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The design of highly interactive displays or installations for public spaces requires understanding of the capabilities, preferences, and experiences of broad audiences. In the case of immersive maps, levels of map literacy are particularly important. This project, The NC Audio Map, explores the ways by which geography might catalyze knowledge acquisition goals. The project seeks to identify what effects information processing through map literacy has on design of a novel installation. Map literacy and interpretation at large, as discussed in previous research are applied to the design of the NC Audio Map ubiquitous computing environment. The ultimate goal is to explore how user experience design may benefit from anticipating user information processing skills.

Headings:

Human-computer interaction

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INTERPRETING THE EXPERIENCE: THE IMPACT OF MAP LITERACY ON INSTALLATION USABILITY DESIGN

by
John L Miller

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Approved by

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Gary Marchionini

Interpreting the Experience: The Impact of Map Literacy on Novel Installation Usability Design[1]

User experience (UX) design is the practice of creating systems so that interaction and information might be made more consumable and significant for the users of said systems. The content expressed in an installation or elsewhere is often varied leaving user experience designers with many factors to contemplate when constructing an interface. The introduction of multimedia into modern communications raises new perceptions regarding the way humans interact with information. Key to this fact is that perception is a process carried out by users, how that perception may be shaped is the job of user experience designers. In addition to organization of materials that order how concepts are encountered, technology plays an important role in experience. Human-computer interactions (HCI) that present users with novel interfaces, as opposed to standard (e.g., mouse-keyboard, print) interaction styles, must deal with the issues surrounding usability and interaction design as well as human perception. Already there is a deluge of factors to consider most noticeably how humans perceive, what context the material at hand

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[1] This document is the accompanying research and design process for a custom-built novel information installation titled NC Audio Map presented during the week of February 15th 2010 in Swain Hall on the University of North Carolina Chapel Hlll campus.

carries with it, and how perception may be manipulated by organization of information and technology.

The significance of research in this area will be to identify new usability techniques that explore broadening the user base, and formulation of educational objectives through new interactions. Museum curators and library professionals involved in constructing new information displays will be interested in findings related to multimedia collection presentation. Research in this area will also be of importance to user experience and human-computer interaction engineers looking for new and expanded definitions of user abilities and how to cater use of new information systems. Practitioners of installation design will also be interested in what is discovered pertaining to theory and methods of user-centered design. Finally, map-artists and counter-cartography movements, and other groups interested in usability that support general cartographic articulation of information might benefit from findings.

State of the Art

To familiarize the scope of what exists currently, examples of commercially deployed novel interface interactions include the Nintendo Wii motion controller and the Apple iPhone. As opposed to interfacing with a two-handed game controller or physical button layout respectively, these two systems move away from previous iterations of human-computer interaction in the world of video games and cell phones. Novel interfaces also include computer interactions where the user may not be at

all aware of the interaction at hand. An installation in a museum for example is a more passive form of interaction than the iPhone or Wii, but information is still being conveyed, just not on the level of direct device interaction (i.e., phone, game controller). Interaction with an installation is done with the entire body and often such systems address multiple users at a given time. Design for public space interactions must take into account several users of varying backgrounds simultaneously. A goal of successful public space interaction design is the ability to speak to each user while facilitating understanding to the group as a whole. Such forms of collaboration and shared experience are emerging trends in new computer interactions that have grown in popularity with the sophistication of ubiquitous computing and social networking.

The commonality between these new systems that I would like to address here is usability design, particularly for installations such as those found in museums or libraries presenting a multimedia collection. Unified by a theme or specific collection that inherently informs users of what kind of experience they might expect, information installations that make use of computer systems face new usability issues. It is of particular interest here what components of usability might lend themselves most effectively to the design of an installation. What I propose is an exploratory study into the world of user experience for installation design and to produce a study that advises the architecture of such systems.

From a wide vantage, the challenges of usability that faced Nintendo and Apple for their novel devices are the same for any usability designer. The components of usability stated by Shneiderman and Plaisant (2004)—learnability, efficiency, memorability, error management, and satisfaction—are meant to define considerations used by designers, programmers, and user experience engineers when producing user interfaces. Each aspect of usability involves the speed, ease, and retention of interaction techniques the system presents in its effort to guide the user through a set of actions. However, this definition of usability makes the assumption that users possess a certain level of 'literacy' to enable interaction and information processing. For example, in an installation the level of information literacy assumed must be broad in order to communicate to a potentially large and varied user base. The point of interest in this research paper is how considerations like information literacy could inform usability design.

Objectives

Objectives included in this exploration of UX are to define information literacy and determine what, if any, specifics could be used in the design of usability for a novel information installation in a public setting. Of special importance to this study are users' innate map literacy skills and the capability of an installation using information organized geographically from metadata of presented objects to utilize said user

skills. Currently map literacy is an underdeveloped field of investigation with little recourse into the potential implications for usability. It is the aim of this study to determine if map reading tasks grouped under the categories of navigation, measurement, and visualization are effective principles to center on usability design (Clarke, 2003). NC Audio Map's objective is to lower the barriers of entry for users to access primary source multimedia materials and develop abstract connections using the following geographically centered interpretive skills. Map literacy levels and the activities associated with them established by Clarke (2003) include:

1. Map Reading - Get the main idea from a single or simple symbol. Simple estimation on familiar symbols. Activities include: search, locate, identify, compare single symbols, measure, calculate, and relative size.
2. Map Analysis - Recognizing properties of symbol groups on the map as a whole and analyzing spatial patterns, more complex estimation. Activities include: more complex recognition, reorganization, decoding, detection, comparison, discrimination, and contrast.
3. Map Interpretation - More tasks leading to understand the meaning of partial phenomena for knowledge enhancement. At this level inferential reasoning is used from the spatial relationships, patterns and map phenomena of one or more referents or source. Higher

order mental models are constructed. The user draws on domain specific knowledge. Activities are exhausted.

Areas with limited scholarship include geographically based visualization of information, novel interfaces—namely installations—and user experience design of such systems. For present-day issues including human-computer interaction and access to large amounts of information in various forms of media the connection between usability and information literacy becomes more complex. Users possessing high levels of information literacy may fully appreciate the experience of interacting with contemporary systems, but what concerns should usability engineers keep in perspective for users unfamiliar with novel interactions? Are some types of literacy more intuitive than others and could UX design that factors into account distinct kinds of literacy increase a system's usability? These are the questions related to usability important for information professionals interested in designing novel interfaces for a multimedia collection using cartographic cues.

In addition to abstract concept formulation by means of geographic organization and novel interaction, the objective of NC Audio Map installation is to promote collaborative exploration of topics to decipher information. By definition a component of a ubiquitous computing (UbiComp) environment is immersion. In a multi person system, also a characteristic of UbiComp, a trade-off between immersion and interaction with other players in the system exists (Abowd & Mynatt, 2000). Factors

that may lend themselves to balancing immersion and collaboration in knowledge formation are intensity of immersion, size of space, relationship between user and content, individuality of experience, harmony of technology and content, and overall level of detail for information objects.

Literature Review

The following survey of pertinent research provides the necessary context to analyze map literacy and the impact it has on UX design of a novel installation. A novel museum installation is characterized by interaction techniques that avoid mouse-keyboard interaction, new methods of collection organization, multiple multimedia inputs and other aspects of ubiquitous computing. Reviewed literature will be organized by the following thematic categories: information literacy, maps as information objects, usability design of open space installations, evaluative techniques for novel installations, geovisualization, and ubiquitous computing. It is my aim to show the gaps and overlapping concepts in concurrent research aid to inform usability design that considers what information processing skills are inherently held by users of a novel installation. Finally, the ways in which user experience designers may harness map reading skills will be addressed by examining previous attempts to conceptualize the novel museum installation from a usability perspective.

From Information Literacy to Map Literacy

Information literacy, established in the Prague Declaration of 2003 for the purpose of an agreed upon definition, formulates the concept as a set functional skills required to navigate modern society's information systems, which include objects like maps. Information literacy is viewed as a right for humans worldwide and also as a set of recommendations for purveyors of knowledge (Doyle, 1994). Information literacy skills include levels of comprehension and evaluation, which have been appropriated to define map literacy. A workable definition of map literacy must first be developed in order to establish an understanding of its place in usability design (Clarke, 2003). The broad skills (that include numerous subtasks) of a map literate user include navigation, measurement, and visualization. Using this and other sources, Clarke's (2003) formulation of map literacy levels define the most basic level as someone who can recognize and estimate spatial qualities between familiar symbols on a map, and the most advanced level of map literacy implies the ability to go beyond recognizing properties and conceptualize abstract relationships between symbols. I argue that the skills of the map literate can be used to outline what a patron is capable of as usability of an installation is developed.

Following a brief description of usability I will address what use map literacy is to the design considerations of user experience engineers.

Usability and Map Literacy

The definition of usability for this paper adheres to the following

conceptual break down (Nielsen, 2003):

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the interface?
- Efficiency: How quickly can users accomplish their tasks after they learn how to use the interface?
- Memorability: After a period of non-use, how long does it take users to reestablish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easy is it for users to recover from these errors?
- Satisfaction: How pleasant or satisfying is it to use the interface?

These qualities are intended to inform the jobs of user experience designers. Usability design by museum professionals and human-computer interaction researchers currently lacks an examination of map processing skills already possessed by patrons in design approaches. It seems logical that addressing all aspects of a user's information processing abilities should be taken into consideration when designing a novel installation.

Later portions of this literature review examine the current methods employed to study installation interaction. To answer the question of what map literacy means to usability design we must understand how maps work. To understand the implications for users and their exposure to maps as information objects, a deconstruction of the objects is necessary. Maps examined as textual objects allow us to consider their power in (and

to) knowledge. By presenting a collection of materials using maps we lay bare connections of whatever qualities a grouping of artifacts may possess, be they social, historical, political, or even scientific (Harley, 1989). One of the most common maps used by the general population are road maps. These maps show cities and routes between them emphasizing popularity of routes, surface area of cities, and many other relationships that involve travel. The constructs developed in road maps use visualization techniques to garner understanding of the relationships they present. It is my assertion that the different levels of map literacy imply latent processing abilities of users that can be incorporated into the usability design process of a collection of materials to harness the aforementioned power of maps.

Research into the use of maps as organizational models for presentation of information will now be discussed to further illuminate current knowledge of how map literacy affects task completion.

Geovisualization

Previous studies that incorporate the concept of geovisualization, the presentation of information objects via maps, seek to understand user's abilities in conjunction with design considerations. All studies reviewed find a gap in usability testing where geovisualization is concerned. Most research on this topic lies in the study of usability testing as a means to evaluate geographic information as a method to visualize data. Researchers tested usability variables involving usage situation,

user requirements, task type, user volume, and data volume (Koua & Kraak, 2004; Marsh & Dykes, 2005; Nivala, Sarjakoski & Sarjakoski, 2007; Kortbek & Grønbæk, 2008).

In studies where usability consideration was tested as an intervening variable participants recognized and appreciated user-oriented design leading researchers to conclude that a user-centered design process should be compulsory for knowledge seeking tasks that implement geovisualization (Koua & Kraak, 2004). Other methods used to present these findings involved quantitative analysis of task completion for users of systems that employed geovisualization. Of importance to my study, the user types ranged in level of experience, which can be directly correlated to the skills defined in map literacy levels. Scenarios that focus on abilities of a user or group of users that test their map reading skills and record the process through observations are used as user cases, which inform experimenters when testing a theory. Multiple user cases were examined across the reviewed literature, an extremely important variable for a museum installation. Cases included individual users and groups composed of both familiar and unfamiliar members (Koua & Kraak, 2004; Kortbek & Grønbæk, 2008). Findings in this area that support my argument pointed to increased accessibility for multiple user experience levels. The broad complexity of tasks performed by participants of these studies can best be described as knowledge seeking tasks; they covered educational objectives as well as known item retrieval (Nivala et al., 2007).

These findings support the importance of examining maps as visualization tools and their ability to encourage abstract conceptualization of geographically visualized content.

I now intend to show that previous installation design of open space information systems like those in a museum may be supplemented using research in the area of ubiquitous computing and that incorporating user centered design principles mean more than participatory design.

Ubiquitous Computing

Ubiquitous computing is the simultaneous use of multiple, fully environmental-integrating computing systems complete with natural, contextually significant interfacing. An environment in accordance with the tenets of UbiComp is said to have the following characteristics (Abowd & Mynatt, 2000):

- They rarely have a clear beginning or end
- Interruption is expected
- Multiple activities operate concurrently
- Time is an important discriminator
- Associative models of information are needed

Developed in coordination with the concept of UbiComp are the notions of body as interaction device and the disappearing computer (Schiphorst, 2007). These concepts refer to how completely a computing system is integrated into a given space. When beginnings and ends to an installation are blurred interaction relies upon intuition. Installations that

employ UbiComp systems rely upon the inferences and intuition that a user brings with them and exercises when interacting with said environment. Data suggests that novel interfaces requiring more than just the body (e.g., hands) to initiate interaction reduce interest and general usability across age groups (Terrenghi & Zimmermann, 2004; Kortbek & Grønbæk, 2008). Again, this research acts as support for implementing map literacy skills that situate a user within a familiar information space.

Consistent reports on user experiences of UbiComp installations note that a contract is needed between multiple input types. For example, work on the LISTEN project incorporated floor sensors that projected aural descriptions of nearby visual items (Terrenghi & Zimmermann, 2004). A natural link between information objects of different media types allows users to create a cognitive link between inputs. This reinforces the potential of using map literacy skills for installation design by incorporating familiar associations with dynamic content continuously represented always referring back to geographic uniformity.

Evaluating Usability of Novel Installations

An examination of current trends in novel installation design by museum professionals will be needed to highlight the importance of my argument by exposing gaps in the methods employed to study usability issues. Ways in which designers may evaluate using map reading skills will be addressed by examining previous attempts to conceptualize novel installations from usability perspective. Presently, attempts to test

successful interaction with a museum installation have relied upon user participatory methods that make inferences from interviews that test concept retention and movement tracking through a museum space using various sensor technologies to inform researchers of user interest levels (Terrenghi & Zimmermann, 2004; Hornecker & Stifter, 2006; Taxen, Bowers & Back, 2003; Taxen, 2004). The purpose of these studies was to retrieve statistics on usability about novel interfaces, however none address usability design that considers user information processing skills such as map literacy. The usability evaluation implemented in geovizualization studies echoes the framework for appropriate methods to measure goals in each of the topics reviewed in this section. One study on the evaluation of UbiComp environments developed a framework of usability heuristics similar to those established by Nielsen, but sensitive to the nuances of human computer interactions in an immersive environment (Scholtz & Consolvo, 2004). One evaluation area in this study supports the impact of interpretive processes held by users is identified as Conceptual Models, which includes predictability of the system by the user and comprehension of vocabulary used in the system. What can be gleaned from these articles are evaluative techniques to measure the goals museum professionals consider to fulfill successful implementation, for example adapting the conceptual model heuristic of vocabulary comprehension to geographic symbol comprehension.

Goals that describe a successful implementation rely on

consistency between user experiences both individually and as a group. Museum and information professionals alike developed goals to gauge success using the techniques above to record user experiences of novel museum installations like, The Well of Inventions, KidStory, DinoHunter, Bystander, the Mariko Mori exhibition at ARoS, LISTEN, HIPS, medien.welten, and Vasa vittrar (Taxen et. al., 2003; Taxen, 2004; Terrenghi & Zimmermann, 2004; Robertson, Mansfield & Loke 2007; Kortbek & Grønbæk, 2008). Goals developed from user interviews include authenticity, unrestricted access to artifacts for all users, transparency of intent, multimedia with textual supplements, and a consistency in presentation across an exhibit. Other metrics for goals based on monitoring sensor data of user movements include length of interaction and overall traffic with support for analyzing user demographics.

Failure to meet goals when evaluating a novel installation exists in participatory design just as they do in front-end analysis. The studies reviewed did not however assume information processing skill levels of users as a design consideration in either front-end or participatory design (Taxen, 2004). Indeed, participatory design uses feedback from group interviews and workshops between museum professionals and patrons to revise and polish experience design. However, the ability to examine an environment on a textual level, as one is able to examine map symbols, is an example of latent skill that may not be as easily monitored if not

considered. Again, the information important to my research that comes from these sources characterizes testing used to evaluate the goals outlined above that sought to identify success in organization and presentation of map literacy in installation design.

NC Audio Map Design Considerations

The project may best be described as an information installation. Using a set of five hypersonic directional speakers suspended from the ceiling of the space in which the installation is housed, carefully organized audio samples are projected onto their respective locations designated by a floor map. The collection of audio from the state of North Carolina was geographically organized by location to which it either originated or pertains. Organization of the audio sample involved reviewing the entirety of materials with specific geographic information associated with the collection; separating the selected clips into an arrangement of three audio tracks with two tracks having completely separate left and right channels; managing volume, panning, fades, and noise reduction.

Visual Element

The initial envisioning of the installation centered on a floor map of the state i.e., an outline of North Carolina filling a 20' x 40' room; the completed design measured a space 12' x 28' in a much larger room. How the audio would be triggered changed throughout the technical specification process. Originally, similar models of audio triggers like those found in The Sound of Art installation were considered for use, however such triggers were decided against due to cost and the limited amount of interaction available in such a scenario (Kortbek, 2008). These triggers relied on a single user to activate audio clips and would continue playing after a user had stepped away. Such an interaction technique

deprives users of interacting with one another by assigning the task of triggering to one individual. The method of triggering was abandoned; instead a continuous stream of the organized audio was implemented. Questions that arose from this implementation include: does un-triggered, continuous audio allow users to share a sense of camaraderie? Does said camaraderie promote or hinder interaction between users allowing for collaborative knowledge acquisition?

The visual component of the installation was created using white duct tape. First, a grid was layered on top of an image of the state of North Carolina in OmniGraffle. Second, a proportionate grid of masking tape was created on the floor of the space in Swain Hall Studio 1 provided by the UNC Department of Communication Studies. Finally, working within each grid section white duct tape was laid out on the floor corresponding to the grid space of the OmniGraffle image. As stated earlier the visual element did not alter from the original conception.

Once the floor map was completed the directional speakers were fastened to the ceiling grid and positioned 15' over the region or city for which each audio file was intended (see Apendix A). Each hypersonic directional speaker unit is comprised of an MP3 player, amplifier, speaker, as well as adapters and wires (see Appendix C).

Audio Element

As stated earlier the audio selection process was strategically carried out with the intent to develop a collection of materials that

possessed a latent relationship. Each directional speaker feed contained a unifying audio element and a unique one, both representative of the area unto which it was projected. The five directional speakers occupied the three main regions of North Carolina, the mountains, the Piedmont, and the coast. While standing under a directional speaker users experience a clear and crisp sound within a very small diameter so as to present the effect of pinpointing an area approximately 6" x 8" on the floor map below. Aside from geographic contextualization the audio collection was also unified by topic. Digitized audio repositories from which the selections came were The Southern Folk Life Collection, Learn NC, and The American Front Porch Project. Types included wildlife sounds, dialect samples, oral histories, commercial music, and news clips (see Appendix B).

In the five audio 'hot spots' projected onto the floor map an audio sample relating to the topic of segregation was included. A clip describing a native black woman's childhood segregation experience was represented in the western region of the state. In the center of the state an interview clip from Louis Armstrong performing to an all white audience, and an oral history account of yet another North Carolina native black woman's first day in an integrated school. Also in the central region of the state an excerpt from an interview with former Senator Jesse Helms where the Senator defends his position on bussing. Backed with this clip was an oral history report from a Chapel Hill native black man describing

his experience at the still standing, but then segregated Varsity movie theatre. Located in the northern portion of the coastal region a news clip about the potential for re-segregation was included, and to the south, an Ocracoke Island white woman recounted a ghost story about a pair of apparitions. Finally throughout the mountains, Piedmont, and coastal audio hot spots wood frog, tree frog, and bullfrog wildlife recordings were overlaid respectively.

Design Defense

Supported by evidence from the literature review, the design decisions of the NC Audio Map concentrate on making connections between spatial, aural, and visual elements to create a unified experience. By making the visual component minimal users had to rely on their knowledge of North Carolina geography to contextualize the audio being experienced whilst standing within the installation. The exclusion of markings to designate cities on the floor map was made as an attempt to downplay the interpretive strategies that Harley argues are ingrained in map readers at the most basic level of map literacy—identifying a single symbol (1989). To make up for the sparse visual component the design of the NC Audio Map relied on projection precision of the directional speakers to compensate any loss of user attention or adoption. Designing audio hot spots to act as the only clue to separate locations within the map was meant to develop an interpretive contract between users and content as suggested in the UbiComp research by Terrenghi & Zimmermann

(2004). Once a hot spot was located users could detect audio loss if they moved outside of the 6” x 8” area effectively linking content from the audio and geographic contextualization from the floor map. Movement in the installation was left to the will of participants. To interact with the content users moved their entire body in and out of hot spots until the audio became clear or new sounds were detected. The design of the NC Audio Map relied heavily on support from the research conducted by Schiphorst on intuitive movement through an installation (2007). To create an educational experience through novel and immersive interactions the NC Audio Map design contextualized the content for users by combining Harley’s metaphor of map-as-power and Schiphorst’s body-as-interaction-device.

Interpreting the Experience

Using geographic organization to fulfill the objective of facilitating abstract knowledge formulation from the audio information presented was certainly the primary objective of the NC Audio Map installation. However other techniques were used in the usability design process. For example, the relationship between each speaker feed was also carefully curated so that when fired, audio samples would not cause confusion by overlapping. By designing the audio experience to highlight a different region with similar stories and wildlife sounds the intended homogeneous effect was to deconstruct the constraints space and time may have over a given topic, in this instance, segregation.

Also working toward the deconstruction of the content was the interaction technique for the audio. As stated, the hypersonic directional speakers present the materials in a highly immersive way, allowing users to focus solely on the content, and make interpretations informed by contextual metadata, i.e. geographic information. The experience of each hotspot is so directed that all other audio tracks become drowned out, leaving the task of analyzing content to a minimal cognitive exercise of listening. The resulting effect leaves knowledge acquisition from the audio clips largely up to the users. The NC Audio Map promotes interpreting relationships, similarities and differences, between the presented primary source recordings unified by their geographic metadata alone. The experience is an exploratory and repeatable activity that is scalable both in terms of physical iterations as well as what content is presentable.

Evaluation & Observations

The following evaluation methods are intended to analyze usability issues, that is, the ease and efficiency of harnessing a technique to achieve goals put forth by professionals in the field. In this instance professionals define common information installation goals of usability as knowledge retention and satisfaction of experience. The information given to the evaluators of NC Audio Map prior to the experience was that the main objective was exploration and discovery. Furthermore, that the installation is intended to be located in a public setting like a museum, library, gallery, university space, or community center. It was constructed

using directional speakers on loan from the RENCI institute located at UNC Chapel Hill, and a floor map constructed to scale using tape to outline the state of North Carolina. Audio projected came from the UNC Southern Folk Life collection, and other digitized audio from UNC Chapel Hill library's collection of digital audio (Appendix C).

A list of heuristic metrics was provided for evaluators upon beginning the installation experience (Appendix D). The intention behind providing the heuristics was to inform the evaluators of the differences between usability metrics as they have come to be understood. The heuristics list put forth by Nielsen is intended for web design usability, as too is the set from Gerhardt-Powals, which focus on high-level cognitive processing (Nielsen 1994, Gerhardt-Powals, 1996). To evaluate UbiComp environments additional considerations were needed, for example, appeal, interaction, impact, attention, and trust (Scholtz and Consolvo, 2004). The differences between the metrics used for web site and installation usability are owed to the nuances of each medium. Interaction techniques, number of users, size of space, amount of fun, are all new points of usability evaluation to be considered for an installation.

Among the evaluators invited to experience NC Audio Map were experts in HCI, communication studies, art, and computer science. Field experts provided insights through the evaluation process of the system recorded as informal interviews and notes taken during experience. A summary of critiques relating to the heuristics and installation goals was

made after analyzing notes from the 15 evaluators, each of whom spent a self determined amount of time in the installation ranging from 10 to 20 minutes. A set of recommendations was made after analyzing the evaluations and assigning specific comments to categories based on heuristics and usability metrics (Nielsen, 1994; Gerhardt-Powals, 1996; Nielsen, 2003).

Recommendations

Recommendations for future iterations of the audio map concept from the field experts could be categorized into heuristic issues of content and craft, and within these, usability metrics identifying attention, adoption, efficiency, memorability, intelligibility, and appeal. Concerning content, insights from evaluators pointed out that in any presentation of collected materials authorial intent exists as a forced message—whether it is transparently perceived by the user or made latent, there is an objective. The NC Audio Map sought to communicate the relationship of geographic space in relation to the concept of segregation that spanned culture and history. Evaluators noted that experiencing the collected materials through novel interaction with geographic visual cues and content presented from non-diegetic audio successfully allowed users to be immersed in the interpretive processes. Some evaluators commented on confusion levels due to both a lack of task and clutter of wildlife sounds in conjunction with narrative audio content. Possible solutions for both of these issues suggested enhancements to the floor map.

The most consistent suggestions regarding craftsmanship agreed upon physically expanding the project; all users desired the experience to be larger. At the time of presentation the NC Audio Map was 12 feet tall by 28 feet long. Two poignant feedback items that supported the physical expansion of the map were to increase the distance between audio hot spots and also to add more hot spots. Other craft based recommendations for the system were to develop a more elegant visual component. The suggested ways to enhance the visual element were to use different materials in construction, for example vinyl instead of duct tape, or the use of a clean room to increase immersion. Also, the addition of visual clues that might act as affordances to aid the user in understanding tasks, for example markings to delineate the boundaries of hot spots or pictures to represent the people in each recording; in the case wildlife recordings, an image of the animal. The issue at stake with the addition of visual cues center on interpretation in that they guide users toward predetermined knowledge goals as opposed to facilitating discovery. However, user-centered design standards as mentioned in the literature review in the work of Koua & Kraak suggest that implementation of more visuals will aid knowledge acquisition tasks (2004).

This crux, or trade-off, highlights the importance of what I hoped to accomplish with the NC Audio Map installation. It was thought that the affordance provided by the hypersonic directional speakers was not quite enough to concretely represent the connection between audio clips and

the places onto which they were projected. To find a balance between visual enhancements, while maintaining the potential for self-discovery through interpretation, how explicit the visual cue is means all the difference. In an open space public setting, interpretation of abstract concepts would be better served by enhanced visual cues relating to content. However, in a museum setting where exploration is valued over transmission of message, craftsmanship that includes more map features like cities, rivers, and terrain topography may enhance user experience, as opposed to direct representation of concepts from audio clips.

Yet another trade-off between experience and interpretation was the recommendation to use sensors to trigger audio clips. As it was, the NC Audio Map presented audio clips as closed loops—users had no control over the firing of audio, only whether or not they positioned themselves correctly for a crisp auditory experience. The use of sensors in the LISTEN installation mentioned in the environmental scan for like projects found that, if triggered by one user, audio clips were viewed as impersonal by users joining the clip already in progress (Terrenghi & Zimmermann, 2004). Again, a trade-off exists in the balance of adoption of the system, invisibility of technology, and level immersion of the user experience (Scholtz & Consolvo, 2004). In defense of a closed loop system, the NC Audio Map was designed to level the barrier of entry so no one user feels divorced from interaction.

Finally, an unforeseen dilemma related to UbiComp goals was

limited user interaction. It was observed by three HCI professionals that because they were tasked with heuristic evaluation they were not inclined to interact with another. Evaluators did comment on their awareness of one another however chose not to interact out of respect for the task of assessment. All evaluators of the installation saw the potential for multiple users, especially children, to experience a greater sense of immersion in accordance with UbiComp metrics once the installation was refined from its current prototype phase and opened to the public.

Conclusions

Five major concepts of interest in reviewed scholarly articles—information and map literacy, usability, geovisualization, evaluative techniques for museum installations, and UbiComp—were used to help explore and define the topic of map literacy and its place in the design of open space, publicly accessible installations. Using the techniques and theories described in the sources reviewed a working definition of successful installation design that considers map literacy to inform usability engineering was implemented in the construction of the NC Audio Map installation. The purpose of this project was to operationalize the goals of novel interaction designers and museum patrons to respectively assess map literacy and its impact on usability engineering and abstract knowledge acquisition. Further research that arises from the NC Audio Map installation for future testing include whether or not natives to the

locations represented in an installation have processing capabilities different than non-natives. Yet another future direction is to test the effectiveness of web based map environments that aim to educate users through geographic organization. The project, as it was presented to evaluators, was an exercise in the construction of an UbiComp environment that emphasized exploring digital primary source multimedia materials for public use and self-guided interpretation. The findings presented here on UX trade-offs informed by recommendations for enhancements to future systems will be used to delineate educational and artistic objectives.

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Appendix A - Installation Design

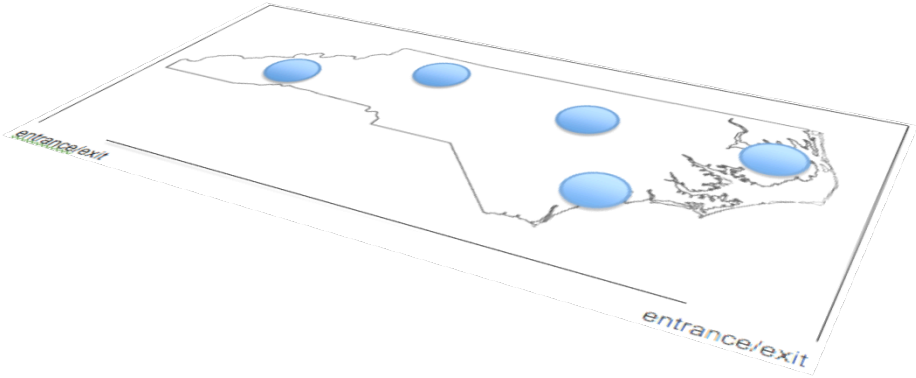
Map Dimensions: height: 12’ x width 28’


resents areas within directional speaker zones

Birds eye view of Installation floor plan.

entrance/exit entrance/exit

3D view of floor with corresponding directional speaker projection (from ceiling)



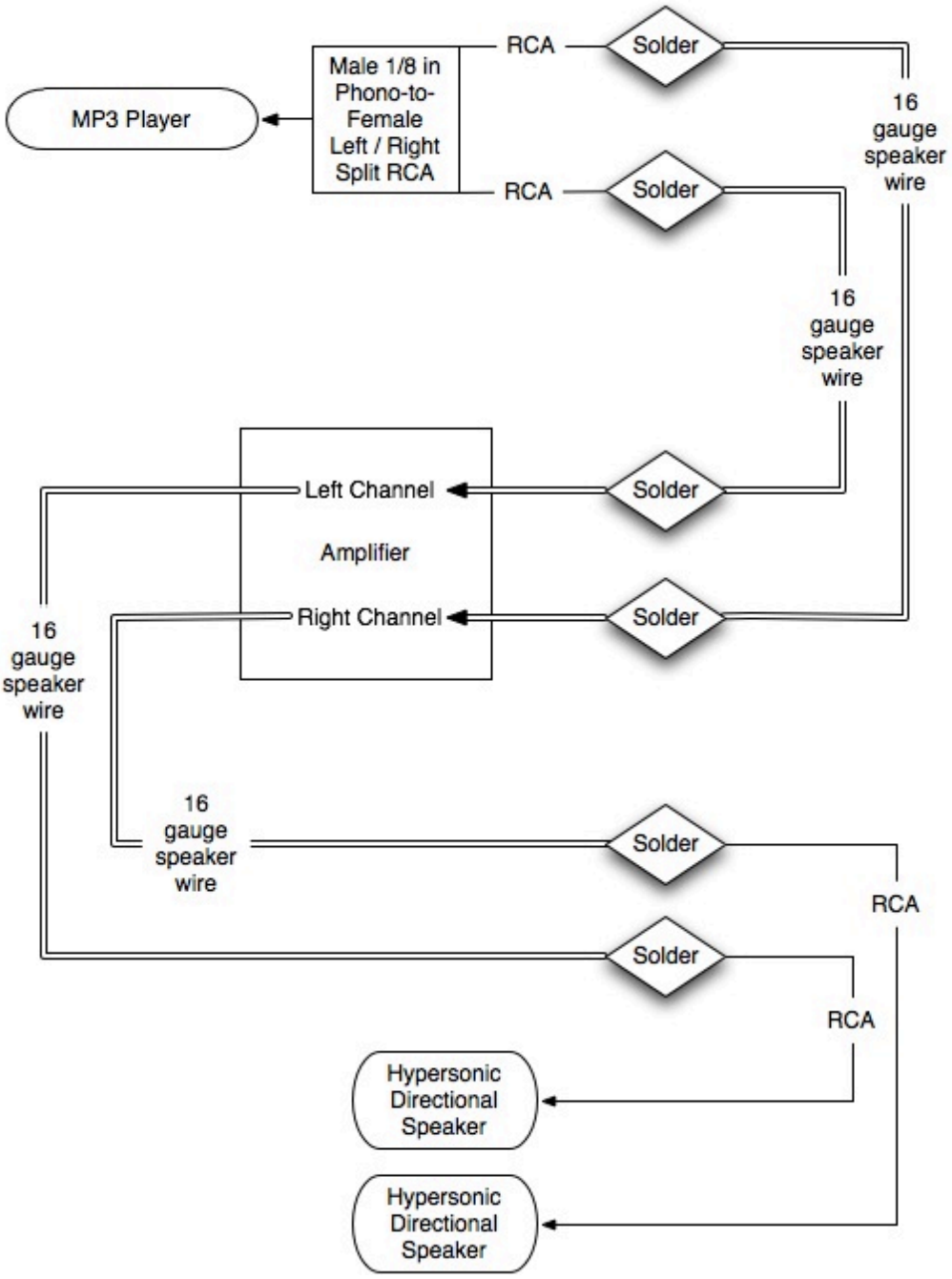
Appendix B – Audio

Music, Dialect Samples: The American Front Porch Project
http://ils.unc.edu/afporch/

Oral Histories: Southern Folk Life Collection
http://www.lib.unc.edu/mss/sfc1/

Wildlife, Oral Histories: Learn NC learnnc.org

Appendix C – Speaker Schematic



Appendix D - Evaluation Heuristics

Nielsen

- Provide a mental model that capitalizes on pre-established mental models
- Floor map and audio as a natural dialog
- Speak the user's language
- Consistency
- Provide an intuitive visual layout
- Make items distinct from one another
- Make functionality obvious and accessible
- Provide good help
- Provide for multiple skill and use levels
- Put the user in control of the task and interface
- Minimize memory load and mental processing
- Design for user error
- Protect the user from details of the implementation

Appendix D cont. - Evaluation Heuristics

Gerhardt-Powals

- Fuse data; reduce cognitive load by bringing together lower level data into a higher-level summation.
- Present new information with meaningful aids to interpretation:
- Use a familiar framework, making it easier to absorb.
- Use everyday terms, metaphors, etc.
- Use names that are conceptually related to function.
- Context-dependent.
- Attempt to improve recall and recognition.
- Group data in consistently meaningful ways to decrease search time.
- Limit data-driven tasks:
- Reduce the time spent assimilating raw data.
- Make appropriate use of color and graphics.
- Include in the [position] only that information needed by the user at a given time.
- Provide multiple coding of data when appropriate.
- Practice judicious redundancy

Appendix D cont. - Evaluation Heuristics

NIST (UbiComp)

- Number of events not noticed by a user in an acceptable time
- Number of times a user needs to change focus due to technology
- % time user spends switching foci
- Continuity for user
- Amount of information user has to divulge to obtain value from application
- Availability of explanations to user about use of recorded data
- Ease of coordination with others in multi-user application
- Number of collisions with activities of others
- Degree of match between user's model and the syntax of multimodal interactions
- Percentage of task completion
- Time to complete a task
- User rating of performing the task
- Time taken from the primary task Degradation of performance in primary task Level of user frustration
- Effectiveness comparisons on different sets of input/output devices
- Number of conflicts Percentage of conflicts resolved by the application User feelings about conflicts and how they are resolved User ability to recover from conflicts