From scroll...
...to codex...
...and back again

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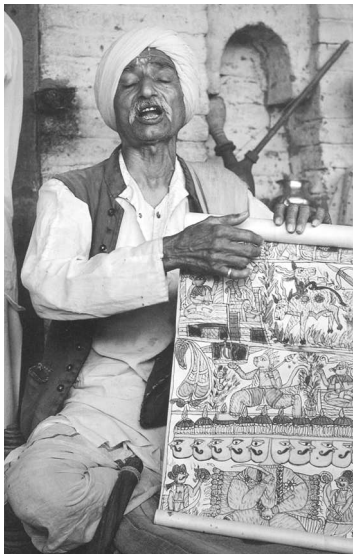
After losing everything he had, including his four brothers and himself, Yudhishthira staked and lost his wife Draupadi to the spiteful and dishonest Duryodhana. On Duryodhana's orders, Dussasana his brother dragged Draupadi by her hair, into the courtroom. The Kaurava then proceeded to disrobe her. Dussasana began to unravel her sari. It came away easily. She was not trying to defend herself. The horrified audience looked on. Then a miracle occurred. Dussasana was pulling at the cloth and it was simply getting longer. He used both his hands and pulled. Still the cloth kept feeding his hands. He could not pull it off completely. The pile of cloth grew and grew by the side of Dussasana, whose anger was mounting. All the colours of the rainbow gleamed from that heap. Dussasana was tired. He could no longer continue the disrobing of the woman. At last, exhausted, he gave up and sat down, with frustration written all over his face.[1]

The events that followed the game of dice between Duryodhana of the Kaurava house and Yudhishthira of the Pandav house, narrated in the Mahabharata, the Indian epic written in the 6th-7th century BC.

[1]Kamala Subramaniam (1997) *Mahabharata,* Bharatiya Vidya Bhavan, Bombay, pp170

From scroll ...



Storyteller from Rajasthan

The noun 'scroll', meaning a rolled-up parchment or paper, is originally associated not with 'roll' but is derived from 'scrow' meaning to write; it follows that the verb 'to scroll' – much in use in computer jargon – meant to write down, to inscribe.

People from different parts of the world have used the scroll format for record keeping and story telling in one form or another for centuries. Egyptians made scrolls by sticking sheets of papyrus or parchment to form a roll. The text was written in narrow columns for horizontal scrolling. In Japan and China, the script was written in vertical columns starting at the top right hand corner. Some of the native North American people produced horizontal scrolls in which traditional stories were told in pictograms.

Generally, Indo European scrolls were written to be used vertically. Some of the early examples of vertical scrolling are the Gandharan Buddhist Scrolls[1] of birch bark from South Asia dating back to the first century AD. The writing on these and other scrolls from this part of the world *'commences parallel to the short side, proceeds to the end of the scroll, and if more space is required proceeds back along the reverse side'.*[2] Scrolls made from cloth, birch bark, aloe bark, palm leaves and on occasions more durable material such as copper, silver and gold were used. Even today, paper or cloth scrolls are used in India for horoscopes and almanacs. Storytellers travelling from village to village still add visual impact to their narration with the help of painted scrolls that are skillfully unfolded along with their stories. It is tempting to make a connection between scroll-based storytelling and the development of other forms of narrative that depend on visual cues, like tapesteries (eg the Bayeux Tapestry) and narrative paintings – leading toward the 20th century creation of films on celluloid and their propensity for narrative.

Scrolls were physically suited to the functional needs of the user. Whether employing the horizontal or vertical method, the user determined how much information was comfortably displayed at any

[1] R Salomon (1999) *Ancient Buddhist Scrolls from Gandhara,* The British Library, London

[2] Jeremiah P Losty (1982) *The Art of the Book in India,* The British Library, London, 11

given time. The only restriction was the user's arm span.

In this article we address not only the connection between scrolling – by which we mean movement through a text rather than inscribing – in scrolls, books and on computer interfaces; but also the implications of scrolling for understanding the nature of reading in general and in particular the act of learning to read. Some scripts, as Manguel notes, are:[1] '*read from right to left (Hebrew and Arabic), others in columns, from top to bottom (Chinese and Japanese); a few [were] read in pairs of vertical columns (Mayan); some had alternate lines read in opposite directions, back and forth – a method called* boustrophedon*, 'as an ox turns to plough', in ancient Greek. Yet others meander[ed] across the pages like a games of Snakes and Ladders, the direction being signalled by lines of dots (Aztec).'*

[1] Albert Manguel (1996) *A History of Reading, London,* Harper Collins, 47-8

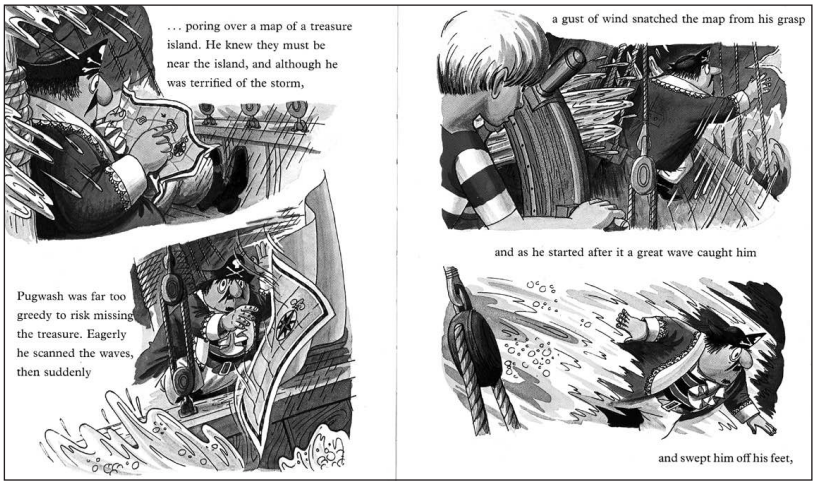
Scrolls, on the whole, are and were meant to be read aloud. The reader mediated between the scroll and the audience, deciphering and representing in sound the script that was often presented with no distinction between upper and lower case, no separation between words and no punctuation (in European scrolls, at least).

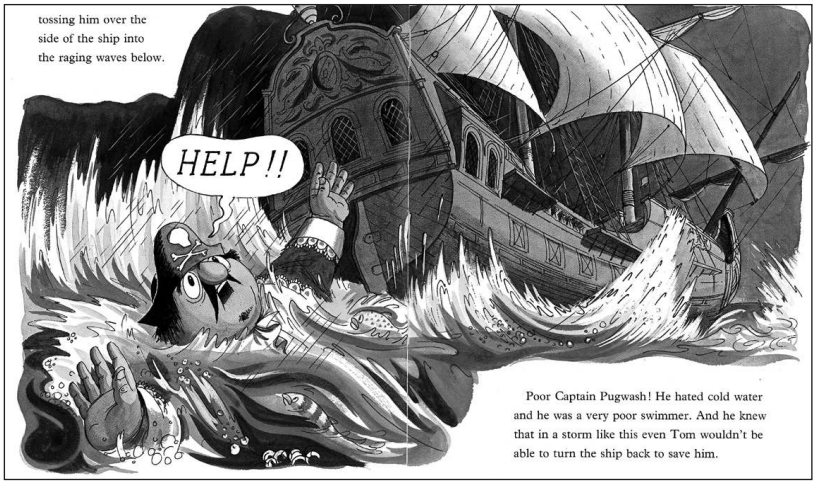
Implications of the scroll for storytelling are that the work is framed as a whole. It is organically associated with the physicality of the scroll, which is held by the storyteller and becomes part of the performance. The scroll is used like a score: it contains cues and signs that determine the overall structure and plot of the narrative, but it does not provide the detailed, often improvisatory dimension added by the teller. Consider the book in comparison: teachers often hold a book – sometimes a large one – for children to see the pictures that accompany the story. The relationship between the image and the tale is different. With storytelling accompanied by a scroll, the visual cues the verbal. With storytelling accompanied by a book, the verbal and visual determine the told story. Significantly, too, the nature of a book, with its cut pages compartmentalizing the text into chunks that have an arbitrary relationship to the narrative as a whole, changes the nature of the read experience. Reading is framed by the turning of pages, and a double-page spread is laid out for us to progress through

the tale. Though usually an almost silent act – the turning of a page – in audio versions of books, there is often a sound cue: *'when you hear this sound – ***** – turn the page'.*

The art of typesetters and editors makes the experience of reading a book as smooth and uninterrupted an experience as possible within the confines of the medium. We notice if the book has been badly set. In the case of a Captain Pugwash story *Pugwash and the Buried Treasure,* for example, '*Eagerly he scanned the waves, then suddenly [page break] a gust of wind snatched the map from his grasp and as he started after it a great wave caught him and swept him off his feet, [page break, turn over…] tossing him over the side of the ship into the raging waves below.'*

Double page spreads from Pugwash and the Buried Treasure





However, functionally the scroll had a fundamental limitation. If the user wished to divert from the linear narration and randomly access something half way down the scroll the or she would have to physically scroll to that position. Codex, or book format has gradually been able to address this problem. Any page can be opened almost instantly or several pages can be flipped through with the thumb.

.... to codex...

Book designers found that a lot of functionality could be added to codex format books. The outside surfaces of the book could be effectively used to facilitate search and identification whether the book was in storage on a shelf or lying on a table. However it was primarily on the inside that designers were able to incorporate innovative information design, gradually pushing the original linear functionality of the book to become nonlinear if the user so wished. This was achieved with effective use of tables of contents, indexes, folios, running heads, footnotes, endnotes and marginalia.

Again, as Manguel (ibid) notes: *'The codex was a pagan invention; according to Suetonius, Julius Caesar was the first to fold a roll into pages, for dispatches to his troops. The early Christians adopted the codex because they found it highly practical for carrying around, hidden away in their clothes, texts that were forbidden by the Roman authorities. The pages could be numbered, which allowed the reader easier access to the sections, and separate texts, such as Paul's Epistles, could be easily bound in one convenient package.' (*p48)

Let us examine just one of these features – folios, or page numbers. Consider for a few moments a book with no folios. How effective would the table of contents be in this circumstance? Would running heads mean much? How would reference items be indexed and then found again when needed? The answer to all these questions is that such a book would probably be considered practically unusable. Folios

are not a post-printing innovation. They were used in Indian manuscripts in the 10th century or possibly even earlier.[1] Only books containing very simple content, no chapter or section breaks and no indexes or reference could get away with omitting page numbers. Book and magazine designers tend to drop folios for aesthetic reasons, from pages with full-page illustration that bleed off the edges. If this is not carefully planned, as it very often is not, it seriously compromises usability and functionality of the publication.

[1] Jeremiah P Losty (1982) *The Art of the Book in India,* The British Library, London, plate III

Other features of the codex were that both sides of a leaf or page could hold text, 'and the four margins of a codex page made it easier to includes glosses and commentaries' (Manguel 1996 p127). Scholarship took a different form, with renowned commentators writing in the margins of key texts, their comments in turn being glossed by students. The organization of texts themselves, 'which had previously been divided according to the capacity of a scroll [or number of scrolls] was changed.' (ibid). Manguel lists the advantages of the codex: *'The text could now be organized according to its contents, in books or chapters, or could become itself a component when several shorter works were collected under a single handy cover. The unwieldy scroll possessed a limited surface…the codex, on the other hand, allowed the reader to flip almost instantly to other pages, and thereby retain a sense of the whole – a sense compounded by the fact that the entire text was usually held in the reader's hands throughout the reading.'* (ibid p127)

Having said this, the cross-referenced, non-linear access to data provided by highly sophisticated information design of printed publications merely points to where the user should look for further related information, within the same volume or in another one. The user then has to rely on efficient library facilities to actually make use of this information.

Invention of moveable type increased access to knowledge which in turn generated new knowledge. Information design within the constraints of the book proved inadequate. The entire system of access and retrieval of information had to be reconsidered. In his essay *As*

We May Think[1] written in 1945, Vannevar Bush foresaw that we will develop new ways of storing and retrieving information because the vast increase in stored human knowledge will make it necessary and not merely because it will be an improvement on current methods. Mark Stefik the author of *Internet Dreams*[2] writes the following in his introduction to Vannevar Bush's essay – '*The value of knowledge is not in its rarity but in our ability to find the golden needle in the information haystack, and to make sense of the haystack as a whole'.* To address these problems, Bush argues that we need to reinvent the library. Although Bush's vision is largely relevant to the development of personal computers and the world wide web, the basic principle of instant access to information at the click of a button is also pertinent to the user's ability to move around an open document on their screen.

[1]Mark Stefik (1996) *Internet Dreams,* The MIT Press, Massachusetts, Chapter: excerpts from "As We May Think"

[2]Mark Stefik (1996) *Internet Dreams,* The MIT Press, Massachusetts, 15

.... and back again

So, we are now in the process of reinventing the library – and therefore the book - in a digital form, and the scroll is back again.

'The word processor treats text like a scroll, a roll of paper sewn together at the ends and its visual structures are still typographic. A word processor stores its text as a simple sequence of letters, words and lines. It remembers margins and pagination; it may remember which letters are to be printed in boldface, in Times Roman, or in 14 point type. ... for a true electronic text is not a fixed sequence of letters, but is instead from the writer's point of view, a network of verbal elements and from the reader's point of view, a texture of possible readings.'[3]

[3]Jay David Bolter (1991) *Writing Space,* Hillsdale, NJ, 5

Consider why scrolling, despite its obvious shortcoming, remains with us. Why does it provide a natural metaphor for narration whether fictional, non-fictional, linear or nonlinear? Is there any other metaphor that could be used more suitably – for example a flowing

stream or river, water running from a tap, a road, or another form of scroll, a tape measure? Essentially, scrolling has the physical quality of gradually revealing and unfolding one continuous story or text, reducing large quantities of information into manageable chunks and presenting only immediately required information at a given time.

Electronic scrollbars are used to scroll through an object, text or graphic, contained in a window that is too large to be completely displayed within the screen window. Vertical scroll bars are used to scroll up and down from the top of an object to its bottom. Horizontal scroll bars are used to scroll right and left sides of the object. By clicking on the arrows at the end of the scrollbars, the user moves the window one scrollable unit in the opposite direction, thereby displaying the required area of the object in the window. The application program defines a scrollable unit. Vertical and horizontal units differ. Most text-processing applications define a vertical unit as a single line of text and a horizontal unit as a percentage of the horizontal screen size. Graphical applications define vertical and horizontal units as a percentage of the visible screen size.

In addition to this basic function, users can interact with the scrollbars in two other ways:

- the position of the rectangular scroll box in the scrollbars is meant to identify the relative location of the object being viewed with respect to the total size of the object. Unfortunately this is not an accurate representation. Therefore, although the user can drag the scroll box along the bar, it is not possible to use this tool to get to a specific location within the window. In the Mac OS Finder, as the scroll box is dragged along the bar, the object visibly moves in the window making it possible for the user to find the required location. However, this is not a feature adopted by all applications.
- scroll bars contain tabs. By clicking in the grey column, the user can scroll by one tab increment. The tab setting is not consistent across applications and operating systems. The tab setting on Mac operating system gives an increment of one page in the direction of the arrow.

We can see how computing capability has already added a degree of functionality to scrolling. The issue of scrolling versus paging has generated much research and until a few years ago tended to favour paging for both performance and user preference. This way of thinking now seems to be under review. In his website *Changes in web usability since 1994,*[1] Jakob Neilsen writes *'In more recent studies, we have seen that most users have started scrolling when they visit a long home page or a long navigation screen. This change in behaviour is probably due to users getting more experience with scrolling Web pages …Thus pages that can be markedly improved with a scrolling design may be made as long as necessary, though it should be a rare exception to go beyond three screenfulls on an average monitor.'*

[1]http://www.useit.com/alertbox/9712ahtml

Hypertext, the other method adopted for connecting large quantities of text, when used well with good site overview, table of contents and topical indexes is a powerful tool. Poor information design supporting hypertext results in information anarchy or lost-in-hyperspace syndrome. Michael Hoffman, a senior technical writer specialising in document structuring and information design argues passionately in his website *Rapid Navigation in Online Documents,*[2] that vertical scrolling is far faster than link traversing. He writes, '*Vertical scrolling actually has the lowest cognitive overhead of all online navigation methods. This is because of the following factors:*

- *scrolling is much faster than page retrieval or link traversal time*
- *longer pages with multiple topics support obvious visual contiguity*
- *it takes fewer aiming, mouse and keyboard actions to scroll than to select a link*
- *Your eyes skim much faster than your eyes can aim and point. You can take in multiple topics almost simultaneously.'*

[2]http://www.cybtrans.com/infostrc/index.html

Hoffman goes on to suggests that hypertext and anchors should be added to, rather than used instead of scrolling. *'Concatenate some of the topic into a long scrolling article, while retaining full hypertext access to permit going directly to any topic (subsection/subheading).*

Perhaps the first example of hypertext: This chronicle of world history is one of the most curious "books" ever made. Written on long strips of paper are notes in German on events from creation to 1595. Although the writing is clear there is no obvious beginning, middle or end. From the British Library Collection

This retains rapid efficient surveying of related topics. Scrolling among contiguously positioned subsections is faster, and more thoroughly visually relates the 'topic' than pressing a Next Topic and Previous Topic keys. With the current approach, a topic is bound to be shorter than the window, in which case you will see white space, or longer than the window, which means you can't see the extended text, unless you scroll. The goal is to enable the user to scan the full text of all nearby topics, efficiently... the model provided by the HTML page with anchors provides a better way to make a set of 'topics' cohere, so that the user can scan and mentally model the documentation and the product more effectively and coherently.'

In hardware evolution it is interesting to note the latest mouse development from Microsoft, who released their IntelliMouse in May 1998, which in some ways has tried to address the scrolling requirements. IntelliMouse has positioned a wheel in the centre of the traditional two click buttons of the mouse. In applications based on Windows 95, Windows 98 and Windows NT, the user can scroll up or down by rolling the wheel forward or backward instead of clicking the scroll bar or arrows. The user can also AutoScroll a document by pressing the wheel and setting a speed. IntelliMouse is not the only mouse on the market designed to aid users with their scrolling needs. Ami Mouse Scroll Pro provides a second wheel for horizontal scrolling.

On first encountering Microsoft's Press Release on IntelliMouse, we were filled with anticipation, but on using one were somewhat disappointed. Indeed, real mice are intelligent creatures, and we thought that finally its electronic point and click name-sake would start behaving like a real mouse, leaving foot prints or droppings to mark where it had been as a reminder to itself or other mice. We hoped that the mouse would wear out a virtual grooved track to frequently visited places and be able to remember certain parts of a document for us and scroll us there when I wanted it to. We guess this will be the next trick for the electronic mouse to learn.

Scroll on

It would seem that at least for the present, scrolling is gaining favour. For online reading, effective ways of balancing it with hypertext and anchor points are being advocated.

Talmud, a 17th century Hebrew scroll from the British Library Collection

However, all the discussion seems to be concentrated around vertical scrolling. On preliminary research, there appears to be no attempt to see if horizontal scrolling is more suitable for the horizontal format monitors in use at present. Text presented in a single column on a horizontal monitor, as it would have to be if vertical scrolling is used, is hard to read due to its length. On an average sized monitor, between 18 and 20 words in 12 point size can be typed in a single line. This is twice the recommended number of words in a line for both screen and printed output. Even with generous line spacing this problem is not really resolved. If we look again at a historic scroll, for example the Talmud, a Hebrew Scroll, written in columns for horizontal scrolling and compare it with the book, we can see that whatever the dimensions of the book, when opened, it generally becomes landscape or horizontal. The spine naturally dividing it into two, allowing for text to be inserted in at least two columns. Therefore, when dealing with large amounts of text for viewing on screen, if we were to consider horizontal scrolling as our basis of design rather than vertical scrolling, we could present the information in two columns rather than one. We could then effectively add information design features such as a system for numbering columns to indicate the extent of the document. Tabs could be set in the scroll bar to move one or two columns at a time.

Rather than use the book metaphor, such as forcing users to artificially turn over virtual pages while providing an appropriate sound effect, it would be far more sensible and productive to adopt features that enhance usability in the electronic medium. By all means make the users pretend they are turning over pages for aesthetic reasons, but let us not confuse that with the aims of making electronically delivered documents easier, more practical, and faster to work with.

Developments in computer technology have largely been led by the requirements of desktop publishing, and consequently catered for print output. Vertical scrolling has therefore seemed the obvious design format to fit in with standard paper sizes. Against this background, impossible restrictions have been imposed on design innovations to try and optimise legibility on screen. If we are to consider the digital book library as a serious alternative, then we have to free the computer from bondage to print and let it flourish in its own right. Print is a well established, robust medium and far better placed to make compromises to meet the challenges of the time. These changes require a major shift in the way we conceive of computers and at present some basic issues such as changing the design of screens to a vertical format is receiving considerable attention.

For example Macintosh, in the early 1990s, developed a screen that was A4 or foolscap in shape and size; there are others, double that size, which enable desk top publishers and book designers to see a double-page spread. The principle of replicating the desktop on the screen has been hampered by the standard sizes of computer screens, designed perhaps more with the TV metaphor in mind than the desktop. But consider the nature and function of the original desktop for a moment. As Robert Craft's monograph of Stravinsky reveals, the desktop is used by composers of all kinds (writers, musicians, artists, architects) as a framed space upon which to play out the imagination and within which to compose (literally 'put together') the new work. That frame helps the composer in that it sets limit to the activity: things are brought on to the desktop and either included or excluded. In the end, the desktop works as a backdrop to the creation of the new work itself, which has its own frame to both define the genre in which it works, set up the dynamics within that genre and if required by the artist, break or subvert the the frame of the genre. Just as important as the material imported and composed within the frame is the space that is allowed within the frame – whether that is the white space of paper in a book surrounding a poem, or the space within which a sculpture works. From this point of view, both book and computer screen are versions of the framed space in which the artist works.

Given time, changes will be made to screen interfaces and frames. However for the present let us concern ourselves with fine tuning the current interface and add functionality that might be beneficial to the user without having to make further investment in new hardware.

If we were to consider the scroll bar as a tape measure, then it could be calibrated, showing the extent of the document with the markers representing the pages. This calibration could be placed inside the scroll column and therefore not require any desktop real estate. Adobe Acrobat PDF viewer offers a pop-up box indicating the extent of the document and the page numbers when the cursor is held in the scroll bar. But most applications do not present this information as an intrinsic part of the scrolling process. The scroll bar seems a more obvious and friendly place for this information. It could then be used to get to a specific page in the document by clicking on the page number rather than to a randomly set tab placement or have to click through the entire document one page at a time. On larger documents, if the calibration became too dense, then with one click, or better still, when the computer senses a delay, a magnification of the required section of the scroll bar is presented to the user to enable accurate selection of a page. Such magnification would also provide the user with a measure of the extent of the document, an impression well provided for in books as an integrated physical and visual part of the whole. The user cannot only see the extent of the document but can also experience its weight.

To take this concept further, it would be helpful for the user to be able to add Post-its as reminders to themselves, much as they would in a book. Again Adobe Acrobat uses the Post-its metaphor successfully. The scroll bar gives an indication as to where the Post-its have been placed. The user would be able to access these from the scroll bar, the text on the Post-its becoming visible when the cursor is rolled over its indicator. If the user had several Post-its attached to a document, perhaps the interface design would give a visual indication as to which ones were the most used. Much as when one looks at a card index, it is apparent which items are the most popular, because its card is thumb marked and dog-eared.

[1]Bruce Tognazzini (1991) *Tog on Interface,* Allison-Wesley Publishing Company Inc, Reading, chapter 22

Research carried out by Bruce Tognazzini[1] on user reaction to keyboard shortcuts and whether they do affect speed, seems to indicate that using the mouse to point and click is just as quick as using a keyboard shortcut, but that users prefer keyboard shortcuts. The primary function of the up, down, left and right keys on the keyboard is to move the insertion beam around a document one letter at a time. In combination with other keys they can also be used to move the I-beam and therefore scroll, albeit rather clumsily, through the document by the word, line or paragraph.

Another keyboard shortcut can be added to these that might please some users. When rapidly scrolling through a document by clicking on the top or bottom arrow with the mouse, the user may occasionally find that they have overscrolled a little. To go back they have to move their cursor to the opposite end of the screen, point and click again. In a situation like this it might be very handy if the user was – without moving the cursor – able to toggle between the two opposite directions by pressing a key while clicking on the mouse. After almost a decade of very little change in the interface design of the scroll bar, Apple has recently given this tool a subtle and useful alternative role. Users of Mac OS8 can choose the *'smart scrolling'*[2] option, which *'places both scroll and arrows at the bottom and right ends of scroll bars and sizes the scroll box according to the visible content of the window'* thus economizing mouse movement and giving the visual impression of the extent of the document in both horizontal and vertical directions. An additional arrow at the top of the vertical scroll bar allows the user to sort the files in ascending or descending order.

[2]Apple OS 8, Appearance – option

Implications for reading

Whether we read vertically from top to bottom, or horizontally from the left or from the right, we assume there will be some common attributes in the sophisticated reader. These will include:

- scanning, where the reader moves along the surface of the text, picking out words and/or images that meet the purposes of the

reading. For example, one might scan the text for evidence of information about a particular character or in answer to a particular question

- skimming, where the reader flits along the surface of the text again, this time from beginning to end in an attempt to capture the gist of its message(s)
- an overview of the text, in which the reader attempts to gain perspective on the whole text in order to see its relationship to the space that surrounds it. This kind of overview may be partiularly employed in the reading of a poem or the taking in and sizing up of an image.

In relation to more specific and practical ways of accessing text, we have already implied that:

- annotating text in the form of Post-its or marginalia is a well-used practice for making one's mark upon a text and getting a purchase on the reading of it
- bookmarking – already a well established metaphor and practice in internet browsing – is helpful in quick access to a particular website.

Reading, whether from top to bottom, left to right or right to left, takes directionality as a fundamental element. As a result, sequence is important and prediction in the direction of reading becomes part of the skill of reading, at the levels of the phoneme, morphological unit, word, clause or phrase, sentence and at the level of the text as a whole. Linked to prediction, anticipation becomes part of the pleasure and part of the mechanism of sequentially informed reading.

Reading a *book,* whether fiction or non-fiction, will involve cross-referencing, browsing, making links by association, skimming, scanning, taking into account the visual identity of a text and the impact of the white space that surrounds it. Issues of framing are important because they act as a reification of ideologies and contexts that bear upon the creation and production as well as the reception of texts. Furthermore, the tensions and complementarities of images and

written text are played out within a particular frame: that of the printed and bound book, in all its tangibility and immediate physicality.

When reading a text on a screen, with the aid of a scrolling device, the experience of reading is quite different: at any one time only a screen-sized portion of the text is visible to us. These portions tend to be closer to two hundred words than the four or five hundred per page allowed in the codex book. There is difficulty conceiving of the whole text – particularly its extent – most of which is hidden from us and is intangible. We are driven by verticality, so that whether our mode of reading is left to right, right to left or top to bottom, we are scrolling from top to bottom of the text. The whole visual identity of a text – albeit framed within the sequentially bound book – is inaccessible to us unless we print out. If we do print out the result is purely functional in an unaesthetic way: we read on A4 (or standard for the culture in which we operate) paper. It is less easy for us to make associations across the text as a whole that are driven by the personal, whimsical, imaginative, associative leaps and links that readers make.

Thus, technology could have saved Dussasana from his frustrated experience in his efforts to disrobe Draupadi. Her endless, timeless, scrolling garment could have alerted him and his brothers of the pointlessness of their action and also prepared them for their eventual bloody end. Alas, but that would have spoilt a really good story.

References

Bolter, Jay David (1991) Writing Space Hillsdale N.J.: Lawrence Erlbaum Associates

Kamala Subramaniam (1997) Mahabharata , Bombay: Bharatiya Vidya Bhavan

Losty, Jeremiah P. (1982) The Art of the Book in India London: The British Library

Manguel, Alberto (1996) A History of Reading London: HarperCollins

Salomon R. (1999) Ancient Buddhist Scrolls from Gandhara, London: The British Libraryp p

Stefik, Mark (1996) Internet Dreams Cambridge, Mass: The MIT Press

Tognazzini, Bruce (1992) Tog on Interface Reading, Mass/Wokingham: Addison-Wesley

www.useit.com/alertbox/9712a.html [February 2000]

www.cybtrans.com/infostrc/index.html [February 2000]