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CONTENT VERSUS STRUCTURE IN INFORMATION ENVIRONMENTS: A LONGITUDINAL ANALYSIS OF WEBSITE PREFERENCES

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Abstract

From the prospective traveler surfing the web for cheap vacations to executives analyzing market trends with a data warehouse, at home and at work, people are confronted with increasingly richer information environments. This study is an attempt at modeling the behavior over time of the “information consumer” (web surfer or executive) in such environments. The objective is to gain a better understanding of how to design the technologies that support and enhance the interaction with these information environments. Two key design variables for information environments are examined: content quality and structural quality. Drawing on research in human-computer interaction and ecological psychology, a behavioral model is developed in which it is postulated that the importance of structural quality will diminish with time, whereas content quality will increase in importance. A two-stage methodology is employed which combines a longitudinal experiment with a cross-sectional survey. Both the survey and experiment are conducted in the context of informational websites. The experiment provided 178 undergraduates with repeated exposure over several weeks to eight custom-built websites, manipulated to vary in content quality and structural quality for which their preferences (and associated rationales) were elicited at three time points over the course of the experiment. Additionally, 163 of the undergraduates also completed a survey providing data about the effect of content and structure on usage behavior for sites for which they had mature experience. Preliminary results of the experimental data support the hypotheses. The research has potentially significant implications for the design of information environments.

1. RESEARCH OBJECTIVES AND QUESTIONS

The objective of this research is to guide vendors and designers of information environments as to relevant design factors for positively influencing usage behavior and preferences. While the context for the study is informational websites, the model and results are relevant to a broader class of information environments ranging from websites like Britannica.com to Enterprise-wide information systems like SAP R/3. The term information environment (IE) is introduced here to encompass this variety in content sources and degree of organization or structure in support of access to information content. For example, an IE could have a

formal structure, as in a database system. Alternatively, it could have a relatively open structure (e.g., a set of hyperlinks on a website) that enables, if not requires, exploration by the “information consumer.” The term information consumer (hereafter consumer) refers to a goal directed individual seeking to take advantage of the information content available to him/her in an IE (as opposed to simply a user of technology). More specifically, the consumer is an adaptive information seeker progressively fine-tuning his/her sensitivity to the structure of the IE until he/she can satisfactorily extract the information content his/her task demands (per Neisser’s (1976) perceptual cycle).¹

More specifically, the research addresses the following questions:

1. What is the impact of the *content quality* of an IE on usage behavior and preferences?
2. What is the impact of the *structural quality* (i.e., how the information is organized and the access paths supported) on usage behavior and preferences?
3. How does the relative importance of these two factors change over time from an initial exposure to mature experience with an IE?
4. What is the impact of content and structure on mature preferences (i.e., after repeated exposures) relative to other constructs that have been used to explain behavior with information technology?

2. THEORETICAL FOUNDATIONS

Human behavior in an IE is an emergent outcome of the dynamic interaction between the characteristics of the IE, the characteristics of the consumer, and the tasks in which the consumer is engaged. Each of these components is described below and unified through the ecological psychology concept of an affordance.

2.1 Components of a Model of Behavior in Information Environments

Task. There is a hierarchy of tasks involved in interacting with IEs ranging from the point-and-click operational aspects up to the more macro information-gathering task that is the initial motivation for the interaction (e.g., Norman 1990). These tasks can be thought of as residing in what Rasmussen (1988) terms a means-end abstraction hierarchy. Tasks at the lower levels are the means for achieving higher-level ends. In the context of website usage, three broad levels can be identified in the hierarchy as follows:

1. Information gathering
2. Navigation of the specific website
3. Browser operation

These levels are equivalent to the abstract, generalized, and physical functions in Rasmussen’s abstraction hierarchy. Together, these three levels can be used to describe a task for accomplishing some higher-level goal or functional purpose as Rasmussen calls it (e.g., the decision end for which information gathering is a means). While it is possible to decompose each of these levels further, this level of granularity is sufficient for present purposes.

Information Environment (IE). Outside of the basic interface (e.g., the point-and-click aspects of a specific web browser), an information environment can be characterized by two key dimensions: content and structure. Content is the information in the environment that the consumer seeks to use directly for his/her functional purposes. Structure is meta-information about the content that facilitates access, processing, and sharing of information (it provides value to the consumer through easier, more effective, and more efficient access to the content).

Information Consumer. The consumer is an individual, able to learn about the IE. The consumer has an innate ability and tendency to find the structure of the IE, even to the extreme of imposing structure where none exists (e.g., Gilovich et al. 1985;

¹The roots of this conceptualization of a consumer-environment relationship is derived from Ecological Psychology as promoted by Gibson (1979) and applied to human-machine systems by Flach et al. (1995).

Lopes 1982). Furthermore, with experience the consumer is able to carry out some actions in the environment automatically (Rasmussen 1988) and does not need to consciously attend to them.

2.2 An Integrated Ecological Model of Behavior Over Time

Intuitively, the content of the IE relates directly to the information gathering task, and the structure of the IE to the navigation task. For the consumer with even basic web experience, the browser operation task is likely to have become largely automatic.

More formally, the ecological concept of an affordance (e.g., Gibson 1979; Norman 1990) can aid in the development of an integrated behavioral model. An affordance is a complementarity between an environment and the skills of a consumer seeking to act in that environment. It is an invariant property of consumer-environment interactions (Turvey and Shaw 1995). An environment can afford certain actions for a consumer with appropriate knowledge and abilities, and a consumer can have the requisite knowledge and abilities to carry out certain actions in appropriately structured environments (Greeno et al. 1993). Furthermore, the affordances perceived by a consumer depend on the consumer's goals (Heft 1989).

The affordance concept thus provides a link between a consumer and his/her environment in the context of specific goals. Indeed, Vicente and Rasmussen (1990) show that Rasmussen's concept of a means-ends abstraction hierarchy can readily be re-conceptualized as a hierarchy of affordances. Thus an IE can afford the provision of valuable information content to varying degrees—depending jointly on its content and the informational needs (goals) and skills of the consumer. Moving down the hierarchy the IE affords, to varying degrees, the navigation necessary to obtain the desired content, by virtue of the structure it provides relative to the skills and navigational goals of the consumer. Further, since the consumer learns with experience, the affordances he/she perceives in an environment will change with time. The content and structural affordances perceived are specific to a consumer, an IE, and a task at a point in time.

Structural quality is high when the affordances at the navigation level in the hierarchy correspond well to the individual consumer's navigational goals at a point in time. For example, structural quality could be enhanced by the provision of a menu appropriately customized to the current skills and goals of the consumer. *Content quality* is high when the affordances at the information gathering level in the hierarchy correspond well to a consumer's informational needs and their ability to consume the information. For example, suppose a consumer wanted information to address the question "Why is the sky blue?" The sort of information suitable for a consumer who has a degree in physics is quite different than for an inquisitive child.

As the consumer learns more about the IE, the tasks at the lower levels in the hierarchy become automatic and the consumer is able to increasingly focus their attention at higher levels in the hierarchy. Thus interactions with an IE will initially be dominated by the navigational affordances (structural quality) and subsequently the information gathering affordances (content quality). The dominant level of abstraction at a point in time is also the basis for a consumer's preference assessments that guide future usage behavior. Since the dominant level of abstraction changes with time (as the consumer learns and moves up the hierarchy), so too should the relative impact of content quality and structural quality on preferences change with time. This analysis of the changing bases for preference assessments is also consistent with action-identification theory (Vallacher and Kaufman 1996; Vallacher and Wegner 1987) and organizational theory of sense making theory (Weick 1979). Figure 1 graphically depicts a model of the interaction between information environments, tasks, and information consumers.

2.3 Hypotheses

The above model leads to the following specific hypotheses that are to be tested empirically:

General:

H1: Structural quality will positively impact website usage preferences.

H2: Content quality will positively impact website usage preferences.

Over Time

H3: Structural quality of a website will have a greater impact on website usage preferences in early usage periods than in later usage periods.

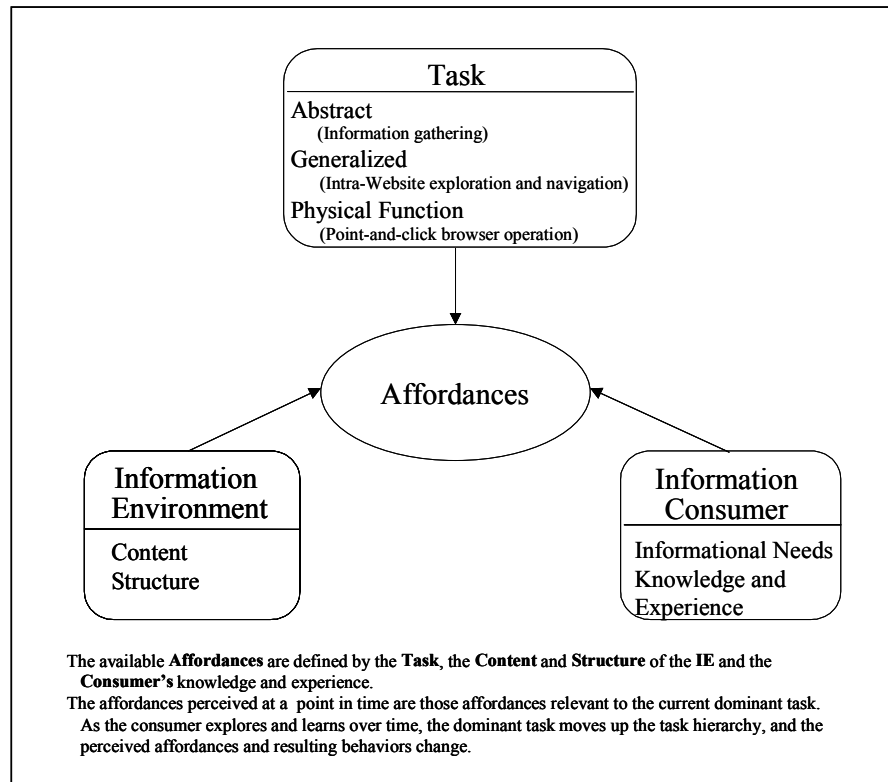


Figure 1. Behavior as a Function of Task, Environment, and Consumer Over Time

H4: Content quality of a website will have a greater impact on website usage preferences in later usage periods than in earlier usage periods.

H5: Content quality of a website will begin to have a greater impact on website usage preferences sooner for sites with higher structural quality.

(Higher structural quality aids the consumer in moving to the highest level in the abstraction hierarchy).

3. METHODOLOGY AND PRELIMINARY RESULTS

A two-part methodology was employed: a longitudinal experiment (for testing hypotheses H1 through H5) and a cross-sectional survey (for testing H1 and H2). The experiment provided empirical data about changes over time in the effect of structural and content quality on preferences. The purpose of the survey was twofold. First, it provides a basis for the development and validation of instrumentation for content and structural quality. Second, it permits an analysis of the role of structure and content quality in usage behavior for sites at a mature stage of usage (per research question 4).

3.1 Experimental Study

Subjects for the study were 178 business undergraduates participating for class credit. A custom portal was developed which provided access to eight sites of interest to students in two broad groupings: Wine and Dine sites and Entertainment sites. The sites were constructed to strategically vary in content and structure, while maintaining a realistic comparison set. Variability in *content* was achieved by manipulating the amount of information provided by each site. Variability in *structure* was achieved by selective provision of JavaScript menus that provided additional access paths through a site and a pictorial representation of the hierarchical page structure (menus were localized to each site, not the portal). In all other respects the sites were comparable, containing the same number of pages and the same degree of page nesting.

Subjects interacted with the portal and websites over a three-week period. Access to the portal was password protected and a log of accesses to each site was also maintained as a manipulation check to ensure subjects reviewed every site. Subjects were informed that the sites would undergo further development during the experiment, and consequently that they should consider re-evaluating their preferences as time progressed. Subjects' website preferences (within the two groupings) and rationales were obtained at three fixed time points during the experiment. To encourage subjects to explore the sites, they were given several search tasks to carry out prior to and during the first week of interaction and were primed to re-evaluate their preferences by noticeable site revisions that were introduced after the first and second preference elicitation. These revisions were applied consistently across the sites: content was simply updated (e.g., changing the recommended entertainment outing for the week) and/or uniformly introduced to each site (e.g., at the second revision, all of the sites introduced banner advertisements). Thus, any observed variability in preferences can be attributed to the changing importance of structural versus content factors over time, rather than any content or structural changes that occurred.

The primary source of data for analysis from the experiment is the rationales. The preferences themselves are likely to be confounded by factors such as the specific topic of the site, rather than the quality of its content on that topic, and the quality of the structure of that content. A coding scheme was developed for measuring the relative importance of content and structural quality in the subjects' preference rationales.

To date, the rationales of 21 subjects, identified as highly involved in the task, have been analyzed.² Coding consisted of counting the number of comments pertaining to each coding category (content quality, structural quality, and an exhaustive set of non-content/non-structure related categories of rationales). The absolute counts were standardized by dividing by the number of total comments made by each individual in order to compare the relative importance of content and structure in determining preferences. The results are shown in Figure 2.

The results are consistent with the hypotheses. Structural quality diminishes in importance with time, and content quality increases in importance (see Figure 2). This suggests that in early interactions with the websites (IEs), the lack of familiarity with the website makes the navigational level affordances dominant in subjects' considerations. With the familiarity that develops by later preference elicitation, activity at the navigational level becomes automatic. Subjects' interactions are then dominated by consideration of the affordances at the information gathering level in the hierarchy and consequently issues of content quality gain in relative prominence.

3.2 Survey

163 students from the experiment also participated in the survey. The survey measured several constructs for the specification of a structural model with a dependent variable of frequency of use of a website. The questionnaire elicited responses with respect to two sites: the subject's favorite site and the school's site. (Use of the school site was not voluntary—it was the primary source for materials relevant to students' programs of study). The questionnaire elicited background demographic data and contained measures for content quality, and structural quality, frequency of use, plus several other potential covariates, and the name and URL of the "favorite site." The content quality and structural quality measures were specially developed for the study. All other constructs were measured with pre-existing instruments. Analysis of the survey data is in progress.

4. CONCLUSIONS AND CONTRIBUTIONS

The preliminary results of this study evidence the need for longitudinal studies of IE usage behavior. The implication for IE designers is clear: the design factors influencing preferences change with time. Consequently, what may make an IE attractive in initial adoption may be quite different from what drives continued usage. Together the experiment and survey provide data that may yield insights into the effective design and use of information environments.

²The "highly involved" subjects were identified using estimates of time spent at the sites derived from objective timestamp data (adjusting for idle time and visits to offsite links).

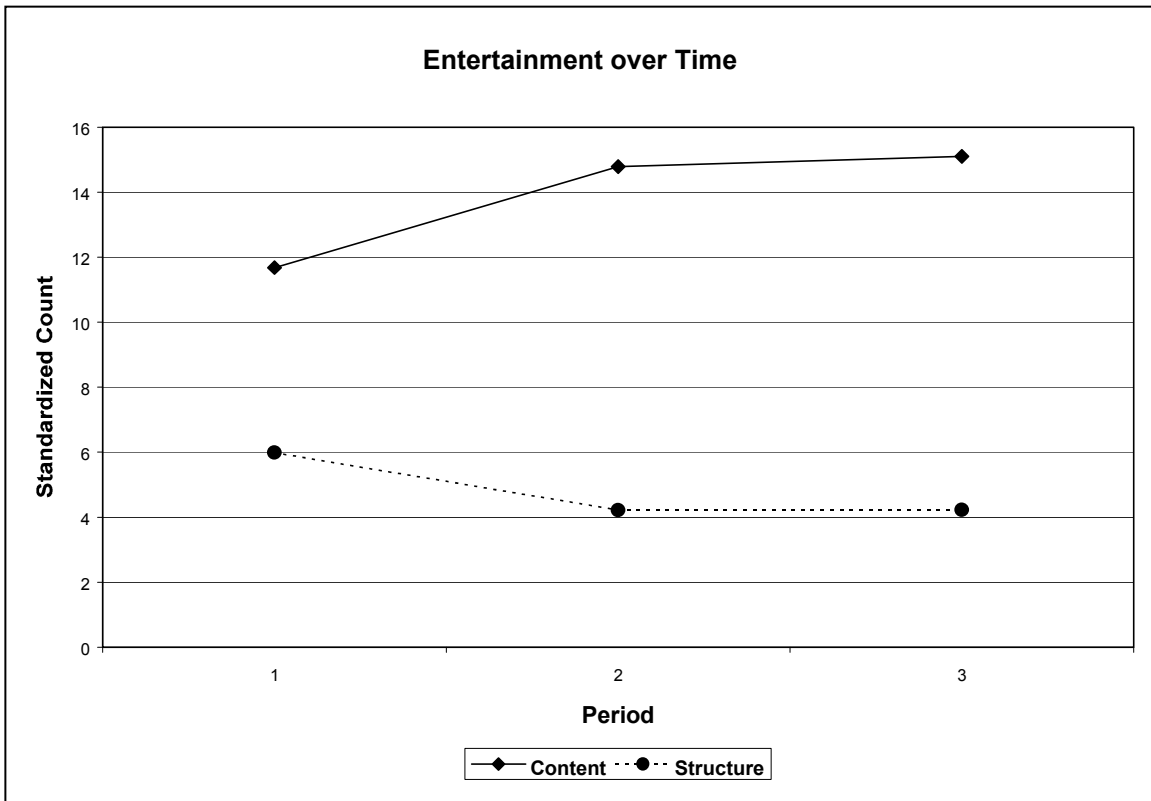
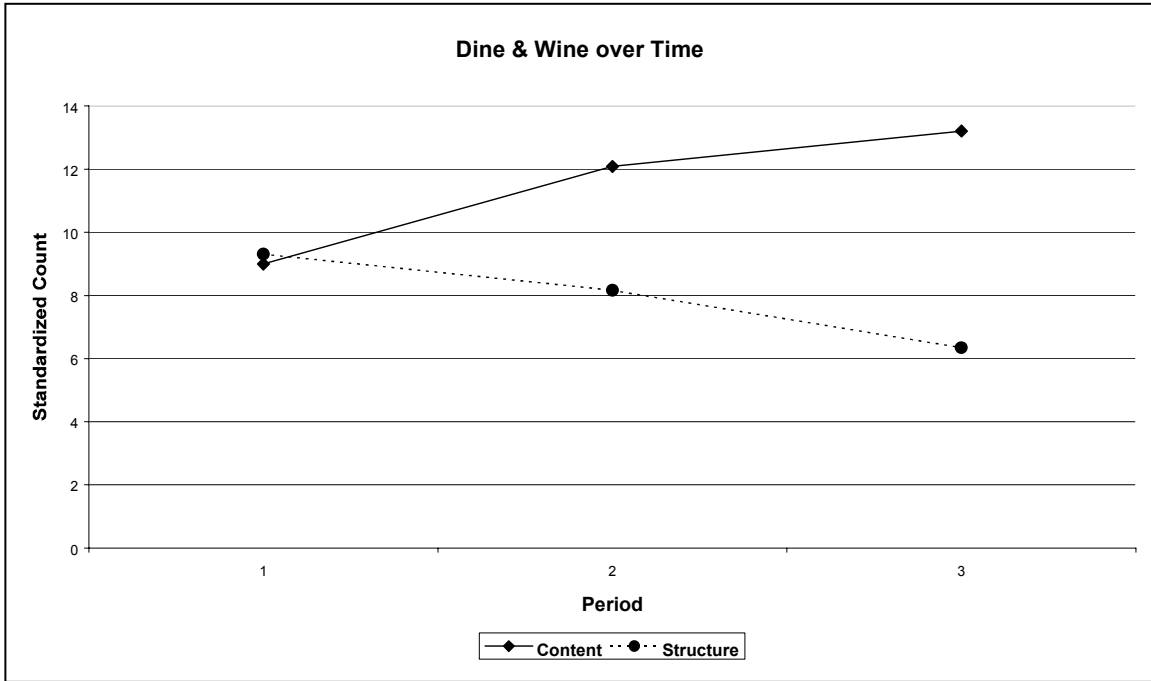


Figure 2. Relative Importance of Content and Structure in Preference Assessments Over Time

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