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Concept Mapping Usability Evaluation: An Exploratory Study of a New Usability Inspection Method

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A key aspect of a website or any artifact is its usability—the ability of the artifact's target audience to carry out tasks safely, effectively, efficiently, even joyfully. One class of usability evaluation methods is inspection methods, in which the usability professional systematically inspects the user interface to discern potential usability problems. Here the article proposes employing Concept Mapping, a proven method of knowledge elicitation and representation, as a new, structured usability inspection method. Nineteen students in a master's-level usability class each generated a Concept Map (Cmap) of 1 of 5 websites. These Cmaps were shared with the sites' webmasters, and the webmasters completed a questionnaire giving us feedback on the value of the Cmaps for subsequent site redesigns. The article presents those data, infers what improvements need to be made in the new Concept Mapping Usability Evaluation method, and invites others to join us in investigating the potential value of this method.

1. INTRODUCTION

As information is produced in geometrically increasing amounts (e.g., Wright, 2008), and advances in technology allow for ever-expansive transmission of this information (e.g., Dubash, 2005), the human has become the primary bottleneck through which this information must squeeze (Bias, Lewis, & Gillan, 2014). Thus, with each passing day Usability (e.g., Nielsen, 1993), or User-Centered Design (e.g., Vredenburg, Isensee, & Righi, 2002), or User Experience (e.g., Hartson & Pyla, 2012), becomes an increasingly important component of the user interface (UI) design process.

Usability is that characteristic of any human artifact that enables the artifact's users to carry out tasks safely, easily, perhaps even enjoyably. The International Standards Organization (1998) defined usability as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (p. 2). Evolving from human factors and ergonomics, the field of usability (and more recently User Experience) is concerned with collecting user data to inform design, early in the artifact development process, and later in the process, to validate the effectiveness of the UI, that is, evaluate the ability of the user to carry out his or her desired tasks with that product.

Usability evaluations can be carried out via a variety of methods. These methods tend to be divided into two categories: testing, which involves observing and measuring representative users—people representative of the product's ultimate user audience—as they carry out prescribed tasks, and inspection methods, which involve a usability professional, or multiple such professionals, simply reviewing a product to identify potential usability problems. Whereas end-user testing or lab testing (see Rubin & Chisnell, 2008) is regarded as the "gold standard" of usability evaluations, inspection methods tend to be quicker and cheaper and have been shown to reveal a large percentage (perhaps 40%; see Nielsen, 1995) of the problems that would be identified via end-user testing. The most popular usability inspection method is heuristic evaluation (e.g., Nielsen, 1994), whereby a usability professional, armed with 10 or so usability heuristics, or rules of thumb, steps through a product and conducts a systematic "professional judgment" review of the UI.

Although such methods provide valuable design feedback, they can sometimes fall short of a critical need in designing human-friendly systems. "A cardinal principle of human-centered computing is that machines must be understandable as well as usable and useful. . . . We believe that what is needed is for machine operations to be apparent, especially to individuals who are not software engineers" (Eskridge & Hoffman, 2012, p. 65). To achieve the level of apparency that will enable high levels of usability, a system must allow users to readily form a "mental model" of the system, that is, an understanding of what comprises it and how it is intended to work.

In his seminal and influential book, Norman (2014) offered the notion of shared mental models (see Figure 1). Norman

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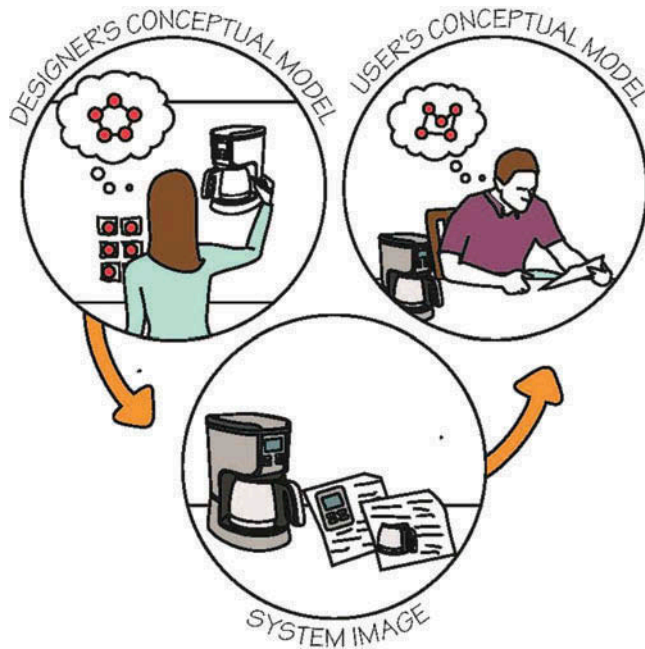
FIG. 1. Norman's (2014) view of mental models. © Don Norman. Reproduced by permission of Don Norman. Permission to reuse must be obtained from the rightsholder.

asserted that the user of any system, of any artifact, would necessarily develop a mental model of how that system works and of how he or she should interact with it to carry out some task. Norman also asserted that the designer/developer(s) of an artifact would have some mental model of how the system/product would work and that that mental model, the designer/developer model, was de facto instantiated as the system/product itself.

We juxtapose this view of usability and mental models with the methodology of Applied Concept Mapping (see Moon, Hoffman, Cañas, & Novak, 2011). Applied Concept Mapping is a diagrammatic method of knowledge elicitation and representation based on a well-regarded theory of human learning and several decades of research. Concept Mapping originated in the 1970s with science educators looking for an approach to assess the understanding of elementary school science students (Novak & Gowin, 1984). Over the past three decades, scores of studies conducted by educators and educational psychologists worldwide have demonstrated that Concept Maps are useful in learning (both individual and collaborative), in teaching, and in assessment. Much of that research is summarized by Good, Novak, and Wandersee (1990); Mintzes, Wandersee, and Novak (2000); and Novak (1991, 1998, 2010).

Concept Maps are spatially organized sets of propositions about some topic of knowledge. Propositions are the basic units of meanings people form and consist of two concepts joined by a linking phrase to make a meaningful statement. Propositions are considered by psychologists and linguists as one of the basic units of meaning that people form (cf. Peirce, 1931–1958).

Concept Maps form meaningful diagrams that are enclosed within geometric figures, with the relations among concepts expressed by one or a few words that label a directional, connecting line. Applied Concept Mapping involves aiding an expert in stating and organizing propositions. Given that Concept Maps are useful in representing and conveying meaning, then perhaps they are useful to describe and illustrate the concept of Concept Maps. Figure 2 is Concept Map about Concept Maps.

Concept Maps differ from other types of diagrams that utilize combinations of graphical and textual elements to represent or express meanings. For example, diagrams that Ackerman and Eden (2001) referred to as "cognitive maps" are large weblike diagrams with up to hundreds of "ideas" represented by the nodes. "Ideas" are typically expressed as sentences or even short paragraphs. Buzan and Buzan's (1996) "mind maps" have unlabeled links between nodes, so links tacitly represent "connections" among ideas. In "conceptual graphs" (Sowa, Foo, & Rao, 1988) the concept nodes are connected using a restricted set of relational links such as "is a kind of" and "has property." "Semantic networks," as described by Fisher et al. (1990) are networks of nodes and labeled links that radiate out in all directions from a central node. In contrast with such variants, Concept Maps have a principled hierarchical morphology; the most important or most general concepts tend to appear toward the top of the hierarchy, and more detailed expressions tend to appear toward the bottom (for a review, see Crandall, Klein, & Hoffman, 2006).

The presence of labeled cross-links also makes Concept Maps unique relative to other forms of meaning diagrams. Crosslinks express relations that cut across the clusters or regions within a Concept Map. For more information on differences between Concept Maps and other types of meaningful diagrams, see Cañas et al. (2003).

Since its beginnings in education, the application of Concept Mapping has evolved in the workplace as a solution for knowledge elicitation and preservation (Moon et al., 2011). This includes applications in facilitating brainstorming sessions; improving the sharing and presentation of knowledge, as well as the level of collaboration and group decision making; strategic intent and planning; anthropological and social science research; socioecosystem management; and large-scale transformation of operations and engineering technical report writing. Empirical research on the efficacy and efficiency of Applied Concept Mapping has included studies of tactical military use, mission planning, information visualization, and job task analysis.

Of particular interest for our proposed purpose is research concerning the use of Concept Maps for fostering shared mental models and teamwork performance (Blickensderfer, Cannon-Bowers, & Salas, 1997). Others have applied mapping techniques to illustrate mental models. For instance, Christensen and Olson (2002) demonstrated
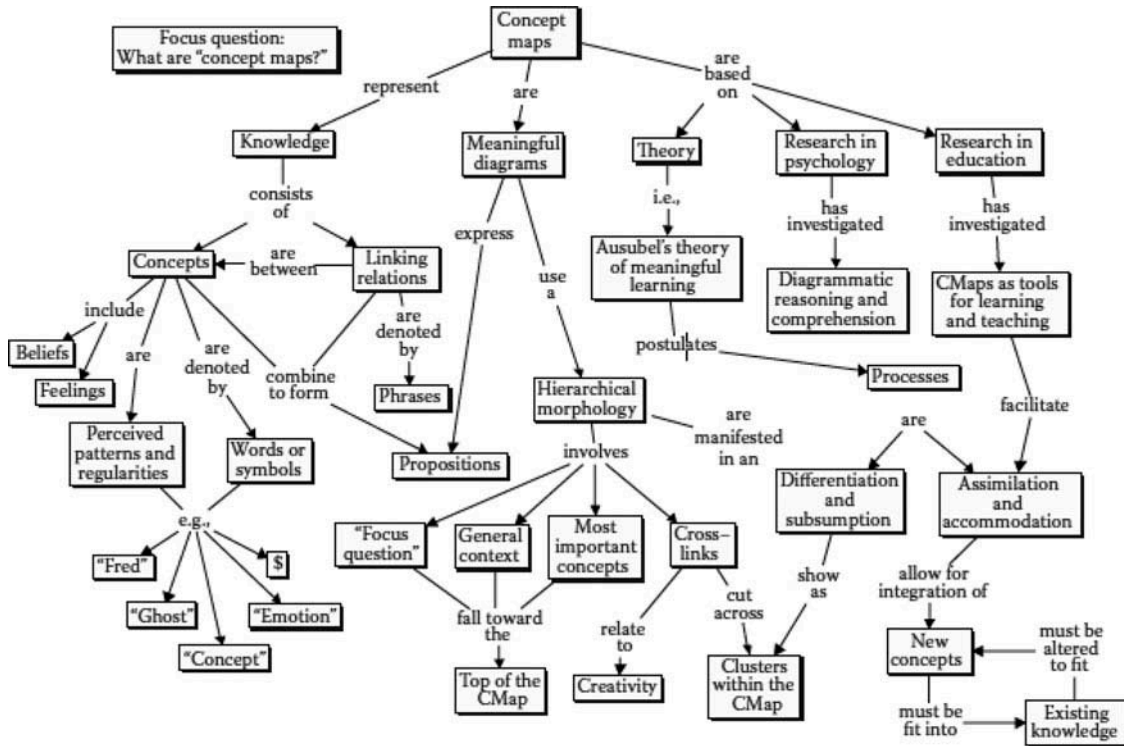
FIG. 2.   A Concept Map about Concept Maps.

the power of the Zaltman metaphor-elicitation technique (ZMET) (Zaltman, 1997) to gain such consumer insight by first eliciting and then mapping consumers' knowledge structures. The article provides illustrations of how ZMET can be used to create a collective cognitive map for a group of consumers, and how ZMET data can be mapped in different ways to give greater insight into consumers' product knowledge structures. (p. 477)

Gerken, Jetter, Zöllner, Mader, and Reiterer (2011) offered an additional example of a group exercise, offering a "longitudinal approach to evaluate the usability of an API." We assert that the practice of usability stands to benefit from structured methods that enable the elicitation and comparison of both user and developer mental models of the system. We are adopting Applied Concept Mapping as a technique to enable such a method, so we propose the Concept Mapping Usability Evaluation (CMUE), an inspection method whereby a usability professional observes/inspects a website or other software UI and generates his or her Concept Map of the product. That Cmap, then, represents the user's mental model, in Norman's terms, of the product. It is our hope that the CMUE, then shared with the product's design/development team, will communicate to the team any points where the users' mental model may differ from their mental model (as instantiated by the design itself).

Cmapping has been used as an assessment tool in other arenas. Daley, Lovell, Perez, and Stern (2011) highlighted various studies where engineering educators "are . . . using [Cmaps] to connect teaching and assessment strategies" (p. 233). They described studies where Cmaps were used, for instance, to "assess engineering students' understanding of atoms [Van Zele, Lenaerts, & Wieme, 2004] . . . , assess student learning following participation in a video game course [Coller & Scott, 2009] . . . , [and] assess interdisciplinary knowledge integration [Borrego, Newswander, & McNair, 2009]" (pp. 233–234). "Their findings indicate that Concept Maps are a viable approach to engineering knowledge assessment" (Daley et al., 2011, p. 235).

Nor is ours, by any means, the first application of Cmapping to the software development process. Faily et al. (2012) addressed the use of Concept Maps to help with "requirements sensemaking." Concerned with the system requirements and their perceived usefulness, their "approach uses concept mapping to both make sense of and improve the quality of a requirements specification" (Faily et al., 2012, p. 218).

Similarly, Dubberly (2011) detailed a case study of one large, team-wide generation of a Cmap to a redesign of java.sun.com. Although they did "follow a user-centered process" (p. 109), they, like Faily et al. (2012), were concerned about system requirements; "we developed the Java concept map so that we could learn what we needed to know" (Dubberly, 2011, p. 109). Their goal was to reorganize the 110,000-page java.sun.com site, and they used their main, consolidated Concept Map as a communications tool. "Sharing a concept map with project stakeholders is an effective way to identify errors in understanding and reach consensus on content definition, structure, and boundaries" (Dubberly, 2011, p. 109).

At perhaps the other end of the product development cycle, Desnoyers (2011) argued for the value of Cmaps in the generation of training materials. Although these earlier uses offer valuable guidance for the developer's use of Concept Mapping during the requirements generation or training stages of product development, our proposed method draws on the tradition of using Concept Maps to gain a sense of how users perceive the system. Note our goal in the current application of Cmaps is not to get the Cmap "right," as it was in the Dubberly work. Rather, it is to generate a Cmap that, in the estimation of the usability professional, accurately reflects the current state of the web (or other UI) design. Then, once the development team has considered the Cmap (with or without being stepped through it by the usability professional who generated it; more on this in the Discussion section), the team will, it is our hope, identify best designs of the UI and effect those redesigns. At that point another CMUE, performed by the same or perhaps a different usability professional, will reveal if the users of the new design will likely come to the same system view as the developers, that is, the intended system view. This is our vision.

The tangible difference between this use of Cmaps and that of Faily et al. (2012) and of Dubberly (2011) is the point of application; the earlier applications promoted use during design, whereas we are promoting use during evaluation. The approach is quite similar: use the Cmaps to lay out mental models of the artifacts, and use those maps to promote dialogue toward building better artifacts. As we address in our concluding section, there is likely room for discussion, and formalism, and teaching, and proliferation of the use of Concept Maps, and a collaborative effort might just raise the value of the methodology for all.

2. METHOD

As this was an exploratory study, our primary goal was to generate several Cmaps, or in this case CMUEs, about a variety of websites, and solicit from the sites' webmasters the perceived value of these CMUEs in providing support for usability evaluation and subsequent redesign. We wished to provide as little direction as possible to those generating the CMUEs, with the hypothesis that different implementations of this method would reveal certain features that were particularly valuable, features that we would prescribe in our subsequent development of the CMUE method.

We solicited five subject websites from a total of four webmasters (i.e., one webmaster offered two sites), with the intention of providing CMUEs of the sites for the webmasters to review and consider as possible drivers of site redesign work. We provided three or four CMUEs for each target website, and the webmaster reviewed these and completed a short questionnaire (Appendix A) about the relative value of the various CMUEs.

2.1. Participant Cmappers

All 20 students from a master's-level introductory course in usability volunteered to participate, with four different students assigned randomly to each of the five subject websites, and were asked to build, each individually, a CMUE of that site. These students had completed half of the graduate-level course, including instruction in conducting usability inspections, in particular heuristic evaluations; each student may or may not have had previous courses or experience in usability. Each participated voluntarily (i.e., his or her course grade was not influenced by choosing to participate). All 20 volunteered (though one later chose not to complete a CMUE), and each student was instructed to download Cmapping tools from http://www.ihmc.us/cmaptools.php.

2.2. Training

None of the students had had explicit instruction in Cmapping. Therefore, we required that each student go through a tutorial on how to construct a Cmap. We introduced, as an independent variable, type of tutorial, with half of the students assigned to any one website being asked to go through an online Cmap tutorial consisting of a prerecorded lecture delivered through PowerPoint. The tutorial was provided by the second author of this article, who uses the tutorial in the context of a graduate-level course, Expertise Management and Knowledge Elicitation. The other half of the students participated in a live, Skyped tutorial provided by the second author, which used the same lecture materials as the online Cmap tutorial. Both types of tutorial lasted about 1 hr.

The online-tutorial students took the tutorial individually and at their leisure, within the 3 days prior to starting to build their CMUE. After the Skyped-tutorial students had received their tutorial as a group, the others (online-tutorial students) joined the group and all 20 were given instruction for how to carry out the CMUEs (Appendix B). They then had 1 week to complete their CMUE and deliver it to the course professor (Bias).

2.3. The Websites

The five websites included two .edu sites (offices at The University of Texas), two .com sites (one company and one individual), and one .org site. We pursued this breadth to have at least some opportunity to discern that one type of site, or a site with certain characteristics, lent itself better or less well to the emerging CMUE method.

- http://ddce.utexas.edu/civicengagement/

  - This is the website of the University of Texas at Austin's Longhorn Center for Civic Engagement, a Division of Diversity and Community Engagement office

○ This site allows people or organizations to post and manage events, recruit volunteers, and track volunteer hours

- http://ddce.utexas.edu/genderandsexuality/

  ○ This is the website of the University of Texas at Austin's Gender and Sexuality Center, another Division of Diversity and Community Engagement office
  ○ This site provides information and services to women and LGBTQA (Lesbian, Gay, Bisexual, Transgender, Questioning, Asexual) communities and provides a place to report incidents of bias

- www.grahamreynolds.com

  ○ This is the personal and professional website of a bandleader and composer
  ○ This site includes schedules and samples, though supports no transactions except for newsletter sign-up and connections to social media

- http://texasarchive.org

  ○ This is the website of the Texas Archive of the Moving Image
  ○ This site allows visitors to search collections
  ○ This site also affords transactions such as donating money or contributing videos

- http://www.perigeantechnologies.com/

  ○ This is the professional website of a Washington, DC, area services, software, and training company
  ○ This site provides information on the company and access to social media connections

Note that the webmaster of this last site is also an author of this article (Moon) and has much experience with Cmapping, including serving as the organizer of a 2015 conference on Applied Concept Mapping (see http://www.acmsymposium.info/). Although his experience likely gives him deep insight regarding Cmapping as an emerging usability evaluation method, his responses could reflect some bias toward the value of Concept Mapping. In every case, next, we have noted which responses were his, so that they might be considered separately from those of the other webmasters who have no such known bias. We view this as basically a case study within the context of the broader experimental study.

2.4. Procedure

Nineteen of the students completed their CMUEs, and these were routed to the respective webmasters. Each webmaster completed a survey for each set of CMUEs (i.e., one webmaster completed two surveys, one for each of his two sites that we tested).

Thus, four webmasters volunteered a total of five websites to be evaluated, websites covering a breadth of domains and types. All the webmasters were familiar with usability engineering in general and with inspection methods and heuristic evaluations in particular. Twenty students in a master's-level usability course were assigned, randomly, to the five websites, four students per site (with one student later opting out). All students were given some instruction on building a Cmap of their target website for the expressed purpose of providing usability feedback for possible redesigns, receiving a tutorial in Cmapping, half an online tutorial and half a live, Skyped tutorial by an experienced Cmapping professional. They were then given 90 min in class, and unlimited time on their own over the next week, to complete their CMUE. Thus, 19 CMUEs were generated. All four of the individual CMUEs performed on a particular website were sent to the site's webmaster (with one webmaster receiving only three, due to the aforementioned opt-out by one student evaluator), along with a survey to complete about the value of the four CMUEs he or she received.

3. RESULTS

The 19 CMUEs (two samples of which appear in Appendix C) ranged from 14 to 55 nodes, with a median of 37. There was much diversity of energy invested, style applied, and specific integration of usability-related comments into the CMUEs themselves. This diversity is captured below in the webmaster's open-ended reactions to the CMUEs. The results of interest, from the Webmaster survey are presented in Table 1.

Whereas all respondents saw the Cmaps of potential value in subsequent redesigns of their websites, only about half (three out of five, and two out of four of those other than an author of this article) immediately imagined particular redesigns based on their received Cmaps. Only one of the four respondents (plus the experienced Cmapping professional) thought the CMUE to be of more value than a heuristic evaluation.

There was no obvious pattern associated with the independent variable of Online versus Skype Tutorial; when webmasters picked the most and least valuable Cmap, of the four (or, in one case, three) Cmaps they received, the selections were almost perfectly evenly split across type of tutorial the Cmapper had received. We interpret this as suggesting that a (scalable!) online delivery of a Cmapping tutorial may be just as good as live, face-to-face training for the purposes of conducting a CMUE. Indeed, usability students are known to use a variety of diagramming methods, so most took quickly to Concept Mapping, regardless of instructional method.

Half of the webmaster respondents stated that earlier instantiations of their site had received explicit, systematic usability evaluations.

The Concept Maps reflected different perspectives of the evaluators. Convergence was not formally measured. Concept Maps have been used to compare mental models (Blickensderfer et al., 1997), and offer interesting opportunities

TABLE 1
Webmaster Survey Responses

Websites	ddce.utexas.edu/ civicengagement/	ddce.utexas.edu/ genderandsexuality/	grahamreynolds.com	texasarchive.org	perigeantechnologies. com/[a]
Questions					
1. "These Cmaps will be of value to me when I next redesign this website."	Agree	Agree	Agree	Agree	Agree
2. "I can already envision particular changes I wish to make to this website based on what I've seen in these Cmaps."	Neither agree nor disagree	Neither agree nor disagree	Agree	Agree	Strongly agree
3. Which of the Cmaps is of more value to you?	OT	ST	OT	ST	ST
4. Which of the Cmaps is of least value to you?	OT	OT	OT	ST	ST, OT (tied)
5. "I [__ have __ have not] performed or received some formal usability testing of this site, before."	Have not	Have not	Have	Have	Have not
6. (Comparing CMUE with Heuristic Evaluation)	"I think a heuristic evaluation is of somewhat more value than a Cmap."	"I think a heuristic evaluation is of somewhat more value than a Cmap."	"I think a Cmap is of somewhat more value than a heuristic evaluation."	"I think a heuristic evaluation is of somewhat more value than a Cmap."	"I think a Cmap is of much more value than a heuristic evaluation."

Note. OT = a Cmap from a student who took the online tutorial; ST = a Cmap from a student who took the Skyped tutorial.
[a]The second author's website.

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to consider conceptual convergence—as opposed to strict reliability measures. Future work will focus on how Concept Maps could be used to compare how multiple reviewers converge on their evaluations.

We acknowledge the potential for response bias among our five webmasters, as they all were aware of our explicit attempt to study the potential value of CMUE. We hope and believe the exploratory nature of this work excuses this potential bias; future empirical comparisons of the efficacy of CMUE versus other usability evaluation methods will require more careful control.

Perhaps the most valuable data were the free-form comments we received associated with Survey Questions 3, 4, and 7. All of these comments are presented in Appendix D. Here we highlight some of them. (Note that [ST] and [OT] are used to represent the CMUE produced by a student who had received Skyped Training or Online Training, respectively. Thus, any occurrence of [ST] refers to one of the nine CMUEs performed by a Skype-trained participant, and any occurrence of [OT] refers to one of the 10 CMUEs performed by an Online-trained participant.)

3.1. Theme 1: The CMUE Is of General Value

The first theme of that we identified in the webmasters' open-ended comments is that the CMUEs were of value to the webmasters as they considered redesigning their websites.

- ". . . the . . . map simplifies the site into a readable format. Seeing all the verbs lined up below the heading both provides a nice tiered approach and layout for what the org does. It makes the site's info scanable and gives an overview of audiences and offerings."
- ". . . best job of processing and crystaliz[ing] the content of the site in the most helpful way."
- "It provided some comments on the sidebar, the functionality of which I was curious about."
- "It gave a good scope of our website, and also allowed me to visually realize some problems in functionality."
- "These cmaps help me in two immediate ways: 1) They give me a sense for what the site 'is communicating' and 2) they give me a tool, a visualization to take to the site owners and stakeholders and start a conversation about what the site 'is communicating.'"
- "I really like the high-level depictions of the concept space and found it really useful in helping to hone what we say and identify any ways that might be improved or altered for greater or lesser emphasis."
- [Moon] "[ST] is a really nice demonstration of what is possible."
- [Moon] "Importantly, we have already included several of [ST]'s suggestions in a new design of the site, which should be posted in the next couple of days! Check it out!"

3.2. Theme 2: Specific Data on What Is of Value

The second theme we identified was a collection of specific ideas about what is of value in the CMUEs, items that we believe will help us be more prescriptive about the particular format or process of CMUEs going forward.

- "By breaking the site info down into 'provides links to' and 'includes information about' I get a good intro to what sorts of resources the organization provides. The 'has . . .' branches are less helpful."
- "Really nice high-level conceptual overview was helpful for organizing big ideas, concepts, themes."
- "This one seemed less useful primarily because the first tier of connections could be broken up better. 'Serves' lumps all the audience members together, 'Has a' seems to shift the focus away from the content to the site elements (not useful to know the site has a search box, slider, and nav bar in this context, even though it is the most elaborated upon branch), and 'Provides' seems to be the most interesting connection, but then stops after one level."
- "This cmap is frustrating because it has the potential to organize the site in an original way, but is ultimately too vague and subjective to be of use. By breaking the site down into 'not clearly defined' and 'has confusing' it seems to indicate which elements need work. This could be valuable; I wanted to know more about how to improve the site for this unclear, confused user. But to simply say is has confusing language, or forms, is not particularly helpful."
- "There seems to a common dichotomy between mapping the content of the site and the site's form itself. I think the most helpful approach is to start with the content exclusively. Mapping the information according to the hierarchy or architecture is a valuable mirror to the impression the site creates that site builders don't necessarily see or think about until mapped like this. If the map is going to focus on site elements, it is probably more narrowly useful to the webmaster(s) instead of the organization's stakeholders."
- [Moon] "[ST]'s map could be significantly expanded (no doubt they ran out of time). Includes nice use of crosslinks to 'Ambiguous Link'—clearly shows a major flaw across several pages."

3.3. Theme 3: The Integration of Usability Comments

A third, more specific theme was that it is important to integrate specific usability comments into the CMUE, and not have them in a separate, accompanying document.

- [Moon] "[ST] map was the only one with substantive usability comments. The other two only described the webpages and the structure of the website. NOTE: All usability review comments should be contained IN

THE CMAP – i.e., not in annotations – for maximum readability and utility."

- "I did enjoy the visual mapping, seeing the elements of website laid out relationally, but what I've valued from usability tests previously is the direct feedback. I think direct responses to using the website and comments on what does and does not work for a new user is extremely important."

3.4. Theme 4: How might the CMUE be shared with the design/development team?

Finally, going into this study we were uncertain if it might be satisfactory to simply send the CMUE to the webmasters, or if usability professionals would need to step through the CMUE with the webmaster or other design/development team members. We received some preliminary thoughts on this matter.

- "I will take these to the site owners and we will compare the cmaps with the impression and information we want these sites to give (as opposed to what these maps indicate). Perhaps we will create cmaps of our own to illustrate what we want the site to communicate clearly."
- "A write up or list as a result of testing would be of more value to our organization. The questions we have about our website's functionality need to be answered by someone going through the experience of finding and watching videos on the site."

4. DISCUSSION AND CONCLUSIONS

We believe we have taken a successful first step in extending Concept Mapping to usability evaluation. We propose employing Cmapping as a usability inspection method, to be used alongside heuristic evaluation and other evaluation methods.

This new method was motivated by a convergence of vectors:

- Broad applicability of Cmapping in various other types of assessment,
- our reasoning that a Cmap generated by a usability professional would be a particular instantiation of Norman's (1990) user's "mental model," and
- the successful application of Cmapping at other stages of software development, such as requirements generation and tracking (Faily et al., 2012) and design representation (Dubberly, 2011).

Here we launch with an empirical study a potential addition to the usability professional's tool belt, CMUE. In this, our first attempt at CMUE, we had 19 students in a master's-level usability class craft CMUEs of five websites. We sent the CMUEs to the sites' webmasters and asked them to give us feedback, via a questionnaire, on the perceived value of the CMUEs to them, in their future redesign efforts.

The webmasters were unanimous in their belief that the CMUEs would be of value to them in improving their websites but mixed as to whether CMUEs would be more valuable than a traditional heuristic evaluation. Given that half of the webmaster respondents stated that earlier instantiations of their site had undergone usability evaluations, it is not as though we had cherry-picked necessarily poor or immature sites that might have been a "target-rich" environment for usability evaluations. Also, de facto the application of CMUEs to subsequent redesign efforts was new to these webmasters. This conspires with the relative maturity of the subject websites and the newness of the participant Cmappers to Cmapping to make ours a conservative test of the possible value of CMUEs.

One of the participants noted that only one of the maps contained "substantive usability comments." This likely reflects how evaluators grapple with a new method, especially an immature one. CMUE offers the potential to integrate usability findings gathered using other methods, and organize them to reflect the perspective of the evaluator. Organizing schemes could reflect the target webpage, or even build the evaluator's perspective into a scheme that would enable the evaluator to suggest improvements to developers. The method could also be used to "make a case" about the usability findings, to help explain them to developers. We believe there are multiple uses for the method and that flexibility in application is a good thing.

We have two fundamental questions coming out of this study. The first is whether the best practice might be to have multiple usability professionals generate their individual CMUEs, or to have them work together to craft a composite CMUE.

Faily et al. (2012), in their use of Cmaps in support of requirements generation and tracking, talk of consolidating multiple Cmaps into an agreed-upon single map. Gerken et al. (2011), in their aforementioned study of the usability of APIs, provide a similar model. This is a direction we can consider as we move forward—possibly consolidating the Cmaps of multiple usability professional to represent one "user's mental model." However, we may find that having multiple, distinct Cmaps is more valuable, as each represents one user model (or one subset of the user audience's mental model).

Our second fundamental question is whether the best practice will be to have the usability professional simply send the CMUE to the product designers/developers, or if it might be critical to have the usability professional step through the CMUE with the other members of the development team. We note that in the large java.com redesign effort, "we also asked the stakeholders to review the concept map as we developed it" (Dubberly, 2011, p. 110). Also,

> reviews took place in one-on-one interviews, on the phone, or via email. We sent drafts of the map to groups within Sun. We also posted large, printed copies in high-traffic areas at Sun; reviewers wrote direction on the map or attached yellow stickies. (Dubberly, 2011, p. 115)

Of course, that approach is more thorough. But when considering the return-on-investment (ROI) for the usability hour and dollar invested, it will be interesting to see if simply sending the CMUE to the development team might yield good return. We expect to test this empirically.

Relatedly, one of the webmasters offered, "I wanted to know more about how to improve the site for this unclear, confused user." Maybe the CMUE will be of optimal value as a conversation starter between the usability professional and other product stakeholders.

One limitation of this preliminary study is that the usability "professionals" were master's-level usability students, and all were new to Cmapping. An additional independent variable we will wish to test in the future is the level of experience of the person conducting the CMUE, experience both with usability evaluation methods and with Cmapping.

But even with Cmapping tyros, and those with only modest usability experience, these first CMUEs fetched, "That said, I will definitely be using the Cmaps for website redesign. Some basic elements need to be shifted, something that is now obvious to me after viewing the maps." We hope other usability researchers will join us in employing CMUEs as part of a program of usability engineering and will help us identify the parameters of best CMUE practice—help us identify, empirically,

- which types of products are well served by CMUEs,
- when in the development cycle they can be most fruitful,
- what types of usability professionals can carry them out for maximal ROI,
- if the CMUE can be delivered to the product stakeholders or must be stepped through with them, and
- what nuances of traditional Cmaps (e.g., specific integrated usability-related comments) might improve the ROI for CMUEs.

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APPENDIX A: Webmaster Survey

Cmap Usability Study – Webmaster Survey
Thank you, in advance, for completing this survey.
Randolph.

Name: _____

Website: _____

You have received three Cmaps of your website, each generated by one of my master's-level Usability students who had just learned about Cmapping. If you will, please answer the following questions, after having considered the Cmaps.

1. "These Cmaps will be of value to me when I next redesign this website."

___Strongly agree ___Agree ___Neither agree nor disagree ___Disagree ___Strongly disagree

2. "I can already envision particular changes I wish to make to this website based on what I've seen in these Cmaps."

___Strongly agree ___Agree ___Neither agree nor disagree ___Disagree ___Strongly disagree

3. Which of the Cmaps is of more value to you?

_____ (Please enter just the first two letters of the filename. Or enter "none.")

Comments:

4. Which of the Cmaps is of least value to you?

_____ (Please enter just the first two letters of the filename. Or enter "all.")

Comments:

5. "I [___have ___have not] performed or received some formal usability testing of this site, before."

6. If you have ever received a heuristic evaluation (professional judgment usability review) of any website you've crafted, please answer the following:

___ I think a Cmap is of much more value than a heuristic evaluation.
___ I think a Cmap is of somewhat more value than a heuristic evaluation.
___ I think a Cmap and a heuristic evaluation are likely about of equal value.
___I think a heuristic evaluation is of somewhat more value than a Cmap.
___I think a heuristic evaluation is of much more value than a Cmap.

7. "Here are any final comments I wish to make about Cmapping as a usability method."

Thanks very much. Randolph.

APPENDIX B: Instructions for the CMUE exercise

You have each received a tutorial on how to carry out a concept map.

I would like to ask you to now build a Cmap – the idea is that your Cmap will be an instantiation of the users' mental model.

We will share your Cmap with the webmaster of the website you evaluate.

He or she – that webmaster – has agreed to receive your Cmaps and consider redesigning his/her website based on your Cmaps.

This has never been done before. Cmaps have been created MANY MANY times before. Cmaps as a type of usability evaluation has never been done before. There is no RIGHT way to do this. I will invite you to do this however you think might work. Please build a Cmap that captures the functionality and flow of the website. If you think the Cmap needs some complementary document, go for it. We may learn an important component of the emerging CMUE technique.

I would like you to spend just 90 minutes or so on this exercise. If you find that is not enough time, and you can build a Cmap on only a subset of your assigned site, that is just fine.

You may do this work here, in the IT Lab, or wherever you are comfortable. I will be around to answer questions.

When you are through, send me your Cmap and I will send you a link to a VERY short survey about your experience.

APPENDIX C: Free-form Comments from the Webmaster Survey

Note, when a particular Cmap is identified below it is called out by a two-letter code, indicating whether this Cmap had been generated by a student evaluator who was in the Online Tutorial [OT] condition or the Skype Tutorial [ST] condition. And "[Moon]" before a comment indicates this comment was from the second author of this article.

Comments on Question 3: Which of the Cmaps is of more value to you?

- I like the way the [OT] map simplifies the site into a readable format. Seeing all the verbs lined up below the heading both provides a nice tiered approach and layout for what the org does. It makes the site's info scanable and gives an overview of audiences and offerings.
- This cmap seemed to do the best job of processing and crystalize the content of the site in the most helpful way. By breaking the site info down into "provides links to" and "includes information about" I get a good intro to what sorts of resources the organization provides. The "has . . ." branches are less helpful.
- Really nice high-level conceptual overview was helpful for organizing big ideas, concepts, themes.
- [Moon] [ST] map was the only one with substantive usability comments. The other two only described the webpages and the structure of the website. NOTE: All usability review comments should be contained IN THE CMAP – i.e., not in annotations – for maximum readability and utility.

- [ST] is likely the most helpful because it pointed out problems with our website more than any other of the Cmaps, giving us perspective on what doesn't work from a new user's experience. It provided some comments on the sidebar, the functionality of which I was curious about. [ST] was also very valuable and extensively mapped. The map concept was most helpful in this Cmap. It gave a good scope of our website, and also allowed me to visually realize some problems in functionality.

Comments on Question 4: Which of the Cmaps is of least value to you?

- This one seemed less useful primarily because the first tier of connections could be broken up better. "Serves" lumps all the audience members together, "Has a" seems to shift the focus away from the content to the site elements (not useful to know the site has a search box, slider, and nav bar in this context, even though it is the most elaborated upon branch), and "Provides" seems to be the most interesting connection, but then stops after one level.
- This cmap is frustrating because it has the potential to organize the site in an original way, but is ultimately too vague and subjective to be of use. By breaking the site down into "not clearly defined" and "has confusing" it seems to indicate which elements need work. This could be valuable; I wanted to know more about how to improve the site for this unclear, confused user. But to simply say is has confusing language, or forms, is not particularly helpful. There are a few specifics that will help us make elements more consistent or clear, but only a few.
- Very hard to follow/understand ideas being expressed.
- [Moon] Both were of equal (lesser) value.
- This Cmap didn't follow the website as closely, so I wasn't sure exactly what is was mapping. Our organization's concept? A narrow focus on media or on a portion of our website? It didn't speak to me about the usability of the website at all.

Comments on Question 7: "Here are any final comments I wish to make about Cmapping as a usability method."

- These cmaps help me in two immediate ways: 1) They give me a sense for what the site "is communicating" and 2) they give me a tool, a visualization to take to the site owners and stakeholders and start a conversation about what the site "is communicating." I will take these to the site owners and we will compare the cmaps with the impression and information we want these sites to give (as opposed to what these maps indicate). Perhaps we will create cmaps of our own to illustrate what we want the site to communicate clearly.

- There seems to a common dichotomy between mapping the content of the site and the site's form itself. I think the most helpful approach is to start with the content exclusively. Mapping the information according to the hierarchy or architecture is a valuable mirror to the impression the site creates that site builders don't necessarily see or think about until mapped like this. If the map is going to focus on site elements, it is probably more narrowly useful to the webmaster(s) instead of the organization's stakeholders.
- I really like the high-level depictions of the concept space and found it really useful in helping to hone what we say and identify any ways that might be improved or altered for greater or lesser emphasis.
- [Moon] [ST] is a really nice demonstration of what is possible. Seems neither [OT] nor [ST] fully grasped the concept – instead, they simply used to Cmap to describe the structure and content of the site. [ST]'s map could be significantly expanded (no doubt they ran

out of time). Includes nice use of crosslinks to "Ambiguous Link" – clearly shows a major flaw across several pages. Importantly, we have already included several of [ST]'s suggestions in a new design of the site, which should be posted in the next couple of days! Check it out!
- I did enjoy the visual mapping, seeing the elements of website laid out relationally, but what I've valued from usability tests previously is the direct feedback. I think direct responses to using the website and comments on what does and does not work for a new user is extremely important. A write up or list as a result of testing would be of more value to our organization. The questions we have about our website's functionality need to be answered by someone going through the experience of finding and watching videos on the site. That said, I will definitely be using the Cmaps for website redesign. Some basic elements need to be shifted, something that is now obvious to me after viewing the maps.

APPENDIX D: Two Sample Concept Mapping Usability Evaluations

The University of Texas at Austin Longhorn Center for Civic Engagement (home page)

Serves → Students, Faculty, Community Organizations, & Alumni

Provides → Links to social media — Which are → Too big

Provides → Information on Volunteering

Provides → News about the organization's activities

Provides → Ways to Donate

Provides → Info. about the Center

Provides → A Google map of volunteer opportunities

Has a → Search box

"slider" — that is → Problematic because of weird transitions

Navigation Bar — that connects

Students — with → Resources for volunteering

Instructors — with → Resources for teaching Academic-Service Learning

Partners — who are → Organizations, UT Depts, etc. — with → opportunities to work with UT students and faculty

Supporters — with → Ways to Donate

Alumni — with → Ways to get involved

Resources for teaching Academic-Service Learning — that showcases → Volunteer Projects through "Stories of Service" videos — that are → "Private" and unviewable