Location Aware Mobile Interactive Guides: Usability Issues

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Abstract

This paper discusses the issues related to the application of wireless communication and positioning technologies to the development of hand-held electronic tour guides. These issues are discussed presenting HIPS, a project recently funded by the European Commission that aims at developing a hand-held electronic tour guide allowing tourists to navigate both the physical space and a related information space when visiting a museum or city. HIPS detects the position of the tourist andprovides personalised and contextual inforamtion.

The methodological approach of the project plays a fundamental role for the development of such a system: user-centered design and scenario-based design are means for assuring that the final system is appropriate to the user and to the context of use. The usability issues of HIPS are also discussed comparing its features to other audio guides like the one currently available in the Louvre Museum.

Keywords

usability, scenario, tourism, localization, audio guides1. Introduction

The integration of hand-held computing with wireless communications and positioning technologies has enormous potential in many fields: location aware mobile devices that permit the navigation of both a physical space and a related information space at the same time represent a new interaction paradigm. While the applications of these technologies are (and will be) predominantly in professional markets, ever decreasing costs will soon bring such systems to the mass market. There ought to be, however, big differences between a system designed for a captive audience such as in professional, "vertical" markets and systems designed for a "non captive" audience such as the tourist/leisure market: the robustness (as perceived by the user) of the system has to be defined differently and generally be much greater for the system to enjoy success. This becomes particularly relevant in projects relying on brittle leading edge technology, where factors such as cost, scale and physical constraints can significantly alter systems performance in the real world (as opposed to the lab/demo).

The perception of robustness of the system by the intended audience of such a system depends crucially on interactivity: where speed of response is not the only issue, but information presentation, gradual degradation and effective feedback are just some other crucial elements. Whereas issues such as data integrity, reliability, security etc. are significantly less important. Quality of interaction can't (or shouldn't) be ensured without centering design on the user, as opposed to, say, testing the validity of a data encryption algorithm .

We believe that for the development of such a system a user centered design methodology has a fundamental role in avoiding "ideal world" fallacies with respect to systems performance, both from the communications point of view and the precision of localization. The human-centered approach (Norman and Draper, 1986) is based on the key idea that placing the users at the center of the design and evaluation activities ensures that the system is designed to meet their needs. The methodology is generally implemented through a spiral or iterative process model, characterized by an iterative design with many cycles of "design—test with users—redesign", based on a massive use of prototypes. This methodology is particularly important for deployment in the real world where physical, geographical, historical and other factors contribute to the potential difficulty of building an ideal infrastructure for the system: our research focuses on the development of a system able to bind the physical constraints of the real world to the rich variety of options in an information space. Information must be presented in a manner appropriate to the user and the context. Where the context also implies the system's performance itself.

2. HIPS

The issues discussed in this paper refer to a project recently funded by the European Commission within the I-Cube initiative (Esprit Long Term Research). I-Cube (an acronym for Intelligent Information Interfaces) is a new European Program that aims at

promoting "human-centered methodologies" for the design of tools supporting people in everyday working or leisure activities . HIPS (Hyper-Interaction within Physical Space) is one of the projects of the I-Cube network, and it is developed by an European consortium[1]. Its main objective is the development of new interaction paradigms for navigating physical spaces.

HIPS is a hand-held electronic tour guide allowing tourists who visit a city or a museum to navigate both the physical space and a related information space at the same time. HIPS guides the tourists in the exploration of the physical environment, providing contextual and personalized information by detecting the location of the user within the physical space.

The system guides the visitor generating audio messages: the user can get instructions for finding items of interest, hear descriptions with references to items seen earlier and to ones that will follow, ask for additional information and receive suggestions on alternative routes. The presentation of information in HIPS will be dynamically generated, adaptive, multimodal, and integrated with maps and spatial directions. When interacting with the user, HIPS will integrate user's requests, the user-model, the history of previous browsing and the physical location at the moment of the query, in order to provide contextual and personalized information. In order to compose context-sensitive multimodal answers to users' requests HIPS will combine small, modular pieces of information of different kinds (audio, video, text) and will be able to identify the situation and to select the presentation form which is appropriate in that context. Furthermore the information content provided by HIPS will vary according to the user's location, preferences and to the information already given.

From a hardware point of view HIPS will be based on a client-server model where the clients ("hippies" for short) that visitors will carry around will be pen driven palmtop computers with a screen, headphones and no keyboard. Localization will be performed by various means: infrared, radio and GPS. Connectivity to the server will be wireless.

3. AUDIO GUIDES IN THE LOUVRE MUSEUM

As a concrete example of the kinds of issues that usability addresses in practice, we will point out some of the problems (and suggest some solutions) of the audio guide available in the Louvre Museum. We chose these audio guides as they are a relatively simple system and raise points relevant to HIPS, bear in mind, however, that these are merely observations from a cursory glance (as users) at the devices from a recent visit to the museum and we did not have the opportunity of applying the usability methodology we advocate.

The hardware for the audio guide resembles a large telephone handset: there's a speaker at one end, a number keypad, a small LCD display, and four additional buttons: play/pause, stop/cancel, rewind/fast forward and volume control. The handset is handed out together with a 4 page leaflet listing the items that have an audio presentation.

The audio guide provides commentaries for a limited number of the items on display in the museum. To hear an audio snippet for a particular piece, the user must enter a three digit code on the keypad (that gets displayed on the LCD) and press PLAY. The codes are listed on the leaflet and displayed alongside the works of art.

The handset is large enough that users would not inadvertently put it in their pocket and forget to return it; however, the principal means of assuring the return of the hardware is that one must leave a credit card or passport as a deposit for the guide. The guide staff places the receipt for the document inside the clear folder holding the leaflet. This is a very effective forcing function to avoid tourists losing the receipt thus slowing down the guide turn-over process; this has he significant effect of changing the status of the textual list from mere "paper" (to crumple up, lose, throw away) to an important part of the audio guide system. The audio guide, given the new "accidental" importance of the leaflet, becomes in effect a system with two parts: a written paper component in addition to the handset audio part.

The leaflet is starkly minimalist: a listing of the items covered by the audio guide alongside their code number. The items are in groups such as "French

Paintings," "Italian Paintings," and "Greek and Roman Sculpture". Each page also corresponds to a wing of the museum, also highlighted on a small plan at the top of the page. Each entry is as follows: the room number the piece is in, the author (or origin) of the work, the name of the piece, and the guide code number. The minimalism of the leaflet leads us to believe that the designers of the system did not envisage the importance afforded to it by the users (or by the placement of the receipt).

A few enhancements to the leaflet would enhance the usability of the system as a whole:

- Detailed plans of the museum would aid navigation. For example they could show the layout of the rooms within a wing and the rooms' name or number, possibly also indicate within the rooms the location of the pieces (to avoid the user from having to scan the whole room to find the number tags).
- Indeed the presentation could be more location centric, and be centered on plans of the wings of the museum.
- Small black and white pictures of the pieces would help in recognizing the less familiar items.

3.1 The Handset Interface

The first thing that an interface designer would notice about the handset, is that the numeric keypad uses the telephone layout: there are two layouts of numeric keypads that are standard: the calculator layout and the telephone layout.

Audio Guide Layout

```
1 2 3
4 5 6
7 8 9
0   C
```

Calculator layout

```
C
7 8 9
4 5 6
1 2 3
0 .
```

Telephone Layout

```
1 2 3
4 5 6
7 8 9
* 0 #
```

The designers, given the resemblance in form and function of the guide to a telephone, made the "right" choice. We couldn't help noticing, however, that there is some "interference" of a calculator layout in the handset. The "0" key is placed on the left below the 7 key, which is the position for the "*" key on a phone, as opposed to centered below the "8" key, where one would expect to find it: the "0" seems to follow the calculator layout as opposed to the phone one. This is reinforced by the grouping of the stop/cancel button with the number keys: in a calculator this is usually in the top left corner above the "7", here it is at the bottom right, aligned with the "0" key, in the position of the "#" key on a telephone keypad. The Stop/Cancel button would if anything best be part of the other functional group of buttons that relate to audio controls: the volume, ff/rew, play/pause buttons.

The issue here is not one of "correctness", but of fundamental usability: a layout of the keypad that users are not used to, requires them to make the extra effort of consciously looking at the numbers on the keypad.

Placing the cancel button together with the numbers, reinforces it's "Cancel" meaning, and plays down it's "STOP" function. Indeed, the button does operate like a calculator's cancel button in that it clears the display. In effect then, the Stop function is a by-product of the cancel function. There is some consistency in this approach, given that the guide starts playing the audio snippet only once the PLAY button is pressed: thus one enters a code, then operates on it.

Unfortunately this mixing of metaphors, phone and calculator, is potentially confusing and gives rise to a problem: if the user enters less than three digits, or a three digit code without an audio clip associated to it, and then presses PLAY, the LCD displays "ERR", indicating an error: not the friendliest of messages.

It would, perhaps, be simpler for the user if the phone metaphor was carried the whole way through:

- the user "dials" a number as in a phone call: once the third digit has been entered the handset starts the audio clip. No need for the PLAY button, and thus no error messages if the user enters less than three digits.

- If the three digit number does not correspond to a commentary, then a "Sorry wrong number" audio clip could be played (which could also be in the form of an engaged sound).

- Alternatively, after the alert, the system could "redirect the call" to the closest number that does have a commentary. Closeness could be computed arithmetically, but also in terms of keypad "distance" (e.g. on a keypad is closer to 4 and 5 than to 3), or by using the last "correct" number to guess where the visitor is likely to be.

Instructions on how to use the guide are given by the handset by entering "7" and pressing PLAY: this is explained at the top of the leaflet and by the staff handing the guides out. A button labeled with "?" or "i" (to maintain the language neutrality of the hardware) that played the instructions might be a better solution.

There is also an ergonomic problem with the placement of the audio control buttons: when the handset is held to the ear, the buttons are not easily accessible since they are opposite the mouth, thus one can't see them while listening to the recording. Given that the best feedback is the audio content itself, it would be preferable if one could operate the controls while holding the handset to the ear. The controls could be placed on the side of the device, their shape indicating their function: a wheel for the volume, a spring loaded rocker switch to advance and rewind. The Play/Pause button or rather Pause/Resume (see suggestions above) could stay where it is, especially if de-pausing automatically rewound the audio track a couple of seconds: this would give time to the user to bring the handset to the ear and most importantly, would provide the context for the spoken text.

A nice feature of the guide is that fast forward and rewind cause a traditional high pitched noise to play: simulating a tape cassette is very effective feedback.

By exploiting the digital nature of the device, however, the audio commentaries for each piece could be broken up into meaningful units ("paragraphs") and marked as such inaudibly, the fast forward and rewind buttons could then be used to jump from paragraph to paragraph, as opposed to advancing linearly. The same audio feedback should be kept nonetheless, so as not to confuse users (who might press the button inadvertently).

The three digit codes correlate loosely with the classification of the works: thus "French paintings" start with a 4, roman sculpture with a 5 and so on. An alternative organization of the codes could use the room numbering scheme: all items start with the two digit number of the room they are in (there are less than 99 rooms) followed by a 1 for the first piece in the room, 2 for the second etc. (there are less than 9 pieces per room the guide describes). This would open the possibility of using "0" for a quick guide to the room itself indicating where in the room the commented pieces are to be found.

By making the room numbers the organizational principle of the coding scheme, the guide becomes location centric, as opposed to "theme" centered, as it is presently. This pushes further the "browsing" function of the guide, that is already intrinsic in the system. The users need only know the number of the room they are in (which is displayed on the doors) to know what code to enter, while the thematic scheme requires consultation of the leaflet or spotting the small tags, as only the first digit is predictable.

What sets the audio guide apart from traditional tape cassette based tours is indeed the freedom from fixed routes. Presentation is self-paced, and the user can browse through the museum at will. Location-centricity enhances browsability as it is the "flattest" organization possible: no structure is super imposed on the collection. In a museum or exhibition, structure is imposed anyway by the physical layout and organization of the exhibits. Location centricity, then, allows that same structure to percolate to the guide.

This seems particularly relevant in the case of guides, such as the Louvre one, that are "pull" only: information is "pulled" by the users, where, when and if they desire. The opposite case of a "push" only guide, is the traditional tape tour—the user has no input

and passively receives information (prototypical examples of "Push" and "Pull" are television and the web respectively).

What distinguishes HIPS as an information appliance is it's potential as both a pull and a push system. On the one hand it can be used to facilitate browsing: the user pulls information simply by standing in front of an exhibit and walking around; on the other, it can be used to push information, by guiding the user along predetermined routes. Clearly, most interesting are the applications of HIPS that mix the two paradigms, as we hope to have shown in the short scenarios above.

In conclusion, usability testing would have spotted all of the issues discussed above and uncovered others that we haven't noticed; a proper design test redesign cycle would also spot problems with our suggestions made above. For example, user testing could indicate the relative importance of features of the system. Maybe, it turns out that visitors never use the fast forward and rewind buttons, and that actually removing them leads to a system that is easier to use altogether (as there are less buttons to get confused by).

4. USER CENTERED DESIGN

One of the main novelties of the HIPS project is the type of development process that will be followed: a User Centered Design process.

User-centered design processes are characterized by:

- an appropriate allocation of function between user and system;
- iteration of design solutions;
- the active involvement of users;
- multi-disciplinary design teams (including both technical and human factors experts).

At each stage of design, user-centered activities are essential in order to understand and specify the user and organizational needs, so that potential design solutions can be evaluated against these needs. There are four essential types of activity:

- understand and specify the context of use: the nature of the users, their goals and tasks, and the environment in which a product will be used;
- specify the user and organizational needs in terms of effectiveness, efficiency and satisfaction; and the allocation of function between users and the system;
- produce designs and prototypes of plausible solutions;
- evaluate solutions against user criteria, preferably by testing them with representative users (Nielsen, 1993).

User Centered Design is successfully used in the development of professional applications which require a high quality of adaptation of new technologies to the work environment. It is much less common as a development process for the design of multimedia applications and tools for the tourist community. In fact we feel that when you design a multimedia system you must pay special attention to the entire context in which the system will be used in terms of the users and what they will do with the system, as well as technical aspects such as what platforms the system is likely to be running on.

Our commitment in HIPS towards user centered design will be realized by a strong involvement of users in all phases of design and development. At the initial phase of design generally called Requirements analysis we will analyze user characteristics and involve users in scenario making in order to guide the functional design. During development we will follow an iterative development process that will be characterized by steps of design/user evaluation/development/ user evaluation. Each step of development will be tested on site with potential final users of the system.

4.1 USER TESTING AND ITERATIVE DEVELOPMENT

At various stages of development the prototypes of HIPS will be installed in the Museum of Santa Maria della Scala and users will be asked to manipulate the tool. During these tests we will carry out a number of measures and observations:

- the time to complete a task such as following a suggested path in the museum
- the success rate in retrieving some information stored on the server

- the typical errors that are made using the interface
- the satisfaction and fun users experience in using HIPS

The objective of these tests are to guide the design of the user interface by eliminating the sources of confusion and frustration, but also to identify those aspects of the user/machine interaction that are most enjoyable and fruitful for a visitor of a museum.

During the test we will use a number of well established usability techniques to collect data on users' interactions :

- videotape of the users in context using the tool
- questionnaires of user satisfaction (SUMI is a well established questionnaire for measuring user satisfaction)
- time and error measures

In some cases, probably in the first stages of development when the system will be only partially functioning we will use test techniques closer to diagnostic evaluations, carried out on mock-ups and other intermediate prototypes (Lindgaard, 1994). This will involve:

- focus groups
- heuristic evaluation
- analytic evaluation to analyze and predict the performance of error-free tasks in terms of the physical and cognitive operations that must be carried out.
- observational evaluation, providing information about what the users do when interacting with the prototypes. Direct observation, video recording, software logging, interactive observation (wizard of Oz), verbal protocols are typical techniques available for this kind of evaluation.

5. SCENARIOS FOR FUNCTIONAL DEFINITION

Scenario building is one of our main design techniques to explore new forms of interaction in which the physical environment is able to react to human behavior, using the palmtop as a mediator. This activity involves the creation of realistic scenarios focused on identifying the features of potential users that may be exploited to adapt the system's behavior, the way in which people can share the experience, for example leaving annotations that other people can reuse and investigating the peculiarity of mapping a hypermedia structure upon a physical space.

Scenario-based design (Carroll, 1995) is a method that allows designers and users to describe existing activities or to envision new activities that can be produced by the interaction with a new artifact. A scenario is intended to detail a usage situation and to document step-by-step actions performed by the users (Lewis & Rieman, 1993). It is usually represented by textual, pictorial or diagrammatic descriptions and can be used in different stages of the development process of an artifact. Nielsen (Nielsen, 1995) states that scenarios can be used throughout all the system development life cycle and discusses seven applications including diary scenarios for data gathering, brainstorming to envision new features of the system, scenarios for design and prototyping, scenarios for heuristic evaluation, stereotypes scenarios for data analysis in exploratory studies, scenarios for task-based user testing.

In what follows, we present the scenarios-based techniques as they have been used in the initial phases of HIPS: requirements gathering and prototyping of early ideas.

Indeed, if we focus on the early stages on the development process, scenarios can be used to characterize episodes or a sequence of activities like in a story. These stories provide the context in which activities are carried out, giving insights about needs, difficulties and motivations people have in particular contexts. In this respect, scenarios are methods for requirements gathering.

A second usage of scenario-based design in the early stages of the development process is the depiction of how a new artifact can support a proposed course of actions. From this point of view, scenarios are a prototyping method, a design proposal.

In HIPS we decided to use a scenario building technique to clarify our thoughts about what the final prototype should be and its potential features and capabilities. The method we used consists of a

gradual development of some basic scenarios (Tognazzini, 1993) where details are incrementally added. Key elements of our scenarios are the intended users (single or groups characterized by the dimensions on which users can differ), their goals, other sources of information accessed during the visit to a museum, the information generated by the user themselves, the user needs, and a script describing a usage context.

From brainstorming sessions we started to envision possible usage scenarios of HIPS. In particular a basic scenario was developed together with a series of more detailed micro-scenarios describing trustworthy situations. These micro-scenarios describe possible alternative environments in which HIPS might be played out.

In what follows three basic scenarios for HIPS are described in order to give a flavour of our use of scenario-based design.

5.1 GUIDED TOUR SCENARIO

John and Mary, two technophile tourists, are visiting Siena. They decide to try out the brand new HIPS guide to the Piazza del Campo. First of all they listen to some brief instructions that encourage them to enter some details about their preferences so that the system may be customized to their likes and dislikes. They tap with a pen on the screen on various boxes and lists. The system then asks what kind of a tour they would prefer: John, who likes sports, opts for the Palio guide, while Mary opts for the history tour. The screen displays a plan of the Piazza with a small "you are here" dot, that moves as they walk around. If that wasn't enough, they notice that the plan rotates as they turn around so that it is always pointing in the right direction. Mary sees a restaurant called "Al Mangia" and wonders whether it has something to do with the Piazza: she looks up a list of items of interest, finds the Torre del Mangia, selects it and the screen displays a crude picture of the Tower in front of her, and highlights it on the plan. A commentary starts playing explaining the history of the tower, when it was built, etc. She then starts walking around the square, and as she approaches buildings, the guide gives her historical information on the building and it's present function. What Mary likes, it that the commentary refers back to things that were mentioned earlier and thus gives a context for the narrative. The explanations also encourage her to see other items, highlighted on the plan, that are relevant to the commentary.

Meantime John is having the Palio explained to him: the history of the contrade, anecdotes on the races etc. He is encouraged to walk around the square and as he approaches the various "corners" of the square, the guide tells him which contrada starts from there, and their achievements in the Palio. John, wants more details on the race itself and so is directed towards the start line, and the rules of the "mossa" (the running start) are explained. He then starts walking around the square following the "race track", and as he proceeds the commentary tells him about this corner being particularly dangerous, how the inclination of the square in that point affects the way the horses are hoofed and so on. When he stops to buy an ice cream he doesn't have to stop the commentary, because HIPS knows that he has stopped, and when he continues at a slower pace (eating the ice cream) the commentary is more detailed, and contains more anecdotes. When John and Mary sit down, after handing back the hippies, for a coffee, they have experienced two completely different tours, and have something (for once) to talk about.

This scenario is intended to highlight the potential of HIPS in overlaying a rich information structure onto a physical space. There are many situations, (outside, historical sites, protected buildings) where it isn't possible to provide rich displays of information (as in a museum). The only solution is for the visitors themselves to carry the information with them. The problem with books is that they necessarily distract the visitor from actually looking at what they are there to see. Audio guides are, in this sense, less intrusive on the visitor's experience. Making the audio commentary location aware, leaves visitors the freedom to explore as they wish, rather than forcing them along a fixed path. Adaptive information presentation, based on the route the user has taken and their preferences enhances the clarity of the presentation and allows relevant connections to be illustrated.

5.2 SCHOOL VISIT SCENARIO

A classroom has been studying basic biology: the food chain, the predator/prey balance, parasitism etc.; their teacher decides to take the class on a field trip to the local natural history museum. When the

noisy, chaotic class arrives at the museum, the teacher hurries to the hippies desk to check out the hippies she had booked three days earlier. After handing over her school ID as a deposit, she collects all the devices. As she hands them out to the children she taps on "student mode" on the screen, and selects the predator/pray educational game. She then sets up her own hippy to be in "teacher mode"; a plan of the museum appears with little dots concentrated all over the entrance of the museum. As the class moves on into the museum the teacher checks that the student tracking function is working correctly: the dots move in synchrony with the children. The teacher then explains the game to the children and divides them into two teams: the predators and the prey. The children enter their names (actually rude and gory handles) and select whether they are prey or predator. The teacher keeps her fingers crossed that the children will behave and starts the game.

When the children put the headphones on, they hear a cacophony of animal noises, a jungle theme for the Vincent Price voice then explains the game again (but it's more funny than the teacher). The predators and the prey hear different versions each specific to their team. After a couple of minutes, Vincent Price sets them off for the real fun.

The goal of the game is simple: survival. The predator team has to identify from various clues what animals are on their team, then find their designated prey. If they manage to find it, they eat it and survive. The prey team has the opposite task, first finding the prey then trying to detect the predator (by finding it in the museum). If they spot a predator the prey is considered safe, and thus it survives. The team with the most survivors wins.

Basically the game is a treasure hunt, where the clues are descriptions of the animals, presented not just with speech but also using sound (from the environment: jungle, sea...made by the animals: roars, snorts etc.) and simple diagrams, maps, pictures displayed on the screen. As in a treasure hunt, the children might need intermediate steps to get the final clue (answering multiple choice questions on the screen, finding related animals etc.). Once they finally identify the right animal they must actually go and stand in front of it for the system to register that they "got it". When a predator find its prey, or a prey spots its predator, the system acknowledges not just the successful child, but also informs the unfortunate counterpart that he/she has been eaten (or spotted). Meanwhile, the teacher can track the progress of the children, by seeing how the teams are doing, which student has found what, etc. She can also follow their movement around the museum with the "kid tracker" function, that also allows her to search for specific children to see where they are, and vice versa to find out who a specific "dot" on the tracker actually is.

When the game is over, or the teacher decides to stop it, the children are told the "final score" and directed towards the meeting point.

This scenario raises various issues:

First of all we wanted to point out the potential of wirelessly networked devices for enhancing group activities, where a group, even if displaced, can maintain contact and interact. A dimension missing from audio based tours (that is instead a feature multimedia kiosks) is the social dimension: families consulting the kiosks together, people looking over the shoulder of others: the audio guides isolate users from their social context. The advantages of a system such as HIPS is that the social aspects can be integrated (in part) as well. Here the interaction between children was very limited and passed strictly through central control (the game), however more freeform decentralized interaction is clearly possible (though using HIPS as a walkie talkie would be overkill).

Secondly there is the issue of privacy that the "kid tracker" raises: in this context a "tracking" function is fairly harmless, indeed it can be a safety feature where children are concerned; however, the idea of being "tracked" is not exactly pleasant. Would such a function be acceptable to a tour group (inverting the guide-group relationship : from having to be spotted buy the group members by raising an umbrella to seeing where the individuals are) ? Would someone want to receive advertisements targeted at impressionist lovers ? This is a serious issue, that we will have to address, especially since HIPS will be designed to scale up to city levels.

Finally, with this scenario we wish to emphasize that adaptivity should also be on a macroscopic

scale, and that different "classes" of users should be addressed (and children are as different as you can get).

5.3 LIVING OBJECTS SCENARIO

The two scenarios outlined above use the wireless, location aware characteristics of the HIPS system to provide highly interactive guides to the exhibits of a museum; different as they are, they have a core in common: a third party that introduces the items and provides commentary and information. In this scenario we wish to turn this model inside out: here it is the exhibits themselves that interact with the user. There is no deus ex machina to guide the user, the user is immersed in an enriched environment, where objects have voices, make sounds, play music. At the risk of being Disney-esque, we believe that interesting possibilities are opened up by such a scenario.

John and Mary, our technophile tourists, check out two Hippies in the Maritime museum and select the Living Museum "tour". As they enter the first room on Viking nautical history, they immediately notice the background noise of the sea and Scandinavian voices shouting to each other. As they approach one of the vessels on show, the noise fades further into the background and a voice starts telling them of the exploits of the crew of the ship, how they sailed far from home to the Shetland Islands. Moving further along, they notice how, as they pass exhibits, some seem to call out to them. Alongside another boat they hear a voice telling them " Don't listen to him and his stories about the Shetlands, you should hear about real sailors, and how we got across the ocean..." they stop and hear the tales of a great Atlantic crossing. John and Mary then wander off into the Roman section: the background theme is now a Ben Hur style Hollywood interpretation of ancient Roman life. A display of oars produces moaning and whiplashes, so they stop and hear the tale of a slave on a trireme. Every now and then, the visitors get slightly confused about where exactly the sounds are coming from, as the headphones don't give them directional clues, but usually the content makes it quite clear which exhibit is addressing them; anyway the screen on the device also shows a small picture of the exhibit that is currently "speaking" so that they can identify it. An option that is also welcome (they did come to the museum together, after all) is being able to switch off the voices and sounds and to simply leave the "environmental" sounds, so that they can hear each other. The tour is minimally interactive, in that it is mainly the physical location of the visitor that drives the presentations, however some exhibits give the users the option of choosing between presentations: e.g. the captain of the ship or the slave at the oars.

The scenario above is deliberately "cheap" and more appropriate for a wax museum than for a "real" museum. We wanted to point out how a system such as HIPS also has potential (and risks) as an entertainment medium.

The scenario raises, however, other points beside the "edutainment" possibilities: a rich user model coupled with a "push" data delivery model can be very powerful: information can be narrowly targeted without being requested. Imagine possible messages from a personal HIPS device in a city scale HIPS network: "Hey John, there's a 39 bus coming in 2 minutes to this stop going to Piazza del Campo (that you asked me to direct you to)", "That Cary Grant movie you're looking for is on sale in the store across the street".

HIPS can be used not just to tell users where they are (and deliver information accordingly) but also to tell others where they are. While the privacy issue, already mentioned above, is serious, there are many useful applications for such a model.

6. LEADING EDGE TECHNOLOGIES FOR TOURIST APPLICATIONS

From a technical point of view as well as a functional one, the HIPS system comprises two distinct uses of wireless technology: location detection and wireless networking. The former is clearly at the core of HIPS, but it could be argued that the latter is not strictly a necessary component. One could envisage standalone devices that were simply location aware: a sort of sophisticated GPS device. We believe however that the networking aspect is crucial for real world deployment:

- There are serious constraints on the storage capacity available on a handheld device (as exemplified by the relatively small selection of audio clips in the Louvre Guide), while this clearly does not apply to a networked device.

- Centralizing data allows a great simplification in "stock management": there is a single type of device that has the appropriate tour "downloaded" to it, thus there is no need to decide how many units have to be in one language as opposed to another, nor to guess the popularity of one tour over another. Furthermore updating of information, new features, etc. can be dealt with centrally and do not require reprogramming all the units.

- The school visit scenario illustrates the rich potential of a networked system in enriching tours with a social dimension that is only possible with a networked system.

- Real time updating of information becomes possible, which offers powerful possibilities not just in city wide scenarios (when is the bus coming?) but also in the context of museums (e.g. a section being closed for renovations, a temporary exhibition, a painting on loan)

Figure 1 contains in form of keywords an idea of the potentialities of HIPS in comparison with other existing tour guide systems. The comparison is made among hippies, CD ROMs, Multimedia kiosks, Audio tours, Tape cassette based tours, Books, Museum layout and nothing (no guide at all). The features that are discussed are location (fixed, mobile), interactivity, customizability, flexibility, content, multilinguality and constraints (physical constraints).

7. CONCLUSIONS

The fundamental question with any leading edge technology, with it's corresponding higher costs, is "is it worth it ?". We believe that the transformation of the user experience from one of consultation, whether with an audio guide, a multimedia kiosk, a CD ROM or even a book, to one of immersion in an information rich environment is extremely significant. The possibility of overlaying multiple information structures over the physical world in a non intrusive fashion, opens up new possibilities that other technologies do not allow.

A number of different issues related to the design of tour guides were discussed in this paper. In particular we believe that the success of the "new generation" systems for tourist applications, especially those exploiting leading edge technologies, strongly relies on the design philosophy adopted during the development process: a deep and continuos focus on the users and the context of use.

NOTES

[1] Partners of the HIPS Consortium are: three universities: University of Siena (I)—Project Coordinator, University of Edinburgh (UK), University College of Dublin (IR); three research institutes: IRST (I), GMD (D), SINTEF (N); an industry: ALCATEL-SIETTE (I); a SME: CB&J (F).

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	HIPS	*CD ROMs*	*Multi-media Kiosks*	*Audio tours*	*Tape cassette tours*	*Books*	*Nothing*	*Museum layout*
Location	Mobile	Fixed You are elsewhere	Not outside; Limited in some buildings	Mobile	Mobile	Mobile		
Interactivity	Push & Pull	Pull only	Pull only	Pull only	Push only	Not interactive		Not interactive
Customiz-ability	Adaptive user model	No	No	No	No	No		No
Flexibility	Multiple tours with the same equipment	Hyper-textual structure	Hyper-textual structure	No	No	No		Structure is super imposed onto the collection
Content	Flexible	Fixed You have to look at reproduc-tions Two visits (real and virtual)	Fixed Distracts from what really matters-items themselves	Flexible	Fixed	Fixed	Best for beautiful places Not so good for more obscure places (e.g. ruins)	Fixed
Multi-linguality	Yes	one language at time	one set of users at time	one language at time	one language at time	one language at time		
Constraints	Localiza-tion system: GPS, IR sensors, DECT	You need a computer	Takes up space; Needs wiring	Need to enter Codes; Small info storage	Differ-ent tapes; Forced Pacing; Small info storage	Cheap; notes; book-marks	No weight	Expensive

Figure 1