

E-book Reader and the Necessity of Divergence from the Legacy of Paper Book

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Abstract— The traditional paper-based book as we know it has been read and loved for hundreds of years. The first generation of e-book readers, based on electronic ink, attempted to emulate the traditional paper-based book, both in content and functionality. In this paper we discuss how the reading of e-books starts to diverge from the legacy of paper books. Many still favor the sensory experience of touching an actual book, smelling the paper, and hearing the sound of turning pages. However, huge memory, easy readability, the possibility of sharing text between users (such as Nook allows), the multi-functionality (such as iPad has) and the ease of downloading books, all make e-book readers increasingly popular. Based on insights gained from ethnographic studies, workshops, focus groups, and questionnaires, we discuss some advantages and disadvantages of e-book readers, speculate on how they may change the way we read, in particular actively, and propose some guidelines for future e-book reader functionality design specifically aimed at the student population. The first prototype resulting from co-design work with primary school students is presented as an example of our design approach.

Keywords- digital libraries; e-book readers; HCI; interface; co-design

I. INTRODUCTION

The idea of an electronic equivalent of a book is not new. Since the Gutenberg project began in the early seventies (by M. Hart as a volunteer-based effort to digitize and archive cultural works, as well as encourage the creation and distribution of e-books [8]), there have been many attempts to design a device from which one could read, store and access books easily.

Developers have been working for over three decades on e-book readers based on LCD (Liquid Crystal Display) technology without success in the market. One of the major difficulties was not only that the visibility of the text in bright light was significantly diminished, but also that the rendering of pictures and drawings was not good enough. In addition, since e-books based on this technology had a tendency to use a lot of power, the life of the battery was short.

With the invention of electronic paper (see [16] for the history and technology behind e-paper), several companies (Sony and Amazon among others) have used this material to create different types of reading devices. The technology

behind e-paper is e(lectronic)-ink. A short summary of how it works is given in the Appendix A. These technologies overcome all major difficulties LCD technology had. Market interest in e-readers is soaring. A natural question that arises is how would these devices influence the act and the experience of reading.

Reading activity itself, whether using paper or e-paper, falls into two major categories of active and passive reading. Active reading is often related to work, research and studies. Passive reading often occurs in the context of leisure. Active reading is frequently associated with other kinds of activities, such as writing, cross-referencing, annotating, self-interrupting, rereading etc. (see [12,17]). Active readers often have a need to search through the text, in order to locate specific words or phrases [20,21]. Generally, this type of reading requires analyzing and structuring large amounts of information from various text sources [17].

TABLE I. READING SITUATIONS

Single text Passive	Enjoying a novel, reading a poem aloud
Single text Active	Studying a textbook or manual, reviewing a proposal
Multiple text Passive	Keeping up with e-mail, browsing the newspaper, surfing the Web
Multiple text Active	Surveying a field, researching a problem, keeping up-to-date professionally

The World Wide Web and hypertext, in particular, have changed the way we read. New technological advances continue to provide more ways of presenting information that allow for a richer experience. Many sources confirm that, if properly designed, multimedia rich presentations not only promote learning (see for example [11,13]), but also have affected the reading of books. For example, company Vook [24] has a product that integrates videos with text (video+book=vook). Potential for classroom use of multimedia applications and innovative interfaces for reading has not gone unnoticed. Recently, in [18], Sharma et al. report efforts to develop software and hardware in order to

turn small classroom PCs into reading and writing devices for children 5-11. This project, even though it is concerned with young students only, has goals similar to what is presented here.

The present article does not discuss technical issues with e-book readers to any significant degree, but rather the use of books or e-book readers as well as the experience of the act of reading using paper based media (mainly books and newspapers) vs. e-book readers (most of which offer the possibility of reading the news online as well). We are interested in a range of topics related to e-book readers: the ways in which they may influence our reading habits, levels of understanding, and how they may be adapted to better suite active reading for specific groups of users such as, for example, students.

Ethnographic studies (observations and interviews) of how people read in different contexts have been carried out. Observations were carried out at the university library, where the majority of users are active readers, as well as public spaces such as bookstores, cafés, busses and trains.

The university library has obtained some e-book readers early on and the opportunity, as one of the authors works at the library, presented itself to observe and interview the users of the library who were willing to try e-book readers. The users of e-book readers were also handed a short questionnaire (see Appendix B) and asked to fill it out. These preliminary studies pointed out in the direction that functionality of the e-book reader needed to be improved in order to better accommodate the needs of an active reader. Additionally, e-book readers were taken to the classroom in the primary school (third grade), to test the device with younger readers. The result there was similar, devices need to be better tailored for the needs of young students.

Focus groups and workshops conducted after the preliminary studies had getting to understand users needs as a goal as well as to gain better understanding of what users do during a typical day at school or university. Mixing of ideas (see [7]) and brainstorming about the future use of the devices was conducted with young users aged 7-8 years. We have attempted to create an interface co-design situation (see [2,3,5,23]). The first prototypes and experiences from these sessions will be presented here. Finally, all our findings are summarized in a future oriented scenario and a set of guidelines for functionality design of e-book readers for students.

The structure of the article is as follows: a short overview of what an e-book reader is, technologies used for e-book readers and a few e-book reading devices are briefly described in Appendix A. Section 1 contains some of our observations, as well as some other research results related to the activity of reading paper based media (books and newspapers).

Section 2 contains the results of observations, interviews and questionnaires we conducted on the use of e-book readers. Section 3 discusses the differences between the affordances two artifacts provide and how those may affect the reading habits in a long run. Section 4 summarizes our

findings from workshops and focus groups in form of a future scenario and design guidelines.

II. READING PRINTED MEDIA

Long sequences of innovations and technological advances have transformed writing from initial carvings on stone, (and later papyrus) to a medium printed on paper. Books themselves have directly affected the development of the society as a significant and primary tool of the mind. As noted in [9], *“Reading itself was for many centuries mainly conceived of as a ruminatio (pondering at length). In the eighteenth century, a new relationship to reading appeared, making it legitimate to browse through vast amounts of reading material. This form of “extensive reading” became pervasive with the advent of newspapers and magazines.”* Today, a new relationship to reading is emerging through the extensive use of digitalized material. People read, world around, both traditional paper and digital material. To better understand the dynamics of interaction between the reader and artifact (whether book or e-book reader), we have conducted ethnographic studies to observe how people read books and other printed material as both active and passive readers.

Short interviews with people reading in libraries, bookstores and on public transportation often yielded unexpected reasons for people’s interest in paper books. For example:

A 15-year-old girl sitting in a café had the “New Moon” book on the table in front of her. As she started to collect her things, we asked whether she had read the book. She said that she had finished and was now rereading it, but more importantly, that she always brought it with her as doing so had started several interesting conversation with people seeing the book and making a comment. “Kind of like you did now”, she noted. She said that she had read all the other books in the series as well and is an active member of several Facebook fan groups related to the series.

In another instance, a 49-year-old woman was walking around, browsing in a small bookstore. After she picked up a large, thick book, she smelled it. We asked why she had done so. The woman said that she does not really know why but that the smell of the book affected her interest in it. For example, she did not like the ones that smelled moldy which she associated with dark cellars. If by contrast the book had “good smell”, she would open it and look through. She also said that she did not do the same with new books. In addition to smell, the title and cover art play a large role in attracting her to the product. She said that she liked this particular bookstore since she could get used books really inexpensively. We asked if she read all of the books she bought. “Not always”, she said, “but I like having them anyway. I think that some day I will have more time to read.”

A 21-year-old male student said that he loves poetry and poetry books because of the poems in them, but also because he may put a love letter or his own poem into them.

Another 19-year-old female student liked the evidence of the time passage linked to events from her life, being visible on the books. For example, she enjoys taking (time and

again) a certain book from the shelf to see the mark of a spilled drink left during a first date.

As examples above illustrate, our general observations found that people have not only varied reading habits but also unexpected factors attached to their love of books.

The following summarizes what was important about paper books to readers we observed and interviewed:

- The smell of the book, in particular in the library and at used bookstores.
- The sense of touch, the feel of the book as one picks it up.
- The quality of the paper. As one subject described, "Touching a glossy page of a book from a photographer, makes me more respectful than reading a novel in a pocket format."
- The size of font and spacing between the lines.
- The weight of the book.
- When the user keeps the book in his/her hand while reading, the grip of the book provides a sense of how far along one has come in finishing the book.
- Cover art (its content, style, quality, texture etc., see also [10]).
- Quickly finding a specific location in the book (through the index, for example).
- Page indexing using post-it notes or other markers give extra functionality to the paper book.
- The ease and speed with which one can move back and forth between pages (see also [22]).
- Notes and underlining done by others in used books is important (and can be experienced as either frustrating or interesting/helpful).
- The amount of wear of the book can affect the choosing of it (see also [5]).
- Sharing a book is important to many readers (not only the actual physical copy but also in discussing the content with others).
- The social aspect of holding and reading a book may be used to communicate a certain message about the reader. "Reading a medicine text book on the bus gives another signal than if I am reading comics," remarked one reader.
- Variety of ways of using books (sometimes not related to reading, such as above mentioned poems holder)

As with other objects acquired in our daily lives, books are chosen emotionally [14]. Both the reading and sensorial experience of the book itself affect our relationship with it. The question was: what happens to all these sensorial and emotional factors related to paper books when they are digitalized?

III. READING THE E-BOOK

In the beginning of September 2009, the library at the University offered to its users the option of checking out e-book readers (SONY PRS 505 and Iliad iRex) thereby previewing the new technology. The interest among library users for checking out the e-book readers was large. Over a 6-month period, the library lent out e-book readers 120 times

with users initially waiting more than a week to get one. Because of the waiting list, students were allowed to use the e-book reader only once. That is to say that there were no repeat users in the sample.

A questionnaire (see appendix B) accompanied each e-book reader, 41 of which were returned completed. Below are findings from the questionnaire:

All respondents (41 users) were interested in reading the university curriculum on the e-book reader.

Approximately half of respondents (21 users) preferred text in PDF format, finding it easier to read.

All respondents (41 users) desired a better framework for downloading e-books from the library into the reader. Six users found the Sony software for communicating between the e-book reader and their computer was difficult to use.

Eight users pointed out that turning the pages on the device was annoying because it took too long.

Six respondents noted wanting to be able to annotate and mark the text on the e-book reader. One person said s/he would want a dictionary included as part of e-book reader software.

- From direct observations of people using e-book readers and short conversations we compiled the list of things they wish for in a new generation of e-book readers. This list is consistent with the findings of earlier studies [11,12,13,17,22]: Color images and text
- Information about original pagination
- Tables of content for each document
- Fixed/standardized layout and page orientation
- Providing a structure to keep similar texts together
- Portability and comfort in use from different positions (sitting, lying down)
- Focus on reading comfort (with clear and large text and the ability to adjust to different lighting i.e. outdoor vs. indoor, daylight vs. nighttime)
- Search capacity (through both the text in use and those available on the device)
- Annotation tools
- Highlighting capacity
- Simplified navigation between documents
- Capacity to interact between different information platform media
- Tools to facilitate collaboration

Many of these items are already supported by the visual and user-friendly format of iPad.

A comment from one participant was interesting: "Iliad shows signs of being designed by engineers who are a little over zealous; it has many functions that work halfway". It in a way summarizes our conclusion: this technology has a far-reaching capacity that, in these first generations at least, has been suggested but not fulfilled. However, e-book readers or similar devices are here to stay. And like it or not, the e-book is not only made for reading on a digital device, but also shapes the reading itself. How the artifacts and actual skill of reading influence and inform one another over time and with different groups of readers is an interesting question to be answered in the future.

IV. DIVERGING FROM THE LEGACY OF PAPER BOOK

It seems from Sections 1 and 2 that books would have a much longer list of “things I love about books” than would e-book readers. However, people are starting to love the new technology as well (see [10]). It is clear that browsing, searching, and powerful annotating (tagging, indexing etc.) provide a clear-cut advantage to e-book readers, at least in active reading and learning situations. To the extent that this advantage is true even within the present technology, it promises to further grow with future advances.

The shift that is about to take place in the e-book reader technology involves its departure from the legacy of the paper book. Admittedly one cannot expect to fold poems within the plastic e-book casing. Nor will one ever be able to experience the level of tangibility offered by books with their weight, size, smell, and other physical properties. While turning pages on an e-book reader may have a sound, most would agree that it is not the same as actually turning the page of a book. So at this stage where e-book readers have in place all of the basic reading functions (inherited from books), they must necessarily depart from these basics and consider the additional affordances of this new digital medium. The e-book reader has the potential to include multimedia presentations, cooperative environments, creative environments related to reading and writing (such as for example interactive writing, hyper fiction, or digital storytelling). Fully personalized, as each owner of an e-book reader will have own selection of books. And technology is available to make all the wishes from the list in section 2 true, and more. Exploring the possibilities is ahead!

As mentioned earlier, with each new technological advance and each difference in the medium from which we read, there are also qualitative changes in the act or reading itself. We have shifted from pondering to hyperlink reading. And writing in the same style. Humorist Carr jokes about his inability to concentrate on a single piece of text any longer, and his lost ability to write. On the other hand, [1] reports that working with e-book readers seem to deepen concentration of the user on the text at hand. Through our observation and interviews, we cannot say anything conclusive about quality of concentration; it would require a much more focused study, which is outside the scope of this research. Whether one is true or the other, it seems that the question about the influence of the new device on the reading quality is in place.

V. FOCUS GROUPS AND WORKSHOP FINDINGS

Two workshops were conducted in September and October of 2009, and two focus groups, in February 2010.

A. First Focus Group

The first focus group was comprised of four randomly selected University students (between the ages of 19 and 32) who were active readers interested in studying the texts they were reading. The main purpose of the group was to hear what students might need or want to see on a device such as an e-book reader.

Findings support that students want something more than the traditional paper version can offer, especially when they are actively reading in order to learn, for example, an academic curriculum. They are willing to sacrifice some of the benefits traditional paper books have in return for the possibility of searching through all of the texts they may have on the reader. As one of the member of our focus group reflected: “It may be disturbing to read texts with links to searchable phrases or external information and be tempted to use them unnecessary, but the gain is BIG”

Results from discussion in the focus group supported a content oriented approach. That is to say within the context of studying and research, the availability of information (the content) is the primary goal. E-book readers have the advantage over paper books of being able to access, annotate, and compile content within a single source – a finding supported by another study conducted at Princeton University [15].

One important advantage of e-book readers is the immediate availability of information. A participant of the focus group noted the advantage of owning one’s own mobile library: “I can move all my books to this device, since I perceive it as a private dings, like the mobile phone. And have them all whenever I need them.”

This finding is also supported by other studies [12,17,15,21]. Worth mentioning here is finding that users bring the e-book reader everywhere and are not afraid of damage or loss as with more expensive devices such as a laptop.

Some participants in the focus group pointed out that they had already tested and used an e-book reader alongside a laptop (like a paper book) when doing homework.

While our users did not discuss the quality of concentration when using the e-book reader, a study, done at Penn State University [1] analyzed student behavior while reading and using e-book readers and found a more immersed type of reading with the latter.

B. Second focus group

The second focus group was conducted in a business setting rather than academic setting. Most participants in this group were passive readers, not interested in reading books with learning as the primary goal. Instead, other functions such as being able to listen to music, take notes, and watch movies were more valued.

A participant, when told what one could do with an e-book reader, said: “So an e-book-reader is like a modern Gameboy to bring on boring trips!”

Another participant said he would consider purchasing an e-book reader if he could easily download the daily newspaper in the morning, the text was easy to read, and the user interface had good navigational buttons.

Another explained his appreciation for pocket sized books, and wished for an e-book reader one could put in a jacket-pocket with the navigational buttons on the back. Regarding the interface, he said: “As long as the text is 12-point and Arial or New Times Roman-style, I don’t really need fancy apps and programs.”

A preliminary conclusion from this second focus group of passive readers was that while interested in the e-book reader, their interest was focused on non-content areas such as platform and the readers use in providing news, entertainment, and pleasure reading in contrast to students who are vitally interested in the content and for whom the platform is less important.

C. Workshop

In addition to the two focus groups, two workshops were conducted at the third grade level (ages 7-8) of the primary school.

During the first session we had a period of observation of how children would use e-book readers (see Figure 1).



Figure 1. Third grade students trying Iliad e-book reader.

The young participants reported a number of problems. They found reading books in PDF format on the e-reader boring, in part because of the content, in part because of problems navigating. Children were frustrated that they could not simply “jump out” of the text and try another. They were comparatively a lot more interested in our supposedly inconspicuous iPhones used to record the session, than at the e-book reader itself.

However, as soon as they were handed paper and color pencils, their interest in drawing their ideas for an interface that would be interesting for them increased dramatically. They spent the remainder of the first workshop vigorously drawing. Students were divided into four groups, each of which was instructed to work on an idea, pre-selected by the children together with an adult mediator. This was an attempt to emulate the mixing of ideas process as discussed in [7,11]. An example of one such idea is shown in Figure 2. Several simple prototypes, one of which is shown in Figure 3, were created and we worked on these together with the same group of children during the second workshop.

Our main findings from this workshop were that working with children in co-design situation is very complex and requires much better preparation and much more time than with adult users. Also, we worked with a too large group of children. At that age the children cannot have long concentration span and they influence each other strongly.

Children were very articulate about what they like and dislike, while working creatively with an idea took longer time to get into. Once going, their fantasy was very inspiring.



Figure 2. Child's drawing of a more visually based interface navigated by clicking on images or text

If the project continues, co-design with children would be the method of choice.

From what we have seen and heard, active readers have higher demands and a longer wish list for good support software on their e-book readers than passive readers do.

However, any item from the wish list changes the e-book reader it into something else, more complex. For example, one “simple” wish for collaboration on projects involving e-book readers could require e-book reader to become an e-writer as well, and ultimately, another communication tool.



Figure 3. Prototype created on the tablet PC.

D. Informing the future design of e-book readers for active readers

Does it make a difference whether one starts from a small PC and makes it into an e-book reader by using appropriate technology for the ease and comfort of reading, such as in [18], or whether one starts from an e-book reader and builds it into a device that also writes, searches, browses, collaborates, perhaps writes hyper-fiction or tells stories? We believe that the convergence will take place. iPad, now widely available, is one possible answer to that question.

From the fall 2010, University Library will test iPads. And iPad is the platform of choice for us to continue working with. This choice is personal; there may be an e-book reader of the next generation that will surpass the iPad. But whatever the platform, there are some general guidelines we will follow in our effort to design e-book reader interfaces better suited for active readers:

- Working with narrower groups of users (for example, active readers, age 7-9, as the use of and

the needs for software change rather quickly at that age)

- Co-designing with users
- Allowing the possibility for end users to participate in the design process

VI. CONCLUSION

Extensive empirical studies have been done on the actions related to reading printed media versus e-book readers. E-book readers at first emulated functionality of the book, but now we see divergence from the legacy of the book. Focusing on active reading, we take a closer look at the design of the future e-book reading devices. In doing so, we have worked with young users in a co-design situation and created the first interface prototype for e-book reader. We have conducted qualitative and quantitative studies with university students who volunteered to try e-book readers. The conclusion of the study is a list of feature users would like to have on e-book readers as well as the set of guidelines continuing towards design of interfaces, better suited for specific user groups.

APPENDIX A

The technology behind e-paper is based on the e(lectronic)-ink developed by Vizplex. Use of e-ink improved the quality of reading experience significantly. A very short summary (see [21] for more details) of how e-paper works: e-ink is like traditional ink in that it is a colored liquid that can be coated onto nearly any surface. Suspended in the liquid are millions of microcapsules that contain tiny, two-toned (dark and light) polymeric particles. Similar to a magnet, the two tones have opposing electric charge. When the e-ink is exposed to an electric field, the particles realign themselves and form crisp text and images. The e-paper uses power only when a page is refreshed or changed ([19]).

All e-book readers consist of an enclosure made of plastic or metal, with buttons to navigate through the documents and to activate the menu. They may have support for USB, memory cards, SD cards, WiFi and GSM communication, touchscreen-interface, audio and have their own web browser. They are usually the size of A4 or A5.

There are many models of e-book readers on the market today. A great summary of devices for reading and the text formats they support is available at Wikipedia e-book readers comparison site [25]. We mention here only the ones used by the library in our study, SONY and Iliad, as well as most fashionable ones today, Kindle and iPad.

Iliad (see Figure 4) is an e-book in A5 format. It came out in mid 2006, has a 8.1 inch e-paper display, and it weighs approximately 0.85 lb. It uses WiFi to connect, and operates on a Linux system. Software developer kit follows with it, allowing users to extend its functionality. One of the more advanced features it has, is the ability to make notes on most of the documents. In 2007 iRex released Version 2, which

has some minor updates, and a Book edition in 2008, which has eliminated WiFi in order to make the reader less expensive.

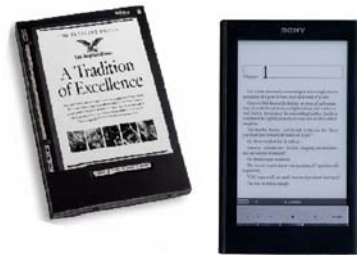


Figure 4. E-book readers Iliad and Sony, used in our study.

Sony has already produced six models of e-book readers. The first one came out in the USA in 2006. The new series of e-book readers, available from 2009, come in 3 different sizes to fit some specific uses. A pocket edition with a 5" screen and navigational buttons, a touch edition (see Figure 4) with a 6" touch screen and a memory card slot and last the daily edition with a 7" touch screen, weighting from 0.5 lb to 0.75 lb. All of the readers have wireless connection through 3G mobile networks.



Figure 5. iPad, iBook reader application.

iPad (see Figure 5) is the newest Apple multitouch tablet, that comes with nearly all the features iPhone has: pretty design in crisp color, a large, 9.7 inches high-resolution LED-backlit IPS display, a Multi-Touch screen and a powerful chip. It weighs 1.5 lb and is 0.5 inches thick.

It is expected to set new standards in functionality and aesthetics. In addition, it comes with iBook application, from which books can be easily downloaded either using 3G or wireless network. Apple claims that the iPad's battery can provide up to 10 hours of video, 140 hours of audio playback, or up to one month on standby [26].

Amazon has released a series of e-book readers. The original Kindle was released in 2007 and the newest Kindle DX was released in May 2009 (see Figure 6). The DX has a 9.7" screen, a function to rotate the picture according to the way the device is held, improved storage capacity and battery-life.



Figure 6. Amazon’s Kindle DX.

The interface is a black and white screen. However, the most interesting distinction is that this 3G version has possibility of access Kindle library from other devices such as iPhone, Blackberry, PC, etc.

VII. APPENDIX B

Questionnaire handed out with e-book readers

We would like to know what you thought about the e-book reader you borrowed from the library. Your input is very valuable to us. It will take only a few minutes to answer the questions bellow. Please return the completed questionnaire to checkout desk at the library at your convenience.

Thank you for your input.

- 1) Which e-book reader did you use? Sony Iliad
- 2) What made you want to try an e-book reader?
- 3) What did you think of the e-book reader? Please comment on the functionality it has
- 4) How did e-book reader function with the resources for your classes?
- 5) What do you think about the library lending out e-book readers?
- 6) Would you care to lend it again?

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