



BINDING

THE ELECTRONIC BOOK:

Design Features for Bibliophiles

ABSTRACT

This paper proposes a design for the electronic book based on discussions with frequent book readers. We adopted a conceptual framework for this project consisting of a spectrum of possible designs, with the conventional bound book at one difference pole, and the laptop computer at the other; the design activity then consisted of appropriately locating the new electronic book somewhere on this spectrum. Our data collection consisted of a web-based survey and two focus groups, all of which used a set of questions based on five human factors, to collect information on the opinions and practices common to graduate students in English and other frequent readers. Our goal was to identify features considered crucial by frequent book readers. We addressed the goal of incorporating these features by developing an electronic book design called the Bi Sheng, which attempts to accommodate the significant features of conventional books while adding functionality derived from the electronic form of the text.

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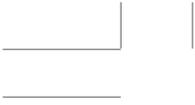
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INTRODUCTION

The electronic book and electronic book reader have not yet been widely adopted by the majority of frequent book readers. This paper addresses the question of what an electronic book might look like that would appeal to this demographic. We ran a study with frequent book readers, in an attempt to gauge their reaction to existing e-books and e-readers, in order to identify what elements they consider crucial in the reading experience. We found that frequent readers would reasonably wish to retain the familiarity and benefits of regular book-reading that they have enjoyed, but would be interested in a technology that added still more benefits. In response, we propose a new design for the electronic book, the Bi Sheng,¹ which will combine the pleasure of book-reading with the flexibility of the e-book and e-book reader.

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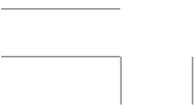
Although he aptly concluded, in 1992, that manipulating electronic text was still more difficult than manipulating paper, Andrew Dillon also proposed that there might be better ways to organize information. However, by the time the second edition of *Designing Usable Electronic Text* (2004) appeared, Dillon's assessment on paper preference and usability had not really changed. He claimed that research still "suggests that paper is by far the preferred medium for reading"



and that transferring texts to the "electronic medium is insufficient and often detrimental to use" (p. 4). The book is not a limiting form, he argued; one could argue for "paper being the liberator as at least the reader always has access to the full text" (117). Proposing a way to shape the electronic text for greater Human-Computer Interaction (HCI), Dillon suggests the TIME framework (task, information, text, and ergonomic variables) in an attempt to work with readers' tendency to impress structure on information (p. 126). For the purpose of our study, we look to a skill which is learned early and is easily transferable – text manipulation (p. 139). Manipulating paper and pages is a crucial and familiar aspect of interaction with a text; any attempt to create an electronic book for the frequent reader must, in some form, reproduce this (p. 179). Because electronic texts, especially e-books and e-book readers, have yet to provide the visual and tactile affordances provided by paper texts (e.g., the two dimensions of the electronic book give no indication of text size, content quality, age, or usage (p. 125), an electronic book which provides those elements would serve as a mid-point between the useful familiarity of the paper text and the potential of the electronic. The Bi Sheng would provide what Dillon (2003) calls for: an e-book reader with a "richer sense of user experience, one that allows for aesthetics as much as efficiency" (p. 68).

A VERSION HISTORY

In the year 2000, D.T. Max looked back at the already cooled e-book industry, recollecting in "1994, when I first reported on the proposed electronic-book industry, I drank a lot of cappuccino with pony-tailed men who quoted Marshall McLuhan. That was a more interesting time in e-book history" (p. 20). Six years after Max's melancholic reminisces, we still do not have a practical, workin and, more importantly, commercially successful electronic book. E-book readers as unique physical devices have existed in the popular imagination for at least fifty years, in part fueled by widespread interest in burgeoning technologies, and in part through the influence of various science- fiction treatments. *The Hitchhiker's Guide to the Galaxy series*, for example, marks a significant point in the fictional life of the electronic book, featuring as it does a book that contains relevant information on every topic of interest in the known universe – a kind of futuristic implementation of the Renaissance wish for a compendium of all knowledge.





There have also been periodic attempts at producing commercially viable e-book readers. Early attempts date at least to the late 1960s, with Alan Kay's Dynabook. Later entries include the Sony Bookman of the early 1990s, and the Rocket eBook, the SoftBook and the EveryBook in the late 1990s. These e-book readers were, however, more like computers than books. Although these devices found markets among readers of technical documentation and technophiles, they have all but disappeared from the marketplace. In 2004, Sony introduced the Sony Librié (EBR-100EP), its first electronic reader, which featured E Ink's electric paper as a reading surface; however, the Librié's inability to store files for more than 60 days (based on copyright restrictions which Sony calls Open MG) and exclusive use of BroadBand e-Book, Sony's own proprietary format, made it impossible to import any other form of documents or store any file indefinitely (Lewis, 2004). Also released in 2004, Panasonic's SigmaBook² was revolutionary, with its two screens and (although it also had restricted titles) ability to download texts from a secondary source: 10 Days Book. At twice the weight and size of the Sony LIBRIÉ, Phred Dvorak (2004) argued that the SigmaBook was simply not user-friendly: it had no internal memory, required different software to read text from different sources and suffered from sluggish screens with poor contrast. Sony's Portable Reader System (Sony Reader PRS-500) is one of the latest efforts to create a viable e-book. David Pogue (2006) praises the advances made with the Sony Reader, especially noting how its E Ink screen provides a pleasant and natural reading experience. Its problems lie in the screen's refresh cycle, page size, counter-intuitive controls, and lack of search function. Pogue forecasts that the Sony Reader will find a niche market, but concludes that the masses may still continue to prefer the freedom and familiarity of "p-books."

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According to Nick Bogaty, executive director of the International Digital Publishers Forum (IPDF), the market for electronic books has seen a steady thirty to forty percent growth for many years. However, the total still represents less than one percent of the overall book industry (quoted in Bradbury, 2006). The cost of existing e-books presents difficulties for some libraries, as well as for private readers. Clyde Laurel (2005) argues that the ongoing licensing fees of e-books present formidable problems, including annual payments and subscription upkeep; at the end of the day, libraries own nothing physical (p. 45).



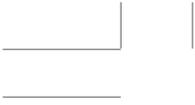


Although research aimed at making e-book readers work better will necessarily improve existing technologies, ultimately, the electronic book, one which seamlessly combines the e-book and the e-book reader, has yet to succeed because it has yet to be produced. The designs are not working – people already have little laptops (with a 7.2 inch screen and weighing in at just above two pounds, Toshiba's *Libretto* was a reading surface and a laptop), so thinking in terms of making the book into a computer has not worked. Another option seems to be moving readers back to the broadsheet, scratching the book out of the equation entirely, and embracing the single sheet of e-paper. Tiny black and white microcapsules are suspended in a liquid and laminated between a clear electrode, and an opaque one. When a charge is applied, the black or white capsules move to the top or bottom of the sheet, creating patterns and text. E-paper is light, flexible, maintains a long-charge, and doesn't require back lighting. Well-marketed by the E Ink Corp, paper is a fantastic development in displays³; however, especially for heavy readers, a sheet of e-paper does not a book make.

Harrison (2000) concludes that that the two largest factors predicting the success or failure of the e-book are the quantity, quality and cost of content material, and the "feel of reading compared to that of traditional books" (p. 38). Kozak and Keolelan (2003) note that critics of the e-reader are right to argue that current e-readers are hard on the eyes, are one more thing to buy and learn and "lack the tactile appeal and 'atmosphere' of conventional books" (p. 295). Robert McCrum speculates that, until the geeks and entrepreneurs can invent something that "looks like a book, feels like a book and behaves like a book," frequent readers will continue to savor that which they already love – the book. E-books and e-book readers have yet to succeed because producers have yet to fully incorporate the familiar pleasures of reading into the design (Ruecker, 2006).

The goal of our study was to bring the readers' emotional, tactile and practical needs into focus, and to design an electronic book which mimics, as closely as possible, the reader's relationship with the paper book while providing the benefits and functionality of the e-book reader. Our proposed electronic book, the Bi Sheng, is designed for those who like to, need to and will continue to have a relationship with books.



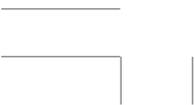


PRIMARY RESEARCH

In order to develop an electronic book that would be more attractive to frequent readers of conventional books, we needed to determine what kinds of features these readers consider essential. A research project was therefore developed that used a web survey and two focus groups to elicit comments about books from frequent readers. The cohort consisted primarily of women between the ages of twenty-six and fifty, with at least one university degree. Half were currently graduate students. There were a total of fifty-eight respondents to the survey, of who seven were also focus group participants. The sample size used in this study gives approximately a ninety-five percent confidence level with a plus or minus ten percent sampling error, given that the majority of participants tended to agree on key opinions (Salant, 55). In general these readers preferred books to other media, although they tended to spend slightly more time reading from the monitor than they did reading from books. They bought nearly four books a month on average for themselves and borrowed twice as many again. They had fairly large personal libraries, with three-quarters of them owning more than two-hundred books at home; their work or office libraries were smaller – more than half had fewer than two-hundred books at the office.

SUMMARY OF RESULTS OF PRIMARY RESEARCH

The results of our study illustrate the depth of the reader's close personal and professional relationship with books. While appreciating a good scholarly apparatus, these readers interact with books out of professional necessity, for escape and relaxation and enjoy them as recommendations. In physical terms, the participants liked handling books, collecting them and re-reading them, in some instances leaving marks on them. The Internet text was seen as either utilitarian or escapist; participants were willing to read short passages off the monitor, but printed longer documents for both reading and retention. Portability and ease of reading were key elements in their reading enjoyment. They enjoyed the smell, feel and shape of books, turning and marking the pages and the weight and feel of books in their hands while they read. In addition, some pointed out that books are portable, comparatively cheap and relatively permanent. Our research subjects regularly read newspapers,





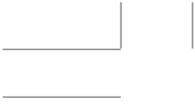
Web newspapers, comic books, magazines, E-mails and CD liner notes. Although photocopies offered the opportunity to mark up text without the danger of guilt, electronic media were preferred for functions, such as searching, scanning, quick answer, fast access and retrieval of the most up-to-date references, books remained part of these readers private and social lives. Respondents expressed doubt that they would ever prefer an electronic book or an electronic book reader over a regular paper book; however, the e-book they would chose would be one which was physically as close to the conventional bound book as possible while retaining the advantages of electronic text.

IMPLICATIONS FOR THE DESIGN OF THE BI SHENG ELECTRONIC BOOK

The Bi Sheng should:

- look and feel like a light, compact and waterproof book with reflective pages.
- provide the ability to annotate individual pages and to mark them with bookmarks or Post-it-type notes.
- be comfortable to hold while sitting or lying down reading and light enough to hold comfortably in one hand.
- incorporate some organic element – a wooden box, a cloth cover, or an earthy smell.
- accommodate any material currently available in conventional bound form, including fiction, nonfiction, scholarly apparatus, illustrations and large print.
- display an individual cover with author, title, cover design, indication of genre, blurbs, reviews and information as to whether the book is part of a series.
- offer a variety of sizes and shapes.
- be interactive and searchable, and allow for scanning, quick answer, fast access and retrieval of the most up-to-date references, as well as a dictionary.
- operate silently with a long battery life; include a mechanism whereby reading can be easily suspended and resumed.
- have files that are retrievable onto a computer.
- provide two formats: one for permanent storage as part of a collection and another for ease of overwriting and reuse.
- allow for collection, display, searching and annotation of short documents tailored for that purpose by the user (i.e., course packs).
- not exceed their conventional bound equivalents in price





PROTOTYPE: THE BI SHENG ELECTRONIC BOOK

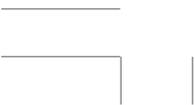
The design solution involves three parts: the book itself, the printer and the software. The design features of the book have been divided into two levels: basic and advanced. The basic features are fundamental – the design would be a completely different solution without these items. The advanced features are also very important in that they include many of the functions by which the electronic book distinguishes itself over the conventional book.

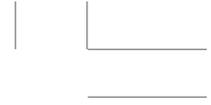
BASIC FEATURES

Each Bi Sheng book will be printed and assembled by the user as required, using a laser-like printing device which will also serve for subsequent disassembly. A book consists of several signatures, bound to each other by a tongue-in-groove strip that forms the spine of each signature. The back faces of the strips on the signatures together form the spine of the book. The number of signatures required will be determined by the length in pages of the longest title store.

The result is a book which will be as thick as the number of signatures required. Once the signatures are assembled, upper and lower boards are attached by means of the same locking system, and a cover image is loaded into the boards and spine. Signatures are advantageous in that they provide additional strength and stability to a book, as opposed to cut sheets which are more apt to be torn loose. They are also easier to bind, since the locking mechanism can be firmly affixed through the punctured stack in a manner similar to that used for Smythe sewing of hardcover books. The locking mechanism also provides points of contact for the leads used to connect the signatures to the computer.

The idea of using multiple pages, rather than a single display screen, may strike some people as too literal an interpretation of the characteristics of a bound book. However, our research suggests





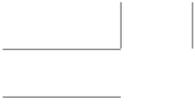
that people feel a strong emotional bond to the form of the book – they are comfortable with an object that has hundreds of pages and a cover. A book without pages forfeits several other functional advantages which were mentioned by participants, including the ability to quickly and easily estimate overall length, and to continuously monitor for proportion completed. Simplicity of backtracking for the purpose of re-reading previous paragraphs or pages is also a factor, as is physical recall of page position and the visual appearance of individual pages of type, which are used by some proficient readers for quick subsequent reference.

The electronic paper used in this model is non-volatile – that is, it will display its contents in a static form for an indefinite period, requiring the application of current only when the paper is being cleared, or loaded with an alternate text for display. The visual flicker caused by monitor refresh cycles is a factor in the irritation reported by many people who have been required to read from a monitor.

E-paper, like that produced by the E-Ink corporation, has a reflective surface which mimics more closely the qualities of actual paper. For instance, the reader would need to provide a light source in order to see the pages, in much the same way a light source is currently required for reading from paper. Ideally, the e-paper should closely mimic the physical attributes of high-quality rag paper. It should have paper-like texture, thickness and flexibility that allow it to bend fairly easily. Ultimately, it should have or display an attractively warm tone, either chamois or ecru.

Another advantage of electronic paper is the comparatively low cost of additional or replacement signatures, which has been estimated by some sources at pennies per page. Although people are willing to own portable electronic equipment, this become a source of anxiety simply because of the replacement cost in the event of loss, theft or damage.





Although it would be simpler and easier to provide a standard blank set of boards to protect the electronic signatures, it seems clear that the particular cover of a given book is an important feature and should not be neglected. This intuition was reinforced by comments made in the focus groups and on the survey, which might be characterized as "apologetic but firm" in the unequivocal statement that covers, however personally embarrassing it might be to make the admission, are important both in the initial choice of a book and in its subsequent enjoyment. Covers serve the function of providing initial attraction to the potential buyer and add to the aesthetic appreciation of the book as a collected and treasured object.

The Bi Sheng therefore comes with a choice of default cover designs, one of which privileges the author and the other the title, and also comes with custom cover designs that would be associated with the currently active title. In order to make this possible, the outside surfaces of the boards are covered with electronic paper that can display in color.

The spine of the book is formed by the outer surface of the locking mechanism on the signatures. Its perforce consists of a series of strips running the length of the spine, with small seams between the strips. The software must divide the spine image for display on these strips.

The first feature necessary in order to provide any kind of interactive processing is a power source. The basic design assumes that power is applied at the time of printing. The Bi Sheng could also come with an AC adapter, a rechargeable battery, or solar cells.



Each page of electronic paper is wired through the signature binding strip

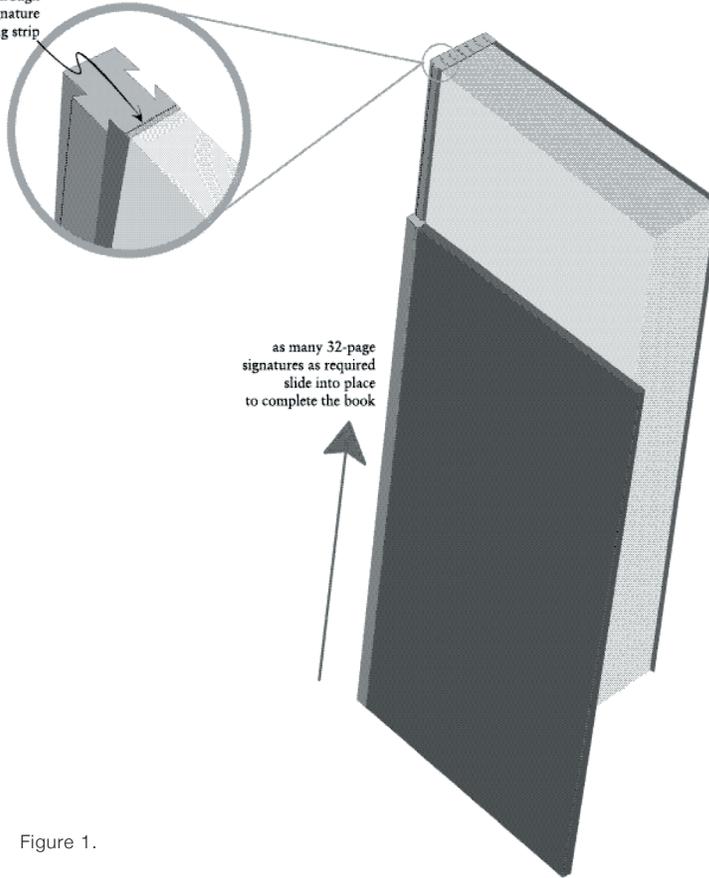
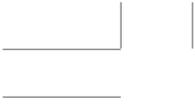


Figure 1.



ADVANCED FEATURES

The Bi Sheng should have the ability to store additional texts for subsequent display without reprinting. These titles are listed on a special multi-book contents page in the front matter, which also has triggers to change the display from the currently active book to one of the alternate titles. The storage mechanism for the multiple titles could be kept in one of the boards. It would also be possible to provide a mechanism for storing and loading alternate titles in a removable cartridge which would in turn be loaded from the computer.

The primary disadvantage of this option is that occasions will inevitably arise on which readers want to store books that vary in length from each other by more than a few pages. The simplest solution is to allow collections of books of any length, and determine the necessary number of signatures in a given assembly by the number of pages in the longest title – regardless of whether that happens to be the title that is chosen as the currently active one at the time of assembly.

The reader who chooses to assemble this kind of collection will naturally be forfeiting some of the advantages of a multi-page electronic book, in that the physical length will be an accurate indicator of overall length only in the case of the longest title and those closest to it.

There are a couple of possible strategies to alleviate this problem. One is to allow the reader to generate anthologies (see below). Another is to have the last page in a particular title marked along the edges with a dark strip, in order to indicate where a given display ends.

In addition to being able to store multiple titles within a single electronic book, the Bi Sheng should also allow the user to collect short documents together into a single title. This feature is particularly important for graduate classroom use, where students and professors routinely refer to items from course packs, which are collections of photo-copied material originating from fiche, conventional printed sources and the Internet.





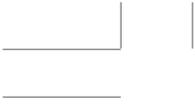
The Bi Sheng also includes a search function that uses a text search for the currently active book, in order to produce an index of successful matching text strings. There are basically two options for providing the Bi Sheng with the search string. One possibility is to allow the user to print the search string using the digital stylus, and to have the software interpret the handwriting in much the same way that some PDAs read writing. An alternative is to have the user type on a miniature keyboard displayed on the touch screen.

Adopting the model of marginalists in conventional books, who read pen in hand, each bound Bi Sheng will come with an electronic stylus that allows the reader to write digital remarks directly to the pages of digital paper. In laptop-based design, a single stylus would of course be adequate, but in the case of the Bi Sheng, it is possible to print an indefinite number of books at the same time, and each book would require its own pen, which would be stored in a slot in the lower board.

The reader's annotations, underlines or illustrations – in short, any marginalia or page marks of any kind – would be stored in conjunction with the text on display, so they could be retrieved again when the text was subsequently overwritten with an alternate stored title, then redisplayed. The printer also allows the user to upload the contents of the Bi Sheng back into the computer with annotations intact.

The need for a mechanism to accommodate annotation arose both in the focus groups and in comments made in the survey. One possible advantage (suggested by the focus group participants) of having the annotations stored and later copied back to the computer, is that people might be able to begin exchanging annotated versions of texts, either through E-mail or via the Internet. On a commercial level, it may even be valuable to have available for resale some of the electronic copies that have passed through the hands of domain experts or even celebrities.





In order to facilitate several of the advanced features, it would be a reasonable solution to incorporate their interfaces into specialized pages in the front matter. This location allows the body of the book to serve as a working surface, whereas placement in either of the boards or as an appendix would tend to require the reader to work at a table, in order to keep the entire book comfortably balanced.

In addition to the standard table of contents page, for example, there would also be a table of stored titles, with a thumbnail version of each cover shown next to the matching title. In order to unload the current title and load one of the stored titles, the user would activate the thumbnail by touching it with the end of the stylus stored in the lower board.

The specialized pages in the front matter would provide the other advanced features which require an active interface and text analysis programming. The search analysis, for example, would display keyword in context, number of hits and matching page numbers. It could also highlight keywords within the text on a given page.

The Bi Sheng should be able to display books from any existing application, in much the same way, that a laser printer can handle text from a number of applications. Like a laser printer, the Bi Sheng printer would accept pre-formatted text – in this way whatever formatting decisions are required can take place while the text is still on the computer, rather than once the titles are loaded into the Bi Sheng. Font changes, for example, would be made prior to printing, rather than after, and the required display fonts would be downloaded to the Bi Sheng along with the text. The Bi Sheng software will install a custom printer driver to output the application's content to an XML-based format, which is then transferred to the Bi Sheng printer.

DESCRIPTION OF THE PRINTER

The Bi Sheng printer is physically and procedurally modeled on a standard laser printer, although users can not only download texts from the computer to the Bi Sheng, but can also upload the Bi Sheng contents back into the computer in order to preserve annotations and other stored material prior to disassembly.



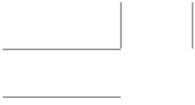


The printer consists of a large compartment with a lid, which is in turn divided into two parts. The first part contains a rack where the unwritten and unbound signatures of electronic paper hang from the ends of their binding strips. It also contains several pairs of unattached upper and lower boards, which are similarly suspended. Each upper board contains non-volatile memory for storing books that will be available, but will not currently be displayed. Each lower board contains a battery pack for use in changing the current book and also for use in functions such as searching and annotating. The second compartment of the printer is the holding rack. It is used during the printing process to hold the parts of the book currently being assembled. It is also the compartment where the user places a book for unloading and disassembly. Once the book is completed, the user opens the lid on the holding rack and removes the completed book. An alternative would be to have the book ejected from the printer, in much the same way paper is ejected from a conventional printer. Since the books will be of variable thickness, however, and since in any case the user needs somewhere to put books for disassembly, a static rack with a lid seems preferable.

CONCLUSIONS

Current research on e-books illustrates interest in improving the design. Although the research done through E Ink and Plastic Logic brings us closer to the kind of light, waterproof, reflective e-paper that makes electronic reading easier on the eyes and cheaper to produce, companies such as Sony have yet to take the needs and experiences of reading longer texts into their designs. The Bi Sheng stands at the mid-point of these varied approaches. Merging what works with current e-book readers with the improved navigation proposed by Paiano and Pandurino (2004) and Sun, Harper and Watt (2004) and adding the technologies currently produced by E Ink and Plastic Logic, the Bi Sheng finally brings the reader into consideration, suggesting, as Back et al. (2001) have, that the form of the text is inextricable from the meaning. For the e-book to make sense, it must preserve the affordances of the conventional book while embracing the unfulfilled promises of the e-book.





The Bi Sheng, along with its printer and software, is an attempt at the design of an electronic book for frequent readers. Plastic Logic is currently using a kind of inkjet printer which can serve as a prototype for the creation of the Bi Sheng desk top e-printer. Combining their plastic electronics with the electronic paper produced by the E-Ink Corporation should make the production of the Bi Sheng possible. The text can be erased or overwritten, and the signatures detached from each other in the printer so that the book is disassembled for reuse. It can be searched and annotated using a digital stylus. It can, in its deluxe form, store more books than it currently displays. The cover and spine can contain designs specific to each title, in much the same way conventional books feature cover and spine designs. The titles would be created by standard computer layout programs and printed to a format that the book can display. The Bi Sheng could therefore display fonts and graphics in a manner similar to the conventional bound book. Its physical thickness can represent the number of pages in the largest title currently stored, and readers can mark their spot with a slip of paper, or can judge proportion remaining against total length at a glance or touch. Rather than telling readers what they need and want out of an e-book, the Bi Sheng is a response to readers' needs and proposes how we can change technology to fit our lives, rather than changing our lives to fit technology.

ENDNOTES

1. The prototype is named after the 11th century (Song Dynasty) inventor of moveable type — Bi Sheng.
2. Panasonic's Words Gear e-book Reader, which promises approximately six hours of battery life, 1024 x 600 resolution, and a 5.6-inch full-color panel, is scheduled for a November 2006 release to the Japanese Market (Ricker, 2006).
3. E Ink's electronic paper is currently being used as part of the Sony Reader, as the display screen for the Weather Wizard and as a display for train information in Berlin.



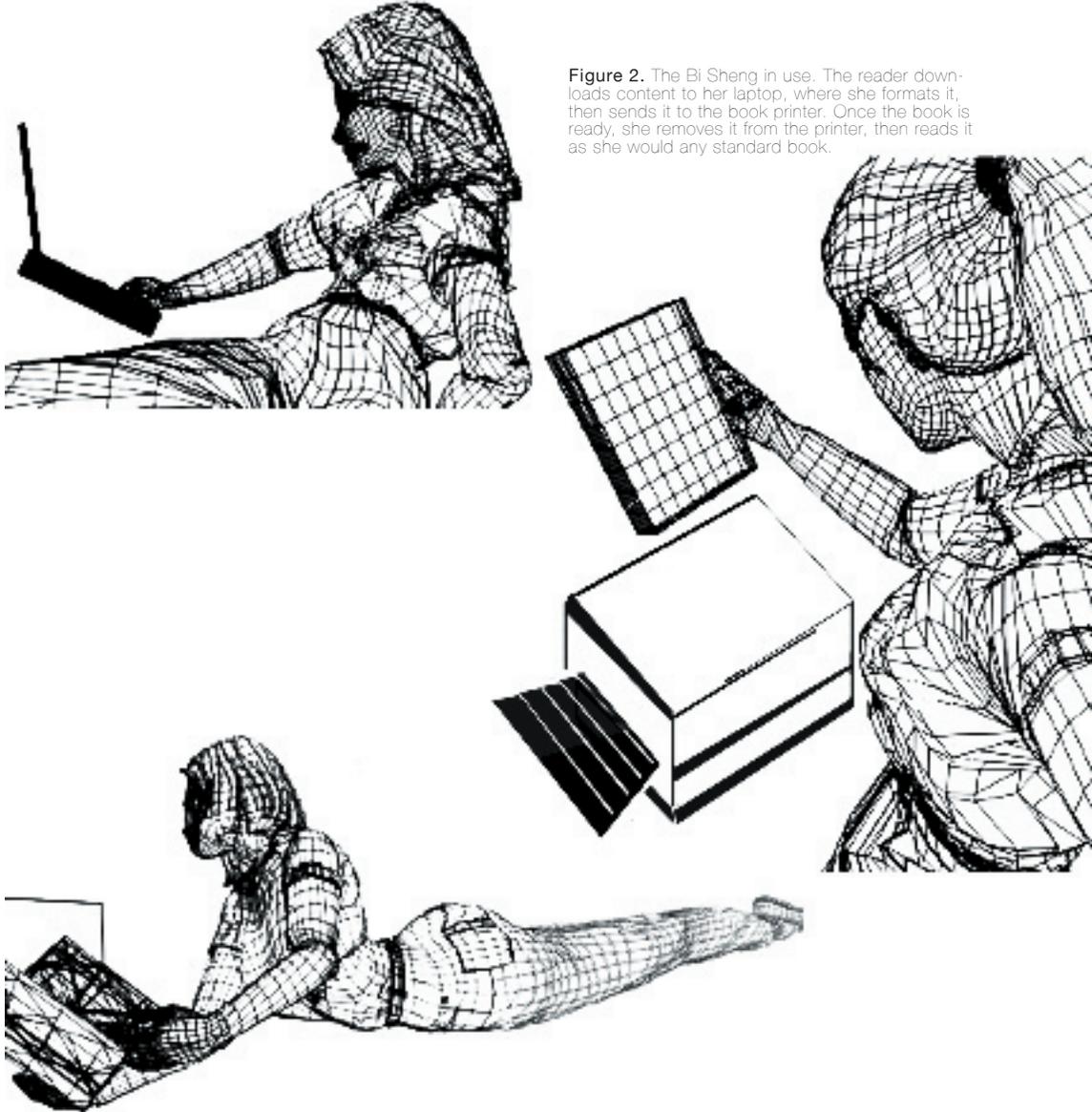
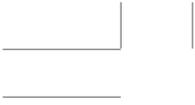


Figure 2. The Bi Sheng in use. The reader downloads content to her laptop, where she formats it, then sends it to the book printer. Once the book is ready, she removes it from the printer, then reads it as she would any standard book.



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