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**James Blustein  
Ishtiaq Ahmed  
Keith Instone**

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Faculty of Computer Science  
6050 University Ave., Halifax, Nova Scotia, B3H 1W5, Canada

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# An Evaluation of Look-ahead Breadcrumbs for the WWW

James Blustein\*  
Dalhousie University  
Halifax, NS, Canada  
jamie@cs.dal.ca

Ishtiaq Ahmed  
Dalhousie University  
Halifax, NS, Canada  
ishtiaq@cs.dal.ca

Keith Instone  
User Experience Design  
IBM.com  
keith@instone.org

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## 1. INTRODUCTION

Breadcrumbs have long been a part of hypertext navigation systems. Although the early implementations were true to the breadcrumb metaphor of marking the specific path a user had taken [1], over time the Web convention of using a list of links to represent the location of the current node has become commonplace [5]. Popularized by large directories like Yahoo!, breadcrumbs can reinforce that users are indeed in the “right place”, educate them on the website’s structure, and help them interpret the other links on the page which are contextual to the node’s location. If users feel disoriented [11, 12], they can select one of the breadcrumb links to go to “higher ground” and hopefully proceed with accomplishing their goal. Studies by Bowler *et al.* [3] and Teng [14] suggest that breadcrumbs are most useful for large and hierarchical sites. The study we report here investigated more powerful breadcrumb navigation constructs within the Open Directory Project. We hope to answer the question if these experimental breadcrumbs can improve performance in key navigation tasks.

## 2. LOOK-AHEAD BREADCRUMBS

Plain regular breadcrumbs show the trail of links leading to the current page (see Figure 1). Teng [14] developed look-

\*Corresponding author

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Figure 1: An example of plain regular breadcrumbs



Figure 2: An example of look-ahead breadcrumbs

ahead breadcrumbs (LAB) to help in navigation. They include a list of links to webpages that are reachable from that particular breadcrumb item, as shown in Figure 2. Upon clicking on any link in the menu or on the breadcrumb item, the browser directs user to the destination page for that link.

### 2.1 Related Work

Some studies suggest that breadcrumbs can lead to more efficient site navigation and improved user satisfaction [3, 7, 10, 14]. The study by Maldonado and Resnick [10], showed that using breadcrumbs can increase the efficiency of navigation. In the study by Lazar and Eisenbrey [7], participants undertook three navigation tasks using a website with or without a breadcrumb-like navigation bar. For two of the tasks, the presence of the navigation bar was found to have a significant effect on speed. On average, it took about 60 seconds less time to navigate a site with the navigation bar than without ( $p < 0.00006$  for Task 1,  $p < 0.03$  for Task 3). Survey results indicated that most of their participants liked having the navigation bar in the site. Lazar and Eisenbrey [7] suggested that breadcrumbs were more useful for experienced Web users than novice users.

Lida *et al.* [9] however, found that the overall use of breadcrumbs can be quite low. They observed that some of their experimental participants did not understand the function of breadcrumbs. They furthermore reported that even regular breadcrumb users were not found to be more efficient than users who did not use the breadcrumbs. The non-breadcrumb using participants preferred using other navigational methods to find information, such as their browser’s Back button. A significant difference was found on the use of Back button between groups who preferred breadcrumbs and who did not. However, no differences were found in

the efficiency measures of total clicks, total pages visited, or time to complete the search tasks.

Another study concluded that brief training on breadcrumbs usage resulted in more efficient navigation [8]. The study used three conditions based on tutorial exposure of breadcrumbs. For Condition 1, participants were briefed twice about the use of breadcrumbs, For Condition 2, participants were given similar exposure without explanation. Participants for Condition 3 did not receive any exposure. On average, participants for Condition 1 completed the tasks faster than other two groups. However, that study [8] did not report the level of statistical significance.

In the study by Teng [14], one group of participants used standard breadcrumbs and another group used menu based breadcrumbs. The study did not find any significant difference in speed between the groups. However, the result from that study found a significant site effect for breadcrumbs navigation. Participants found breadcrumbs more useful when they returned to a familiar website. Unlike Teng's experiment, which only went less than  $7 \pm 2$  levels deep in two subparts of the Canadian government public website<sup>1</sup>, our experiment (described below) uses a single website with questions at depths of 5, 6, 7, and 7.

The depth versus breadth tradeoff in menu design has been the topic of much research [6, 15]. Limitations of short-term memory play an important role in users' ability to learn and remember the structure of a website. However that limitation can be compensated for by an optimal design of menu-based systems [6]. LABs do not reduce the breadth when user moves deeper in the site hierarchy.

## 3. EXPERIMENT

We conducted an experiment to determine what factors affect its use, and if further development of LAB is warranted.

### 3.1 Method

#### 3.1.1 Measures

We evaluated the breadcrumbs for:

**speed** measured by the time it took users to correctly determine that they had found the webpage they were seeking;

**preference in use** measured as the proportion of mouse clicks on breadcrumbs to the combination of clicks on navigational aids (e.g. the Back button) in the browser and breadcrumbs;

**preference in retrospect** stated preference for LAB over regular breadcrumbs in a post-test questionnaire (after all four questions had been answered);

**lostness** operationalized by Smith's measure [13] for the number of unique and total pages visited by the participant in comparison to the optimal number of page visit required to find the answer to the question; and

**efficiency** which is similar to lostness but also accounting for accuracy of locating the correct target webpage [13].

<sup>1</sup>[URL:http://www.canada.gc.ca/](http://www.canada.gc.ca/)

#### 3.1.2 Participants

Twenty-six volunteers were randomly assigned in a balanced<sup>2</sup> within-subjects (repeated-measures) design.

#### 3.1.3 Protocol

Participants were prompted by questions to try to find particular webpages in copies of the Open Directory Project ([URL:dmoz.org](http://URL:dmoz.org)) website (DMOZ). DMOZ is a hierarchically structured website with webpages in more than 590,000 categories. Each participant sought four different webpages. Participants used websites equipped with one type of breadcrumb for the first and third questions, and the other type for the alternate questions.

Before the practice sessions began, participants were instructed verbally on the use of both types of breadcrumbs and the browser toolbar. Participants were also provided with an information sheet on breadcrumbs. Each of them were given computer based instructions on how to look for the answer in the pages and how to avoid visiting external pages. Participants were not allowed to open multiple windows of the browser and prohibited to use the search feature of the website.

Each question referred to a different part of the site, so each time a participant navigated the site the probability of revisiting the pages were reduced. The first two tasks were specified as practice session and the last two as the test session. The questions were designed to require the same amount of navigation. Debriefing questionnaires supported the contention that the questions were equally difficult.

Participants were free to use the navigation features of their browser (e.g. the back button) but not the search feature of the website.

#### 3.1.4 Instrumentation

A copy of DMOZ was obtained using the HTTrack website copier software<sup>3</sup>. We developed specialized software to create and insert LAB into the website. The Uzilla browser [4] (an instrumented version of Mozilla) was used to record and analyze every user action during the experiment.

## 3.2 Results

Ninety-two percent of participants stated a retrospective preference for look-ahead breadcrumbs (LAB) over regular breadcrumbs. Over 60% of those stating such a preference indicated that LAB made navigation easier for them.

The measurements were analyzed using a 2-way repeated measures ANOVA with breadcrumb type as a within-subject factor and order as a between-subject factor. Although differences, and interaction effects, were observed when all four questions are considered together, no significant differences were found (at  $\alpha = 0.05$ ) within the last two questions for the measures of speed, efficiency, lostness, and preference in use. However, interaction effects between breadcrumb type and order of session was found in the experimental (i.e., last two) questions for lostness ( $df = 1, F = 4.26, Pr > F = 0.0510$ ), effectiveness ( $df = 1, F = 9.41, Pr > F = 0.0056$ ) and speed ( $df = 1, F = 5.75, Pr > F = 0.0254$ ). Recall that the first two questions were for practice only and should not be considered actual use.

<sup>2</sup>One volunteer dropped-out leaving  $N = 25$  participants.

<sup>3</sup>[URL:http://www.httrack.com/](http://www.httrack.com/)

### 3.3 Discussion

The difference between the practice questions and the experimental session clearly shows that for breadcrumbs to be useful they must be learned, although that learning can happen with little practice. Despite being more visually complex, and therefore presumably requiring more processing, there was no slow down (or other detrimental effects) associated with the use of look-ahead breadcrumbs (LAB). Users preferred LAB to regular breadcrumbs. The potential for a halo effect is mitigated by the specific comments regarding why LABs were preferred. The evidence from this experiment corroborates the hypothesis that LAB can be a useful addition to hierarchical websites.

The experiment highlights the need for carefully controlled experiments to evaluate hypertext interfaces. The site effects found by Teng [14] and us warn of the danger of controlling to the point of overfitting to artificial constraints (e.g., matching sites exactly using so-called 'Botafogo metrics' [2]).

### 4. CONCLUSION

We have shown that look-ahead breadcrumbs (LAB) can be used in large hierarchical websites with no detrimental effects. Furthermore, in contradiction to earlier studies, we found that LAB are quickly learned and appreciated. We focus our attention on hierarchically structured websites as LAB intrinsically represent hierarchies, but future work could investigate the use of such breadcrumbs in other types of structures.

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