

# Evaluation of Electronic Guidebook Mobile Web Resources

## Executive Summary

The Electronic Guidebook research project began in 1998 at The Exploratorium, an interactive science museum in San Francisco, in partnership with researchers at Hewlett-Packard Labs and The Concord Consortium. The original metaphor for the Electronic Guidebook was a pocket guidebook for travelers to which personal annotations could be added. This metaphor has since expanded into a guidebook designed not only to enhance a user's visit, but also to serve as a "mobile learning partner" supporting sustained ubiquitous inquiry and investigation in a seamless museum experience before, during, and after the visit.<sup>1</sup> To realize this vision, a test-bed and wireless infrastructure was created at the Exploratorium to conduct research about 1) information technology infrastructure (networked components delivering the information), 2) human computer interaction issues around form factors, content design, and handheld uses, and 3) the potential impact of wireless infrastructure and mobile web resources on teaching and learning science.

This project has tested and deployed a variety of new media and communication technologies including wireless networking, infrared beacons, radio frequency tags, remote triggered digital cameras, and personalized web services. Early phases of the project tested different form factors of mobile devices and deployed a wireless network using a variety of handheld computers and radio-frequency identification (RFID) tags to link visitors with exhibit-related content delivered by a Web-based server. To enable the handheld to be context-aware, a point-of-information station or 'pi-station' was designed to hold a digital camera, an RFID transmitter/receiver, and an HP Cooltown infrared beacon which sends the URL to a handheld that is in close proximity to an exhibit. The web page corresponding to this URL is then automatically downloaded from the content

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<sup>1</sup> Because visitors spend about 30 seconds per exhibit in museums, a key notion was to support sustained inquiry in a "seamless visit" to the Exploratorium in which visitors could explore an idea before coming to the museum, experience a phenomena and/or test out ideas while at the museum, and continue a personal investigation after leaving the museum setting.

server and displayed by the PDA's browser. This work demonstrated the feasibility of delivering text, images, digital audio and video over a wireless infrastructure to a handheld. In addition, users were able to record their visit by bookmarking exhibit content, taking digital pictures from a camera near the exhibit, and accessing this information later on a personal "MyExploratorium" Web page in the museum or following their visit.

Two parallel studies were conducted in the Spring of 2002 in the context of the Electronic Guidebook Project. The first study asked how users responded to a mobile web resource designed to improve and transform user experiences in a hands-on museum. In this study, users were given a handheld with exhibit-related content that was delivered over a network in the museum. The second study investigated how users used mobile wireless technologies to support recording and remembering user's museum experiences. Here, the user roamed the museum, bookmarked exhibit labels and took personalized photographs, interacting with the exhibits on the floor, and later viewed these on the Web at a MyExploratorium page.

Teachers, AM explainers<sup>2</sup>, PM explainers<sup>3</sup>, member visitors, and staff tested the Electronic Guidebook and were then interviewed about their experiences. Several recurring issues and (often conflicting) themes emerged from our analyses of observations and interviews. In evaluating the Electronic Guidebook in the first study, we found that:

- The handheld resources successfully prompted users to think about and interact with exhibits in new ways.
- Users felt a sense of isolation —A majority of users expressed a concern that the handheld interfered with exhibit play.
- Users did not have a strong preference for any single type of content, but did mention explanations, how-to videos (e.g. "Try this", "Possible patterns"), and exhibit evolution as some of their favorites.

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<sup>2</sup> AM Explainer – These are members of the Explainer program who work at the Exploratorium in the morning. AM Explainers are typically high school graduates and/or first or second year college students.

<sup>3</sup> PM Explainer – These are members of the Explainer program who are typically high school volunteers who work at the Exploratorium in the afternoon.

- Users did not indicate a strong preference for any single type of media (i.e. text, audio, video), but liked different media for different purposes and media used in combination.
- Younger audiences were drawn to the digital video examples of how to play with exhibits.
- Users attempted to link real-place and virtual information, switching between the two contexts, and some were able to switch smoothly between the two.
- When objects displayed in the mobile web resource such as a picture of a stop watch or sand-shaping tool was not available in the real space, it was more difficult for users to move between virtual and real place contexts.
- Teachers felt the mobile web content would be more useful as learning activities before and after museum visits, rather than during.
- The weight of the HP Jornada 690/720 was considered too heavy for many users to carry around.
- The wireless network performed well on the first floor, but was intermittently available on the mezzanine level.

When the Guidebook was used as a remembering tool in the second study with HP, we found:

- There was a strong perceived value for record keeping, and in particular for those personalized photo records that allowed the capture “unique scientific phenomena.”
- The handheld tended to interfere with hands-on activities at the exhibit.
- Users liked the images, but did not like the blurred or low-resolution display.
- Users expressed the need to have more control in the positioning and timing of the camera operation.
- Users did not show any difficulty swiping their device at the mounted radio frequency identification (RFID) to bookmark an exhibit.
- A majority of visitors (10/17 visitors) did revisit their pages on the web after their visit.

Based on these studies of a broad range of prototypical users, there are some refinements on the current study, the handheld design, and open questions that merit further investigation in the following areas:

### 1) Networking Technologies

- Because of the unreliability of the network access in some areas of the museum (e.g., on the second floor), a better configuration of access and antennas in the museum space should be investigated.
- If Electronic Guidebook users continue to have MyExploratorium pages, a system design and web server architecture will need to be designed to support online public and private spaces.

### 2) Content-Information Design for Handhelds

- Because some users (typically older people) had difficulty navigating the interface, future studies should include more user training as well as standard usability testing as part of the early evaluation.
  - More empirical evidence from users is needed to understand if handheld content should give direct answers to content questions or simply raise curiosity.
  - While using the Electronic Guidebook, some visitors reacted more favorably to certain exhibits which could be operated with one hand (like the Spinning Blackboard) than to others. A larger variety of exhibits should be investigated to see if there are special exhibit characteristics that can benefit from the use of an online PDA.
  - Teachers facilitated interactions with children and other visitors during the study. Further investigations are needed to better understand the effectiveness of the Electronic Guidebook as a teaching tool rather than simply an informing tool.
  - When the device was switched from an HP 690 to 720 model, additional design time was needed to reformat many of the content pages to fit the different screen size. New content design or computational infrastructure / database solutions should be developed to avoid these kinds of modifications.

### 3) Research Methodology

- Specific resources designed for a targeted audience with an authentic task are needed. (E.g., teachers who are tasked with designing a curricular unit using Exploratorium exhibits.)

- We should study user pairs and groups as well as individual users in order to explore learning conversations (e.g. between teacher-learner, expert-novice explainer, learner-learner.)
- We should introduce digital video, not just audio, to help capture gestures, attention switching between the exhibit and handheld, conversations with others, and other behaviors.
  - We should include a variety of methods to formulate user requirements and new concepts for future redesigns of the Egbook such as scenario-based design or participatory design practices (from the field of Computer-Human Interaction) that involve getting early input from target audiences.
- We should define tasks that users are likely to engage in and design content for those purposes.

In summary, these two studies have uncovered clear potential for a portable Electronic Guidebook. This research points to the need for further empirical learning technology research and development in the following areas:

- What is the role of the Electronic Guidebook when used as an interactive guide for ubiquitous learning and teaching with portable activities before, during, and after museum visits? What are the cognitive and instructional impacts of these activities?
- How do we support rapid customization of content that can be easily adapted to particular audiences? What technology solutions can be leveraged to support the design of flexibly adaptive content? (e.g., 're-usable learning objects' that modularize electronic information that can be reused, searched, and modified independent of their delivery media and accessed dynamically via a database.)
- What is the role of 'intentional remembering' in a social context of a museum? Is it better to support user-activated records (e.g. photo, bookmark, sound, note-taking) or support automatically-triggered records for delayed retrieval (to not interfere with exhibit play)?
- How do we situated online mobile content and drawn upon interaction design to promote new ways to play, learn, and teach with a tool like the Electronic Guidebook, yet also address and resolve issues of user isolation?

- Which instructional design frameworks and/or design principles can be derived from our research which can be leveraged by other museums and wireless content providers to create mobile resources for learning?