Supplemental Appendix to "Website Morphing"
How to Build a Morph Taxonomy

A website will morph efficiently if it is able to identify rapidly the visitor's cognitive-style segment and choose the optimal morph for that segment. To apply website morphing researchers and developers must (1) choose cognitive dimensions, and (2) create links with cognitive cues that maximally appeal to different cognitive-style segments. It is an open scientific question whether there is a cognitive structure that applies to all contexts, however, there do appear to be basic dimensions that apply to website design. Researchers can test further the dimensions that we identified or, using accepted methods of scale development (e.g., Churchill 1979; Peters 1981), researchers can select cognitive-style dimensions that are appropriate for their context. Once the cognitive-style dimensions are identified, researchers can then select the characteristics of click alternatives that are informative of customers' cognitive styles.

Cognitive Dimensions

Cognitive styles are believed to be enduring aspects of how a person gathers and processes information. The selection of the best cognitive-style dimensions involves data collection, interpretation and judgment. Many dimensions have been proposed and tested, often in subsets. Cognitive styles tend to be defined as ipsative scales, for example, a website visitor who is more deliberative is expected to be correspondingly less impulsive.

Table SA-1 – Potential Cognitive Dimensions

- Deliberative vs. impulsive
- Imagery vs. verbal
- Analytic vs. holistic
- Quantitative vs. qualitative
- Technical vs. non-technical
- Innovators vs. late adopters
- Leader vs. follower
- Field dependence vs. field independence
- Cognitively flexible vs. inflexible
- High need for cognition vs. low need
- High need for closure vs. low need

Table SA-1 presents a list of cognitive-style dimensions that we found in the academic literature.[1] (See text for citations.) The set of potential dimensions is large; there is no consensus in psychology on the number and naming of cognitive dimensions. In our context we sought to identify cognitive dimensions that were important in customer buying, operational in website design, and parsimonious in number.

Step 1 requires judgment by researchers, developers, and managers to examine the possible set of cognitive dimensions to choose those that are most relevant for their customers. For example, the analytic vs. holistic dimension is commonly acknowledged as important in cognitive psychology and is relevant for most marketing websites design. We expect analytic customers to prefer detail so that they might study each component of the problem. Alternatively, we expect holistic customers to want to see the big picture and not get bogged down in the details. Deliberative vs. impulsive is another appealing candidate. It is widely recognized in psychology and is relevant to most website designs. We expect customers who are deliberative to want large amounts of information while we expect impulsive buyers to want to complete tasks with the minimum number of clicks. Other candidate cognitive-style dimensions might be appropriate for specific contexts. For example, the leader-vs.-follower and technical-vs.-non-technical dimensions might be important for technological products. If the product or service category is especially suitable to sound or pictures, the visual-vs.-verbal dimension might be relevant.

We recommend that researchers use prior experience and qualitative interviews to identify and/or confirm the cognitive-style dimensions that are most likely to be appropriate for the context being studied. If a dimension is chosen that is not relevant, the morphing system will return a null effect. On the other hand, if too many dimensions are chosen, there will be a corresponding exponential increase in both development cost and required sample size for the priming study.

The next step is to create multiple scales for each candidate dimension. We recommend preliminary market research with potential customers in the product class (N ~ 100). Each customer completes a self-evaluation on the cognitive scales. Based on these data, we used exploratory factor analysis to group the scales and then confirmatory reliability analysis to "purify" the scales. However, structural-equation modeling is also appropriate (e.g., Gerbing and Anderson 1988). Because the Gittins' engine works best with a moderate number of segments, we used median splits on the resulting dimensions.

[1] The literature also posits learning styles, cognitive controls, and performance, but these tend to be less enduring than cognitive styles. See, for example, Santally and Alain (2006). We might also explore cultural dimensions.

In our application we began with four dimensions (deliberative vs. impulsive, analytic vs. holistic, visual vs. verbal (read/listen), and leader vs. follower). Based on the priming study, we regrouped these dimensions into dimensions that are described in the text. Analytic vs. holistic and visual vs. verbal appeared to be a common dimension in our context. The single scale, read vs. listen, was a factor unto itself. This left us with four dimensions providing $2^4 = 16$ segments.

Using Cognitive-Style Dimensions in Website Design

Step 2 is website design. We wish to select website characteristics that are effective in achieving the goals of the website (selling broadband service for the BT application). At the same time, we would like to choose the website characteristics such that visitor choices among click-alternatives provide as much information as feasible for the Bayesian inference loop (Figure 2 in the text). If links are too similar, choices (i.e., clicks) will not reveal enough information about the visitor's cognitive styles. Basically, more information can be gleaned by the Bayesian loop if the click-alternatives are different within a page on characteristics that are differentially preferred by visitors with different cognitive styles.

A link (click-alternative) provides cognitive cues. Visitors' choices during navigation rely on these cues and, thus, reveal cognitive styles. For example, consider cognitive cues on the opposite extremes of a visual vs. textual continuum. An online bookstore could easily have, on the same webpage, a pictorial link and a textual link both of which take the user to the same place, say to the "search inside a book" area. An automobile website might have click alternatives of "car specifications" and "vehicle recommendations." The former is likely to appeal analytic customers and the latter to holistic customers.

Our design philosophy is to use a simple backbone structure that is easy to understand and navigate, but which allows the website to morph based on the cognitive cues provided by choices among click alternatives. We designed the Gen-1 BT website based on judgment, discussions with managers, and our previous work on customer advocacy. In addition to differences among click alternatives, we hoped that choices in the backbone between data, advisors, community, and learning center would be informative cues. Pretests helped us fine-tune the website. Nonetheless, in the priming study we discovered that the Bayesian engine would work better if we had greater discrimination among click alternatives. The Gen-2 website will be designed to provide that greater differentiation among early click alternatives.

The design of efficient websites, which provide maximal information on cognitive styles, is an extremely interesting research area in itself. The BT application demonstrates a "proof of

concept." We hope that further development will lead to much more efficient website designs. Research on efficient website design might benefit from efficient experimental designs (for an overview see Chaloner and Verdinelli 1995; Kuhfeld, Tobias and Garratt 1994; and Toubia and Hauser 2007). Some of this work can be adapted or extended to the experimental morphing websites design with substantial impact on theory and practice.

Additional References (not listed in the text of our paper)

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