INFORMATION VISUALIZATIONS OF ELECTRONIC DOCUMENTS: USABILITY AND READING PATTERNS

Kasper Hornbæk (Department of Computing, University of Copenhagen, DIKU)[1]

Erik Frøkjær and I have recently been investigating if information visualizations support reading of electronic documents. Reading of such documents is becoming increasingly widespread, for example in digital libraries and on the World Wide Web. However, readers experience various difficulties with electronic documents compared to paper: electronic documents take longer time to read, it is difficult to get an overview of the structure of the document, navigation is hard, and fatigue is likely to occur if reading for extended periods of time.

It has been suggested that information visualizations of electronic documents may support reading and ease the difficulties mentioned above. One kind of information visualization shows an overview of the entire document together with a detailed view of the contents of that document. These so-called overview+detail interfaces have been used in for example Adobe Acrobat Reader. Another kind of information visualization shows only the important parts of the document. George Furnas's fisheye interface is one example of this. However, few empirical studies have investigated the usability of information visualizations for electronic documents. The studies we know of have failed to find an advantage of information visualizations over common, linear interfaces. In addition, no studies have investigated how information visualizations change users' reading patterns.

In an experiment, we compared the usability of a baseline, linear interface with an overview+detail and a fisheye interface. Twenty subjects answered questions and wrote essays about scientific documents discussing object-oriented systems development. In all, the experiment resulted in more than 100 hours of logged interaction with the interfaces.

The experiment revealed several differences in usability between the interfaces. The subjects preferred the overview+detail interface, stating that they liked the overview of the structure of the document and that navigation using the overview was pleasant. When subjects wrote essays after having read a document with the overview+detail interface, they got higher grades than subjects who had used the other interfaces. Subjects who used the fisheye interface were faster. However, they answered fewer incidental-learning questions correctly, suggesting that they had a shallow understanding of the document. When answering questions, subjects using the overview+detail interface were approximately 20% slower than subjects using the linear interface. We found no difference between interfaces in the quality of subjects' answers to questions.

Recently, we have worked on visualizing reading patterns from the logged interaction data. To explain the differences in usability, we created two visualizations of reading patterns. Progression maps show how reading progresses, visibility maps show for how long different parts of the document are visible. The progression map helped identify

[1] From November 2001 I am an assistant professor at Natural Sciences IT Competence Center, University of Copenhagen.

three phases in the subjects' reading activity. Some subjects started with an initial orientation phase, in which they navigated non-linearly through the document and read the abstract, the introduction, and the conclusion. In the linear read-through phase, subject read through the documents from the beginning to the end, making occasional jumps forwards and backwards. In the review phase, subjects apparently reviewed what they found to be the main points of the document. The duration of these phases differed between interfaces. In the fisheye interface, subjects used longer time on initially orienting themselves and less time on reading linearly through the document. With this interface, subjects used an overview oriented reading style, first getting an overview of the document, later reading the details. The visualizations of how reading progress also give an explanation of why the overview+detail interface was slow for answering questions. When subjects had located an area in a document that contain the answer to the question we gave them, they often continued to explore the document. These further explorations happened because the overview appears as an easy way to navigate. Perhaps the overview also created associations for subjects about what to explore next. A negative way to put this is to say that the overview distracted subjects.

For designers, our studies suggest that overview+detail interfaces support reading, and should be used more in systems for information access and use. Fisheye interfaces support quick, overview-oriented reading, but subjects do not get a deep understanding of the document read. Consequently, fisheye interfaces should mainly be used for time-critical tasks. The most common interface in practical use we found to be inferior in usability compared to the information visualizations. It should be avoided whenever possible.

Three areas of further research are needed. First, visualization of reading is a useful technique for studying reading activity that gives more fine-grained information than simple usability measures. In addition, progressions maps are more manageable than data from eye-tracking studies. Such visualizations will be useful in further studying reading activities. Second, our study show that overviews may be made more content-rich, and that algorithms for fisheye interfaces may be further improved. Third, attention in information visualizations needs to be better understood, especially how the overview distracts/creates associations.

Further details may be found in K. Hornbæk & E. Frøkjær, (2001), 'Reading of Electronic Documents: The Usability of Linear, Fisheye, and Overview+Detail Interfaces', *Proceedings of ACM Conference on Human Factors in Computing Systems (CHI'2001)*, Seattle, WA, 31st March-5th April 2001, p. 293-300, and in my PhD thesis 'Usability of Information Visualizations: Reading and Interaction Processes' (2001), e-mail me at kash@diku.dk for a copy.