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Serving Visitor Communities: A Mediated Experience of the Arts

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1. Introduction

The fifty-year old man was apparently hesitant carrying such a small and expensive computer around in the museum and in particular he was afraid he would not to be able to use it. As soon as he stepped into the Sala del Mappamondo, wearing a headphone and firmly grasping the device, a deep loud voice started speaking "*This is the Sala del Mappamondo one of the most important halls of the whole Palazzo Pubblico. The wonderful frescoes, even the more religious ones, impose themselves as the very first examples of laic art involved in history and contemporary political life."* Just another audio guide, thought the man a little bit relieved about the situation. Yet, when he approached the opposite wall the voice started speaking again *"This is La Maestà, depicted by S. Martini in 1315. The fresco is located in the main part of the hall, the central point that gave the orientation of the Sala del Mappamondo. By contrast, the Guidoriccio fresco, located just behind you, was a sort of 'poster', glorifying the power of the Siena Republic."* The man turned around and the voice continued "*In front of you, you can see the Guidoriccio, it was also painted by S. Martini […]"*. The man was amazed; the audio guide seemed to work by itself. Suddenly, he recalled the small computer that he was still firmly grasping. He looked at it and first of all he noticed a small picture of the wall in front of him, all the frescoes were blurred but one: so that one is the Guidoriccio.

Half an hour later, during the post-experiment interview, the man claimed that the audio guide helped him to get oriented in the space: he actually never discovered that the guide provides a self-oriented map of the museum.

The design of entertainment and edutainment systems is a compelling and challenging adventure. Such systems are not intended to help users perform work-related tasks and, most of the time, they cannot be brought back to clearly stated user requirements: their ultimate mission is to engage the user and to stimulate learning. The nature of this kind of system imposes a mediation between designers' visions and user needs. Within a three years project[1] named {HIPS (Hyper Interaction within Physical Space)} funded by the European Commission in the I^3 Programme, we pursued the ambitious goal of designing an electronic tourist guide that transforms the user experience from one of simple consultation (commonly achieved with audio guides, multimedia kiosks, CD ROMs or even books) to an immersion in a rich information environment. We implemented two prototypes, one indoor in the Museo Civico di Siena and one outdoor in the campus of the University College of Dublin. The project finished in October 2000 and the system is currently maintained in laboratory.

[1] HIPS Consortium: University of Siena (I) - Project Coordinator, University of Edinburgh (UK), University College of Dublin (IR); IRST-ITC (I), GMD (D), SINTEF (N); ALCATEL (I).

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Our first objective as designers was to envision new human activities which can be supported by technology and then define the technological requirements needed to support such activities, trying to conceive non-intrusive and non-compulsory instruments. This vision ended up with a number of design concepts that were implemented in the final prototypes. The concepts of *immersive environment* and *environment sensitive user interfaces* were used to establish the primacy of environment; technology is fundamental only if it supports rather than overcomes the "real" experience, the real interfaces in museums are the rooms and the frescoes themselves. The concept *situation-aware content* highlighted the need to provide information in a way that relates to previously delivered information, for instance, using comparisons to previously seen exhibits, and making frequent use of reference to space and time (e.g. *as you have just seen, in front of you*, etc.). Finally, *social navigation* was the concept that drove the necessity of thinking about a museum visits not just a single person experience but rather as a collective one.

In our vision, the tourist guide should assume the role of a travelling companion that tells stories about what the visitor looks at, without requiring any explicit intervention for accessing information in an attempt to minimise the boundary between the physical space and the related information using the movement of the visitor as mediator.

The technology we used allowed multiple information structures to be overlaid on the physical world in a non-intrusive fashion, opening up new possibilities for creative design. This experience demonstrates that the success of entertainment or edutainment systems, especially those exploiting advanced technologies, strongly relies on a design philosophy that mediates between a deep and continuous focus on the users and innovative visions.

The HIPS audio guide is characterised in five important respects: (i) It is aware of the visitor's location, orientation and distance from objects[2]. It has knowledge of the physical space and features of the artworks inside it. In presenting information about artworks, appropriate language phrasing is used, along with modified images (e.g. blurring the surrounding space when displaying the location of an artwork), making the user terminal an enrichment of the visiting experience, and helping the visitor discover what is hidden to his eyes. (ii) It responds to user movements: the HIPS audio guide interprets visitor movements in context, for example the description of a small painting will be stopped automatically if the visitors walk away, but the description of a wall-size fresco will continue if the visitor moves away to look at the fresco as a whole. (iii) The guide stores the history of the visit and of the interaction and uses this to decide what information to present, and thus the user will not be presented with the same information twice: at a second visit to the same object, a richer dynamic presentation will be provided in the new context (e.g. *'you are again in front of […]'* and following with previously unheard descriptions). (iv) By asking for further information, or on the contrary, moving away or explicitly stopping a presentation, the visitor gives strong evidence as to his preferences and interests. The subsequent presentations can be made more effective if the system is able to exploit this knowledge (e.g. *"regarding Simone Martini, you know that the author of this fresco was a strong enemy of his: a legend says that […]"*); (v) the audio experience follows the user activities dynamically and in a longer term view: the length and the style of the presentations are adapted to the user style of visit (e.g. briefer and more general descriptions where the visitor moves through the art space without becoming particularly involved; or longer, deeper and more exciting explanation styles when they do become involved). (vi) While language is the most effective modality for presentation of information and audio is the preferred media to deliver it, in a situation where artworks have the precedence in using the visual channel, we experimented with the use of images to help the visitor appreciate small details in a fresco, used 3D images to help the user to orient himself in the space. Finally, (vii) the HIPS guide gives the user the

[2] Infrared was used as the basic technology for visitor's localization in the physical space of the museum. Yet, HIPS actually implemented a three-level representation of the physical space in order to abstract away from the specific technology and to allow symbolic reasoning on the visitor's movements. This representation is briefly introduce in section 3, for further details see (Bianchi, Zancanaro 1999).

possibility of annotating the information space for subsequent visitors, offering individual reflections and comments in the form of *user activated hotspots*; this possibility enriches the space with a sort of personalised track.

But do features such as these actually make a system as useful and enlightening as it was for the fifty-year old man? The effectiveness of the standard usability evaluation methodologies in the field of art, entertainment and leisure is questionable, since the visitor usually does not have a clear goal in mind that can be achieved by a sequence of predefined tasks. Rather, it is the context that shapes the relationship between human actions and system outcomes. However, this relationship is not a simple one. Some features of the system may induce errors or confusion, or perhaps a technical fault may occur in the external environment, which the system is unable to handle. Thus it is necessary to analyse the richness of the context of interaction when discussing usability and engagement. We chose to assess the usability of the system by measuring the impact of the HIPS audio guide at four different levels: phenomenological, cognitive, emotive and socio-cultural. The evaluation at the four levels was carried out on the basis of the direct observation of the activity of real users (i.e. English speaking visitors of the Museo Civico in Siena).

The HIPS experience, although limited, demonstrates that the success of entertainment or edutainment systems, especially those exploiting advanced technologies, strongly relies on a design philosophy that mediates between a deep and continuous focus on the users and innovative visions.

2. The museum experience

Museums[3] are non-competitive and non-evaluative environments where visitors are free to move around and learn concepts through the objects exhibited. A museum visit is a personal experience encompassing both cognitive aspects (e.g., the elaboration of background and new knowledge), as well as emotional aspects (e.g., the satisfaction of interests, the fascination for the exhibits). The optimal tourist guide should support strong personalization of any offered guidance in an effort to ensure that each visitor be allowed to accommodate and interpret the visiting experience according to their own pace and interests. This is why our tourist guide is able to adapt the presentation of information to the idiosyncrasies of each particular visitor by appropriately selecting:

(i) what to tell (taking into account his personal interests);
(ii) the amount of information delivered (providing long or short descriptions of artefacts);
(iii) the way in which the information is presented (e.g., deciding whether an audio or textual commentary is appropriate), and
(iv) making reference to other exhibits in the same museum and in particular to those already presented to the user (in order to reinforce learning).

However, the ideal audio guide should not only guess what the visitors want but also take into consideration what they have to learn, thereby making the museum experience really useful and memorable. Therefore, it is also important for our guide to stimulate new interests and to suggest new paths for exploring the museum. Hence, a system to support visitors in their visit should take into account agenda, expectations and interests as well as the peculiarities of a cultural experience in a physical environment.

2.1 Visitor's agenda, expectations and interests

The visitors' own agenda and preferences greatly determine their expectations and behaviour during a visit and should be considered carefully by a flexible guide when planning a situated presentation of information. Usually, visitors have general expectations: they will see valuable objects, they will learn more about what they are interested in, they may possibly buy interesting material at the

[3] In this paper, we use the term "museum" in a wide sense, to include traditional museums, open-air expositions, tourist sites, zoos, etc

bookshop and so on. Of course, expectations also vary in accordance with the specific type of museum/cultural site being visited. For example, general art sites, such as historical buildings or cities that were not purposefully designed as exhibitions, typically allow the visitor to anticipate a more situated and contextual visiting strategy. Expectations are also a function of how accustomed the users are to museum visits, of their cultural level and of their interest in the specific exhibition topics (for example, the desire not to miss the Gioconda in their first two-hour visit to the Louvre might severely influence the visitors' anxiety and visiting path). The visitor's initial expectations can also change during the visit, possibly as a result of their enjoyment of the exhibition. Typical signals for this change are an increase in interest for the items displayed and slower movement through the items. This scenario requires that the successful digital companion maintain a dynamic model of visitor's expectations, agenda, preferences, interests and knowledge.

2.2 Reflective and experiental cognition in exploring art settings

In his book, *Things that make us smart*, Don A. Norman (1993) analyses the nature of {experiential and reflective cognition}. An experiential mode of interacting with the environment is achieved when people assimilate information without apparent effort by just letting the external world drive emotions and perception. Reflective thought takes place in the same "environmental" conditions but requires more conscious effort and initiative in assimilating information. If we apply this notion to the context of a visit to an art setting, we could say that the reflective modality of interaction is related to the deliberate intention of the user to consult information of interest whilst the experiential modality relies on the capabilities of the environment to attract and stimulate the visitors without requiring an explicit initiative from them. Inspired by this view, we aimed to design both modalities of interaction within our tourist guide. In particular, for mediating the experiential modality, we adopted the concept of {*optimal flow}* (Csikszentmihalyi, 1990): the absolute absorption in the activity where the experience is guided by external events, which stimulate the visitor and facilitate the assimilation of information. Supporting the optimal flow means embellishing both the physical and virtual environment in such a way as to motivate the visitor through a sense of engagement thereby enhancing the experience. Our tourist guide supports both the experiential and reflective modalities of interaction letting the visitor explore content more deeply while experiencing the emotional effect. To elucidate further, the reflective modality of interaction is mostly related to the deliberate intention of the user to ask for information (explicit queries to the system through a Personal Digital Assistant-PDA), whilst the experiential modality is mediated by a natural input, namely the visitor's physical movement.

In order to design a complete experience for the tourist, it is essential that all the elements that comprise the system be harmonised, ranging from any data that may be manipulated during the interaction to both the contents and the physical layout that cooperate to define the experience.

To reach an optimal flow during the users' interactions, all these elements should be strongly integrated. If the users focus on a single element (e. g. a single data item or a single object) or if they can sense an inconsistency between them, the flow of interaction is damaged. In the following sections, we illustrate how the museum experience was designed, from the initial modelling of the physical space and visiting strategies through the interaction mechanisms and, finally, content design.

3. The vision: hypernavigation in the physical space

3.1 Beyond traditional audio guides: adaptivity and location-awareness

Until recently, the state of the art in visitor enhanced user guides was the delivery of content in the form of audio presentations through headphones. There was little consideration as to the individual needs of the tourist or indeed their location within the museum or site.

The technological guide envisaged here is characterised in five important respects:

(1) it would be adaptive to the needs of the individual user;

(2) it would be aware as to the location of the user;

(3) it would respond to user directives and interactions with it;

(4) content would be delivered using a rich media portfolio;

(5) users could annotate the information space for subsequent users offering individual reflections/comments in the form of *user activated hotspots*.

Many existing systems merely presented prefabricated dialogue to the user resulting in low relevance and user dissatisfaction. In contrast, we seek to track the users movements and orientation, build up a profile of individual user preferences through a user profile and to capture user interventions through the user interface. Collectively this renders an adaptive personalised user experience. In addition, we sought to deploy a rich portfolio of media types in content delivery including, audio, text, graphic and video. The incorporation of user augmentation of the content space via hotspots was pivotal in allowing users to take collective ownership of the content thus enhancing the visitor experience.

However, the most significant disadvantage of the current range of audio guides is often represented by the fixed content of the messages, which does not guarantee that visitors are offered the most suitable information with respect to their current location, interests and needs.

{Adaptive Hypermedia} (Chen and Magoulas, 2005; De Bra et al. 1999) are hypermedia systems in which either the presentation of information or the hyper-link structure (or both!) are dynamically modified according to the specific context of use. They are often compared to {Dynamic Hypermedia}. The former exist prior to their use and the user model is employed to hide part of the structure (or to highlight another part). Fully dynamic hypermedia, on the other hand, does not exist until the very moment in which a user explores them; they are dynamically created on the fly using automatic text generation techniques (Isard et al. 2003; Oberlander et al. 1998).

In the digital guide that we envisage, we combine the benefits of location-aware systems with the advances made in parallel in the field of adaptive and dynamic hypermedia; this way we gain more effectiveness in the mobile delivery of information.

Reasoning from localisation information, a model of the current user is collected. For example, a visitor staying in front of an object for a while may, under certain conditions, be interpreted as interest, whereas a quick crossing can show disinterest or boredom. Similarly, the path that the user takes provides a measure of how much that visitor follows the suggestion of the guide. The user's input (both implicit and explicit) is interpreted by the system in order to plan an "intelligent response": simple reactions to user movements are not, in fact, sufficient for this kind of interaction. The movement has to be interpreted in the physical context (e.g. whether the visitor is close to a large fresco or a small painting) and in the semantic context of the presentation (e.g. whether the visitor is listening to the presentation of a painting or to the general presentation of the room).

Indeed, a notion of space that relies on naive geometry rather the usual Cartesian geometry is needed. Rather than depend on the approximate location and orientation we receive from the location sensing devices, we re-interpret the data *functionally*, in terms of what exhibit(s) the user is near, and which are they looking at. Such an approach allows us to abstract away from the particular localisation system. We use naive notions such as *area* (a closed region of space identified with a name and a type, e.g. a room, a floor, etc.), and *exhibit*. Areas can contain other areas, and one or more exhibits.

This representation of space allows the rules of behaviour for the system to be encoded in a more natural and intuitive way. As an example, what should the system do if the visitor moves away during a presentation? Some rules that can be encoded using the above representation of space are:

- If the presentation is about a painting, don't stop it unless the painting is no longer in the visitor's sight;

- If the presentation is about a room, don't stop it unless the visitor leaves the room.

3.2 The tourist visiting styles

One of the primary requisites for identifying the most effective presentation strategies for visitors moving in a physical space is understanding visitors' possible behaviour. Direct observation of human activity is one of our primary sources of design inspiration (Hutchins, 1995). In our tourist guide, we both exploited the results of ethnographic studies documented in literature, and also performed an intense period of observations in two museums in Siena: Museo Civico and Santa Maria della Scala.

Documented ethnographic studies showed that visitors tend to move in exhibition settings in homogeneous modes. In particular two French ethnographers, Veron and Levasseur (1983), classified visitors in four categories defined on the basis of the following variables:

- geometry of pathways;
- time spent in front of each artwork;
- the global time of visit;
- the number of stops.

The patterns of behaviour derived by the combination of these variables resulted in the (metaphoric) {visitor categories} shown in Figure 1. This classification inspired our design and suggested how to isolate significant variables linked to physical movements, and how to relate these movements to the browsing of information spaces.

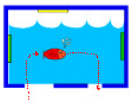
	**The ant visitor***:* «ant» visitors are those who follow the path proposed by the curator, taking time to observe all (or almost all) artworks. They stop frequently and the entire visit is quite long. Ant visitors usually move close to walls and artworks, avoiding empty spaces.
	**The fish visitor***:* the «fish» visitor moves preferably in the centre of the room, performing a «slipping» visit of the exhibition. Fish visitors usually cross empty spaces, and have a «peripheral» vision of the contents of the room. Fish visitors do not pay attention at details of artworks and prefer a «holistic» observation. Even if they stop rarely in front of any specific artwork, they have a rapid look at most of them, but only for a short time.
	**The butterfly visitor***:* the «butterflies» perform a sort of «pendulum visit». They frequently change the wall of the room, moving from the right to the left wall without following the proposed path. Empty spaces are usually avoided. The butterfly observes almost all the artworks, stopping frequently. The duration of the stops varies for each artwork. The visit is mostly guided by the «affordance» of the elements in the physical space.
	**The grasshopper visitor***:* the grasshoppers observe only artworks they are interested in, without following the proposed path. The visit is mostly guided by personal interests and pre-existing knowledge about the contents of the exhibition. The grasshopper crosses empty spaces, stops rarely, and the time spent to observe single selected artworks is quite long even if the entire visit is quite short.

Figure 1: Veron and Levasseur classification

This classification was confirmed by observations we made in two museums in Siena with the following elaborations:

- The original classification was proposed for exhibitions, that is, physical spaces purposefully designed as exhibition spaces. Since our (indoor) experimental site is a historical museum that was in origin the building of the Sienese municipality, it is neither an exhibition space nor a pure museum. This means that some variables considered extremely significant for the Veron and Levasseur study, such as the concept of «proposed path», acquire a different meaning in our scenario. For us a «path», is any uninterrupted sequence of artworks.
- Visitors move in the space because they are driven both by intentional motivations (personal interests and preferences) but also by visiting strategies that are affected by the properties of the environment. In the latter sense, the movements of the visitor mostly depend on natural and

contextual affordances of the space (Norman, 1999). Some of these affordances can be used to model the physical movements of the visitors (Marti et al, 2001).

The results of this study were used to develop a «Visiting Style Module» (VSM), a software module that supplies patterns of movements that can be coupled to information contents with the aim of providing the visitor with appropriate content for the specific context of the visit.

3.3 The environment as a medium

According to (Bordegoni et al., 1997), a medium is a physical space in which perceptible entities are realised. Indeed, in a museum (as well as in a cultural city, an archaeological site, etc.) the most prominent medium is the environment itself. If a digital tourist guide is to build coherent and effective presentations that allow the users to appreciate what they are visiting, then the guide has to take into consideration this special status of the environment. The aim is to *integrate* the 'physical' experience, *without competing* with the exhibit items for the visitor's attention. From a multimedia point of view, this means that additional uses of the visual channel have to be carefully weighed. In our guide, we prefer to exploit the audio channel (mainly for language-based presentations, although the role of non-speech audio (e.g., music or ambient sounds) has also been investigated). Yet we use images on the PDA to support the visitor in the orientation task (3D or 2D images are used to support linguistic reference to physical objects). In this latter case, the visual channel is shared between the PDA and the environment but the goal is still to provide support to environment-related tasks[4].

From a multimodal point of view, other modalities are employed to focus the visitor's attention on specific objects or to stimulate interest in other exhibits. For example, in our tourist guide the linguistic part of the presentation (speech audio) makes large use of deictic and cross-modal expressions both with respect to space (such as "here", "in front of you", "on the other side of the wall", etc.) and to time ("as you have seen before", etc.). At a deeper level, presentations are planned to contain elaborations on visual details or comparisons to other exhibits[5].

Ultimately, the goal of a location aware system for cultural visits is to help visitors to adapt their visiting experience to their own interests; but in some cases a visitor should be encouraged not to miss some particular exhibits (for example, you cannot visit the Louvre for the first time and miss the Gioconda). Sometimes this task can be accomplished by direction giving, but there are other ways to promote exhibits: for example, by providing at the beginning of the visit a list of hotspots, or by planning a presentation that, in a coherent way, links the exhibit in sight to others which the visitor's interest model suggests. More generally, further research is needed towards implementing pedagogically-motivated systems with meta-goals to pursue, educational strategies to follow and intentions to satisfy. In this respect, the interaction between the visitor and the system must evolve from simple interaction to full-fledged collaboration (for a discussion on this topic applied to cultural tourism see (Stock, 1999)).

4. Interaction and content design: envisioning a human experience

4.1 Interaction design

When we started to design the interaction between the visitor and our tourist guide, it was clear that we didn't have to design only a tool, but also new human activities that could be performed in the museum, thanks to a new technological infrastructure. Our idea was to not constrain people to follow pre-defined patterns of interactions, confining them to the mere role of "users of

[4] Actually, the PDA screen is also employed to suggest further navigation in the virtual space of information; an alternative realization for this would have been the use of auditory icons [Mynatt et al., 98].

[5] The extent to which the system inserts elaborations and comparisons depends on the user model.

technology", but to offer new opportunities for using contents and artistic spaces to build up new experiences. Therefore our first objective as designers was to envision new human activities which can be supported by technology and then define the technological requirements needed to support such activities. This vision concluded with a number of design concepts that were implemented in the final prototypes. These include:

Immersive environment

1. The user is immersed in a rich audio environment. Different reading styles characterise the way in which artworks are described from different perspectives (historical, artistic, anecdotal descriptive).
2. The rhetorical styles are tailored to the context (use of deictic expressions) and to the iconographic contents (artworks representing people are described in first person, as if the character presents himself or herself).
3. The rhythm of narration (length, duration) is tailored to the visitor's movement (long and detailed descriptions, for example, are provided to visitors who move slowly and stop in front of each artwork, according to the Veron and Levasseur classification).
4. Experiential cognition is mediated by a natural input: the physical movement. Reflective cognition is allowed by intentional and context driven interaction (explicit queries to the system).

Situation-aware content

The audio descriptions are segmented into Macronodes (Not, Zancanaro, 1999), small blocks of information that are dynamically combined to form an audio presentation. Each of them contains different kinds of contents with explicit deictic reference to the physical position. The flow of narration is made more fluid and harmonised to the context of visit. The use of different reading styles, together with the integration of 3D sounds and music, are means to create rich audio environments. Our tourist guide reproduces a sort of "empathic effect" mediated by human voices and immersive information spaces to engage the user in an intense meeting with art.

Environment sensitive UI

The idea of the environment as interface is an interesting one, but requires more than just models of visiting strategies. Affordances of cultural settings play a central role in shaping the interaction. These include: a) properties that are «intrinsically» connected to a particular setting, such as the physical dimensions of the artworks, their position, their artistic importance; b) architectural elements like access points to a room, arches and steps; c) dynamic and contextual configurations of elements present in the space (crowd, lights). The role of the affordances in attracting the visitor can be hampered when combined in certain configurations (crowd and bad light conditions often drive the visitor to skip important artworks). We envisioned the possibility to design audio triggers to attract the visitor's attention. If the user reacts positively, moving to the mentioned artwork while listening to the description, then the system continues to provide information; otherwise it only mentions the artwork without further elaboration.

Social navigation

Our tourist guide provides some very basic support to the development of a social memory in the community of visitors by "marking" a moment of the visit. By pressing the "hotspot" button on the PDA, the visitor stores into the system the current position, an image of the artwork, the related description, and personal comments. This facility may be used to recommend a tour to a friend, to elaborate on contents, to plan another tour and so on.

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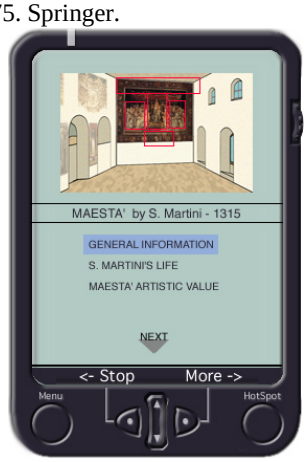


Figure 2: The PDA interface

4.2 Content design

Several issues arise when allowing for the dynamic presentation from a hypermedia repository of information in response to a user moving in a physical space. The most important of these is that the situational contexts in which the information is presented varies. The main factors determining the situational context are user position and movement (e.g., whether she is in front of an object or whether she is simply walking around a room) and the structure of the surrounding physical space (e.g., whether objects being described are close or not). In order to dynamically adapt the presentations of objects to the particular visitor in a particular context, the HIPS audio guide must have an internal representation of the content that can be expressed.

In the context of the HIPS project, we have developed a formalism to annotate multimedia repositories of data called the {*Macronodes formalism}* [Not and Zancanaro, 2000]. In this formalism, the atomic piece of data is called a *macronode* which, for textual information, typically corresponds to a paragraph. Indeed, a macronode can encode data in different media such as audio, images or a combination of these. A presentation for the HIPS audio guide is the concatenation of different macronodes chosen to fit the visitor's needs.

Macronodes, grouped in networks, have a semantic description that allows the system to decide which macronodes have to be included in the presentation. In addition, the content of each macronode can be expressed in many slightly different ways, the most appropriate one is chosen on the fly to ensure cohesion with respect to other macronodes of the same presentation.

For the HIPS audio guide in the Museo Civico, 170 macronodes were prepared, for 31 exhibits. The macronodes encompassed 344 audio files.

Each exhibit has a "welcome" macronode, that is, a macronode used to introduce the exhibit in a simple way when the user approaches it. This type of macronodes is very simple and usually consisted of just a welcome statement in different versions (for example, *"this is …"* or *"in front of you, you can admire …"*, *"you're back to …"*). Each exhibit is additionally associated with a number of "caption" macronodes, prepared according to different perspective (for example, historical, anecdotal, artistic, etc.). This kind of macronodes are used as the core of a presentation and therefore they are quite complex. Usually, each caption macronode consists of a main part (for example, *"The Guidoriccio has been painted in a less complex way than the Maestà but Simone did not renounce to his love for details …"*) to which some optional part are added to ensure adaptation and cohesion (for example, after having introduced the Maestà in the previous example, we can add as an optional part *"that you've just seen"*, of course this part will be used only if appropriate).

Finally, other macronodes are provided as "additional info", that is, information that cannot be used by their own but can be added to captions to enrich the presentation with further details. Each macronodes in this category has a given perspective but it is also explicitly specified to which

caption it can be added and which communicative function it fulfils with respect to the caption (to give background information, to further elaborate one or more details, etc.). For example, a biography of the painter can be linked as background information on the historical caption of a fresco.

Using macronodes, the HIPS audio guide is able to tailor the content of the presentations to the visitor. In particular, the knowledge about the visitor's interests allows it to choose the preferred perspective with respect to which information has to be presented. The visiting style influences the amount of information (i.e. the number of macronodes) as well as the choice of the communicative style of the presentation. Example 1 shows an "elaboration-based" presentation of the Maestà which is more suited for visitor with the "ant" visiting style and example 2 shows a "comparison-based" description of the same fresco more suited for "fish" visitors.

Example 1: «elaboration-based» description of the La Maestà	**Example 2: «comparison-based» description of the La Maestà**
This is the great fresco La Maestà, depicted by Simone Martini in 1315. La Maestà was the first decoration piece in Palazzo Pubblico, therefore it acquired through the centuries a particular value for the Sienese population. It's not surprising that the very first decoration of Palazzo Pubblico (the site of political power) was a religious artwork. Only four years before, in fact, the 'Fabbrica del Duomo' the other civic power of Siena influenced by the bishop, commissioned the famous 'Maestà' to Duccio di Boninsegna. The traditional spirit of competition between the two great 'factories' of the city demanded an adequate reply.	*In front of you, you can admire the great fresco La Maestà, depicted by Simone Martini in 1315. The fresco is located in the main part of the hall, the central point that gave the orientation of the Sala del Mappamondo. On the contrary the Guidoriccio fresco, on the opposite side of the room, was a sort of great 'poster', glorifying the power of the Siena Republic. It was a sort of historical documentation more than an artwork to be judged for its artistic value*

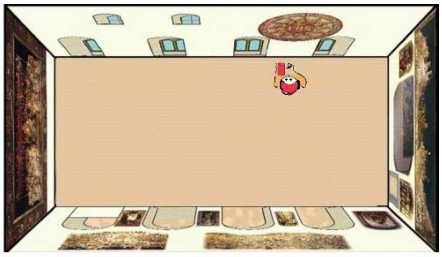
5. Walkthroughs

5.1 San Bernadino and the Monogram

This example illustrates that two visitors who access information on the same frescoes in a different order get presentations which are similar[6] in the content yet "tailored" to their physical movements in the museum.

A prominent goal of any intelligent audio guide in a museum should be to help the visitor in locating the frescoes presented in the physical space while avoiding confusion when referring to different frescoes in the same presentation.

Let's consider a visitor in the Sala del Mappamondo. After having listened to the general introduction to the room, the visitor walks toward the fresco representing the Bernadian Monogram. As soon as he approaches the fresco, the HIPS audio guide starts the presentation: "*This is the Bernardian Monogram. Batista di Niccolò da Padova painted it in 1425. The portrait of San Bernardino is located behind you.*"



As you can note, HIPS uses spatial expressions such as *"This is"* and *"behind you"* to help the user to easily recognise the topic of the presentation and the other

[6] Of course, the presentations could have been different on other respect as well, depending on their interest models and the visiting styles. This example has been simplified in order to clearly illustrated the effect of the previous interactions with the system on the a presentation.

relevant fresco involved in the description.	
When the visitor follows the system's implicit suggestion and moves toward the opposite side of the room, the HIPS audio guide starts the following presentation: *"On the column in front of you, there is the portrait of San Bernardino. It was painted by Sano di Pietro in 1460-1461. The saint can be easily identified by the monogram he holds in his hand. You just saw the bernardian monogram depicted on the opposite wall."* As before, the system makes use of spatial expressions, but openly remarks that the other mentioned fresco has already been seen to avoid confusing to the visitor.	
Now, let's consider a different visitor that just after entering the room turns his attention to the San Bernardino fresco. The presentation produced by HIPS is quite similar to the one presented to the previous visitor for the same fresco, but with a notably exception: *"On the column in front of you, there is the portrait of San Bernardino. It was painted by Sano di Pietro in 1460-1461. The saint can be easily identified by the monogram he holds in his hand. The bernardian monogram is also depicted on the top of the opposite wall."*	
Of course, when the visitor then moves towards the Monogram fresco, the presentation will be similar to the one presented to the first visitor for the same fresco, but with the explicit mention of the fact that the San Bernardino fresco has already been seen: *"This is the Bernardian Monogram. Batista di Niccolò da Padova painted it in 1425. You just saw the portrait of san Bernardino on the opposite wall."*	

5.2 The Maestà and Santa Caterina da Siena

These examples illustrates how different reading styles are used in the HIPS guide to immerse the visitor in a rich audio environment and to produce engaging presentations.

The rhetorical styles of the presentations are tailored to the context (use of deictic expressions) and to the iconographic contents (artworks representing people are described in the first person, as if the character presents himself or herself). The pace of narration (length, duration) is tailored to the visitor's movement (long and detailed descriptions are provided to visitors who move slowly and stop in front of each artwork).

Let's suppose that the visitor now moves toward the big fresco La Maestà at the end of the room. As soon as he approaches the fresco, the HIPS audio guide starts presenting the fresco with a polite male voice: *"In front of you is the Maestà, one of the absolute masterpieces of Sienese art, painted by Simone Martini in 1315."* And after a small pause, then a new male voice, with a strong Italian accent continues: "*The Virgin is depicted as the Sienese people's protector, and as a symbol of municipal justice: this particular devotion to the Virgin derived from the famous Battle of Montaperti in 1260, when Siena defeated the army of Florence and preserved its freedom."*	
The visitor laughs because of the strange Italian accents and walks away from the fresco. As soon as he turns to the left a creepy female voice starts talking into the headphones: *"I'm Santa Caterina da Siena..."*. The visitor is astonished but soon, looking at the PDA display, they see that the portrait of Santa Caterina is depicted on the column just in front.	
After he has listened to the life of Santa Caterina in her own voice, the visitor decides to move out of the Sala del Mappamondo. But while he is going to exit, the HIPS guide with a male voice and a 3D sounds effect says *"Behind you, there is another important fresco of Simone Martini: Guidoriccio da Fogliano."* Is it worth a look?	

6. The evaluation

The evaluation of the impact of enabling technologies in the field of art, leisure, learning and entertainment is not a trivial task. It is evident that the subject of evaluation is not "usability" *per se* but a wider and fuzzy notion of engagement and intellectual comfort that the user may experience.

From the very early stages of the HIPS development process, we applied traditional user-centred design to conceive and refine initial concepts, to learn from users' visiting strategies and needs, to observe and develop user profiles and to evaluate efficacy and effectiveness of intermediate solutions. These research methods provided indispensable input into the development process but they were insufficient to answer some of the most crucial questions which were more global in nature, such as:

- will the users have to change their practices to exploit the new capabilities of the system?
- how motivated will they be to do so?
- will they discover new ways to use the system to improve their experience?
- will they use the system in a creative way to learn about art?

- will the system adapt to the learning process of the users who will continue to explore and use additional functionality over time?

For each of these questions we wished to assess the complex relationships between artistic contents, context of use, physical environment, cognitive, cultural, motivational and emotional components at stake. In short, the overall experience of use.

However, the evaluation of such experience was not focused on in just the final prototype, but evolved through the entire life of the project. From the initial phases of c*ollection and inspiration*, we learned from previous works including field studies and surveys, and we defined the theoretical and technological framework. We observed and interviewed people, consulted experts, studied the environmental features of the museum (artistic, physical, social, economical, cultural), shared ideas and concerns in every stages of design. During co*ncept generation* we explored ideas, composed concepts, developed mock-ups and evaluated alternative solutions with users. During the *sharing and demonstration of the final system*, we presented results and asked different users to try out and assess the final product. The outcomes of this phase were fed back into the design process to refine and consolidate the system.

To provide the reader with a broad view of the evaluation process of HIPS, we will consider the history of the project from the evaluation of specific aspects of the system carried out on intermediate prototypes, to the description of a full scale assessment carried out in a museum.

Part of the initial evaluation was inspired by a comparison with existing audio tourist guides, in particular tape cassette guide and “telephone like” guide. Whilst the tape cassette guides show evident limitations for a successful visit (content-centred organisation, fixed contents, constrained paths), the telephone handset exhibits a more interesting behaviour.

What sets this kind of audio guide apart from traditional tape cassette based tours is the freedom from fixed routes. Presentation is self-paced, and the user can browse through the museum at will. Location-centricity enhances the access to the contents since the code organisation is not structured and very easy to access. Indeed to hear a description for a particular piece, the user must enter on the keypad the code displayed alongside the works of art.

However, these audio guides provide commentaries for a limited number of the items on display in the museum and the information is fixed (the same description is available for each work of art, the visitor cannot ask for more/different information). Another feature that seems particularly relevant in the case of these guides is that they 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. From the beginning of the project, it was clear to us that what could distinguish HIPS was its potential as both a pull and a push system. On the one hand we thought about a system that could be used to facilitate browsing: the user could pull information simply by standing in front of an exhibit and walking around; on the other, it could be used to push information, by guiding the user along predetermined routes.

Another distinguishing feature of HIPS with respect to traditional guides was the auditory interface of the system. We put specific effort into designing an auditory space that could support the visitor not only in getting information about a piece of art but in sustaining a quality of experience based on the perception of the physical space around. Indeed, we considered the role of hearing in sensing and interpreting the outside world and designed informative auditory events for perceiving the space and interacting with it.

During the project development we produced some evidence concerning the relationship between the behaviour of people in physical spaces and auditory information content (Marti et al., 2000).

We developed “enriched commentaries”, that is, varying descriptions in terms of voice used, pace of narration, reading styles and the use of 3D sounds, each associated with different contents (episodes from the Saints biographies, anecdotes regarding characters and events of Siena, general and artistic descriptions etc). These commentaries turned out to be very effective in supporting the

memorability of contents, and highly effective in keeping the attention and encouraging their interest in the artworks. The different voices and reading styles were easily perceived by the listeners, and they helped them in recognising different topics and types of contents: in particular, the longer the commentary, the more recognisable the type of content. The listeners' perceptions of them and their ideas and expectations about their "way to work" contributed to form a coherent mental model of the system's behaviour.

In terms of a qualitative appraisal of the *enriched* comments, such comments were preferred to the plain ones; moreover, some of the users that listened to the plain comments suggested that they could be made more appealing by introducing different voices.

These results formed an extremely rich basis for the design of a texture of sound that could be endowed with cues for information recognition and interpretation, without interrupting the user's condition of flow in listening to the information. The spatialisation of sound was used in the final prototype to match the perceptual features of the physical environment seen by the user with a corresponding information space heard by them. In this respect, within such a texture of auditory space, the delivered descriptions were endowed with further perceptual features able to mark different levels of content.

Another aspect of the system that received a systematic evaluation in the course of the project was the adaptation of contents to the physical movement of the visitors. Our guess was that different types of user (ants, butterfly…) would require presentations that differed both in quality and duration. For instance, we though that short descriptions were probably suitable for *fish* visitors, whereas longer ones were more suitable for *ants*. We conducted experiments administering presentations that were not adapted to user movement strategies (Marti et al., 1999).

The results showed interesting behavioural differences between those users who were assigned a path matching their visiting style versus those who were not: the degree of information skipping and of explicit requests for more information significantly increased if the spatial user-model was altered. These results produced evidence on the relationship between visitor behaviour in physical spaces and information content. In particular we showed how visitors' behaviours can be used as a heuristic principle for content organisation and specification of spatial user models.

A prototype of the final system was installed in the museum for two months and evaluated by visitors who volunteered to try it and provide feedback. The subjects who took part in the evaluation were recruited in the museum on the day of the test. All of them were English or english speaking tourists.

Figure 3: Trials in the Museo Civico

The user performance was assessed on four levels: phenomenological, cognitive, emotive and socio-cultural (Marti, Lanzi, 2001). At the phenomenological level, the performance measure concerned:

- user's perception of the adaptation to the visiting style (personalisation of the information, pauses, pace of narration) and the physical movement as a primary means for accessing information;
- effectiveness of auditory comments (deictics, pronouns, etc) in supporting the user's orientation and recognition of artworks;
- tool flexibility (tailoring to the user's changes of path or visiting style).

At the cognitive level the performance measure concerned the cognitive effort associated with the use of the tool, the comprehension of the contents and the user's conceptual model. At this level, scenarios were used when questioning the design of the system. Norman's cycle of cognition based on: goals, intentions, planning, execution, perception and evaluation, was used to generate questions such as "How does the artefact evoke goals in the user?" or "How does the artefact make it easy or difficult to carry out the activity?" or "How does the artefact support the user when a shift in her/his goals occurs?".

At the emotive level, the performance measure mainly concerned aspects of experiential cognition including observation of frustration or confusion and expressions of satisfaction and engagement.

At the socio-cultural level, the performance measure concerned the social aspects of group activity mediated by the system (communication, knowledge sharing, collective memories); appraisal/dislike of contents and the impact of narrative styles (male/female voices, accents, music, reading styles).

The evaluation at the four levels was carried out on the basis of the direct observation of the activity (video recorded) during free exploration and scenario execution. Scenarios were used as a means to create a context for the activity whilst a series of exceptional circumstances or constraints were artificially provoked in order to evaluate the system under specific conditions. At the end of each session, the visitors were involved in a debriefing and encouraged to comment, analyse and interpret events that occurred during the test. The subjects were asked to describe their experience by commenting on the video recording of the test.

The most enthusiastic comments regarded the possibility of freely moving during the visit whilst being simultaneously assisted by the new guide. Visitors felt comfortable listening to descriptions without interacting too much with the PDA interface, which was mainly used in case of poor performance of the system (delay in loading a presentation, lack of information etc.). Another feature that was truly appreciated was the tailoring of information to the context. They recognised an original capability of the tourist guide to follow their movements and offer appropriate information at a specific moment of the visit. Essentially, the capability of the system to activate a relationship between the user, the guide, and the surroundings, with the aim of facilitating and improving the visit, was recognised.

The use of different voices and unusual stories about the museum made the visit even more pleasant and enticing. All visitors appreciated these features and declared an interest in using the system for exploring open spaces. Some of them asked for a direct connection to their PC at home so as to prepare the visit and elaborate on it afterwards. Some visitors were amazed to discover unknown interests when the guide presented unexpected information. We could directly observe the capability of the guide to catch the visitor's attention since they liked to spend quite a long time listening and looking for details. Tourists who tried the system were very aware of how to handle the prototype. Some remarkable problems were noticed that did not hamper the positive effect on the global experience: slow performance, heaviness of the hardware used for the trials; a rare but still possible fragmentation in the narration. We believe that the perception of robustness of the system by the intended audience depended crucially on the quality of interaction. Speed of response was not the only issue, but information presentation, gradual degradation and effective feedback

were some other crucial elements. Whereas issues such as data integrity, reliability, security etc. were significantly less important, quality of interaction never was, and the users appreciated the effort of centring design on human needs and characteristics.

7. The outdoor HIPS prototype

As a proof-of-concept of the validity of the design concepts that drove the HIPS project, a second prototype has been implemented in a completely different scenario. The new HIPS audio guide has been designed with the purpose of guiding a visitor on an outdoor walk on the campus of University College Dublin (UCD) and describing the various buildings' architecture and history. With few exceptions, the system architecture behind of the outdoor prototype was the same as the indoor one.
Being designed for outdoor visits, this prototype cannot employ infrared to localise the visitor physical position: GPS has been used instead. Moreover, the adaptivity component, prominent in the indoor prototype, has been replaced with a simpler module that just triggers canned presentations when the visitors reach certain zones. By contrast, the hotspot functionality plays a central role.
An evaluation of the outdoor implementation of HIPS was carried out on the campus of the university. Each subject was given a brief introduction to the goals of HIPS. They were then asked to follow a short route around the campus that included four exhibits. On completion, each user was interviewed and a short questionnaire was filled in. The whole procedure took approximately 30 minutes. Weather conditions at the time were dry but overcast. As the evaluation took place during late summer, students had not yet returned and there were still some visitors around the campus. A number of these agreed to participate in the evaluation.
Results of the evaluation were encouraging. Users grasped the concept reasonably quickly and, in general, considered the system usable though some expressed some reservations about the perceived lack of user input. One issue that caused some concern was the discrepancy between perceived position and actual position. Even though the position fell within the standard GPS error (+/-20m), some users seemed somewhat perturbed when they discovered that their actual position did not coincide exactly with that shown on the map. A solution to this might be the use of a more course-grained map. While users were generally satisfied with the presentations, some concern was expressed with the actual responsiveness. Ideally, a presentation would be triggered at the exact place from which the accompanying photograph was taken. However, this can be difficult to achieve and, at best, one can only assume that the presentation will be triggered within a certain zone. Clearly, such issues need to be considered carefully when designing information spaces.

6.1 Current Developments: Gulliver's Genie

Development of the HIPS outdoor prototype has continued after the project formally terminated and it has morphed into a system that we eventually termed {Gulliver's Genie} (O'Grady and O'Hare, 2002; O'Hare and O'Grady, 2003). In principle, the objectives are identical; however, the architecture of the Genie differs radically from HIPS in that its constituent entities consist of {intelligent agents}. Historically, the use of such agents on mobile devices would have been computationally prohibitive. Ongoing developments in PDAs and so-called smartphone technologies have rendered such concerns obsolete. In summary, the Genie may be regarded as a Multi-Agent System (MAS) that encompasses fixed network servers and databases as well as mobile devices. {Agent Factory} (Collier et al, 2004; O'Hare, 1996), an integrated environment for the design and fabrication of intelligent agents provides the delivery engine around which the Genie is constructed.

In the case of outdoor users, the availability of a wireless data networking facility is essential. The somewhat protracted deployment of 3G networks represents a significant development for people planning the deployment of services for mobile users. However, it must be remembered that mobile computing users will always be at a computational disadvantage in comparison to traditional fixed workstation users. This issue is particularly pertinent when it is considered that users' expectations are shaped by their normal experiences; thus mobile computing applications have ample scope to disappoint! In the case of the Genie, a particular challenge is to dynamically build presentations and make to them available to the tourist in a just-in-time basis. The key obstacle is of course the limited bandwidth available to subscribers. Downloading content with a rich multimedia component over a standard 2.5G connection (in this case, GPRS), takes minutes, not seconds. To overcome these limitations, the Genie adopts a strategy which we have termed {intelligent precaching} (O'Grady and O'Hare, 2004). In brief: A detailed model of the information space is constructed. This model is continuously interrogated in light of the tourist's ongoing movement. Presentations are assembled dynamically and stored on a cache on the server. When the tourist passes a certain threshold, a presentation is downloaded to the cache on the user's device such that it is available when the tourist encounters the attraction. The unpredictability of the available bandwidth and the inherent inaccuracy of GPS both conspire to make this process somewhat error-prone. However, ongoing development in 3G networks as well as Satellite-based Augmentation Systems (SBASs) offer considerable opportunities for improving and fine-tuning the process.

Figure 4: The evolution of the HIPS outdoor prototype to Gulliver's Genie.

Naturally, it was necessary to conduct user trial, the results of which are described elsewhere (O'Grady et al, 2005). The results suggest that users see the potential for services such as the Genie and would, in principle at least, be prepared to pay for them. However, they have high expectations and delivering services that meet their expectations will continue to challenge both service providers and software engineers for the foreseeable future.

8. Conclusion

We believe that, in the development of HIPS, the user centred design approach played a fundamental role in generating original ideas and combining them with the use of advanced enabling technologies.

Marti, P., Zancanaro, M, O'Hare, G., O'Grady, M, Not, E., Bianchi, A., O'Donnell, M., Serving Visitor Communities: A Mediated Experience of the Arts. In: (Ed. P. Purcell) Networked Neighbourhoods: The Connected Community in Context, 397-422, (2006). ISBN: 1846282675. Springer.

In this chapter, we discussed the design and the prototype implementation of an innovative tourist audio guide. This was conceived combining together several new technologies in such a way as to deeply modify the visiting experience. The technologies we used allowed multiple information structures to be overlaid on the physical world in a non-intrusive fashion, opening up new possibilities for creative design. The technologies in question include both hardware (localisation technologies, radio LANs, handheld computers) and software (adaptive text generation, GIS, user modelling, etc.). The result, while not a commercial system, offers many advantages over commercially available systems. It allows communication between members of a community via the public availability of 'hotspots'. The presentations are adapted, firstly to the context of interaction (what have they heard/seen before, etc), and secondly in regards to the very way they appear to use the museum (visiting style modelling). This experience demonstrates that the success of entertainment or edutainment systems, especially those exploiting advanced technologies, strongly relies on a design philosophy that mediates between a deep and continuous focus on the users and innovative visions.

A further valuable result of our work, and all I^3 projects, is the sharing of expertise between the consortium members -- the connected community of research. We each came away with knowledge held elsewhere in the consortium, and have established strong research links between the institutions.

References

Bianchi A., Zancanaro M. (1999) Tracking User's Movements in an Artistic Physical Space. In Proceedings of I3 Annual Conference, Siena October 1999.

Bordegoni M., Faconti G. Maybury M.T. Rist T. Ruggeri S. Trahanias, P. Wilson, M. (1997) A Standard Reference Model for Intelligent Multimedia Presentation Systems, Computer Standards and Interfaces, 18, pp. 477--496, 1997

Chen, S., Magoulas, G. (2005). Adaptable and Adaptive Hypermedia Systems, IRM Press, 2005.

Csikszentmihalyi, M. (1990) Flow, The Psychology of Optimal Experience New York: Harper Perennial.

Collier, R., O'Hare, G. M. P. Lowen, T. D., Rooney, C. F. B. (2003). Beyond Prototyping in the Factory of Agents, Proceedings. 3rd International Central and Eastern European Conference on Multi-Agent Systems (CEEMAS), Prague, Czech Republic.

De Bra, P. Brusilovksy P., Houben G. (1999) Adaptive Hypermedia : From Systems to Framework.

Hutchins, E., (1995) Cognition in the wild, MIT Press.

Isard, A., Oberlander, J., Matheson, C. (2003). Speaking the User's Language, IEEE Intelligent Systems, vol. 18, no. 1, pp. 40-45.

Mann, W.C., Thompson, S.(1987) Rhetorical Structure Theory: A Theory of Text Organization, In: L. Polanyi (ed.): The Structure of Discourse, Ablex Publishing Corporation, 1987.

Marti, P. Rizzo, A. Petroni, L. Tozzi, G. Diligenti, M. (1999) "Adapting the museum: a non-intrusive user modeling approach", Proceedings of UM99, Canada.

Marti, P., Ciolfi, L. Gabrielli, F. (2000) "Designing auditory spaces", Proceedings of the Annual Conference i3AC2000, Joenkoeping, Sveden, September 2000.

Marti, P., Gabrielli, L. Pucci, F. (2001) Situated Interaction in Art, *Personal Technologies*, 5:71-74, 2001.

Marti, P. Lanzi, P. (2001) "I enjoyed that *this* much!" A technique for measuring usability in leisure-oriented applications, In Joanna Bawa & Pat Dorazio, The Usability Business: Making the Web Work, in press.

Norman, D. A., (1993) Things that make us smart, Addison-Wesley, Reading, MA.

Norman, D. A. (1999). The invisibile computer MIT Press.

Not, E. Zancanaro, M. (2000) "The MacroNode Approach: mediating between adaptive and dynamic hypermedia" In Proceedings of the International Conference on Adaptive Hypermedia and Adaptive Web-based Systems, AH'2000, Trento, August 2000

Oberlander, J., O'Donnell, M., Knott, A., Mellish, C. (1998) Conversation in the museum: experiments in dynamic hypermedia with the intelligent labelling explorer. In The New Review of Hypermedia and Multimedia, vol. 4**, pp.** 11-32.

O'Grady, M.J., O'Hare, G.M.P. (2002). Accessing Cultural Tourist Information via a Context Sensitive Tourist Guide, Information Technology and Tourism Journal, Vol.5 No.1 Cognizant Publishers.

Marti, P., Zancanaro, M, O'Hare, G., O'Grady, M, Not, E., Bianchi, A., O'Donnell, M., Serving Visitor Communities: A Mediated Experience of the Arts. In: (Ed. P. Purcell) Networked Neighbourhoods: The Connected Community in Context, 397-422, (2006). ISBN: 1846282675. Springer.

O'Grady, M. J., O'Hare, G. M. P. (2004). Just-in-Time Multimedia Distribution in a Mobile Computing Environment, IEEE Multimedia, vol. 11, no. 4, pp. 62-74.

O'Grady, M.J., O'Hare, G.M.P., Sas, C. (2005). Mobile Tourists, Mobile Agents: A User Evaluation, Gulliver's Genie, Interacting with Computers, vol. 17, no. 4, pp. 343-366.

O'Hare, G.M.P. (1996). The Agent Factory: An Environment for the Fabrication of Distributed Artificial Systems, In: O'Hare and N.R. Jennings (eds). Foundations of Distributed Artificial Intelligence,. Sixth Generation Computer Series. Wiley Interscience Publishers, New York.

O'Hare, G. M. P., O'Grady, M. J. (2003). Gulliver's Genie: A Multi-Agent System for Ubiquitous and Intelligent Content Delivery, Computer Communications, vol. 26, no. 11, pp. 1177-1187.

Petrelli, D. Baggio, D. Pezzulo, G.(2000) "Authors, Adaptive Hypertexts, and Readers: Supporting the Work of Authors for User's Sake", In Proceedings of the International Conference on Adaptive Hypermedia and Adaptive Web-based Systems, AH'2000, Trento, August 2000.

Stock, O. (1999) Was the Title of this Talk Generated Automatically? Prospects on Intelligent Interfaces and Language, Proceedings of IJCAI99, the 16th International Joint Conference on Artificial Intelligence, pp. 1412--1419, Stockholm, 1999

Veron E. Levasseur M. (1983) Ethnographie de l'exposition Bibliothèque publique d'Information, Centre Georges Pompidou Paris 1983.