The effect of display size on reading and manipulating electronic text.

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With the advent of hypertext the presentation of electronic text is becoming an increasingly important issue. However, most research to date has focused on simplistic measures of reading speed or navigation in highly controlled presentation formats, often using very constrained texts and task scenarios. The present paper attempts a more meaningful analysis of the effect of window size on reader comprehension and manipulation of real-world texts. Reading a journal article for comprehension and a software manual for specific information are both investigated. Results indicate that screen size is not a major factor in performance on either task but readers express a strong preference for larger screens.

INTRODUCTION

As advances in technology make information presentation via computer screens more acceptable, it is generally assumed that text will increasingly be accessed on screen as well as, or instead of, on paper (Wright and Lickorish, 1988). However, until recently concern focused mostly on the legibility of the screen image (Bauer and Cavonius, 1980, Gould et al., 1987) and research has indicated that particular factors of image quality are crucial determinants of legibility (see Dillon et al., 1988 for a detailed review). Important as this work is, it provides no insight into the higher cognitive issues involved in reading and manipulating computer-based text. Such issues grow in relevance as the advantages of electronic storage, transmission and presentation of text become apparent to industry, commerce research and education.

Specifically, little work has been done on the electronic presentation of lengthy texts where problems of navigation and location as well as manipulation of the document arise. With paper, readers have acquired a range of physical and cognitive skills for manipulating text and the relatively standard format of texts allows for easy transfer of these skills across the spectrum of paper documents. How electronic text may best be designed to facilitate similarly easy use remains an open question.

The present paper investigates one aspect of electronic text presentation that is likely to affect readers' use of text, namely, display size. Computer screens typically present 25 lines of text to the user and it is tempting to assume that, within limits, a larger screen would be better. Large text displays require less manipulation to view the full contents, scanning forward and backward does not require numerous screen changes and it is easier to mimic the book image with such displays.

However, the research findings seem to contradict this view. Duchnicky and Kolers (1983) investigated the effect of display size on reading constantly scrolling text and reported that there is little to be gained by increasing display size to more than 4 lines either in terms of reading speed or comprehension. Elkerton and Williges (1984) investigated 1,7,13, and 19-line displays and reported that there were few speed or accuracy advantages between the displays of 7 or more lines. Similarly, Neal and Darnell (1984) report that there is little advantage in full page over partial page displays for text-editing tasks.

These results seem to suggest that there is some critical point in display size, probably around 5 lines, above which improvements are slight. Intuitively this seems implausible. Few readers of paper texts would accept presentations of this format. Our experiences with paper suggest that text should be displayed in larger units than this. Furthermore, loss of context is all too likely to occur with lengthy texts and the ability to browse and skim backward and forward is much easier with 30 or so lines of text than with 5 line displays. Of the experiments cited, only the Duchnicky and Kolers study was concerned with reading for comprehension and their passages were never longer than 300 words. Thus the findings on window size bear little relevance to reading lengthy texts.

The present paper reports on two studies which attempted to overcome the deficiencies of earlier studies by employing texts and tasks that readers would encounter in the real world. The two texts were a software reference book on MS-DOS and an academic journal article. The reader's task with the former text involved location of information in order to answer specific questions and with the latter text, reading for comprehension.

METHOD

These studies took the form of two separate experiments, full details of which can be found in Richardson et al (1988) and Dillon et al (1988). In the first experiment, 16 subjects performed 10 information location tasks with the software reference manual. Screen sizes of 20 and 40 lines were employed in a counterbalanced order as a within subjects variable. The experimental interface facilitated paging forward and backward, jumping to specific pages or sections of the text and searching for text strings. In the journal article study 32 subjects read an academic journal article for comprehension with screen sizes of 20 and 60 lines employed as a between subjects variable, 16 subjects per condition. The experimental interface in this situation facilitated paging forward and backward and jumping to the beginning and end of the article. Task order, subject experience and text suitability were appropriately controlled.

RESULTS

Experiment 1 : The Software Reference Manual

Performance data

Command usage rates were calculated and these indicated no significant effect for screen size. However the next page/previous page commands were used twice as frequently in the small screen condition emphasising the need for readers to page through twice as many small screens to access the same amount of information.

Time to complete tasks was also computed for each subject. No effect was observed for window size here ($t = 0.18$, d.f. = 18, $p > 0.85$) though the subjects' mean performance rates were faster with the large screen for seven of the ten tasks. Time spent consulting the Contents and Index was computed as it was thought that scanning this type of information may be affected by display size but likewise; no effect was observed ($t = 0.45$, d.f. =15, $p > 0.60$).

These results indicate that there is no significant performance difference between large and small windows for a task of this nature.

Qualitative data

Even though no significant performance differences were found for window size, 13 of the 16 subjects expressed a preference for the larger window. The most remarked-upon difference was the necessity for constant page-turning with the small window, even when subjects only wished to read a comparatively small section of text. This was frequently described as “irritating” or “frustrating”. The increased page-turning also gave subjects the impression that reading from a small window was slower.

A second disadvantage of the small window was the loss of information pertaining to section and chapter headings. Several subjects remarked that it was all too easy to forget which section they were in or when one section had ended and a new one begun. This was less of a problem with the large window as there was a much higher probability that a given screen would contain such information in the form of a section heading. As a result of this, readers claimed that navigation was more difficult with the small window as you “don’t get a feel for the whole” and the text seems “patchy”.

Though the vast majority of users emphatically preferred the large window, 3 subjects were less convinced of its advantages. They felt that visual scanning of text was probably easier with the small window as it required less ocular movement and it was easier (quicker) to come to a decision as to whether a given page contained the target information. However, they all remarked that such benefits were probably counterbalanced by the constant page-turning requirements.

In conclusion, it seems that for an information location task of this nature a smaller screen incurs no performance decrement though readers much prefer a larger screen.

Experiment 2: The academic journal article

Comprehension measures

Comprehension scores were derived by scoring the subjects' summaries according to a procedure based on the work of Kintsch and van Dijk (1978). This involves an iterative propositional analysis of the original text to produce a hierarchy of ideas or core concepts. The first level analysis reduces the original text to its basic propositions which in turn are analysed to produce a second level abstraction and the procedure continues accordingly until a top level is arrived at where a global 'gist' of the text is described. Summaries are scored according to the presence of particular ideas, usually from the second or third level of the hierarchy (the lowest level being too specific and the higher levels being too general).

The original text was analysed and a hierarchy of propositions developed. Examination of a random sample of summaries indicated that for the text employed, a second level analysis was most appropriate and all summaries were scored according to their inclusion of propositional units from that level.

While a slight trend was observed favouring the large screen (mean comprehension rate 9.75 compared to 8.125 for the small screen), a t-test between conditions revealed no significant effect for display size ($t=0.70$, $df=30$, $p>.4$).

Performance measures

As stated earlier, users of a small screen will need to page about more than users of a large screen in order to read similar amounts of text. Thus, gross indices of command usage offer little insight into any possible manipulation effects. In order to obtain a better impression of text manipulation only changes in direction of viewing and jumps in the same direction of 2 pages or more were examined. Each change of direction or jump of at least 2 pages counted as one manipulation. In other words if a subject read serially through the text from start to finish, their manipulation score would be zero.

A t-test between conditions revealed a significant difference ($t=2.39$, $df=30$, $p<.025$), with readers of the small screen manipulating the text more. Given the coding of manipulation that was employed, the screen size effect does not result merely from the extra keypresses required to view the same information in the small screen conditions. It seems that subjects reading from the small screen jump about and manipulate the text significantly more than subjects reading from the large one.

Qualitative data

Subjects were once again provided with an opportunity to express their reactions to the screens and of the 8 subjects who expressed a wish to alter the display size, three-quarters were subjects from the small screen condition who wanted a larger window.

It seems therefore, that screen size does not significantly affect comprehension of an academic article but small screens lead to higher manipulation rates. Once more, subjects seem to prefer a larger screen.

CONCLUSION

Taken together, these results indicate that while comprehension and performance rates may not be significantly affected by the variations in screen size used here, subjects clearly prefer a larger screen. Furthermore they manipulate the text more with a small window. The fact that subjects in the journal article task were not faced with a time constraint may have hidden any comprehension effect that might exist i.e., subjects in a small screen condition need to manipulate and navigate through the text more than readers using a large screen and therefore spend longer on the task in order to achieve comparable levels of comprehension. Obviously further work is needed. Certainly, where lengthy text is concerned, screen size differences do not stop at the 5 line threshold.

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