Improving Electronic Guidebook Interfaces Using a Task-Oriented Design Approach

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ABSTRACT

Item selection is a key problem in electronic guidebook design. Many systems do not apply so-called "context-awareness" technologies to infer user interest, placing the entire burden of selection on the user. Conversely, to make selection easier, many systems automatically eliminate information that they infer is not of interest to the user. However, such systems often eliminate too much information, preventing the user from finding what they want.

To realize the full potential of electronic guidebooks, designers must strike the right balance between automatic context-based inference and manual selection. In this paper, we introduce a task-oriented model of item selection for electronic guidebooks to help designers explore this continuum. We argue that item selection contains three sub-tasks and that these sub-tasks should be considered explicitly in system design. We apply our model to existing systems, demonstrating pitfalls of combining sub-tasks, and discuss how our model has improved the design of our own guidebook prototype.

Keywords

Electronic guidebooks, museum tour guides

1. INTRODUCTION

In many situations, people want information about objects in their physical environment. People in museums often want to learn more about works of art. People in airplanes or on a hike see natural features, such as mountains and lakes, and want to learn more about them. As people walk down a street, they may want information about a store or restaurant that is across the street, e.g., the store's hours or the restaurant's menu.

Visitors typically obtain such information from paper guidebooks. However, paper guidebooks have several disadvantages, e.g., they tend to limit the visitor to a relatively linear experience. We focus here on two key disadvantages of traditional printed materials. First, due to physical size limitations, guidebooks have room for only a subset of the information of potential interest: guidebooks can not feasibly contain all information about all objects. Judicious selection of content can not entirely alleviate this problem, because different users have different information needs. Second, finding objects of interest in guidebooks is often difficult. People often have trouble looking up information about a specific object, exhibit or landmark, e.g., because they do not know the proper name of the item of interest. Even if they do know the correct term, the process can be tedious, potentially requiring multiple page references to index pages, etc., to locate the desired text. In other words, printed guidebooks do not support lightweight, random access to specific information.

The advent of cheap, portable computing devices has made electronic guidebooks possible. If well-designed, electronic guidebooks have the potential to alleviate many of the problems with traditional guidebooks. The space limitations of printed guidebooks nearly disappear for electronic guidebooks; a personal digital assistant (PDA) or a display-enhanced cellular phone can put a huge volume of information at the disposal of the user.

The impact of the electronic guidebook on lightweight access is more complex. On the negative side, the increased information volume provided by electronic guidebooks means that the user must negotiate an even larger space to reach the specific information in which they are interested. Further, we expect that electronic guidebooks will need to be inexpensive and/or highly portable, and will therefore (continue to) have limited channels (e.g., displays) for offering selections to users. On the positive side, electronic guidebooks can incorporate technologies to improve the user's ability to get information about particular items easily and directly, e.g., by providing search tools or by drawing inferences about the user's interests.

Because of these trade-offs, the actual value of a given electronic guidebook depends heavily on the design of its selection mechanism. A poor design can make it prohibitively difficult for the user to select objects (often even more difficult than it would have been in a printed guidebook). A good design can provide the user lightweight access to information, offering a significant improvement over a traditional guidebook.

One of the most important ways to provide lightweight access to information is to present fewer objects to the user. Systems can use a number of technologies to prune the information space, inferring user interest from context. For example, some location-based systems always give the user information about the object nearest to them. The danger is that if the space is pruned too aggressively, the user will be unable to get the information they want. In the example of a location-based system, if the user wants information about an object that they can not approach closely (e.g., because crowds block access to it, or because it is a stained-glass window that is out of reach), they will not be able to get the information. Our goal is to help the designer create a system that uses context-awareness [9] to eliminate as much information as possible without preventing the user from getting the information they want.

To date, commercial and research investigations in the area of electronic guidebooks have tended to focus on the use of a technology rather than on the user's task. Our thesis is that the selection mechanisms of electronic guidebooks can be improved by using a simple task-oriented model of item selection. We have identified three key sub-tasks by which users indicate interest in an object: location, intimation, and selection. By identifying these sub-tasks and exposing them to designers, the model can help prevent several important classes of user interface design flaws.

The ideas presented here should be useful to designers of electronic guidebooks and other context-based information systems (e.g., display-augmented cellular phones). To the greatest degree possible, we abstract the technologies used and the nature of the content presented.

In the next section of this paper, we describe our interviews with curators and other cultural heritage professionals, and discuss our observations of visitors to museums and historic houses. We then describe our task-oriented model. We characterize many electronic guidebooks according to the model and then discuss the implications for these systems. We next describe how this model has improved the design of our own electronic guidebook prototype. We then discuss related work and alternative approaches, and present conclusions and future work.

2. ATTINGHAM

In this section, we provide some background information that has informed our design work. Specifically, we discuss three lessons obtained from a series of interviews with conservation professionals.

Our research has a particular focus on guidebooks for historic houses and museums. In general, historic properties are buildings that represent a particular time period or periods. They generally have contents (e.g., furniture, interior decoration such as curtains or carpeting, and artwork) that are presented in a historically correct manner.

We wanted to observe visitors to such sites, as well as to benefit from the knowledge of the curators and other professionals who are responsible for the *presentation* of such sites. Presentation is the interface between the visitor and the location, encompassing issues such as the information given to the visitor, the method of delivering that information (guidebook, docent, etc.), and the arrangement of objects in a room.

To study presentation methods, one of the authors of this paper attended the 49^{th} Attingham Summer School during the summer of 1999. The Attingham Summer School is a well-established 3-week study course; participants are generally cultural heritage professionals such as museum curators, architectural historians, and conservators [1]. Participants visit approximately 3 dozen historic houses throughout Great Britain. Tours are generally given by the curator or owner of the property and include extensive discussion of presentation issues. Some tours are private, while others offer the opportunity to observe the general public. The program also includes a number of lectures and panel discussions.

In 1999, the program included several dozen participants. Participants came from a variety of institutions in Europe, North America, and Australia, e.g., the Louvre, Versailles, the Victoria and Albert Museum, and the Frick Collection. The program afforded ample opportunity for lengthy informal interviews with nearly all of these individuals.

During the program, the author learned a number of lessons. Here we highlight three of the points that are most relevant to this paper:

Lesson 1: It is a top priority for the visitor to experience "the romance of the place."

This sentiment was captured in a presentation by Martin Drury. Mr. Drury is the Director General of the National Trust, a non-profit organization that maintains many of the historic houses in Britain. At a presentation to the Attingham group, Mr. Drury stated that the highest presentation goals of the National Trust are to:

(1) Preserve the spirit of the house;

(2) Present an environment pleasant to the visitor's sense and mind, e.g., be visually appealing and leave intact indicators of history; and

(3) Intrude as little as possible between the house and the visitor.

In fact, the desire to allow the visitor to "get the sense of the place" is so important that many presentation experts, particularly from Europe, prioritized this goal over education. In general, they were concerned about anything that might make the visitor less immediately connected to the house and its contents. For example, they were concerned about "cluttering" rooms with large printed informational posters because they felt these would detract from the visitor's experience.

We conclude that in historic house presentation, as well as in other cultural presentation arenas, a major goal is to intrude as little as possible. Education is also a goal, but is often a lower priority than the visitor's experience. This implies that whatever technologies are used should be both physically non-intrusive and lightweight (consuming as little of the user's attention as possible).

Lesson 2: Visual identification is a highly effective way to help visitors identify objects of interest.

The author carefully examined the many methods used for presenting information. Purely textual descriptions in guidebooks were not sufficient; even curators sometimes had difficulty identifying which painting on a wall was described by a given piece of text in a guidebook. Labels were more successful for certain collections, such as major paintings, but were intrusive and were not feasible in historic interiors with a large number of irregularly-shaped objects, many of which are fairly distant from the visitor, e.g., chandeliers. A photograph accompanying the text description seemed to be the most reliable way to help the visitor associate text with a given object. However, this technique was rarely used, presumably because of the expense and because a printed guidebook with a picture of every object would be quite large.

Table 1. A characterization of electronic guidebook systems.

# of Lvls.	*System Name*	Reference (or Date)	Hardware Platform	Technology Used to Support… Location	Intimation	Selection
1	AcoustiGuide™	(*ca*. 1995)	audio player			keypad
	VisibleI iGo™	(*ca*. 1996)	tablet PDA	***portable browsers***		touchscreen
	Intel tablet PC	ICHIM '99	tablet PC			pen
	Audio AR	CHI '95 [2]	audio player	infrared		
	ABTA	(*ca*. 1996)	tablet PDA	infrared		
	HyperAudio	CHI '99 [7]	tablet PDA	infrared		***portable labels***
	Ansae Gnole™	(2000)	tablet PDA	RFID or infrared		
	HIPS (Siena)	ICMCS '99 [3]	tablet PC	microcell RF + infrared		
2	CyberGuide	CHI '96 [5]	tablet PDA	GPS or infrared		pen
	GUIDE	HCIMD '98 [8]	tablet PC	microcell RF		pen
	HIPS (GMD)	HCII '99 [6]	handheld PC	infrared		AccuPoint™
3	Touring Machine	ISWC '97 [4]	wearable PC + tablet PDA	GPS	vision + compass	touchpad

Lesson 3: Spatial location is a poor indicator of visitors' interest in objects.

The author observed many situations in which spatial proximity was an extremely poor indicator of the visitor's interest in an object. Because the contents of historic houses are fragile, the visitor is generally expected to walk through the house on established paths that avoid items such as expensive carpets. Further, unlike in traditional museum settings, objects of interest may be anywhere in the room. For example, in some situations members of the group lay down on the floor so they could study plasterwork on the ceiling.

3. Model

We applied the lessons learned from our interviews and personal observations to a simple model of user interaction with electronic guidebooks. We describe the model, which deals solely with the item selection problem, in this section. The section is organized as follows. First, we state our assumptions. We then identify two dominant paradigms that have emerged for electronic guidebooks and discuss their shortcomings. We next describe a task-oriented model: we identify sub-tasks in selection, and we argue that systems that are structured to support these naturally-occurring sub-tasks better meet users' needs. Finally, we discuss the utility of the model for designers.

3.1 Assumptions

We make the following assumptions about the technological and social environment. First, we assume that the user's goal is to get detailed information for some object. This information is provided through an audiovisual *information channel*: a video clip about the making of an object, a text description of a painting, etc. Second, we assume that any choices presented to the user are provided through an audiovisual *control channel* that is limited compared to the amount of information that the system might provide. We assume a single channel for each of information and control; we are working on the tradeoffs involved in choosing between channels or combining them (e.g., presenting distinct text and audio information).

As mentioned above, we have attempted to make our discussion largely independent of (1) the technologies used (e.g., for presentation, computation, communication, and context-determination) and (2) the nature of the content presented (we do not consider whether the content is static/dynamic, generic/personalized, etc.).

3.2 Portable Browsers and Portable Labels

Several electronic guidebook systems have already been designed and deployed. Here, we briefly critique the two main paradigms for item selection used by past and current systems. This will help illustrate the usefulness of the task-oriented model described in this section.

Nearly all electronic guidebooks have been conceived for use indoors and in specific contexts. Several examples of such systems are listed in Table 1. Many fall into the category of *portable browsers,* i.e., systems that permit the visitor to browse information while visiting an exhibit. As an example, Visible Interactive's iGo™ was a commercial system that was briefly used in museums in North America. The iGo displayed menu entries on the touchscreen display of an Apple MessagePad™ PDA; the visitor manually navigated the menus, causing the iGo to display the desired image and audio information. Most of the remaining systems can described as *portable labels* that infer interest in a given display when on-board sensors detect that the visitor is

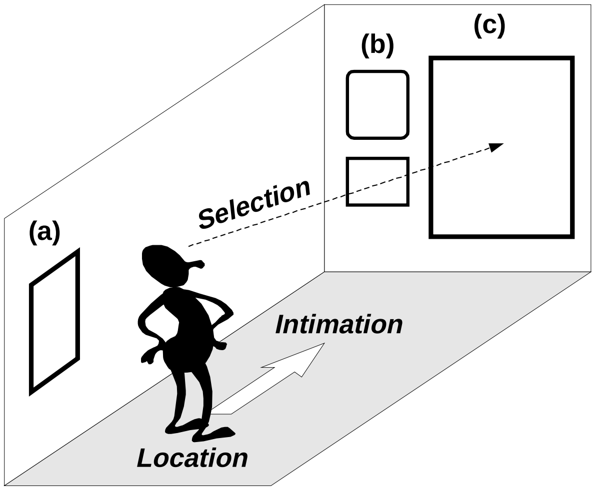

Figure 1. Three sub-tasks: an example.

Table 2. Technologies for determining positional and directional context.

Name	Description	Pos.	Dir.
DGPS	differential Global Positioning System (satellite); outdoor only	×	
IR	infrared beacons or networks (e.g., IrDA)	×	×
magnetic	magnetic flux sensor ("electronic compass")		×
μcell RF	microcellular wireless networks (based on, e.g., IEEE 802.11)	×	
RFID	radio frequency identification	×	
tracking	computer vision		×

physically near that display. With portable labels, the user receives information about the object to which they are physically closest. For example, in the "Audio Augmented Reality" research prototype [2], when the user approached a statue, audio information about that statue was played into their headset.

Portable browsers and portable labels are endpoints in a continuum of manual (nonrestrictive but heavyweight) and automatic (restrictive but lightweight) selection mechanisms. These extremes have respective advantages and disadvantages that motivate our model.

Portable browsers do not restrict the information space, so users can get information about all objects. However, portable browsers place the entire burden of selection on the visitor. This can be quite tedious, particularly with the limited user interfaces afforded by most portable computing devices.

Portable labels make search more lightweight, by automatically inferring which items are of interest to the user. However, portable labels have several limitations (none of which have been discussed in the literature, to our knowledge). These limitations are rooted in the fact that, as we observed at Attingham, the user's proximity to an object is an inadequate indicator of their interest. First, visitors may not be *permitted* to approach items of interest. In most historic properties operated by the National Trust, for example, visitors are constrained to roped-off paths for both conservation and security reasons [Sarah Woodcock, personal communication]. Second, visitors may be *unable* to approach items such as ceiling frescoes or wall decorations. Third, visitors may *prefer* viewing distances for some items (e.g., large paintings, as in Figure 1) that are incompatible with proximity-based inference.

3.3 A Task-Oriented Model

Our model is intended to help avoid problems such as those just described. The model aims to help the designer identify the amount of automatic context-based inference that can be perfomed without over-restricting the user's choice of information. It is based on the simple observation that the task of selecting items from the environment can be usefully decomposed into three primitive sub-tasks. The visitor performs each sub-task with the support of the guidebook system. The sub-tasks are as follows:

(1) *Location:* Visitors, through their spatial position, implicitly limit the information in which they can plausibly express interest.

(2) *Intimation:* As visitors become aware of items, they will demonstrate tentative interests. By observing these hints indirectly (e.g., from facing direction) or directly (e.g., from pointing gestures), the system may further restrict the information presented to the visitor.

(3) *Selection:* Visitors make explicit or implicit gestures to select particular items of interest.

We justify these primitives using two arguments.

The first argument is empirical: the primitives reflect the actions performed by visitors as they approach (and then focus their attention on) objects. For example, visitors choose a room, an orientation within that room, and finally a specific object. Monitoring visitors "doing what they do naturally" seems to be the most straightforward way to infer their information needs. Furthermore, such monitoring must reflect the visitor's different needs and behaviors during different actions. The naming of our sub-tasks reflects how these behaviors relate to the guidebook system. For example, a visitor's directional orientation intimates (i.e., hints at) a degree of interest in certain objects to the system.

The second argument is practical: there are situations in which combining any of the sub-tasks leads to loss of functionality. We illustrate this with an example. The visitor in Figure 1 is interested in the large picture labeled (c). A system that combined location with either intimation or selection might infer that (a) was of interest; a system that combined intimation with selection might not distinguish between (b) and (c).

3.4 Utility

The thesis of this paper is that is useful to consider each sub-task explicitly and independently from the other sub-tasks. Intimations of user interest and attention, such as facing direction, must be separated from selection. Designers of portable electronic guidebooks must keep each sub-task in mind while designing their interaction mechanisms so that they do not inadvertently reduce the usability of their systems.

Designers apply the model by explicitly considering each sub-task separately. There are good motivations to combine sub-tasks; perhaps most importantly, combination decreases the number of modes of user interaction, which can in turn reduce the number of context-awareness technologies and user interface mechanisms. The resulting reduction in weight, size and power consumption is important in mobile device design. However, as we have just described, combining sub-tasks may make choosing an item difficult for the user. The designer must therefore make decisions appropriate for each sub-task, balancing factors such as the user's tolerance for inference errors, physical limitations of the environment, etc.

In Table 1, we describe a number of existing electronic guidebooks, classifying each by the number of distinct *levels of interaction* seen by the user. The systems use technologies described in Table 2. As mentioned, most systems use only one level of interaction. The problems with this approach were described when we discussed portable browsers and portable labels. Three systems separate the task into two levels of interaction, combining location and intimation. By doing so, these systems have lost the ability to use other techniques or technologies for intimation. Only the Touring Machine [4]separates all three sub-tasks into distinct levels of interaction.

Combining some of the three sub-tasks is not necessarily a sign of bad design – not all systems are designed to be general. In particular, research prototypes are often designed to explore specific issues (e.g., context-awareness technologies [5] or personalization techniques [7]) in specific situations. That said, there are few examples of three-level systems and little (if any) discussion of the issues in the literature; this suggests that more study and greater awareness are warranted.

The model is very simple and very specific to the problem of item selection, but it addresses a key design issue. The need for the model can be demonstrated by showing how easy it is to design a system with an inappropriate user interface. Figure 1 shows how *every* museum information system (and nearly every context-aware guidebook system) described in the literature uses its context-awareness mechanisms in a way that frustrates the user's ability to select items. (Of course, some projects have done so because of budget or technology limitations; others may simply not consider this problem to be part of their project scope or focus. The usability problem remains.)

In the next two sections, we describe how we applied the model just described to improve the design of our own electronic guidebook system.

4. INITIAL DESIGN

After conducting our background research at Attingham, we set out to design an electronic guidebook. Based on our observations, we made the following decisions:

First, we knew that it was important for access to be non-intrusive. Therefore, we ruled out augmented reality designs, at least for the present, since headware arguably makes the visitor feel less connected to the location they are visiting.

Second, we believed that a visual selection mechanism was likely to be the most effective, based on our experience with printed material while at Attingham. Therefore, we wanted to explore visual selection mechanisms.

Third, we knew that it was important for access to be lightweight. Therefore, any device we designed should have a simple selection mechanism. Therefore, we ruled out 3D navigation as the visual selection mechanism, because we believed it was unnecessarily complex for our application.

Fourth, based on our observation of visitors to historic houses and other museums, we knew that proximity-based approaches would probably not give the user the information they wanted in the vast majority of cases. Therefore, we ruled out proximity-based selection.

We developed a design consistent with these decisions. In this design, the user uses an overview image map of the rooms in a house to navigate to image maps of the views from different perspectives in individual rooms, e.g., an image map of each wall in a given room. From a given view, the user can select items of interest from the image map. This gives users the required control (it does not automatically eliminate objects the way automatic selection does) and the advantage of visual selection. However, it does require manual navigation on the part of the user, i.e., no pruning of the information space is done. Therefore, it is not as lightweight as we would like.

Upon reflection, we realized that our design uses a single metaphor (image maps) to perform several different tasks: identifying the user's position within the house, identifying the user's perspective in a room, and identifying the specific item in which a user is interested. This purely manual approach places a greater burden than necessary on the user. We concluded that it is not sufficient to simply avoid over-restricting; we must also avoid under-restricting as well.

Obviously, it is a natural instinct for designers to minimize implementation complexity by using a single technology in a design. However, in this domain, such a technology-driven approach does not best meet the needs of the user. We argue that the design space contains a number of choices that ought to be made independently to best meet the needs of a given task and to get the right combination of manual and automatic selection. Each of these choices should be made by studying the user's task rather than by trying to minimize the implementation complexity. Only in this way can the user get a selection mechanism that is as lightweight as possible without being overly restrictive.

5. MODIFIED DESIGN

We now apply the general model to the specific case of designing an electronic guidebook for a historic house.

5.1 Requirements

To apply our model to this design problem, we consider the needs of each level independently.

Location: In a historic house or museum, the visitor is generally only interested in the objects in the room in which they are currently standing. Therefore, it is useful to automatically restrict the objects to those in that room.

Intimation: The user generally has some orientation in a room, as well as a given field of view. One design would be to automatically display to the user the contents of the room from a given orientation (facing south wall, facing west wall, etc.). These facings might be determined using "electronic compass" technology. However, there is a chance that this would be disconcerting for the user if the views changed too quickly as the user moved around. An alternative would be to allow the user to change the facings using a lightweight gesture such as pressing a button; this is feasible since there are a limited number of facings. Study is warranted to determine whether an automatic or manual approach will be best.

Selection: The user may be interested in any of a number of objects. We therefore believe that the user should be allowed to manually choose which object to investigate. Visual selection is a very intuitive means, established to a limited degree in traditional guidebooks.

The interesting point is that by analyzing the problem with our model, we realized that we require 3 different mechanisms to provide the optimal combination of manual and automatic selection. Based on the model and our requirements analysis, we discarded initial designs that were based on portable browser (hierarchies of image maps) and portable label (infrared beacon) ideas. Although the new hybrid design means more work for implementation, we believe it will give the user a much better experience.

5.2 Prototype

Our implementation, based on the Casio Cassiopeia™ E-105 PDA, is partially complete. The E-105's facilities have made implementation of audiovisual content delivery fairly straightforward. For example, the E-105 supports 65,536 colors on a 240x320 liquid crystal display, as well as monaural speakers and a Walkman-style stereo headset jack. The E-105 can display still images, (very short) video clips, and several hours of CD-quality audio clips. The E-105 measures 0.8 x 3.2 x 5.2 inches and weighs 9 ounces. Unlike larger, heavier tablet computers, it can be held comfortably in one hand, as shown in Figure 2.

We have made the following technical choices to meet the needs specified by the model:

Location: The E-105 has a built-in infrared transceiver, which can be used to identify the user's current room.

Intimation: We may extend the E-105 with an "electronic compass" to automatically determine the user's facing. Alternately, we may determine the user's facing using an explicit but lightweight user gesture (e.g., using the thumb-actuated selector available on many PDAs such as the E-105).

Selection: A photograph (image map) of the room can be displayed so that the user can use the E-105 stylus to select objects. When they select objects, the E-105 can provide details via a text display or the headphones.

Figure 2. A user scenario, showing the size and form factor of the device.

Therefore, the guidebook will be a handheld PDA. It will automatically restrict the objects to those in the current room. It will automatically (or allow the user to manually) display an image of the objects the user is facing. When the user selects a given object from this image, text or audio information about that object will be presented to the user.

6. RELATED WORK AND ALTERNATIVE APPROACHES

In the Model section above, we discuss a number of electronic guidebook systems. The commercial systems have been very conservative in their use of context-awareness technologies, and most of the research systems have focused on either simple explorations of context-awareness [2,5,8] or personalization [3,6,7]. To our knowledge, our characterization of the item selection task and our taxonomy of these systems according to their support for sub-tasks is unique.

A number of alternative approaches could be used. For example, one could imagine an electronic book that consisted of a text query system. However, such a system can only complement, not replace, a navigational guidebook system. The main problem is that the names of objects are not known in all cases (this is similar to the problem with using an index in a printed guidebook).

Augmented reality systems, i.e., systems that modify the user's view, are another alternative approach. For example, a head-mounted system could overlay a user's view of a physical object with information about that object. The Touring Machine is actually an augmented reality system [4]. We believe that the curators' perspective would be that this would be invasive, and that people should not experience locations "through" an intervening layer. However, it is possible that if the technology becomes sufficiently non-invasive, and if image registration becomes highly accurate, these technologies will become more acceptable. Even in this ideal future, however, automatic inference based on gaze may not be sufficient; users may glance away from an object of interest while they are thinking, and that gesture probably does not mean that they want to change the content to which they are currently listening. Also, handheld (printed or electronic) guidebooks could still serve the function of encouraging interaction among visitors; just as visitors share printed guidebooks, e.g., pointing to specific passages, they might share electronic guidebooks. Further, people seem to have a natural affinity with guidebooks. In any case, until the technology becomes non-invasive and the registration issues are addressed, electronic guidebooks are a good solution.

7. CONCLUSIONS AND FUTURE WORK

To realize their full potential, electronic guidebooks must be designed so users can select items with little effort. Therefore, designers must choose a combination of automatic and manual selection mechanisms that are appropriate to the environment, the capabilities of the computing platform, and the needs of the user population.

In this paper, we have considered the ways in which previous commercial and research systems have addressed the selection problem. Many of these systems use a single technology for all levels of the selection problem. We argue that design of electronic guidebook systems can be improved by a task-based approach that is based on the user's natural selection behaviors. Such an approach can help the designer prune the selection space as much as possible without over-restricting the user's choices.

We have applied this task-based approach to a specific issue, information access in historic houses. Our model revealed that we had an oversimplified design, and suggested improvements, which we are currently implementing.

We are interested in a number of other issues. For example, we would like to observe visitors using our prototype guidebook with a three-level selection mechanism. It would also be informative to study the gestures or other means by which users intimate that they are interested in an object. Other possible subjects include guidebook personalization, or user response to text versus audio presentation in an electronic guidebook, e.g., how different presentation modalities affect interaction between visitors.

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