

Usability Evaluation of Paper/PC/e-Paper Proceeding Books

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Abstract

We have compared usability of paper/PC/e-Paper (electrophoretic display) proceeding books assuming they were used by audiences during a conference.

Subjects were requested to point out the difference between the figures in slides and proceeding when they were assumed to be audiences for a short presentation of 5 minutes. Correct answer rates were evaluated when they were using the three different medium respectively. The e-Paper proceeding showed better preference, in subjective evaluation, than PC proceeding. Full page showing by e-Paper may be preferred than partial page showing by PC. The e-Paper proceeding has shown, however, lower answer rate than the other two mediums. The longest time, on e-Paper, required for paging was assumed as the cause of the lowest correct answer rate shown for the e-Paper proceeding book.

1. Introduction

Proceedings for conferences are a promising application of electronic paper. This study focuses on an electronic paper proceeding which was used for the field test at Pan-Pacific Imaging Conference (PPIC '08) held June 25 to 27 in 2008¹⁾.

We have performed quantitative evaluation of usability of the electronic paper proceeding. Usability of paper, PC, and e-Paper (electrophoretic display) proceeding books were compared assuming they were used by audiences during a conference.

2. Experimental method

Subjects were requested to watch a slide show of a five minutes presentation and to check the corresponding paper (4 pages) in the proceeding (Paper/PC/e-Paper) simultaneously; this was a simulated situation of an actual conference. Subjects were ordered certain tasks to identify the small difference between the slides and the written paper. Procedures how to reach corresponding papers are different in the three mediums.

a) Paper proceeding; subjects can find a target article by searching a table of contents in the front part of the paper proceeding book of 499 pages.

b) PC proceeding; subjects can directly reach a target article by clicking the title of the paper in the table of contents shown on the display.

c) e-Paper proceeding; subjects can reach a target article by choosing a target date, and then choosing a target session, and finally choosing the title of the article.

Subject can view only 3/4 page on a screen of PC proceeding but they can read whole the article by using scrolling procedure. Subject can view each whole page area, on the other hand, on the paper proceeding and also on the e-Paper proceeding.

Motivation for each subject was unified by telling them "Suppose that you have been ordered to present a detailed report after attending a conference". This order means that they have to

find more detailed information by watching presentation slides than the simple information that can be obtained by only reading the proceeding.

Experimental conditions are shown in Table 1. Table 2 shows three mediums and their testing scenes. Numbers of slides were different in each article; minimum 5 to maximum 11 slides. First slides were always shown 30 seconds and the other slides were shown equal period by dividing the rest 4 minutes and 30 seconds. The tasks for a subject are as follows:

- 1) A subject must take a picture with a camera when he/she found some additional information, on the slides, which does not appear in the proceeding.
- 2) A subject must write down the title number of the graphics when he/she found more detail information, on the proceeding, which does not appear in the slides.

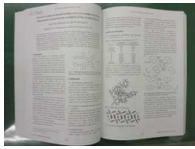
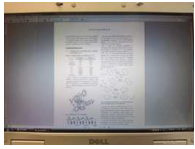




We evaluate the performance of completing the task by calculating the completion rate of taking picture and writing down the title number of the graphics. Subjects were also requested to answer their impression to the each medium by using the following two methods;

- 1) Choosing their impression to the each medium among five ranks of impressions: 1(very difficult to use), 2 (difficult to use), 3(intermediate), 4(easy to use), 5(very easy to use)
- 2) Writing down some free comments to each medium.

Table 1 Experimental conditions

Media	Paper (A4 size)
	PC (15.4 inch, backlight type liquid crystal display, 1680×1050 ppi)
	Electronic Paper (9.7 inch :142.1 x 205.5mm) Electrophoretic display (monochrome): 1200 x 825 ppi, 4 Gray-levels)
Place	Soundproof chamber
Number of trials	3 times at each medium
Subjects	6 students (twenties)

Table 2 Three mediums and their testing scenes

Paper	PC	e-Paper
		
		

3. Experimental result

3-1. Performance evaluation

Performance of task (Completion rate) was calculated by using the following formula:

$$\text{Completion rate} = 1 - \frac{\left(\begin{array}{c} \text{Number of miss checks*} \\ + \\ \text{Number of wrong answers**} \end{array} \right)}{\text{Number of item to be taken or written}}$$

*Number of miss checks: number of lost items should be taken or written.

**Number of wrong answers: number of items which should not be taken or written.

Figure 1 shows mean values, in six subjects, of completion rate at each medium (error bars: standard deviation). Performance rate of electronic paper is shown lower than both paper and PC in Fig. 1.

3-2. Subjective evaluation

Figure 2 shows averaged results, in 6 subjects, of 5 ranks of impression to each medium (error bars: standard deviation). The best score is indicated by paper, while the worst score is indicated by PC.

3-3. Free comments by the subjects

Table 3 is a summary of comments by the subjects: positive comments and negative comments. As for easiness of finding a wanted article, e-Paper and PC were preferred than paper; e-Paper and PC were given positive comments while paper was given negative comments.

As for readability after finding wanted article, paper was preferred, on the contrary, than PC and e-Paper; paper was given positive comments while PC and e-Paper were given negative comments. Distinctive negative comments to PC and e-Paper are as follows:

PC: "Inconvenience of scrolling show" given by more than half of the subjects.

e-Paper: "Inconvenience of slow page flipping" given by every subject.

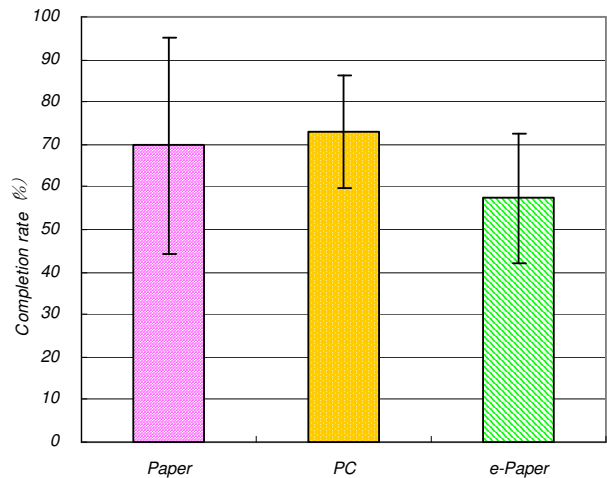


Fig.1 Performance

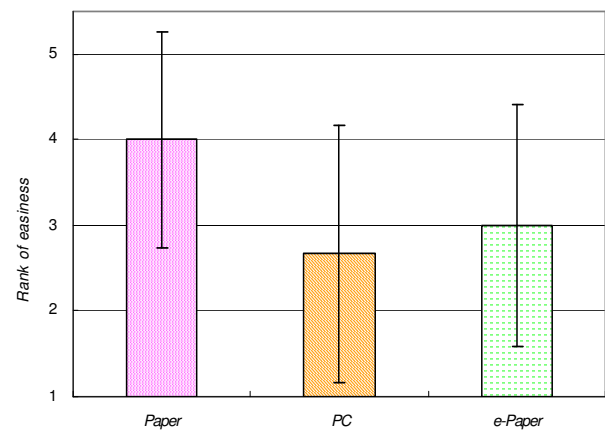


Fig.2 Subjective evaluation of easiness of task

Table 3 Typical comments by the subjects

		Paper	PC	e-Paper
		← Positive (number) Negative→	← Positive (number) Negative→	← Positive (number) Negative→
Easiness of finding a wanted article		(2) Difficult to find the wanted pages	A table of contents is useful(1)	Easy to find the wanted pages (2)
Readability after finding the wanted article	Page showing	Simultaneous showing of two pages are useful (2)	(1) Only a limited part of a page can be see	A whole page can be seen (1)
	Paging method	Easy for browsing (3)	(4) Scroll show is inconvenient	(6) Slow page flip is unfavorable
	weight	(1)Heavy	(1) Impossible to lift	Light (1)
others		(1) Thick	(1)Readable Not readable(1)	

Table 4 Distinctive features of each medium

	Paper	PC	e-Paper
Display size	A4 size×2	≈B4size (15.4 inch)	A5 Size
Paging method	Paging	Scrolling	Switching
Page showing	2 pages	3/4 page	1 page

4. Discussion: reason of difference in the three mediums

Table 4 summarizes distinctive features of each medium. We consider rather slow page switching of 1.5 second on e-Paper proceeding may be the major reason of its inferior completion rate. Slow page switching may be one of major weak point, in the tested e-Paper proceeding, to be improved when we want to practically use e-Paper proceeding during a conference.

We also consider one whole page showing assured by the e-Paper proceeding may be the major reason of its better score than PC proceeding, on which only 3/4 portion of a page can be viewed.

5. Summary

We have compared usability of paper/PC/e-Paper (electrophoretic display) proceeding books assuming they were used by audiences during a conference. We evaluated performance in requested tasks and subjective impressions at each medium. Results are summarized as follows:

- 1) The e-Paper proceeding showed better preference, in subjective evaluation, than PC proceeding. Full page showing by e-Paper may be preferred than partial page showing by PC.
- 2) The e-Paper proceeding has shown rather lower performance, in our trial tasks, than the other two mediums. The rather slow page switching on e-Paper was assumed as a cause.

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Author Biography

Yuta Nakayama was born in 1987. He received his B.E. degree in 2010 from Tokai University. He is expected to receive his M.E. degree from the graduate school of Tokai University in 2012. He is now engaged in a study of readability as a target of Electronic Paper