Seeing the Invisible

A search for the hidden language of wireless infrastructure

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Introduction & Background

Wireless networking has grown quickly since its consumer introduction in 1999. Manufacturer advances in hardware and software, as well as decreasing broadband prices, have followed pace with business and consumer adoption to create cheaper and more abundant access points. While first seen only in niche locations and applications like technology-firms or universities, hotspots have become relatively commonplace, though not ubiquitous. Today's mobile technology consumer is able to purchase inexpensive equipment and choose amongst a number of neighborhood network locations, beyond his or her home, to wirelessly connect to the internet.

While the average computer user has been relatively successful in discovering and utilizing wireless networks, there lies a discrepancy in that such an invisible infrastructure is not immediately apparent to the human senses. When searching out an object or service in the physical world, people rely on a familiar visual system of symbols, signs, and artifacts. Online resources such as hotspot maps provide another source of information, as do conversations with people and the use of various detection devices. Perhaps the most straightforward method of discovery is utilizing past knowledge of a familiar location.







The rapid development and deployment of wireless networks has created a broad range of these symbols and methods for people to utilize when searching out a network. Two-dimensional graphics and icons are used in signage to inform people of available networks. The arrangement of furniture and architectural space may be more or less attractive to mobile computer users looking to browse the internet. The forms of hardware networking products, wires, antennae and other visible infrastructure may also cue users to the existence of a hotspot. A set of values has been attributed to the use and implementation of these and numerous other factors to create the beginnings of a language of wifi.

A similar language is already apparent in other infrastructure. To make use of electricity, people look for an outlet. The shape, size, geometric holes, and standard placement on a wall near the ground together form the cues needed to discover and make use of the service. The same is true for other forms of infrastructure at the point in which end-users interact. Telephone wall-jacks, water spigots, and television antennae all afford and communicate their associated infrastructure in a visible, symbolic manner. Without these points of interaction, end-users would have a much more difficult time consistently finding and using these services.



In addition to individuals and their discovery of these networks, business owners look to create environments that are conducive to or suggestive of a wireless hotspot. Wifi availability at a business is typically not the primary attraction or means of revenue for a business owner. Situations and wireless implementations may vary when taking into account the primary service or space. The business of a café relates to a customer through coffee and other edibles, while an airport or train station focus on transportation services. This creates a separate set of requirements and goals from the end-users of wifi, although the successful implementation of a hotspot using a common symbolic language benefits both parties.

As the infrastructure of wifi continues to mature, both end-users and suppliers will form a system of values and uses that go beyond bandwidth or range. Studies of wifi availability have found that the factors determining hotspot placement and capabilities are complex and not immediately apparent (Grubesic and Murray 2004). In addition to technical factors, a wide range of social and behavioral issues may determine how people make sense of these emerging networks. The variety of implementations could be specific to the associated business services and clientele whose needs and preferences will be diverse and unique. Considering these issues, this study looks into how people match their uses of wifi to an underlying value system in searching for, selecting, and utilizing a wireless network. When and if this language of wifi use and value is understood, is there a method in which this knowledge can be used to assist in the design of wireless network hotspots?

Foundations of Methodology

Given the complexity of this system of uses and values, the researchers will draw upon a number of previous research traditions in the design of this study.

Card sorting has traditionally been used by HCI researchers to increase the usability of a system by creating more natural groupings of functionality. Participants are asked to review the terms listed on a number of cards, group them in a manner that makes sense, then explain the reason for their grouping to the researcher. The data is then entered into a spreadsheet, and over the

course of many evaluations, a consistent pattern emerges in the groupings. Cluster analysis can be used to give a visualization of the results (Gaffney 2000).

Numerous theoretical resources from studies of the human relationship to infrastructure will also be drawn upon. Susan Star describes the research technique of isolating a "master narrative", which corresponds to the paradigmatic assumptions that underlie people's interactions with certain kinds of infrastructure (1999). Star posits that one might comb through source data to identify particular literary devices that reveal these assumptions, including such rhetorical techniques as personification, passive voice and the alteration of modalities in language.

Stewart Brand (1994) suggests that the physical environment can be separated into several layers of infrastructure, which change at different rates and have a tendency to shape each other in particular ways. This suggests an potential direction of inquiry: what do wifi users think about the environments in which wireless hotspots are found, and how do they believe a hotspot venue shapes the creation and use of wifi in that location? Furthermore, how might other kinds of infrastructure, such as the placement of power outlets or the configuration of seating, be associated with wifi in a user's mind?

Christopher Alexander (1977) believed that through vibrant buildings and towns, one could observe a "pattern language" – an interwoven set of coherent designs that reflected particular human needs and activities. This suggests an appropriate structuring for results as separate design elements may be coalesced into such patterns during the study's analysis.

In his studies of homeowner theories about the workings of their thermostats, Kempton (1986) found that people often developed "folk theories" regarding the operation of technology. These theories are based on metaphors that relate these invisible systems to others which may be better understood by the user. There may be value in investigating what metaphors people use for the operation of wifi hotspots, and to understand how those metaphors guide them.

The field of learning sciences and the work of Sasha Barab and Kurt Squire (2004) assists this study through the formulation of design-based research. While some theories may help guide this study, Barab and Squire emphasize that design-based research steps beyond testing theories and into the messiness of real-world practice. Through capturing complex social interaction in context, new theories may be generated using design to create broad models of how humans think. An ideal result will be flexibly adaptive theories that remain useful even when applied to new contexts with changing situational variables.

Overall, the study will ground its methods in an epistemology which values an analysis that emerges from the data, as opposed to an attempt to frame results in a way that can confirm or disprove a particular theoretical construct. The researchers would strive to ensure that the only assumptions brought to their procedure would be the foci of data collection (human beliefs, values, and uses for wireless hotspots), and the belief that hotspots are valued for more than simply wifi. This is an orientation that is common in both design-based research and certain methods in the social sciences, such as ethnomethodology (Garfinkel 1984) and grounded theory (Glaser and Strauss 1967). However, assumptions will be characterized more by the topics of study rather than by the forms they take in the lives of participants, therefore, the methodology will necessarily have more in common with design-based research than social methods. It would

be best to describe this orientation as being *phenomenological* in bent; that is, the procedure will revolve around the building of a bottom-up structure based on observations of phenomena, rather than attempting to adapt an existing theory to those phenomena.

Methodology

This study will start with a semi-structured, participatory interview, performed in two phases. The participants chosen must make regular use of wifi, with preference toward those that are somewhat technically savvy, use mobile computing devices, travel frequently, recently moved to a new area, or operates a business that provides wifi. Each of these optional characteristics aides in a participant's experience and insight into either searching for, selecting, or making use of a wifi hotspot. In the first round, the goal will be to select 12 participants from a variety of age groups and professions.

The first phase of the participatory interview is a free association of wifi symbols, places, concepts, artifacts, and values. The goal of this phase is to discover a list of data that will frame the working research area. The interview will begin in a very open context, letting the participant steer the discussion toward wifi related topics that are at the forefront of thought. This will allow initial information to be retrieved with as little bias as possible before slowly moving into open-ended questions or scenarios to further disclosure. To discover information related to the discovery of wifi, such questions would include, "Recall a situation when you badly needed to find a wifi hotspot," or, "Draw a sign that a store owner might use to advertise their wifi." In doing so, participants are guided towards insights regarding the physical environments of wifi hotspots. To probe into the selection of a particular hotspot, scenarios pertaining to making choices between found networks or different physical environments will be introduced, and the subject asked to comment upon them. Finally, understanding the use of these hotspots will require asking questions related to task context, such as, "While using wifi, describe what you see looking up from your laptop," and "If wifi were available in your local park, what applications would you use make us of?"

Having generated a set of loosely categorized values, situations, preferences, and narratives from the first phase, the second phase will help further associate uses and values through a participatory analysis. Working with the participants interactively will provide a deeper understanding of the values they place on wifi environments, and how they associate them in different situations. The free-association terms will be individually written onto Post-It notes with nouns, such as (for a neutral example) "backpack", "classroom", and "bartender" on one color and adjectives, such as "comfortable", "curvy", and "distracting" on another color. The Post-Its will then be placed on a surface in ways that help to reveal how places, symbols, and artifacts relate to values, behaviors, and attitudes. After each participant sorts the Post-Its, a photo will be taken of the arrangement for documentation. Through the compilation of all participant's arrangements, association trends between nouns and adjectives will begin to emerge in a quantifiable manner.

Upon completing the participatory study, the results will be compared against well understood and codified design principles. Sources for these principles will include canonical texts such as Lidwell et al's *Universal Principles of Design* (2003) and experts from design-related fields. Certain situations of wifi usage are expected to be more directly related to certain design

principles while others may require more research and the consultation of various design professionals. We may further draw upon business owners and and other non-user stakeholders, through the use of focus groups and individual consultation, in order to further contextualize these results. Once understood and organized, the resulting groups should act as a guiding tool in the selection and priority of design criteria according to the desired outcomes, business requirements, and usage patterns.

To test the validity of this design matrix, a series of photos and written scenarios will be created in collaboration with design experts. Participants will review the photos and scenarios to give their opinion on how well each case relates to certain aspects of wifi and its representation within the design matrix. Particular questions and focused objectives are difficult to determine in advance and this removed from the originating data. An example could be, if the color red is found to be associated with unreliable wifi networks, than a participant could be asked to arrange a group of wifi-related logos from their least to most favorite. If lower-rated logos contain more red, than that facet of the design matrix would be considered more valid. Depending on feedback, this and earlier areas of the methodology will be iterated to focus and validate findings.

Contributions

The most direct contribution of this study will be made to the designers associated with the planning, design, and creation of wifi enabled spaces. Architects, graphic, interior, industrial, and interaction designers, will have a reference guide with which to better support wifi users, providers, and businesses considering adding a wireless network. Measurable features beyond the traditional bandwidth and network range can be understood as factors of success and acceptance in wifi deployments. These networks can be created in a manner that fit into part of a richer social and environmental tableau.

The end-users will be assisted through both an increased awareness of network availability and the selection and use of environments that more closely match their patterns of usage. These environments will also be better suited to the business owners who design, construct, and operate them. When retrofitted into an existing business, decisions can be made that keep the core-competency of the company as the primary attraction of customers. This will increase not only the revenues of the business, but the quality of service end-users receive.

The method in which this information is collected and organized could itself become a substantial contribution to design research. This would be achieved through finding the patterns and behaviors that people move through in their daily lives and bridging those with established theories that can be used to support them. By creating a reusable system of working through open-ended design questions, other theories may evolve as to how people give meaning to the spaces, forms, and symbols that define an environment. The result discussed in this proposal pertains significantly to wifi and may not be directly transposed into other types of infrastructure. Even the results of this study could become less relevant as wifi hotspots mature and people adopt new associations and values. However, it is likely that other types of invisible infrastructure and implementations into other situations could benefit from this method of inquiry.

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