

Sean C. Aery. Breadcrumb Navigation Deployment in Retail Web Sites. A Master's Paper for the M.S. in I.S. Degree. July, 2007. 60 pages. Advisor: Barbara M. Wildemuth.

In online retailing, effective navigation aids can help users to find products of interest, thus contributing to a site's usability and, ultimately, increasing sales. A breadcrumb trail in a Web site serves as a secondary navigation aid to help users to see a site's structure, visualize a path he or she has taken to a page or product, or otherwise understand the relationship of a page's contents to other pages within a site.

Through content analysis, this study explored the deployment of breadcrumbs—both in presentational and functional terms—in the Web sites of the top 100 online retailers (by annual sales). A wide variety of implementations was discovered and documented. Many deployments proved to be incongruent with recommendations in the literature. Analysis was performed given the perspective of an existing research framework developed by Instone (2002) which classified breadcrumbs into three types. A considerable number of sites' deployments could not be sufficiently classified using that model. As a result, changes to the framework are suggested, including the addition of new concepts such as “facet breadcrumbs” and “hybrid breadcrumbs.”

Headings:

- World Wide Web—Navigational Aids
- World Wide Web—Electronic Commerce
- Web Sites—Design
- Corporations—Internet Resources

BREADCRUMB NAVIGATION DEPLOYMENT PATTERNS IN RETAIL WEB
SITES

by
Sean C. Aery

A Master's paper submitted to the faculty
of the School of Information and Library Science
of the University of North Carolina at Chapel Hill
in partial fulfillment of the requirements
for the degree of Master of Science in
Information Science.

Chapel Hill, North Carolina

July, 2007

Approved by

Barbara M. Wildemuth

Table of Contents

Introduction.....	2
Literature Review.....	3
Types of Breadcrumbs: Existing Framework.....	4
A New Twist: Faceted Browsing	7
Additional Breadcrumb Types.....	10
Proliferation of & Conventions in Deploying Breadcrumbs.....	11
Breadcrumb Visibility & Use.....	15
Impact of Breadcrumb Use on Navigational Efficiency, Mental Models, and Satisfaction	18
Research Goals & Questions.....	21
Methods.....	23
Sample.....	23
Data Recorded for Each Site	24
Breadcrumb Navigation Data Collected for Each Site.....	25
Data Analysis	30
Results	30
Discussion	36
Summary and Conclusion	47
Appendix A: Breadcrumb Conventions.....	55
Appendix B: Breadcrumb Deployment by Industry	58

Introduction

Web sites typically feature several navigational aids to help users find pages or products of interest. A breadcrumb trail is a secondary navigation aid, meaning that it is an accessory to other more prominent navigation features such as search boxes and primary menus. According to Instone (2002), breadcrumbs manifest as a (usually horizontal) list of hyperlinked elements separated by a character such as ">". They "convey information to the user (about the site structure or the path they have taken)," and "give users a way to select links from the breadcrumb (in order to go 'up' in the site hierarchy or to re-trace their steps)."

Many (Rogers & Chaparro, 2003; Hudson, 2004; Krug, 2006) have noted the origins of the term "breadcrumb trail" in Web parlance—it is a metaphor for the clever way-finding technique employed by Hansel in the Brothers Grimm fairy tale *Hansel and Gretel* to return home after being carried blindly into the woods. All pointed out the incongruity in that in a Web context, breadcrumbs do not always represent the path from which one has arrived at their current location. Hudson (2004) and Krug (2006) both noted an additional irony in the metaphor: in the fairy tale, the breadcrumbs are eaten by birds and thus do not actually help young Hansel. Regardless, the term is clever, catchy, and has caught on as the agreed upon name for this type of Web navigational aid.

Unfortunately, other than the name, there exists little else about breadcrumbs that has reached such consensus. Many questions abound. How are they currently being deployed on the Web and how common are they? What conventions are designers following? Do different industries utilize different types of breadcrumbs? There exists sparse empirical evidence about breadcrumbs; they are an oft-overlooked and under-researched aspect of Web navigation. In fact, Web usability guru Jakob Nielsen even claimed that “breadcrumbs are not important enough for a dedicated study.” (2007a). Nevertheless, this paper aims to analyze in depth the deployment of breadcrumb navigation in the world's most popular retail Web sites. In pursuit of a greater understanding of these navigational aids, content analysis will be performed, tracking various characteristics of breadcrumbs in these sites.

Literature Review

This literature review will encompass what is currently known about breadcrumbs, including both the opinions of experts and the results of systematic investigation. It will begin by discussing an existing framework (Instone, 2002) for classifying and describing breadcrumb deployment. It will look briefly at the impact of faceted browsing on breadcrumb navigation. It will then cover the proliferation of breadcrumb navigation and conventions in its deployment: what do we know about how many sites include breadcrumbs and how are they typically displayed? How should they be displayed? Next, it will cover usage and visibility: do users notice breadcrumbs? Do they use them? Then it will

explore whether users understand breadcrumbs, regardless of whether they see or use them. Finally, it will discuss what is known about the impact that usage of breadcrumbs has on users' navigational efficiency, mental models, and satisfaction. These issues provide context for this paper's research goals and questions, as described at the end of the literature review.

Types of Breadcrumbs: Existing Framework

In his seminal poster presentation, Instone (2002) developed a framework for studying and discussing breadcrumb navigation. Instone's framework has gained traction. It has been cited in several subsequent studies (Colter, Summers, & Smith, 2002; Rogers & Chaparro, 2003; Ahmed & Blustein, 2005; Blustein, Ahmed, & Instone, 2005) and was later endorsed by Spool (2005) and Krug (2006). The cornerstone of his framework is the definition of three distinct types of breadcrumbs (location, path, and attribute), based on their function. Instone's original definitions are provided below verbatim, and then discussed in more detail.

Location Breadcrumbs.

Location breadcrumbs convey the position of the page within the site hierarchy. This is the most common type of breadcrumb on the web today because with static pages, this is the only reasonable implementation. Users can often take several different routes to a page, but the breadcrumb will tell them "where they are." (Instone, 2002)

According to Instone's (2002) presentation, location breadcrumbs indicate "[t]he single location of [a] page within [a] site's hierarchy," are "[h]ard coded," and

are the “best choice for static sites.” In his blog, Instone (2005) stressed the value in location breadcrumbs: “breadcrumbs are most useful to tell users ‘where they are’ - location breadcrumbs - when they ‘teleport’ to a deep page within a site,” agreeing with Spool (2005). Nielsen (2007a) also advocated for location breadcrumbs to aid users who have “arrive[d] directly at a page deep within the site. This scenario is when breadcrumbs show their greatest usability benefit, but only if you implement them correctly—as a way to visualize the current page's location in the site's information architecture.” This type of entry into a Web site represents a considerable number of users for the top online retailers. According to the Top 500 Guide (2007, p.32), “[o]f the top 100 retailers, 13 merchants generated 30.1% to 40% of all site traffic from search engines, compared to 50 between 20.1% and 30%; 31 from 10.1% to 20%; and 6 below 10%.”

Path Breadcrumbs.

Path breadcrumbs represent the original metaphor of the term and show the path the user has taken within the site to get to the current page. The same content from the site can be presented with different breadcrumbs because users can take different routes. With database-driven sites where the page can be dynamic and based on user-state information, path breadcrumbs are becoming more common. (Instone, 2002)

Instone's (2002) examples include screenshots from Epicurious.com, which uses “faceted browsing” and produces different breadcrumbs based on the sequence of clicks a user has performed to arrive at a given item page.

Reflecting in his blog, Instone (2005) stated, “There does not appear to be as much value for path breadcrumbs on sites. The browser does an acceptable, but not perfect, job of keeping track of a user's path.” Nielsen (2007a) agreed. While

not using Instone's terminology, he is critical of path breadcrumbs. He claims that "[o]ffering users a Hansel-and-Gretel-style history trail is basically useless, because it simply duplicates functionality offered by the Back button, which is the Web's second-most-used feature."

Attribute Breadcrumbs.

Instead of having the breadcrumb represent the location of or path to the current page, some sites use breadcrumb-like navigational features as meta-information to describe components of the site. The most common examples are ecommerce sites that use breadcrumbs as a type of extended keyword to convey product meta-information, such as subject, price, category, style, and brand. (Instone, 2002)

Instone (2002) proceeded to explain that attribute breadcrumbs "could be either path or location breadcrumbs." Thus, the three types become harder to distinguish, and by logic, not mutually exclusive. However, this also may be specious reasoning if accepting that, per definition, location breadcrumbs "indicate [a] single location in [a] site's hierarchy," whereas the attribute breadcrumbs he used as examples—mostly from Amazon.com—were all presented as sets or lists (see Figure 1). On his blog, Instone (2005) added to the definition: "a list of locations for a given object." He used a comparison: "In a real bookstore, there is [one] place on the shelf - attribute breadcrumbs show all of the locations the book may have been placed." He continued to be cautious about describing the utility of these navigational aids: "The jury is still out on attribute" breadcrumbs and "[w]e need some research here to see if/when these breadcrumbs help" (Instone, 2005).

Figure 1. Attribute Breadcrumbs Indicating a List of Possible Locations for a Particular Book on Amazon.com (Instone, 2002)

Look for similar books by subject:

Browse for [books](#) in:

- [Subjects](#) > [Computers & Internet](#) > [Web Development](#) > [Internet Commerce](#) > [Web Site Design](#)
- [Subjects](#) > [Computers & Internet](#) > [Networking](#) > [Internet, Groupware, & Telecommunications](#) > [Internet Publishing](#)
- [Subjects](#) > [Computers & Internet](#) > [Web Development](#) > [HTML, Graphics, & Design](#) > [Interface Design](#)
- [Subjects](#) > [Computers & Internet](#) > [General](#)

To summarize this framework: location breadcrumbs are used in static, hierarchical sites where an item resides in a single location, and are helpful to users who arrive deep in sites from external search engines. They help to answer the question, “Where am I (in relation to other parts of a site)?” Path breadcrumbs answer, “How did I get here (and how can I go back to where I was)?” They are possible with dynamic sites, indicate a path taken to an item, however, there are questions about the utility of such navigation, given that they duplicate the functionality of the Back button. Attribute breadcrumbs are intended to answer the question, “What are the properties of the thing(s) I am seeing on this page?” They feature a list of breadcrumb trails representing possible locations or paths to an item, though it is also unclear whether these help users. In describing his framework, Instone (2002) admitted, “These definitions do not provide any answers, only more questions.” Some of these questions will be explored below.

A New Twist: Faceted Browsing

Instone (2004) took on a different aspect of Web navigation in a presentation about faceted browsing. According to Instone, faceted browsing is

an “[i]nteraction style where users filter a set of items by progressively selecting from only valid values.” He contrasted this with the “[o]ld days” of clicking on categories to traverse a hierarchy to arrive at desired nodes or pages. In the faceted browsing experience, a user will “click, get a sample of results (‘1-10 of 149’)” and then “select a category to get fewer results.” Morville and Rosenfeld (2007) referred to this type of sequence as “guided navigation” (p.225).

Nielsen, Snyder, Molich, and Farrell (2001) discussed the utility of faceted browsing as applied to category pages in e-commerce Web sites, especially those which offer a high number of products. According to Nielsen et al. (2001), category pages are “those mid-level pages in an e-commerce website that help customers find the product listing pages — and thus, the products they want to buy” (p.2). Their research likely predates the term, faceted browsing; thus, their term of choice for this phenomenon is “winnowing.” They defined winnowing as “any method of interaction that lets the user refine a set of products, reducing the number of items in the set according to criteria chosen by the user” (p.32). This definition is fully consistent with the principles of faceted browsing. They went on to assert that “a site with many choices must help users arrive at a manageable set to consider. Winnowing capabilities separate great sites from good ones” (p.32). The business case for this claim is that it “can decrease the chance that users will become overwhelmed and give up” (p.32). They also recommended that, as part of the interface, “[t]he winnowing tool should also let users expand the set again” (p.32).

Morville and Rosenfeld (2007) also noted both the adoption and utility of faceted browsing in e-commerce, explaining that “[g]uided navigation was quickly embraced in the online retail arena, where there’s a clear link between findability and profitability” (p.225). They discussed Wine.com, whose main shopping page “presents three ways to browse, providing multiple paths to the same information” (p.225). They also noted that, with faceted classification, some facets are “flat lists (e.g., price)” whereas “some must be represented hierarchically (e.g., type).”

This begs the question of where breadcrumbs come into play in a faceted browsing environment. One aspect of faceted browsing that Instone (2004) highlighted is the “facet history” and two related questions: “How do you know what you have selected?” and, “How do you undo it?” He acknowledged that breadcrumbs are one possible place for this information, but posed new questions—namely, “Are breadcrumbs a good user interface for this?,” “Do users understand what they are doing when they undo?,” “How useful is the ‘remember what you chose’ aspect” and “Should history be integrated with selection?” Such a facet history is illustrated in the Home Depot Web site as shown below (see Figure 2). Faceted browsing thus introduces a new twist on breadcrumbs, and with that, a whole new set of questions.

Figure 2. Facet Selections in the Home Depot Web Site Interface—X’s Enable Undoing Individual Selections



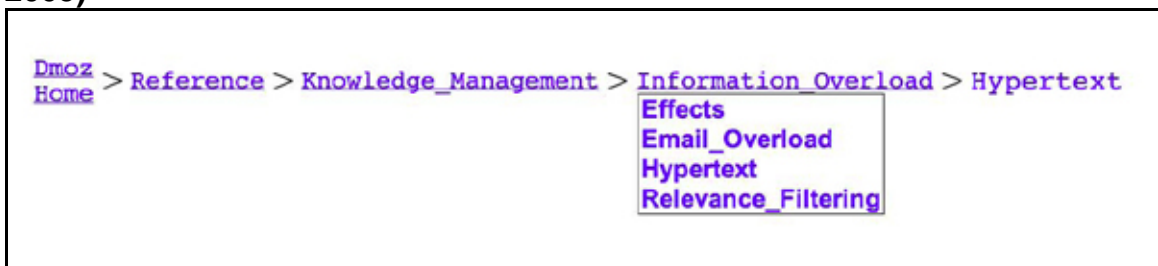
Additional Breadcrumb Types

In addition to Instone's work, two other studies have defined terms for specific types of breadcrumbs. Bowler, Ng, and Schwartz (2001) developed and tested "selection list navigation bars." With this type of breadcrumb trail, each nodal element functions as a pull-down list; the result is that not only can users follow links directly to visited points in the site hierarchy, they can also jump to sibling pages of those visited points (see Figure 3). Teng (2003, as cited in Blustein, Ahmed, & Instone, 2005) developed "look-ahead breadcrumbs," which similarly reveal a list of links to pages reachable from each node in the breadcrumb trail (see Figure 4).

Figure 3. Selection List Navigation Bars (Bowler et al., 2001)



Figure 4. Look-ahead Breadcrumbs (Teng, 2003, as cited in Blustein et al., 2005)



True implementations of neither selection-list navigation bars nor look-ahead breadcrumbs were found in the sample during the course of this research. However, one site (Zappos.com) did employ selection lists for some elements in its breadcrumb trails (see Figure 5).

Figure 5: Selection Lists in Zappos.com Breadcrumb Trails

The screenshot shows the Zappos.com website interface. At the top, there is a navigation bar with links for 'Shoes', 'Bags', 'Brands', and 'Search', along with sub-links for 'Women', 'Men', 'Kids', and 'Gift Ideas'. Below this, the breadcrumb trail is visible: 'Men's: Casual: Sandals'. A dropdown menu is open under 'Sandals', listing various shoe styles such as 'Airport Safe, Steel-Free', 'Barefoot', 'Boat Shoes', 'Boots', 'Clogs/Mules', 'Comfort', 'Eco-Friendly Footwear', 'Elasticated', 'Hemp', 'Hook and Loop Fastener', 'Loafer', 'Made in the USA', 'Monk Strap', 'Narrow Widths', 'Oxford', 'Removable Insoles', 'Sale Items', 'Sandals', 'Slip-On', and 'Slippers'. Another dropdown menu is open under 'Ankle Strap', showing 'Any Color' and 'Any Price' options. The page also features a 'Save This Search' button, a 'Go' button, and pagination information: 'High Price Show 12 per page | 99 per page'. Two product listings are visible: a Keen Newport sandal for \$100.95 and a Skechers North Haven sandal for \$78.95, both with 'Free Shipping Both Ways!' and 'Free Overnight Shipping' offers.

Proliferation of & Conventions in Deploying Breadcrumbs

Nielsen (2007a) claimed that with breadcrumbs, “[c]onsistency breeds familiarity and predictability, which breed usability,” and stressed that designers must follow established conventions. Yet, the questions remain: how common

are breadcrumbs as a navigational aid, and how are they typically arranged when deployed?

One study measured breadcrumb inclusion (Colter, Summers, & Smith, 2002) by analyzing 3,453 commercial Web sites (all sellers were featured in Google Catalog, which is now Google Product Search). Only 17% of these sites included breadcrumbs.

Usability and IA professionals have anecdotally speculated about the ideal syntax and presentation of breadcrumbs (Nielsen, 2000; Instone, 2002; Krug, 2006; Nielsen, 2007b). Colter et al.'s study (2002) actually included a syntactical content analysis of several sites. These sources will be expounded below, however, a discussion about conventions will be best preceded by a look at the anatomy of a breadcrumb trail.

Anatomy of a Breadcrumb Trail. Instone (2002) distinguished breadcrumbs as a typically horizontal “list of elements (links)” divided by a “separator.” The separator is either a character (such as a “>”) or an image (such as an arrow graphic). Figure 6 illustrates one typical example. Each of its components is discussed below.

Figure 6: Breadcrumb Trail from a Product Page on HomeDepot.com.

You are here: [HOME](#) > [Electronics](#) > [Cameras & Camcorders](#) > PowerShot Digital Camera

Indicator of the Breadcrumbs' Purpose. Krug (2006, p.78) advocated for using the words “You are here” (as implemented in this example) to make the breadcrumbs “self-explanatory.” He makes this argument despite positing that “[m]ost people will understand what the breadcrumbs are,” regardless of an

indicator. More discussion of this argument will follow in the Visibility & Use section below.

Home Link. Several elements (“HOME,” “Electronics,” “Cameras & Camcorders,” and “PowerShot Digital Camera”) are included in the breadcrumb shown. The first element in a breadcrumb trail does not necessarily have to be a Home link, but Instone (2002) said that the first element “usually represents the homepage.” Likewise, Nielsen (2007a) claimed that breadcrumbs “almost always” start with the homepage. However, to date, no studies have indicated a more concrete tally.

Including a Home link may benefit users in their navigation. One study (Stevenson, 2003) illustrated users’ preference for clicking on the Home link in a breadcrumb trail over clicking on a site’s logo to navigate to a home page. During task completions, all participants in this study (n=13) clicked on the Home link in the breadcrumb at least once; 47.4% of all clicks home were via the browser’s Back button, 44.1% were via the breadcrumb home link, and only 7.5% came via the main logo or other clicks. The utility of the breadcrumb Home link would be even more significant if extrapolated to cases where users do not have the option to navigate home via a Back click (such as when arriving to a site via deep link or external search).

Separator. In the example shown in the figure, the greater-than character (>) separates the elements. Colter et al. (2002) found that in sites that use breadcrumbs, 47.10% used the greater-than (>) separator. Other popular characters in use were the colon (:), 11.10%, the forward slash (/), 8.90%, the

double greater than (>>), 6.80%, the arrow (→), 5.80%, and the pipe (|), 4.90%. No other separator character or image was found in more than 2% of the examples in their content analysis.

Krug (2006) advised designers to use the > symbol. His rationale is that the greater than symbol "seems to be the most satisfying and self-evident-- probably because it visually suggests forward motion down through the levels" (p.78). Nielsen (2007b) also advocated for the > symbol and warned against other symbols and characters such as the colon (:) because they can confuse users, "indicat[ing] alternative choices on the same level (and not a progressively deeper nesting of options...)."

Current Item / Page. The last element in the breadcrumb trail in the figure is the name of the current item/page being viewed. Instone (2002) remarked on the last element in the breadcrumb trail: it "usually represents the name of the current page; sometimes this is (erroneously) a link to the current page." Krug (2006) advised that "the last item in the list should be the name of the current page, and making it bold gives it the prominence it deserves" (p.78). Finally, Nielsen (2007a) claimed that breadcrumbs "almost always" end with the current page as the last element and, like Instone, noted that all elements should be links except for the current page, "because you should never have a link that does nothing."

Breadcrumb Visibility & Use

It is worthwhile for designers to consider how frequently breadcrumbs are used in comparison with other site navigation, and whether users even notice breadcrumbs at all. What factors impact the use and visibility of these navigational aids? Several studies (Lazar & Eisenbrey, 2000; Colter et al., 2002; Lida, Hull, & Pilcher, 2003; Stevenson, 2003; Rogers & Chaparro, 2003; Hull, 2004) have attempted to measure visibility and usage through various methods. Most involve assigning participants tasks to complete in various Web sites that feature breadcrumbs, capturing and analyzing clickstreams, and interviewing participants after the tasks have been completed.

Studies focusing on breadcrumb visibility have shown that many users do not notice breadcrumbs. Lazar and Eisenbrey (2000) reported that “most people actually *do not* look at [breadcrumbs].” In Stevenson’s (2003) study, the majority of participants (54%) reported that they did *not* notice the breadcrumb trail (although all thirteen actually clicked on the Home link in the trail). Lida et al.’s research (2003) contrasted two sites: one (Google Directory) yielded high visibility (72% of participants recalled seeing them), and another (OfficeMax) yielded low visibility (only 36%), thus suggesting that different implementations may lead to greater visibility.

Measuring actual usage of breadcrumb navigation requires different methods; after all, a user who sees a breadcrumb trail does not necessarily use it. Colter et al. (2002) found that breadcrumb use was moderate among four major Web sites (Wal-Mart, Target, Epicurious, Yahoo). While 13 of 14

participants (93%) used breadcrumbs at least once during completion of the assigned tasks, breadcrumbs were used in only 22% of those tasks. Individual clicks were not reported. In Stevenson's study (2003), just over half (54%) of the participants said that they would *not* use this navigational aid *at all*.

Breadcrumb clicks (on elements other than the Home Link) accounted for a total of only 12 (9%) out of the 133 navigation-related clicks. Similar results were found by Rogers and Chaparro (2003): breadcrumb clicks accounted for only 6% of overall navigation. Lida et al. (2003) reported even lower usage (3.5% of total clicks in OfficeMax.com; 1.4% of total clicks in Google Directory). While these statistics are indicative of low use in both sites, it is also notable that breadcrumbs in OfficeMax were actually used much more frequently than those in Google Directory, despite being reported as less visible. Thus, visibility and use are not necessarily related. Also, the contrasting nature of the two sites is important: this may be evidence that site users are more likely to use breadcrumbs for shopping purposes on an e-commerce site than they are to use them in general information-seeking tasks.

Regardless of whether users actually see and choose to utilize breadcrumbs in their navigation, it is another issue to consider whether users actually understand breadcrumbs. Some research indicates that they do not. Five of the fourteen participants (36%) in Colter et al.'s study (2002) incorrectly guessed that location breadcrumbs (indicating present location in a hierarchy) indicated the path they had taken to arrive at the current page or a record of where else on the site they had visited (these types would be path breadcrumbs,

by Instone's (2002) definitions). The same phenomenon is seen in Stevenson's study (2003). Her participants "seemed to view the [breadcrumb trail] as a substitute for the back button instead of as a means for orienting themselves with where they were within the website." The cause of such misunderstandings remains to be discovered.

The evidence that many users do not notice, use, or understand breadcrumb navigation begs the questions, "Why?" and, "What can be done to change this phenomenon?" Hudson (2004) diagnosed some potential causes. He asserted that users ignore breadcrumbs for many reasons: they are not widely and universally utilized, they are sometimes not used consistently even within the same site, and designers often hide them outside of the main content area or fail to make links apparent. An example he used is Amazon.com: it "has a breadcrumb navigation line at the top of some intermediate pages, but not individual product pages" (p.80).

Looking at the present and future of breadcrumb use and visibility, Nielsen (2007a) is more optimistic, providing anecdotal observations of breadcrumb use by participants in his own research. In response to evidence that breadcrumbs are often overlooked, he claims that "The case against breadcrumbs is crumbling. Every year we see more people use breadcrumbs in our studies."

Lazar & Eisenbrey (2000) suggested that user education is the key to visibility and usage: "[t]he first step in making navigation bars handy in practice is to teach users that they exist and are a valuable resource." Research by Hull (2004) built upon on this claim. Hull's results revealed that users are (about one-

third) more likely to use breadcrumbs in navigation when they are first given minimal training about and exposure to them. Using this information, Hudson (2004) discussed potential techniques for educating users about breadcrumbs, including explanatory pop-up text and animated demonstrations. He also implied that designers can help by being more attentive to conventions when deploying breadcrumbs, such as making the links “visually obvious” (p.80).

Should users be given explicit instruction about breadcrumbs as some of these researchers have suggested? Or will breadcrumb usage increase in time with mere exposure? It remains to be seen whether breadcrumb deployment is becoming more commonplace on the Web. Yet, if this is in fact the case, users may naturally become more educated about them, be quicker to notice their presence, and should be more apt to use them. As Hudson (2004) hinted, users may eventually "catch up with [the] technology" (p.80).

Impact of Breadcrumb Use on Navigational Efficiency, Mental Models, and Satisfaction

Usability professionals are quick to proclaim the benefits of deploying breadcrumbs on Web sites in order to aid user navigation. For example, Straub (2004) said that breadcrumbs “increase efficiency. They support site learning. They reduce the user's ‘where-was-I?’ memory burden by providing a list of recently visited pages. They make it easier to cross levels of the navigation decision tree within the browser environment.” Others remark on breadcrumb navigation when considering a user’s entry point to a site. Spool (2005) stated, “Where breadcrumbs are useful is in a context we call teleporting. Teleporting is

what happens when a user suddenly finds themselves in the middle of the information architecture, often because of a search result.” Nielsen (2007a) agreed with Spool: “Breadcrumbs afford one-click access to higher site levels and thus rescue users who parachute into very specific but inappropriate destinations through search or deep links.” Such claims generally fall into three categories: they help users get places faster (navigational efficiency), they help users understand a site’s structure (mental model), and they otherwise enhance the user’s perceived experience (satisfaction).

When making decisions about whether to deploy breadcrumbs on their Web sites, designers may benefit from considering these heuristics. However, it is also important to review the empirical research that has been completed that investigates these claims. Both are summarized below.

Navigational Efficiency. Most claims regarding the benefits of breadcrumbs focus on the navigational efficiency they afford. Krug (2006, p. 77) asserted that good breadcrumbs are "self-explanatory, they don't take up much room, and they provide a convenient, consistent way to do two of the things you need to do most often: back up a level or go Home." Hudson (2004) outlined reasons why breadcrumbs are good for navigation, namely: they enable users to stay in a general area of interest without backing out to the homepage, it is otherwise hard to navigate backwards, and they help users understand a site's hierarchy.

Several researchers have attempted to determine whether the use of breadcrumbs has resulted in improvements in the navigational efficiency of Web

site users (Lazar & Eisenbrey, 2000; Lida et al., 2003; Rogers & Chaparro, 2003; Hull, 2004). Efficiency measures include time to complete tasks, total mouseclicks, and total page views. Of these four studies, two (Lazar & Eisenbrey, 2000; Hull, 2004) found that participants who used breadcrumbs completed tasks more efficiently, and the other two (Lida et al., 2003; Rogers & Chaparro, 2003) found no statistically significant evidence that the use of breadcrumbs improves efficiency. This conflicting evidence leaves this an unresolved issue.

Mental Models. Straub (2004) claimed that breadcrumbs will improve a user's learning of a site, and it seems likely that the use of breadcrumb navigation enhances people's understanding of a site's structure. However, research into these claims is limited. To measure mental models, Rogers and Chaparro (2003) asked users to choose from four graphical representations, the model that best resembled the structure of the site with which they had just finished interacting. Almost all of the users who were given breadcrumbs in their interface (28 out of 29) correctly indicated that the site used a hierarchical model, whereas half of the users in the group that did not have breadcrumbs present in their interface (5 out of 10) incorrectly identified the site as non-hierarchical. Mental models are intricately robust and complex concepts, however, and this study barely scratches the surface by asking a single structural question. Much more research is needed in this area to support claims that breadcrumbs enhance the development of users' mental models.

Satisfaction. As with studies of mental models, empirical research in this area is sparse. Lida et al. (2003) measured user satisfaction using a 12-item adaptation of an End-User Computer Satisfaction (EUCS) instrument. Two sites were utilized to complete assigned tasks (Google Directory and OfficeMax); participants used breadcrumbs more frequently on OfficeMax and were significantly more satisfied with the experience. Lida et al. noted the correlation, but qualified it by illuminating several other factors that may have impacted satisfaction.

Research Goals & Questions

The literature reviewed above acknowledges different implementations of breadcrumb navigation on Web sites, and shows that Instone's (2002) framework is popular for classifying deployment. Several studies indicate that many users fail to notice, use, and understand these navigation aids. Experts have made anecdotal recommendations to designers for deploying breadcrumbs in a manner that helps users to see, comprehend, and efficiently utilize them; these recommendations include following certain conventions, being consistent, and helping to educate users—whether implicitly or explicitly—about using breadcrumbs. It highlights the importance of useful navigation in e-commerce Web sites, discusses the impact of faceted browsing on online retail sites, and relates faceted browsing to breadcrumb deployment.

Building on the existing literature, this study employs content analysis to determine whether claims and recommendations are consistent with actual

breadcrumb deployment, and to measure how breadcrumbs are being deployed in practice (both visual design conventions and behaviors). A clearer understanding of these factors may help designers to make better decisions about whether to include breadcrumbs as a navigational aid, and, if so, which conventions to follow. It also aims to test whether Instone's (2002) definitions are sufficient to classify breadcrumbs as currently deployed. Finally, it investigates the impact of breadcrumb implementation on user satisfaction ratings for online retailers.

Specifically, this study will address these research questions:

- 1) How commonplace is the inclusion of breadcrumb navigation in popular retail Web sites?
- 2) What conventions are designers following when deploying breadcrumbs on retail Web sites? Are these consistent with recommendations in the literature?
- 3) Is Instone's (2002) framework sufficient for classifying breadcrumb deployment in current retail Web sites? Is an alternative framework needed?
- 4) Is there a relationship between breadcrumb deployment and a retailer's particular industry?
- 5) Does an online retailer's deployment of breadcrumbs relate to its users' satisfaction while browsing its site?

Methods

All of the Web sites of the top 100 online retailers were investigated in this content analysis. For each site, an industry and satisfaction index were noted as reported by an independent market research publication (Top 500 Guide, 2007). Data on breadcrumb deployment was then collected from both product pages and category pages in each site. To determine design conventions, attention was paid to the sequence of elements within the breadcrumb trails, and the separator characters between them. To gauge and classify deployment by behavior using Instone's (2002) framework, determinations were made as to whether more than one breadcrumb trail was possible for any given product, and whether breadcrumbs existed when entering a product page via external search. These behaviors were tracked in order to differentiate path breadcrumbs from location breadcrumbs. The third type—attribute breadcrumbs—are more visually distinct and were noted when found. Finally, the characteristics of breadcrumb deployment within faceted browsing environments was also noted.

Sample

The sample for this study includes the Web sites of the 100 largest online retailers, ranked by 2006 annual sales. Rankings were taken from the *Top 500 Guide: Profiles and Statistics of America's 500 Largest Retail Web Sites Ranked by Annual Sales* (2007), compiled by *Internet Retailer* magazine. Of the top 100 retailers, 39 companies own and operate two Web sites, and one (Sears Holding Corps.) owns three sites (including sears.com, landsend.com, and kmart.com).

The unit of analysis was the individual Web site; thus, 141 sites in total were slated for investigation. In the course of the study, one site (<http://aafes.com>) had to be omitted because it required account creation for which military association was a prerequisite. Three other sites had to be omitted to avoid duplication; the URLs redirected to other sites in the sample (jcrewfactory.com to jcrew.com, nikestore.com to nike.com, and beauty.com to drugstore.com). Ultimately, 137 sites were investigated. This is not a sample representative of all Web sites in existence, nor even all e-commerce sites, but it does represent a reasonable sample of the most popular retail sites on the Web.

Data Recorded for Each Site

Some data collected for each site was taken from a report (Top 500 Guide, 2007) compiled by an independent market research organization. These data elements include rank (in the top 100, ordered by 2006 online sales), name of company or holding firm, URL, industry, and satisfaction index. In the report, each company was classified into one of fourteen industries:

Apparel/Accessories, Books/CDs/DVDs, Computer/Electronics, Flowers/Gifts, Food/Drug, Hardware/Home Improvement, Health/Beauty, Housewares/Home Furnishings, Jewelry, Mass Merchant/Department Store, Office Supplies, Specialty/Non-Apparel, Sporting Goods, and Toys/Hobbies.

The satisfaction index was calculated by an independent market research organization (FGI Research) by using the methodology of the University of Michigan's American Customer Satisfaction Index (ACSI) (Top 500 Guide, p. 24;

details available at <http://www.theacsi.org/>). The data was reportedly collected in February 2007 from over 20,000 respondents who had visited the top 100 online retail sites within the previous two weeks but did not necessarily make a purchase. A satisfaction index rating was available for 92 of the 137 sites (Top 500 Guide, p. 20). Ratings are integers that can range from 0 to 100; the ratings ranged from 67 to 85 within the sample.

Breadcrumb Navigation Data Collected for Each Site

Two aspects of each site were investigated for breadcrumb deployment: 1) the category pages—the “mid-level pages in an e-commerce website that help customers find the product listing pages” (Nielsen et al., 2001, p.2); and 2) the individual product pages, each of which features a single product.

Variables collected from category pages: Several variables were collected from category pages, as described below. All are discrete/nominal variables. Explanations are provided for why and how these variables were collected.

Breadcrumbs present? (Yes, No). Data collection for each site began with a visit to the site home page. A top-level category in the navigation was clicked (i.e., “Electronics” for mass merchants, “Men” for apparel stores, or “Furniture” for houseware stores). A subcategory was chosen, and then another, if possible. Drilling into subcategories generally revealed breadcrumbs quickly; if not, multiple alternate routes were chosen again from the homepage until a reasonable assertion could be made that breadcrumbs did not exist.

Current category element listed in breadcrumb trail? (Yes, No). While viewing a specific category page (i.e., “Men’s Sandals”), it was noted whether the last element in the breadcrumb trail displayed the current category or if this was missing from the breadcrumbs.

Separator character used (open-ended). The separator character used in breadcrumb trails on category pages (i.e., >) was noted.

Current category element presentation (Plain text, Self-linked, Bold, Colored, Other). If the current category did exist in the breadcrumb, the presentation style was noted, including whether it was a link to the current page, plain unclickable text, or if font-weight or alternate colors were used to differentiate the current item.

Facet selection history in breadcrumb? (Yes, No). While browsing through category pages, attention was given to any indications of faceted browsing capabilities, such as navigation to “Narrow by” or “Filter by” attributes such as “Price” or “Brand” or “Size.” When possible, product groups with many properties (such as Digital Cameras or Books) were chosen to help test whether this type of browsing was enabled. If faceted browsing was possible, facets were chosen and it was noted whether these specifications were reflected as elements in the breadcrumb trail.

Facet selection history—facets individually removable? (Yes, No). If facet selections appeared in the breadcrumb trail, it was noted whether those specifications could be individually undone regardless of the sequence chosen.

Variables collected from product pages. In addition to category pages, several variables were also collected from individual product pages, as described below. All are discrete/nominal variables. Explanations are provided for why and how these variables were collected.

Breadcrumbs present? (Yes, No). This variable was tracked independently of category page breadcrumbs. After navigating through subcategories, an individual product was chosen and it was noted whether breadcrumbs existed on the product page.

Home link present? (Yes, No). In the product page, it was noted whether a link home was provided as the first element in the breadcrumb trail.

Home link term or phrase used (open-ended). The syntax was recorded in cases where a home link is provided to indicate whether each site uses "Home," "Homepage," the site name, or other terminology.

Indicator present? (Yes, No). It was noted whether signage existed near the breadcrumb trail (such as "You are here:" that provided indication of what the breadcrumbs were.

Indicator term or phrase used (open-ended). If an indicator existed, the syntax was recorded.

Separator character used (open-ended). The separator character in the breadcrumb trails on individual product pages (i.e., >) was noted.

Possible breadcrumb trails to individual product (Only one/fixed, More than one) The purpose of including this variable was to distinguish whether breadcrumbs were location or path breadcrumbs by Instone's (2002) definitions.

This determination is not evident when browsing to a product page once, thus it required (in some cases) extensive browsing through a site. Products with several characteristics were chosen as targets (such as sale items that produce two or more breadcrumbs, e.g., “Men’s > Athletic > Shorts,” and, “Men’s > Clearance > Athletic”). Multiple attempts were then made to arrive at the same product via different paths. If multiple paths were not evident, alternate products were chosen and tested until a reasonable assertion could be made about fixed breadcrumbs. This assertion was also supported by analysis of the next variable (see below).

When coming to a product page from external search, does a breadcrumb trail exist? (Yes, No). This test intended to reveal whether breadcrumbs are deployed on product pages when users enter directly from an external search engine. The intent here was twofold: to discover if search-engine shoppers are missing a navigation aid that those who start at the homepage have, and to further distinguish whether the breadcrumbs are path or location breadcrumbs. The Google search engine was used for this test. Before searching, the browsing history, cache, and cookies were cleared from the browser (by using Ctrl-Shift-Del in Mozilla Firefox). This process ensured that any state-maintaining information that the site may have kept while the other variables were being collected was eliminated and that this process simulated a user entering the site for the first time. A product whose breadcrumb trail had already been noted was then used for the search, using this syntax: *site:www.example.com “full product name”* The relevant search results were then clicked to verify the breadcrumbs.

If multiple breadcrumb trails had still not been revealed at this point, an additional measure was taken to double-check. Scrolling to the last page of Google search results reveals the message, *“In order to show you the most relevant results, we have omitted some entries very similar to the [number] already displayed. If you like, you can repeat the search with the omitted results included.”* This option was clicked, thus often revealing more relevant results of the product page for breadcrumb analysis.

One of the purposes of collecting data about 1) whether multiple breadcrumb trails can exist for a given product, and 2) whether breadcrumbs appear when entering a site from an external search was to attempt to classify sites' breadcrumb deployment practices based on Instone's (2002) framework. Sites which have one fixed, consistent breadcrumb trail for each product would be using “location breadcrumbs.” Sites which can yield various trails for a given product and yield no breadcrumbs upon entering the product page from an external search referral would be using “path breadcrumbs.” Any site which could yield multiple breadcrumb trails for one product yet also features breadcrumb navigation when entering a product page from an external search would be unclassifiable by Instone's definitions.

Attribute breadcrumbs present? (Yes, No). Every product page was inspected for attribute breadcrumbs, which resemble a list of multiple breadcrumb trails displayed on the same page (Instone, 2002).

Screenshots. In the course of capturing all data, multiple screenshots were recorded for each site. Each site yielded at least three screenshots: a

category/subcategory page, a product page, and a product page after entering from Google search. Many sites required even more screenshots: a category page with facets selected, and a product page featuring different breadcrumbs from a previous screenshot of the same product.

Data Analysis

The majority of the data collected was analyzed using frequencies of occurrences of the various breadcrumb properties recorded. Frequencies were used in the analysis of the first three research questions, dealing with proliferation, conventions, and classification within Instone's (2002) framework. Cross-tabulations and Fisher's Exact test were used to examine the relationship between the deployment of breadcrumbs and the Web site's industry. Fisher's exact test was used instead of chi square because 68% of the cells in the contingency table had expected frequencies less than 5, making its validity questionable. Finally, an analysis of variance (ANOVA) was used to examine the relationship between satisfaction and breadcrumb deployment.

Results

The first research question asked about the occurrence of breadcrumbs on the Web sites in the sample. Table 1 shows how many sites included breadcrumb navigation, and whether it was included on category pages, product pages, or both. Over three-fourths of the sites included breadcrumbs; and almost two-thirds of the sites included breadcrumbs on both category and product

pages. Even though attribute breadcrumbs do appear on product pages, for the purposes of this study, they were not considered product page breadcrumbs.

Table 1. Breadcrumb Deployment on Retail Web Sites

	Number	Percent	Number	Percent
Breadcrumbs present			104	75.9%
On both category and product pages	86	62.8%		
On category pages only	14	10.2%		
On product pages only	3	2.2%		
Attribute breadcrumbs only	1	1.0%		
No breadcrumbs present			33	24.1%
<i>TOTAL</i>			137	100.0%

Note. Attribute breadcrumbs were deployed in two sites (Amazon.com and Buy.com). Buy.com is the only site that used attribute breadcrumbs exclusively. Amazon.com was counted as “category pages only” because attribute breadcrumbs were not considered product page breadcrumbs.

The second research question inquires about design conventions. A number of conventions used in deploying breadcrumbs were investigated. The first was the presence (or lack of) an indicator of the breadcrumb’s purpose (e.g., placing the phrase “You are here” at the beginning of the breadcrumb). Of the 104 Web sites that included some type of breadcrumbs, only 13 (12.5%) included such an indicator. Of those 13 Web sites, eight of them used the phrase, “You are here,” and the remainder used other text. Details on the use of these indicators are available in Appendix A.

Product pages were also investigated to determine whether sites included a link to the home page in the breadcrumb trail. Of the 89 Web sites that included product page breadcrumbs, 58 (65.2%) included a home link—all as the

first element in the trail. Over three-fourths of these sites used the word “Home” for the element. Further details may be found in Appendix A.

The frequency of use of various separator characters to divide breadcrumb trail elements was also calculated. Table 2 shows the conventions used. Almost two-thirds (63.5%) of the sites used the greater-than (>) character, and no other character was found in more than 10% of the sites. Two sites used different separator characters for different pages: TigerDirect.com (> on product pages; >> on category pages) and JR.com (| on product pages; > on category pages). For these two sites, the product page character was counted, and the category page character was discarded.

Table 2. Separator Characters Used in Breadcrumb Trails

Character	Number	Percent
>	66	63.5%
:	10	9.6%
>>	8	7.7%
	6	5.8%
/	4	3.8%
image of arrow	3	2.9%
Other image	2	1.9%
Dot	2	1.9%
...	1	1.0%
,	1	1.0%
<	1	1.0%
<i>TOTAL</i>	<i>104</i>	<i>100.0%</i>

In addition to the first element and separator characters, the last element in the breadcrumb trails for each of the sites in the sample was analyzed. On

category pages, the current category was listed in the breadcrumb trail in most (91%) of the sites. On the other hand, however, the current product was only displayed in product page breadcrumbs in less than one-third (30.3%) of the cases. For both category pages and product pages where the last element represented the current item, it was styled most frequently as unlinked plain text (50.5% for category pages; 74.0% for product pages). Further results from the last-element analysis may be found in Appendix A.

A considerable number of sites were found to be displaying facet selection choices as part of the breadcrumb trail in category pages. Over one-third of the sites with category page breadcrumbs (34.0%) used them to show facet selection history. This represents almost one-fourth (24.8%) of the sites in the sample of 137. Of those deploying breadcrumbs for facet selection history, almost half (44.1%) also enable the removal of individual facet choices, regardless of the sequence chosen. Appendix A includes further frequency data about these occurrences.

Product pages from each site were analyzed to determine whether breadcrumbs were fixed, or whether there could exist different possible breadcrumb trails for the same product. Table 3 illustrates that the majority of sites (71.9%) with product page breadcrumbs afforded more than one trail.

Table 3. Number of Possible Breadcrumb Trails to an Individual Product

	Number	Percent
More than one	64	71.9%
One / Fixed	25	28.1%
<i>TOTAL</i>	<i>89</i>	<i>100.0%</i>

Another analysis of breadcrumbs on product pages revealed whether breadcrumbs also existed upon entering a product page from an external search engine. Table 4 shows that they did exist in most cases (83.1%). Four sites were indeterminable: newport-news.com, abebooks.com, abebooks.co.uk, and cvs.com. For these sites, individual product pages could not be found through Google search; thus, it could not be determined whether breadcrumbs existed on product pages when entering from an external search referral.

Table 4. Existence of Breadcrumbs on Product Page Upon External Search Referral

	Number	Percent
Breadcrumb Trail Exists	74	83.1%
Breadcrumb Trail Does Not Exist	11	12.4%
Could Not Be Determined	4	4.5%
<i>TOTAL</i>	89	100.0%

The third research question asked whether Instone's (2002) framework is sufficient for classifying breadcrumb deployment in current retail Web sites. The intersection of the factors measured and displayed in Tables 3 and 4 creates a matrix by which breadcrumb deployments can be classified by Instone's (2002) definitions. Location breadcrumbs will have only one possible breadcrumb trail for products. Path breadcrumbs have multiple possible trails, though will not exist when entering from external search. Any other implementations (beside attribute breadcrumbs, which are omitted from this matrix) will be unclassifiable using Instone's (2002) framework. This matrix is shown in Table 5.

Table 5. Breadcrumb Classification Matrix

Type	Number of different breadcrumb trails per product		Breadcrumbs present upon external search referral	
	Two or more	One	Yes	No
Path breadcrumbs	X			X
Location breadcrumbs		X	X	
- Undefined -	X		X	
Indeterminable	X		?	?

Note. Question marks indicate that a determination could not be made as to whether breadcrumbs were present upon search referral.

Analysis of all 89 sites with product page breadcrumbs revealed that over half (55.1%) do not fit into any particular classification between path or location breadcrumbs. Table 6 illustrates the distribution of classifications; location breadcrumbs accounted for 28.1%; path breadcrumbs 12.4%; and four sites (4.5%) remained indeterminable because of difficulties reaching product pages from search queries.

Table 6. Deployment of Different Types of Breadcrumbs

Classification	Number of Sites	Percent of Sites
Path breadcrumbs	11	12.4%
Location breadcrumbs	25	28.1%
- Undefined -	49	55.1%
Indeterminable	4	4.5%
<i>TOTAL</i>	89	100.0%

The fourth research question inquired whether there was a relationship between breadcrumb deployment and a retailer's particular industry. A contingency table was constructed, with a row for each of the 14 industries,

showing how many sites in each industry did or did not use breadcrumbs. Fisher's Exact test indicated that there was a statistically significant relationship ($p=0.0129$) between industry and breadcrumb deployment (see the table in Appendix B). Based on the examination of expected and observed frequencies, the actual frequency of breadcrumb inclusion deviated considerably from the expected value in two particular industries. All 19 Mass Merchant retail sites in the sample (100.0%) deployed breadcrumbs of some type—more than expected. In the Apparel/Accessories industry, only 20 out of 34 sites (58.8%) included breadcrumbs—less than expected.

The final research question concerned whether there is a relationship between user satisfaction and the deployment of breadcrumb navigation on a site. An analysis of variance between satisfaction and breadcrumb inclusion revealed no statistically significant relationship between the two factors ($F=0.056$, $p=0.813$). The mean satisfaction value for sites with breadcrumbs was 73.96, and those without had a mean satisfaction rating of 74.19.

Discussion

A discussion of the results found in this study will follow. Findings will be discussed as relating to the five aforementioned research questions.

How commonplace is the inclusion of breadcrumb navigation in popular retail Web sites?

Over three-quarters of the Web sites of the top 100 online retailers—104 of 137 sites (75.9%)—included some type of breadcrumb navigation. This figure is considerably higher than the 17% rate that Colter et al. (2002) discovered. Such a discrepancy likely indicates a trend—that breadcrumb deployment has become much more commonplace over the past five years. It is, however, possible that differences in the samples may have influenced the disparity between these statistics. Colter et al. analyzed all online retailers included in Google Product Search in 2002; this current study examines only the Web sites of the top 100 overall. Those in the top 100 could be more likely to offer a wider variety of products than those in Colter et al.'s sample, which, in turn could increase the likelihood of breadcrumb implementation. Regardless, it is evident that breadcrumbs are now very common amongst the most popular online shopping sites, and very likely that deployment is on the rise.

What conventions are designers following when deploying breadcrumbs on retail Web sites? Are these consistent with recommendations in the literature?

Given the evidence that many users do not see or understand breadcrumbs, it may be beneficial for designers to follow certain conventions when deploying them on sites. They should at least be aware of the recommendations, the rationale behind them, and the general conventions that other designers are following in practice.

Krug (2006) suggested putting indicator text next to the breadcrumb trail to help users understand what it represents. However, of the 104 sites analyzed that have breadcrumbs, only thirteen (12.5%) have such an indicator. Of the thirteen, eight (61.5%) use the text “You are here” as Krug recommended; thus, only eight out of 104 (7.7%) use this particular convention.

Analysis of the first element in breadcrumb trails revealed that of 89 sites with product page breadcrumbs, 58 (65.2%) include a link to the site’s home page. This is more consistent with Instone’s (2002) statement that this convention is “usually” the case, rather than Nielsen’s (2007a) claim that it is “almost always” the case. With 31 (34.8%) of the sites’ product pages neglecting to provide a link home in the breadcrumbs, a considerable number of designers seem to be denying users a navigational option that Stevenson (2003) found to be preferable from a user perspective.

Separator character conventions appear to be in line with recommendations by Krug (2006) and Nielsen (2007b), both of whom advocated for the greater-than (>) character. Sixty-six of the 104 sites with breadcrumbs (63.5%) used the greater-than character. The colon (:) had the second-most uses with 10 (9.6%), and the double-arrow (>>) was third with 8 (7.7%). All other conventions were found in less than 6% of the sites. In 2002, Colter et al. also found the greater-than character (47.1%) and the colon (11.1%) to be the most frequently used characters, and it appears that designers are even more likely now to opt for the greater-than character than they were in 2002.

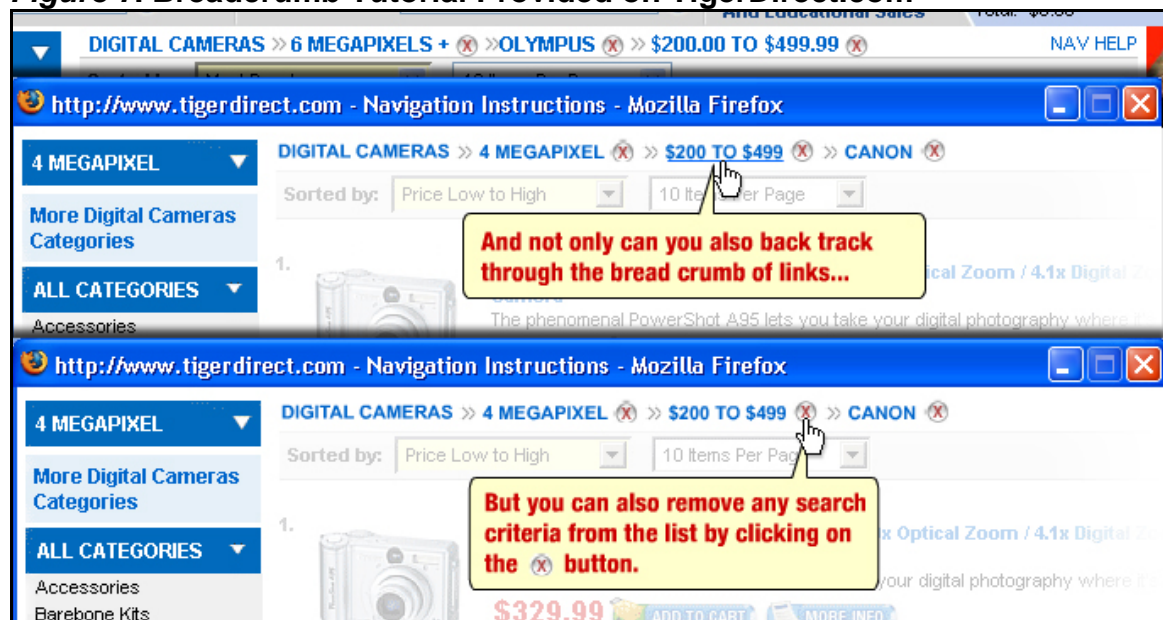
In regard to the last element in the breadcrumb trails, there is a clear difference between the implementations on product pages and those on category pages. In category pages, 91 out of 100 (91.0%) sites display the current category being viewed; however, on product pages, only 27 of 89 (30.3%) sites display the current product in the breadcrumb trail. Thus, product page last-element implementation is inconsistent with claims that the last element “usually” (Instone, 2002) or “almost always” (Nielsen, 2007a) represents the name of the current page, and 62 of 89 sites (69.7%) ignore Krug’s (2006) recommendation that “the last item in the list should be the name of the current page” (p.78). Another one of Krug’s recommendations—that the current item should be “bold” to give it “prominence” (p.78)—has also not been heeded. In category pages, only 13 of 91 (14.0%) sites use bold style to differentiate the current category and, in product pages, only five of 27 (18.5%) use bold for the current product. Finally, several sites violate another heuristic admonishment—made by both Instone (2002) and Nielsen (2007a)—that the current page element should not be a link. In category pages, 25 of 91 sites (27.5%) violate this recommendation.

Inconsistencies in deployment within the same site were also discovered. Of the 104 sites deploying some type of breadcrumb, fourteen (13.5%) included category page breadcrumbs without offering product page breadcrumbs and three (2.9%) included breadcrumbs on product pages, but not on category pages. Of the 86 sites deploying both product and category page breadcrumbs, two sites (2.3%) used different separator characters for the different types of pages: TigerDirect.com (> on product pages; >> on category pages) and JR.com

(| on product pages; > on category pages). Both Nielsen (2007a) and Hudson (2004) warned that such inconsistencies can be confusing to users.

Of the 137 sites analyzed, only one (TigerDirect.com) heeds Hudson's (2004) recommendation to explicitly educate site users about breadcrumbs, building on evidence from Lazar and Eisenbrey (2000) and Hull (2004). In this site, to the right of the breadcrumb trail (see Figure 7) is a "NAV HELP" link. When clicked, a short animated Flash-based tutorial launches to illuminate the breadcrumb trail and inform the user about how it can be used.

Figure 7. Breadcrumb Tutorial Provided on TigerDirect.com



Is Instone's (2002) framework sufficient for classifying breadcrumb deployment in current retail Web sites? Is an alternative framework needed?

While Instone's (2002) conceptual framework has provided an organized schema upon which to classify breadcrumb deployment, it appears that it is not quite sufficient for classification of all implementations in current retail Web sites.

In the course of studying each of the 137 sites' breadcrumb navigation implementation, data was collected that would hopefully indicate whether location or path breadcrumbs had been deployed (attribute breadcrumbs are visually distinct from these other two types). If, by definition, location breadcrumbs show the "single location of [a] page within [a] site's hierarchy" and are "[h]ard coded" (Instone, 2002), there would not be multiple breadcrumb trails possible for any given product. Path breadcrumbs would then be distinguished by having multiple potential breadcrumb trails for a product, and would "show the path the user has taken within the site to get to the current page" (Instone, 2002). By this definition, a path breadcrumb also would not appear if entering a page from an external search referral. Both Instone (2005) and Nielsen (2007a) have praised location breadcrumbs for their utility for helping users who have entered a page via teleporting from search engines or other external links, and in contrast, have questioned the utility of path breadcrumbs. Nielsen (2007a) also argued that, "Breadcrumbs should show the site hierarchy, not the user's history."

Of 89 sites with breadcrumbs on product pages, 25 (28.1%) were determined to be using location breadcrumbs (only one breadcrumb trail possible for a given product). Eleven (12.4%) were determined to be using path

breadcrumbs (multiple breadcrumb trails possible for a given product and no breadcrumbs appear upon entry from Google search). Product pages could not be accessed via Google search for four sites (4.5%)—it is possible that those sites are designed in a way that prevents Google from indexing individual product pages. Finally, 49 sites (55.1%)—the majority—could not be classified by Instone’s (2002) definitions, as they enabled multiple breadcrumb paths for products, yet also yielded breadcrumbs upon entering via search. These 49 sites appear to fall somewhere between location and path breadcrumb deployment. In their breadcrumb trails, they do provide a seemingly useful hierarchical context for those entering product pages from searches; yet at the same time, they also reflect a history of navigational choices as users come to a particular product page through interaction with the site.

Instone (2002) has a precise assessment of the design intent for breadcrumbs, that they have two purposes: conveying to users information “about the site structure or the path they have taken” and enabling them to “go ‘up’ in the site hierarchy or to re-trace their steps.” This appears to be true of all of the breadcrumbs noted in the 137 sites. However, it is evident that organizing implementations into one of two classifications: “you are here” and “how you got here,” is too constrictive to accurately describe the ways that breadcrumbs are actually being deployed on the Web.

Perhaps Instone’s (2002) definitions are too rigid, or perhaps changes in Web site implementation since 2002 necessitate a new framework. Instone’s (2002) definitions and, especially, Nielsen’s (2007a) arguments seem to focus on

whether sites are hierarchical or not. However, information architecture in large sites such as those of the top 100 online retailers cannot be easily classified as either hierarchical or non-hierarchical. Morville and Rosenfeld (2007) indicated that “large web sites... typically require several types of structure” (p.81) and advocate for using multiple organization structures in concert to “create a cohesive organization system” (p.81). The dynamic Web environment affords placing the same products or pages simultaneously in different places in multiple hierarchies. Morville and Rosenfeld explain that, “[w]hen you’re dealing with large information systems, polyhierarchy is unavoidable” (p.220) and that, “[i]n digital information systems, the only real challenge introduced by polyhierarchy is representing the navigational context” (p.221). Multiple organization structures and polyhierarchy undoubtedly complicate breadcrumb deployment, but should not be overlooked when defining and discussing breadcrumbs.

The three defined types—path, location, and attribute—also do not fully account for the implementation of breadcrumbs for faceted browsing. Of the 100 sites with category page breadcrumbs, 34 (34.0%) feature the facet selection history in the breadcrumb trail. This figure represents 24.8% of the entire sample of 137 sites. In a way, these breadcrumbs behave somewhat like path breadcrumbs as they reflect navigation choices made by users—usually in the sequence that the choices were made—and afford different breadcrumb sets for the same end result. However, of these 34 sites, 15 (44.1%) enable users to remove individual facet selections from the breadcrumb trail (usually by clicking on an “X”), regardless of the sequence in which they were selected (see Figure

8). This option represents a navigation behavior not possible with location, path, or attribute breadcrumbs. A new term, such as “facet breadcrumb,” may best characterize this type.

Figure 8. Three Examples of Removable Facet History Selections in Breadcrumbs (From Top: HP.com, MusiciansFriend.com, Overstock.com)



The first example in Figure 8 (from HP.com) clearly indicates facet selections made to limit a result set within “Notebook PCs,” and would be representative of a facet breadcrumb. However, closer inspection of the other two examples in Figure 8 (MusiciansFriend.com and Overstock.com) reveals that not only are facet selections appearing in a breadcrumb trail, but they are being appended to an existing trail whose elements already represent either a hierarchy or a path; the nature of the breadcrumb trail actually changes between where it begins and where it ends. This hybrid approach is also not covered by Instone’s (2002) framework, and perhaps “hybrid breadcrumbs” should be added to the lexicon.

Finally, attribute breadcrumbs were readily classifiable by Instone’s (2005) description that they are a “list of locations for a given object.” However, they were found in only two sites (1.5%) of the 137 analyzed. There remains some ambiguity in his original (2002) definition: they “could be either path or location breadcrumbs.” Also, from the original (2002) definition, they are apparently

found in “e-commerce sites that use breadcrumbs as a type of extended keyword to convey product meta-information, such as subject, price, category, style, and brand.” This part of the definition hints at facets—in fact, the term “attribute” can be a synonym for “facet”—but Instone’s (2002) examples illustrate the “list of locations” definition (2005). Instone used Epicurious.com (a faceted browse interface) as an example for path breadcrumbs in the (2002) presentation, not attribute breadcrumbs. If the term “facet breadcrumbs” ever gains traction, then the implementations that Instone considers “attribute breadcrumbs” might be better distinguished with a different name. “Multiple location breadcrumbs” is one possibility.

Is there a relationship between breadcrumb deployment and a retailer’s particular industry?

This study has shown that there is indeed a statistically significant relationship between industry and breadcrumb deployment. Two industries—Apparel/Accessories and Mass Merchant—exhibited particularly aberrant deployment rates. For the entire sample, a rate of 75.9% deployment was observed, and so would be expected within each industry. There were 19 Mass Merchant sites in the sample, and all 19 (100.0%) had breadcrumb navigation; on the other hand, only 58.8% of Apparel/Accessories sites included breadcrumbs. Each of these deployment patterns is likely to come about for a different reason.

Mass merchants likely have more total products for sale, as well as a wider variety of products, than other retailers. Thus, these sites’ information

architectures may yield hierarchies that are broader and deeper than those in other industries. Krug (2006) noted that breadcrumbs are most valuable “for a large site with a deep hierarchy, or if you need to tie together a nest of subsites” (p.78). Therefore, secondary navigation support, such as breadcrumbs, may be most suitable for such sites.

The perceived utility of breadcrumbs may be only marginal for smaller sites and, in these cases, designers are more likely to omit them. The products that apparel and accessories retailers sell may have less organizational facets than those in other industries, which could potentially make breadcrumbs less useful in this context. For example, retailers such as Abercrombie, Gap, Nike, and American Eagle—none of which include breadcrumb navigation in their sites—only sell their own brand of products. Thus, a breadcrumb element representing a brand selection would have far less utility in these sites than in a site whose company retails products from a variety of brands. Another possibility is that some apparel and accessories retailers may have a narrower target market than other industries (especially mass merchants), obviating the need for multiple-audience organizational schemes. Retailers such as Lane Bryant, Victoria’s Secret, Delia’s, and Catherine’s may have chosen not to include breadcrumbs in their sites because their hierarchies are more shallow than others; there is no hierarchical level needed in the information architecture to differentiate women’s products from children’s or men’s.

Does an online retailer's deployment of breadcrumbs relate to its users' satisfaction while browsing its site?

An analysis of variance showed that there was not a statistically significant relationship between user satisfaction and breadcrumb navigation deployment. This is perhaps due to breadcrumbs' modest role as simply a secondary navigational aid, unlikely in and of themselves to have much impact on users' perceived experience. As Krug (2006) noted, breadcrumbs are "most valuable when used as part of a balanced diet, as an accessory to a solid navigational scheme." Similarly, Nielsen (2007a) said, "[b]readcrumbs won't help a site answer users' questions or fix a hopelessly confused information architecture."

Summary and Conclusion

This study had several limitations. The most prominent limitation was that no users were tested or interviewed, thus, it does not contribute new knowledge about important questions such as how users perceive and utilize breadcrumbs. One limitation was encountered with the sample that may have impacted the results: namely, several companies operate multiple Web sites and individual sites were the unit of analysis. Of the top 100 retailers, 39 companies own and operate two Web sites, and one owns three sites. For example, compusa.com and compusabusiness.com are both entities of CompUSA—both sites were analyzed, and both followed very similar breadcrumb conventions and deployment, whereas Apple, Inc. operates only apple.com, and had only one site in the sample. Not all Web sites of the same company produced similar data,

though it is reasonable to assume that the results are slightly biased toward the practices of businesses operating more than one site. Another limitation is that there was a decidedly subjective element in the data collection. Only a handful of products and categories were able to be tested for each site for determining breadcrumb behaviors. Though reasonable attempts were made to formulate these determinations, it is quite possible that some sites analyzed only feature breadcrumbs for some of their products and categories, or use various conventions or implementations in different site areas.

Despite the limitations, this study yielded some interesting results that have implications for Web site designers. Breadcrumbs were found to be very common among the Web sites of the top 100 online retailers—over 75% of such sites use them, and this is likely a growing figure. There exist many recommended “best practices” in the literature for design and deployment conventions; some are generally being followed, whereas others are not. The majority of sites (63.5%) use the greater-than (>) character to separate elements, as recommended. But despite studies that have shown that users struggle to see and understand breadcrumbs, only 12% of sites with breadcrumbs have text near the trail as an indicator, and less than 1% of sites (one site out of 104 with breadcrumbs) feature a tutorial about them. Over one-third of sites with product page breadcrumbs fail to provide a Home link in the breadcrumb trail even though there is evidence that users prefer to use this link.

Web designers may benefit from the results of this study as it illuminates the conventions popular sites follow in breadcrumb deployment. Understanding

recommendations in the literature, and their relation to actual deployment conventions can help designers to make better decisions about what users will expect to see and attempt to utilize for navigation. As Nielsen (2007a) said, “[c]onsistency breeds familiarity and predictability, which breed usability.” In e-commerce, usability translates into sales.

The findings of this study also have more theoretical implications. The definitions in Instone’s (2002) framework were found to be insufficient for classifying the deployment of breadcrumb navigation in current retail sites for several reasons. His definitions are constrictive in that two of the three classifications, which indicate to users “you are here” (location) and “how you got here” (path), are not necessarily mutually exclusive—many of the breadcrumb deployments investigated simultaneously showed characteristics of both path and location breadcrumbs without discretely fitting into one classification or the other. The definitions seemingly fail to account for the polyhierarchy and multiple organizational structures enabled and necessitated by the modern Web. Indeed, many breadcrumbs were found to be indicative of both a hierarchy and a path—the path which a user has followed to a product determines which hierarchy of several possibilities is reflected in the breadcrumbs. Additionally, even with the 64 product pages whose breadcrumb trails depend upon the path taken to get there from within the site, 49 (76.6%) still reveal breadcrumb trails—sometimes in a hierarchical context—to users who enter that product page from an external search.

In total, over 55% of product page breadcrumb deployments could not be classified into any of Instone's (2002) three types (location, path, or attribute). Furthermore, it is evident that faceted browsing (or guided navigation) on category pages is impacting breadcrumb deployment. Nearly 25% of the Web sites of the top 100 online retailers feature a facet selection history in category page breadcrumb trails. In almost half of these cases, individual facet selections in the breadcrumbs can be canceled regardless of sequence. Instone's (2002) framework does not account for this phenomenon, nor does it account for hybrid uses of breadcrumbs that begin showing elements of the site's hierarchy and end with individual facets of a product. While a new framework has not been proposed to fully replace Instone's (2002), suggestions have been made for new classifications, such as "facet breadcrumbs," "hybrid breadcrumbs," and "multiple location breadcrumbs."

A statistically significant relationship was found between a retailer's industry and its inclusion or omission of breadcrumb navigation. Deployment is not consistent across all industries; thus, users may have different expectations for the navigation aids they will have at their disposal while shopping for different kinds of products, and designers may benefit from this knowledge. No statistically significant relationship was found between user satisfaction and breadcrumb navigation deployment on sites. This finding would indicate that designers should focus their attention, first, on other aspects of navigation and information architecture to have the largest impact on user satisfaction.

Many new opportunities exist for researchers to explore breadcrumbs, building on this study. Much remains to be discovered about user interaction with breadcrumbs. Faceted browsing and facet breadcrumbs may be changing the game, but will this type of implementation change users' perceptions and attitudes toward breadcrumb deployment? How frequently are these types of breadcrumbs used in retail Web sites and do they assist users with finding the products they desire? Building on Instone's (2002) initial work, and considering its limitations illuminated in this study, is a comprehensive new framework possible for studying breadcrumb navigation? If, as this study indicates, breadcrumbs are becoming more commonplace, and designers are creating new ways to utilize them—especially for e-commerce interfaces—there should be increasing motivation to explore breadcrumb navigation deployment in the future.

References

- Blustein, J., Ahmed, I., & Instone, K. (2005). An evaluation of look-ahead breadcrumbs for the WWW. *Proceedings of the sixteenth ACM conference on Hypertext and Hypermedia, September 6-9, (pp. 202-204)*. New York: ACM Press.
- Bowler, D., Ng, W., & Schwartz, P. (2001). Navigation bars for hierarchical Web sites. *SHORE 2001: University of Maryland Student HCI Online Research Experiments*. Retrieved June 27, 2007, from <http://www.otal.umd.edu/SHORE2001/navBar/index.html>.
- Colter, A., Summers, K., & Smith, C. (2002). Exploring user mental models of breadcrumbs in Web navigation. Retrieved June 27, 2007, from <http://www.angelacolter.com/site/breadcrumbs/index.html>.
- Hudson, W. (2004). Breadcrumb navigation: there's more to Hansel and Gretel than meets the eye. *Interactions, 11(5)*, 79-80.
- Hull, S.S. (2004). Influence of training and exposure on the usage of breadcrumb navigation. *Usability News (Wichita State Software Usability Research Laboratory)(6.1)*. Retrieved June 25, 2007, from <http://psychology.wichita.edu/surl/usabilitynews/61/breadcrumb.htm>.
- Instone, K. (2002). Location, path, and attribute breadcrumbs. Poster presentation at The 3rd Annual Information Architecture Summit sponsored by ASIS&T. Baltimore, MA. Retrieved June 25, 2007, from <http://instone.org/files/KEI-Breadcrumbs-IAS.pdf>.
- Instone, K. (2004). Fun with faceted browse. Poster presentation at The 5th Annual Information Architecture Summit sponsored by ASIS&T. Austin, TX. Retrieved June 25, 2007 from <http://instone.org/files/FunFacetedBrowse-IAS04.pdf>.
- Instone, K. (2005). Star Trek and breadcrumbs. *Keith Instone*. Retrieved June 27, 2007, from <http://instone.org/node/89>.
- Instone, K. (2007). Breadcrumb navigation increasingly useful. *Keith Instone*. Retrieved June 27, 2007, from <http://instone.org/alertbox-breadcrumbs>.

- Krug, S. (2006). *Don't Make Me Think: A Common Sense Approach to Web Usability*. (2nd ed.). Berkeley, CA: New Riders.
- Lazar, N., & Eisenbrey, M. (2000). Website structural navigation. *SHORE 2001: University of Maryland Student HCI Online Research Experiments*. Retrieved June 27, 2007, from <http://www.otal.umd.edu/SHORE2000/webnav/index.html>.
- Lida, B., Hull, S.S., & Pilcher, K. (2003). Breadcrumb navigation: An exploratory study of usage. *Usability News (Wichita State Software Usability Research Laboratory)*(5.1). Retrieved June 27, 2007, from <http://psychology.wichita.edu/surl/usabilitynews/51/breadcrumb.htm>.
- Morville, P., & Rosenfield, L. (2007). *Information Architecture for the World Wide Web*. (3rd ed.). Sebastopol, CA: O'Reilly Media, Inc.
- Nielsen, J. (2000). Is navigation useful? *Jakob Nielsen's Alertbox*. Retrieved June 27, 2007, from <http://www.useit.com/alertbox/20000109.html>.
- Nielsen, J. (2007a). Breadcrumb navigation increasingly useful. *Jakob Nielsen's Alertbox*. Retrieved June 27, 2007, from <http://www.useit.com/alertbox/breadcrumbs.html>.
- Nielsen, J. (2007b) Why this site has almost no graphics. *Useit.com*. Retrieved June 27, 2007, from <http://www.useit.com/about/nographics.html>.
- Nielsen, J., Snyder, C., Molich, R., & Farrell, S. (2001). Category Pages. In *E-commerce User Experience*. Fremont, CA: Nielsen Norman Group.
- Rogers, B.L., & Chaparro, B. (2003). Breadcrumb navigation: Further investigation of usage. *Usability News (Wichita State Software Usability Research Laboratory)*(5.2). Retrieved June 27, 2007, from <http://psychology.wichita.edu/surl/usabilitynews/52/breadcrumb.htm>.
- Spool, J. (2005). Value of breadcrumbs. *UIE Brain Sparks*. Retrieved June 27, 2007, from <http://www.uie.com/brainsparks/2005/09/26/value-of-breadcrumbs/>.
- Stevenson, N. (2003). Will you return home?: A study on the utility of navigational aids. *A Master's paper for the M.S. in I.S. degree, UNC-Chapel Hill*.
- Straub, K. (2004). Do you hear what I hear? ... Or why it may not matter that users still ignore breadcrumbs. *Human Factors International - UI Design Newsletter*. Retrieved June 27, 2007, from <http://www.humanfactors.com/downloads/oct04.asp>.

Top 500 Guide: Profiles and Statistics of America's 500 Largest Retail Web Sites Ranked by Annual Sales. (2007). Chicago, IL: Vertical Web Media LLC.

Appendix A: Breadcrumb Conventions

Indicator of Breadcrumbs' Purpose

	Number	Percent
Indicator Exists	13	12.5%
No Indicator Exists	91	87.5%
<i>TOTAL</i>	<i>104</i>	<i>100.0%</i>

Indicator Syntax

	Number	Percent
You are here:	8	61.5%
Back to:	2	15.4%
Browse:	1	7.7%
Search:	1	7.7 %
Group:	1	7.7%
<i>TOTAL</i>	<i>13</i>	<i>100.0%</i>

Home Link on Product Page

	Number	Percent
Home Link Exists	58	65.2%
No Home Link Exists	31	34.8%
<i>TOTAL</i>	<i>89</i>	<i>100.0%</i>

Home Link Syntax

	Number	Percent
Home (or HOME)	44	75.9%
[Store Name]	8	13.8%
Home Page (or Homepage)	4	6.9%
Shop	2	3.4%
<i>TOTAL</i>	<i>58</i>	<i>100.0%</i>

Current Product Listing in Product Page Breadcrumb Trail

	Number	Percent
Current Product Listed	27	30.3%
Current Product Not Listed	62	69.7%
<i>TOTAL</i>	<i>89</i>	<i>100.0%</i>

Current Product Syntax in Product Page Breadcrumb Trail

	Number	Percent
Listed as Product Name	23	85.2%
Listed as SKU #	4	14.8%
<i>TOTAL</i>	<i>27</i>	<i>100.0%</i>

Current Product Visual Style in Product Page Breadcrumb Trail

	Number	Percent
Plain Text	20	74.1%
Bold	5	18.5%
Self-linked	1	3.7%
Other	1	3.7%
<i>TOTAL</i>	<i>27</i>	<i>100.0%</i>

Current Category Listing in Category Page Breadcrumb Trail

	Number	Percent
Current Category Listed	91	91.0%
Current Category Not Listed	9	9.0%
<i>TOTAL</i>	<i>100</i>	<i>100.0%</i>

Current Category Visual Style in Category Page Breadcrumb Trail

	Number	Percent
Plain Text	46	50.5%
Self-linked	25	27.5%
Bold	13	14.3%
Other	4	4.4%
Color	3	3.3%
<i>TOTAL</i>	<i>91</i>	<i>100.0%</i>

Facet Selection History in Breadcrumb Trail

	Number	Percent
Facet Selection History in Breadcrumb Trail	34	34.0%
No Facet Selection History in Breadcrumb Trail	66	66.0%
<i>TOTAL</i>	<i>100</i>	<i>100.0%</i>

Facet Selection History—Facets Individually Removable?

	Number	Percent
Yes, Individually Removable	15	44.1%
Not Individually Removable	19	55.9%
<i>TOTAL</i>	<i>34</i>	<i>100.0%</i>

Appendix B: Breadcrumb Deployment by Industry

Breadcrumb Deployment by Industry

Industry	Breadcrumb Deployment Observed		Breadcrumb Deployment Expected		Total
	No	Yes	No	Yes	
Apparel/Accessories	14	20	8.19	25.81	34
Books/CDs/DVDs	2	5	1.69	5.31	7
Computers/Electronics	3	21	5.78	18.22	24
Flowers/Gifts	1	2	0.72	2.28	3
Food/Drug	5	6	2.65	8.35	11
Hardware/Home Improvement	0	3	0.72	2.28	3
Health/Beauty	1	2	0.72	2.28	3
Housewares/Home Furnishings	2	5	1.69	5.31	7
Jewelry	2	1	0.72	2.28	3
Mass Merchant	0	19	4.58	14.42	19
Office Supplies	0	3	0.72	2.28	3
Specialty/Non-Apparel	3	10	3.13	9.87	13
Sporting Goods	0	4	0.96	3.04	4
Toys/Hobbies	0	3	0.72	2.28	3
TOTAL	33	104	33.00	104.00	137