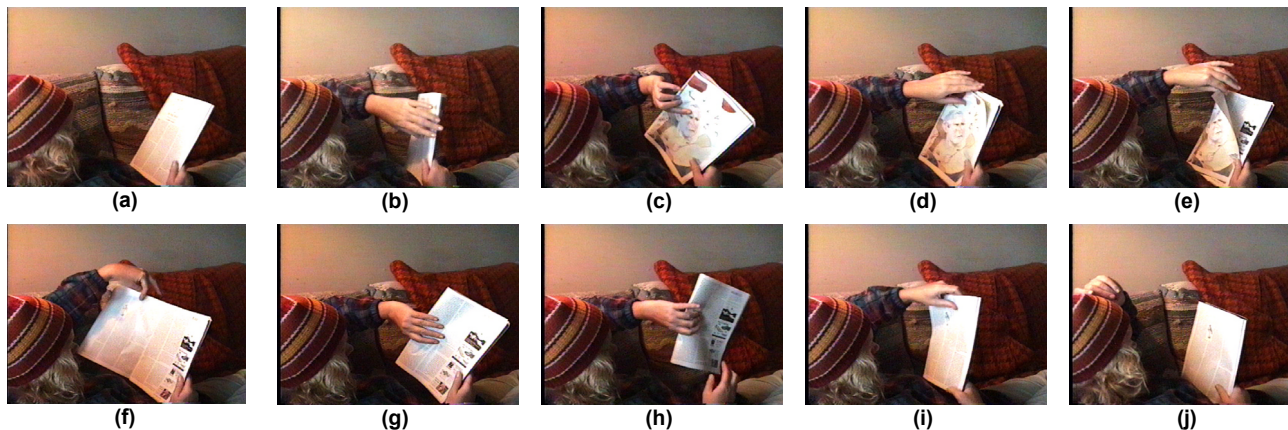Interestingly, the videotapes also reveal that other aspects of the

Figure 4. A complex page turn while reading a long article

physicality of reading and navigation are actually preserved in the physical-digital transition to a reading device. For example, readers are no less apt to make anticipatory gestures in a digital medium than a physical one. Figure 5 shows two comparable anticipatory gestures.

Figure 5. Comparable anticipatory page turning gestures

In fact, much of the physicality of reading does seem to be retained when people read ePeriodicals. They hunker down when they're reading intently; they squirm when they're losing interest; they drink, talk, scratch their faces (a more common phenomenon than one would expect), pet cats, and adjust the material that they're reading. In this way, the most basic properties of reading can be expected to transcend the paper-digital transition.

5.5 Beyond lightweight navigation

While we feel that the absence of lightweight navigation is a crucial difference between reading physical and digital forms, we have identified several other ways that coarser-grained within document navigation might be improved as well. One has to do with a missing navigational strategy – flipping through multiple pages at a time – and the other has to do with the role of metadata in jumps, navigation to predetermined places.

Flipping multiple pages. From the observations and interviews, we noted that readers flip multiple pages in several different situations. When readers are opening a new magazine they often flip through it quickly or open it at random. They will also flip ahead or back when they're finding the next thing to read (or deciding that indeed there is nothing left that they want to read). This type of navigation goes hand-in-hand with one of the key features of magazines, the opportunity they provide for serendipitous encounter of new unsought information [4].

Furthermore, flipping makes magazines easy to browse; because longer, heterogeneous material of this sort is rarely read linearly with a uniform intensity throughout, flipping through pages very quickly is an important form of navigation even if the reader appears to be making his or her way through the magazine linearly. For example, Jay describes what happens when he tires of a long article:

> "An article will go on and on … [and] at some point I'll think, 'okay. I've gotten this whole point. I'm tired of this. When is this going to end?' And if it's like three more pages, then I may just either give up. Or just go into a scan mode, where I just flip, you know, see what grabs my attention."

A reader can turn digital pages very rapidly, but there is no experience comparable to flipping multiple pages at a time, and certainly no way to experience the pleasurable serendipity of opening a new magazine directly to an interesting article.

We noticed one likely manifestation of this difference in the electronic magazines: sometimes ePeriodicals readers seemed to

have great difficulty finding the next thing to read; two of them spent more than half of their time trying to find the next thing they wanted to read, and two more spent more than a third. None of the paper magazine readers spent that great a proportion of time looking for the next article of interest.

The role of metadata in jumps. Physical magazines offer rich metadata, both explicit (for example, the Table of Contents and page numbers) and implicit (for example, the feel of the pages in each hand give a reader tactile feedback about how much of the magazine they've read and how much is left). Although we can recreate some of this metadata (e.g. the representation of the heft of a book in [2]), and indeed make the jumps to the start of articles much more accurate through the use of links, we still need to take care to offer the right subset of the metadata in the situation at hand.

We have already noted that our readers on paper read the Table of Contents not just as a navigational mechanism, but also as a substantive overview to what's to come in the magazine. While the digital versions of the magazines offered the same kind of Tables of Contents that the paper ones did, they also offered menu-driven navigation by article title. But does title or feature name offer the right kind of metadata for the reader to navigate definitively? Sometimes it does. Jay's claim that he'd go first to the *Current Cinema* feature was borne out in practice. But there was also ample evidence from the talk-aloud reading sessions in the post-observational interviews that title wasn't enough. Each of our readers specified favorite authors or photographers; in an earlier quote of Jay's, he cites a particular author (Jeffrey Toobin), who he'd read. Furthermore, the title doesn't always accurately convey the article's topic, or what the reader perceives to be the interesting part of the article. In our earlier discussion, Gene ends up deciding he would read an article he'd originally rejected on the basis of its title and a descriptive blurb by virtue of its illustration.

Indeed, we repeatedly observed the ePeriodicals readers bailing out of an article that wasn't what they expected from its title, or returning to an article they had already read because they didn't remember its title. It may be that the navigation menu didn't present the right metadata for a given reader, or that it wasn't enough metadata for the reader to make a choice, but it was a seemingly crucial distinction between the types of navigation we observed on paper and on the screen.

6. CONCLUSION

We are left with a twofold question: (1) how relevant are these navigation study results for a broader range of digital library materials and (2) for the results that are broadly applicable, which will be the most important in the transition from paper to digital? For, as we pointed out earlier, each re-creation of the affordances of paper has an associated cost.

The answer to the first question is relatively straightforward. Despite the fact that magazines like the *New Yorker* often represent leisure reading or reading to stay informed, the strategies people use to read them are not limited to the particular genre. A significant number of related genres including journals, textbooks, and anthologies are likely to have subparts. Thus they might be read as partially and with as variable interest as a magazine. Certainly the kind of skimming, scanning, and glancing we observed are common when people read longer documents, in

situations as varied as students reading for a class (see the navigation example in [11]) to office workers assimilating a PowerPoint presentation. In these complex documents, people may variably attend to text and graphics the way they do when they are reading a magazine. And certainly readers either turn pages or scroll in much of what they read online. Thus much of what we have learned seems applicable to navigation in other kinds of digital library documents.

The second question invites reflection. Certainly in a perfect world, we would like navigation to be as rich and as transparent as what we observed on paper, but as we noted in our introduction, resources are often limited, and it's important to extract the most essential (and sometimes the least obvious) qualities of interacting with paper. Much attention has already been focused on some aspects of navigation such as the use of implicit metadata in jumps and moving forward while reading (especially in hardbound books – most of the electronic book projects we cite have been particularly strong in this area). Let's focus instead on two of the more invisible and more important of the navigation-related activities that we observed on paper: lightweight navigation and approximate modes of navigation like flipping.

Flipping and random access are vital for promoting serendipitous encounter of new information. While there are a number of ways of giving the reader a well-constructed overview of a book, magazine, or document (e.g. [13]) and facilitating direct access to a place within, there is less attention paid to the more serendipitous aspects of flipping. Reclaiming that serendipity – drawing the reader into something unexpected – is vital in this age of improved search, hypertext links, personalization, and all kinds of ways of getting to exactly where you want to go.

Lightweight navigation seems to be a common activity on paper; yet despite the fact that some of it is possible on the digital page, given current technology, we see far less of it. Perhaps it is possible, but like other kinds of digital interaction (e.g. annotation), this type of navigation becomes interruptive rather than unselfconscious and integrated into the flow of regular activities. Page turning has shown itself to be a prime example; the lightweight navigation that is an important, yet invisible, part of reading on paper is not easily reclaimed in digital page turning.

Does lightweight navigation matter, especially within a page? We might be tempted to think that our observations of readers folding pages to narrow their scope might be due to columns devoted to advertising or other layout elements (e.g. cartoons) that aren't related to the text at hand. Yet there's some call for a more general facility to narrow a reading surface so one can experience text without distractions, so attention can be single and more complete [8]. Readers also consciously evaluate tradeoffs between readability (e.g. layout with wide margins and easy-to-read fonts) and seeing enough at once to get the desired amount of context [11].

In the final regard, navigating digital materials on the screen is a complicated affair. Too often it has been reduced to a battle between scrolling and page turning, between specialized hardware devices and on-screen controls, or between being book-like and being hypertextual. Yet our observations show that these may not be the real issues. Closer attention to navigation is essential to realizing that vision of software and devices for reading digital library materials that not only capture the affordances of paper, but also transcend paper's limitations.

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