

Ebook - the Missing Link between Paper and Screen

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Introduction

The first electronic books (ebook) have already appeared on the market, e.g. Rocket eBook^{TM1} and Softbook². By looking at these two examples we can describe or define an ebook as a mobile, physical device to display electronic (i.e. digital) documents. It differs from desktop and notebook computers which are still the primary interfaces to electronic documents by its highly specialized interface design that allows a limited set of interaction operations. Though quite expansive compared to paper books, ebooks seem to be successful. It can be suggested that the reason for their success lies in the fact, that the ebook is compared to computer screens and offers several advantages with regard to them. One of the most important insufficiencies of computer displays is the low resolution that causes users to dislike reading from screen. An advantage of ebooks is that they are close to paper books with respect to paging, sequential order, mobility and physical weight. Ebooks can be placed somewhere on the connecting line between the world of paper and screen. Physical properties (display resolution and weight) provided by hardware technology form the basis on which the ebook as a new personal artefact can be developed. Given these foundations the major research implications lie in the interface design, i.e. to bring usability to electronic documents which is yet lacking.

Related research areas

To get a deeper insight to this question research concerning reading from screen, comparing paper and screen, hypermedia and new interfaces for electronic information has to be taken into account. Each of these research areas throws a different light onto possible approaches to improve the usability of electronic documents.

Reading from screen

A broad overview of the empirical literature about reading from screen is given by Dillon [Dil94]. The assessment of reading from screen can be measured by outcome (reading time, accuracy of recall etc.) or process (eye movement, manipulation etc.) variables. The results of most empirical studies are contradictory and not comparable due to different methodologies and materials. Most of the studies date from the eighties and early nineties using inferior hardware (from today's view). However, basic ergonomic issues like flicker, image polarity and anti-aliasing made their way to improve today's displays. Although reading textual information from screen is part of every office jobs, only a few authors have bothered with layout principles [BMO92, DK98] and the same holds for ergonomics of typeface or size [TBH95, HY96, GC96]. On screen white space and margins, a major typographic tool, are playing a minor role (cf. [KL95]). This is one reason why readers prefer to read from print out. What can be taken from research with respect to ebook development is to group influencing aspects into technical, presentational and interactional that can be addressed separately (cf. [Mut96]). With regard to assessment we have to be careful to define a set of standardized tests to guarantee comparison.

Paper vs. Screen

The use of paper as a knowledge storage has a long tradition. Over centuries techniques concerning layout and manipulation of information were developed. Comparing a medieval hand-written book with a modern one shows that still the same principles are at work. School education concentrates a reasonable amount of time in teaching reading and writing, mostly based on paper artefacts. We use paper to acquire, provide and modify information. Spatial location, time sequence, frequency of occurrence and word meaning are automatically encoded into memory [HZ79]. As automatic processes they only need minimal energy from our limited-capacity attentional mechanisms. This incidental memory can be effective as a mnemonic device [Roth71]. Lovelace and Southall showed that content recall was reduced by scrolled text presentation [LS83], the most frequent mode on computer screens. It is remarkable that ebooks by using paged presentation (e.g. [SchGP98]) come back to a characteristic of printed text. Electronic text does not provide a global perspective, i.e. relating parts of text with respect to physical position and logical role (cf. [Fre94]). Forming a mental representation is therefore difficult. This effects even writing where a lack of global view has to be compensated by reviewing a paper version (cf. [HH88]). Paper documents have as well some social connotations as shown by Sellen and Harper [SH97]. Exchanging print outs for review, collaborative modifying and personal delivery of documents can be used to foster social contacts and relations.

¹ www.rocket-ebook.com/Products/Tour/index2.html

² www.softbook.com/softbook_sys/consumers_sb.html

The first application areas of electronic documents were on-line help systems and technical documentation (cf. [Lan94]). Typically only a small text part out of a huge document is needed. Search and retrieval facilities give quick access to information that, printed out on paper, would fill an office room. Text processing software, beloved because we do not have to rewrite a whole document when discovering an error, produces temporal electronic documents; as indicated by the acronym WYSIWYG, print out is meant as the final result. Support for active reading, i.e. reading, marking and annotating (cf. [SchGP98]), is hardly found in electronic document software. Some hypertext applications offer to put comments into a separate window and text processing software can be operated in review mode at the cost of complete change of text appearance. Powerful management and processing of information dominates software features, ignoring simple layout rules and manipulation requirements. The following table lists some relevant differences between paper and screen.

Aspect	Item	Paper	Screen
technical	physical quality	weight, mobility, tangibility	virtual
	interaction media	hand, fingers, pen	keyboard, mouse
	reading location	free	fixed by place of computer
	persistence	centuries	max. decades
presentational	presentation unit	page	variable (window)
	layout	fixed/static, margins	variable, margins rarely
	personalization	none	application depend
	number of parallel presentation units	several	1-2
	structure	sequential	application depend
	implicit cues	page size, thickness	application depend
	media	text, picture, diagram	text, picture, diagram, video, audio, embedded application
interactional	navigation	backward, forward	application depend
	editing	adding freeform notes anywhere	keyboard and mouse in editing areas
	search and retrieval	'good memory'	application depend

Table 1 Comparison Paper vs. Screen

Hypermedia

When talking about electronic documents we can not limit our view to text and pictures or diagrams. An electronic document may consist of several media types (e.g. video, audio, interactive embedded application). These media may appear within one presentational unit or in a separate one that is linked to the origin. Orientation problems in hypermedia documents are well known (cf. "to be lost in hyperspace" [Con87]). Facilitating navigation is therefore a major research topic (e.g. [ThHH95, McDST98]). The fact that orientation problems already appear with continuous text on screen (see above) is often overlooked. The idea of hypertext initiated by Vannevar Bush and continued by Douglas Engelbart and Theodor H. Nelson builds up a network of knowledge and information, searchable and retrievable from anywhere at any time. By the World Wide Web this idea has become true in a way. For knowledge workers hypermedia offers the possibility to organize and manage information of different kind supported by elaborated computer tools. However, information management (i.e. structuring and hyperlinking) has to be strictly separated from information presentation.

New interfaces to electronic documents

The incredible growth of the WWW forced the development of new interfaces for electronic documents like the book space [CRY96] or the zooming browser [BHS+97]. The exploration of electronic document presentation has led to 3D-views (e.g. [Ren95]) and dynamic presentation [Won96, BB98]. The reason for leaving traditional 2D-interfaces can be found in the limited space the computer screen offers for displaying information. To overcome the small PDA-screen Kamba et al. used semi-transparent control objects successfully [KEH+96]. However, semi-transparent and layered interface objects require focused or divided attention that can affect mental load [HIV+95]. On the other side advanced presentation principles for documents can lead to new insight into literature as had been shown by the "Virtual Shakespeare Project" [Sma96].

Building the bridge

The form factor of an ebook is much closer to paper books than to desktop computers. However, as long as there are no physical pages to turn over, which might be possible in ten years (cf. [JCT+97]), we have to deal with the major restriction of screen: only one display. By its physical and computational properties the ebook builds a bridge between paper and screen that is more than a simple connecting line.

Preparing the ground

What do we want to offer by an ebook? At first place reading should be as effortless as on paper. To support readability, i.e. to help the reader to easily comprehend the text, the use of conventions for layout and structure is a major precondition. Simple and consistent typographic cues, below conscious notice, provide orientation and structuring. Different reading styles (skimming, scanning, searching, receptive reading, critical reading, cf. [Loi91]) require an adaptive interface that provides dynamic presentation as well as stylus and touch input. Stylus based interaction has to be as natural as pen and paper, e.g. pressure sensitivity and erasing by turning the stylus (cf. Wacom Intuos Pen³). The basic design of an ebook consists of a lightweight, high resolution, touch sensitive display of letter or paperback size, a stylus for freeform marks and notes, and some buttons with predefined function (e.g. zoom in/out). As a personal artefact the user will expect an integrated organizer (calendar, address book, notebook) (cf. [WSchS97]). Precondition to hypermedia capability is a color display. The ebook will be regarded as the most convenient interface to electronic documents because it makes information from internet, desktop computers or PDAs available, allows input of personal marks and notes, and supports the management of a personal information space by one specially designed interface.

Balancing

The key to a usable interface is a proper balance between the qualities of paper and screen. For paper these are for example static presentation, freeform notes and marks, flipping through and glancing. Hyperlinking, elaborated management and retrieval functions, and dynamic media capability are some of the most important screen qualities. With regard to document presentation this implies to balance a) static (derived from paper) and b) virtual (derived from screen) properties.

a) Static properties are provided by introducing the principle of *texture*, i.e. a fixed division of an electronic document into presentation parts, that makes it possible to estimate document length and relative position. Implicit cues, valid for all documents, assure basic orientation. How important this feature is can be demonstrated by the following observation. Readers normally do not confuse paper and electronic documents. However, with Postscript- and PDF-documents some people cannot decide whether they read the text from screen or from paper. *Texture* - in case of Postscript and PDF it means fixed page layout - is a way to use automatic memory encoding (see above). In imitation of the WYSI... acronyms the texture principle could be called WYSIWITIS: what you see is what it is.

b) The use of virtual presentation principles is needed to overcome the restrictions of only one available display. A combination of a virtual desktop, semi-transparent layers and zoom makes navigation in and between documents possible in a natural way. An example makes this clear. You take up your ebook to read a magazine article. On your virtual desktop you see a collection of books and magazines; by selecting the magazine you zoom into the contents list where you select the article. Zooming has a double meaning within the virtual presentation: first it means scaling and second following a hyperlink. Zoomed into the article you go through the pages until you find a remarkable statement which you annotate with a half page of handwritten notes. The annotation is written on a semi-transparent layer with the statement in the background still visible. On paper you would have run out of space for the lengthy note but the virtual desktop allows to "tunnel" the document dimension. When finishing the annotation the note layer will zoom out into a thumbnail representation. All zoom operations are dynamic (growing, shrinking) and the time component has the advantage of automatic memory encoding (see above). Dynamic presentation is well known from TV and we are already adapted to it. Semi-transparent layers ensure contextual relations when following hyperlinks and they are the best way to display control objects and dialog components.

By merging paper and screen qualities we will derive new properties that are yet unexplored. Hyperlinking, for example, should be possible between any information bits saved in the ebook, without regarding the media type. Handwritten notes should be integrated into the search and retrieval facilities. Glancing could be supported by dynamic document viewing (cf. [BB98]), that extracts or highlights major phrases and paragraphs.

On the other side

The development of the ebook is the first serious approach to make electronic documents usable, i.e. available for active reading. Long before the ebook becomes a perfect personal artefact it will influence the design of desktop computer interfaces, which lack a natural interface for the whole scale of document manipulation (from writing to marking). At the

³ www.wacom.com/productinfo/accessories.html

end several ebooks might build together with other specialized artefacts the interface to a distributed ubiquitous computer that manages ones personal information space. A cheap ebook might even take up social functions from paper like lending, sharing, exchanging. Meanwhile a seamless transition between ebook and desktop computer is needed for document and note exchange.

Conclusion

In the information age reading and writing as culture technologies grow in importance. Though we can look back at more than 35 years of computer supported document processing, paper is still the preferred media for reading. This is not only due to insufficient hardware but also to unsatisfactory interfaces and presentation principles. Research has discovered some important aspects. Nevertheless it cannot offer definite answers to the usability of electronic documents. The ebook as a lightweight, mobile, personal artefact is the first sincere step in the development of usable interfaces to electronic documents. A balanced contribution of paper and screen qualities make the ebook a unique tool to handle ones personal information space and to fill the gulf between printed and digital information.

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Birgit Lemken holds a master in Computer Science from the FernUniversitaet Hagen, Germany. She is working as a research assistant within the project group ProSEC (human computer interaction and CSCW) at the Institute of Computer Science III, University of Bonn, Germany. She was member of the project group 'Virtual University' at the FernUniversitaet Hagen (Germany's distance teaching university). Her research interests cover human interfaces to electronic documents, hypermedia modeling and presentation, ergonomics of interface design and computer supported group work. Her interest in the design of human interfaces to electronic documents comes from the experiences within the project 'Virtual University', where hypermedia course material was provided by WWW and students were meant to work through their material on screen. At the moment she analyses the role of electronic document interfaces in computer supported group work.

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