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"Augmented itineraries": Mobile services differentiating what museum has to offer

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ABSTRACT

Museums are the mechanism through which we research, interpret and present our insights into the natural and cultural worlds. They represent our belief systems concerning cultural inter-relationships, our relationship with the environment and of our place in the Universe. They are windows on the "dream-time" of humanity.
Wireless technology is becoming a part of the museum experience. In an effort to bring art and science to life for a new generation of technically sophisticated patrons, an increasing number of museums are experimenting with advanced mobile technologies to make museum going more interactive, more educational — and more fun. An ideal electronic guide to a museum is one that you take at the entrance, put in your pocket and forget you have. It should fully support a free, natural visit providing the most appropriate information at the right time and place. The only activity required of visitors is to enjoy the exhibition: the interaction is with the (augmented) museum, no longer with the guide; the guide analyses the context and composes presentations adapted to the current situation.
In this paper we present the results of an experimentation conducted in the Florence's Uffizi Gallery with groups of user using the MOBILearn systems a novel application based on innovative mobile-learning services specifically designed to improve the Museum "experience". The main objective of this paper is to describe the results of qualitative research into the behavior of users during the trial. In particular the paper will present the participants' overall experience, responses and needs; the participants' responses to, and perceptions of, specific system capabilities (including responses relevant to the particular device they used in the trial), pointing to comments and suggestions that may serve to improve the system; and will finally identify "key findings" and provide general observations on how the MOBILearn system can change users' experience of a museum.

Keywords: *mobile learning, interactive services for museums, user experience, augmented itineraries.*

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1. Introduction

Museums are the mechanism through which we research, interpret and present our insights into the natural and cultural worlds. They represent our belief systems concerning cultural inter-relationships, our relationship with the environment and of our place in the Universe. They are windows on the "dream-time" of humanity.

Wireless technology is becoming a part of the museum experience. In an effort to bring art and science to life for a new generation of technically sophisticated patrons, an increasing number of museums are experimenting with advanced mobile technologies to make museum going more interactive, more educational — and more fun. An ideal electronic guide to a museum is one that you take at the entrance, put in your pocket and forget you have. It should fully support a free, natural visit providing the most appropriate information at the right time and place. The only activity required of visitors is to enjoy the exhibition: the interaction is with the (augmented) museum, no longer with the guide; the guide analyses the context and composes presentations adapted to the current situation. Of primary importance in an augmented museum is the interpretation of both visitors' behaviour (e.g., stops, long stay, coming back) and the context where the action takes place. The places of use (a museum, the open air), the device (a PDA, a phone) or the available infrastructure (networks, GPS, infrared) are as important as social aspects (e.g., being alone or not, who the others are, if this brings pressure) and personal traits (e.g., attitudes, preferences, interests). In this paper we present the results of an experimentation conducted in the Florence's Uffizi Gallery with groups of user using the MOBILearn systems a novel application based on innovative mobile-learning services specifically designed to improve the Museum "experience".

2. The MOBILearn Project

The MOBIlearn project, co-funded by the European Commission, the National Science Foundation and AU Department of Education, Science and Training in July 2002, is strategically positioned to provide relevant research outcomes in the field of innovative use of mobile environments to meet the needs of learners, working by themselves and with others (www.mobilearn.org). The MOBIlearn project directly targets priority areas for the knowledge society, and addresses the need for Europe to stay dominant in the crucial area of mobile applications. The MOBIlearn project exploited a partnership that is truly international, capable and influential, including well-known Universities with a large user-base (Open University, University of Birmingham), and calling on expertise from two US World-level academic institutions (Stanford University and OKI/Massachusetts Institute of Technology), mobile operators from four countries (Telefónica, Cosmote, Deutsche Telekom, Telecom Italia), European-leading commercial organisations (Space Hellas, GIUNTI Ricerca, Emblaze Systems, University for Industry), World-class mobile devices manufacturers (Hewlett-Packard, Nokia), and Australian on line learning content providers (www.education.au). The objective of the project is to improve the knowledge level of individuals through cost and time optimization of learning processes. This maximises the opportunities of three representative groups (Taylor, Murelli, Brugnoli, Frohberg, Clow, McAndrew, 2005):

- Workers, to meet their job requirements and to update their knowledge continually;
- Citizens as members of a culture, to improve their learning experience while visiting a cultural city and its museums;
- Citizens as family members, to have simple medical information for everyday needs.

3. The integrated MOBILearn System

From a technical point of view the development of MOBILearn System was aimed to the creation of a virtual network for the diffusion of knowledge and learning via a mobile environment where, through common themes, it is possible to demonstrate the convergence and merging of learning supported by new technology, knowledge management, and new forms of mobile communication. This also creates a virtual point of mobile access to content that could be used at a European and International level. A subsidiary goal is to develop deeper understandings of the social processes and interactions that arise when connectivity reaches a critical point, so that we are alert to the possible emergence of "ambient intelligence" equivalents of the widespread take-up by users of SMS. To this end, from the technical point of view the main objectives are to design, develop and operate the MOBILearn system, as a reference mobile learning architecture, to be accessed by the consortium partners and users in trials. In order to obtain a final system that is actually able to provide effective and efficient mobile learning services, it is necessary to design, develop and implement the single modules within a more general and “high-level” framework. Instead of designing a "vertical" architecture, probably able to support only few specific mobile applications, it has been preferred to make the effort of developing an open abstract framework for mobile applications, within which single "concrete" services can be implemented. This choice was motivated by the need of guaranteeing the interoperability amongst different applications and the possibility of using existing modules and services to develop new mobile applications.

The process that has been followed for MOBILearn is to develop an *Open Mobile Access Abstract Framework (OMAF)* based on layers of infrastructure and application profiles, instead of targeting a single vertical architectural implementation. Since its purpose is only to focus on the interfaces between layers, in order to ensure a good level of interoperability, the OMAF does not need to be implementable in detail. Notwithstanding, an "instantiation" of the OMAF model has to be implemented into a demonstrator and tested in real users' trials. As it is perceived today, the OMAF model should bring to data extensions (such as mobile/location aware learning objects, with geographical references included in their metadata structure) and new services definition which could sit on top of the infrastructure and learning services, under definition within IMS-ALF and OKI initiatives. The MOBILearn system results from the integration of several subsystems, each one providing mobile learners with a specific set of functionalities and features. Since not all components are relevant to this paper a set of them have been chosen to be described in the following paragraphs: the MOBIlearn Learning Content Management Subsystem, MOBIlearn Adaptive Human Interface Subsystem, the Context Awareness Subsystem.

3.1 The Learning Content Management Subsystem

On the basis of the requirements and specifications of MOBILearn, an existing learning content management system (LCMS), which was already a distributed architecture interfacing with one or more repositories of learning objects, has been adapted to the specific needs and requirements of mobile learners. The LCMS was developed natively in xml, with data models and storage formats fully compliant with main e-Learning specifications, including *IEEE LOM* and *Content Packaging*.

3.1.1 Description

The subsystem produced by WP7 is essentially a complete Learning Content Management System (LCMS) that can be used to create, manage, index, publish and deliver on desktop and/or mobile devices instructional or knowledge based content in the form of Learning Objects (LO). The system allows for a scale of delivery superior to a simple Learning Management System due to its ability to create, store and reuse a vast range of Learning Objects. The proposed subsystem combines the function of administration and management with content creation and customization. The subsystem offers a comprehensive knowledge resource from which instructional content can be assembled and delivered to multiple mobile users. The subsystem provides:

- instructional designers with the ability to create new contents aimed at addressing specific training needs or the assembly of new learning objects from existing instructional content
- content editors with the facility to edit and approve new course content prior to publication
- tutors with the means to determine the administrative parameters in accordance with instructional requirements, user profiles and course registration
- system administrators with a means of continuously updating course resources in accordance with training needs
- learners with a mobile access to contents through a user-friendly interface and an intuitive interaction approach

The mobile learning content management subsystem can be specifically customized to provide information that is directly relevant to instructional needs. Equally, the administrative features can be tailored to provide a wide range of parameters designed to direct users to specific courses, track their progress, monitor their performance and interface with development plans and assessment procedures. Every feature of the LCMS is designed to provide just in time mobile learning that is relevant and manageable.

The subsystem has been designed and developed to accommodate the needs of different types of users:

- A system administrator who manages the overall process and assigns roles
- A portal administrator who personalizes the layout, monitors the use and manages the enrolment (subscription and management) of users (and groups of users) to contents
- A publishing process administrator who manages the status of contents published on the repository
- Authors who are enabled to produce learning objects, to edit them and to publish them on a repository

- Mobile learners who can access complex contents and learning objects available to them, as well as services (chat, forum, etc.) of the portal.

3.1.2 Functionalities

The Learning Content Management Subsystem is composed by several modules, each one capable of providing specific functionalities to the users previously mentioned.

Production and Packaging of Information Objects: is a client/server module that allows the creation of Learning Objects according to widely accepted standards and specifications (IMS/SCORM, LOM, AICC, etc.). Can be used also for indexing rough resources (images, videos, audio files, text, etc.), through the use of metadata. A light version can be accessed by end users (learners) to produce, package and store their own objects

Information Objects Storage: Local and/or remote repository used by the packaging module to store and retrieve indexed resources. It is based on an XML-native database. Can be used also for recording information about the users (profiling)

Semantic Priorities Tagging: software module that enables content designers/owners to create structured (multi-media) learning objects to tag the different components with *semantic priorities*. This allows to automatically re-structuring the learning object according to the user profile, the pedagogic objectives, the features of the devices adopted in MOBILearn and used by the mobile learner. This solution will preserve existing collections of learning objects, but it could imply a review and adaptation of IEEE LTSC standards for mobile learning;

Content Delivery: a web-based module that actually delivers the Learning Objects. It is a complete Learning Objects Management System (LOMS), which allows for the customisation of the default layout for each user. Provides additional services like: chat, forum, e-mail, etc. Both the use of Learning Objects and the users' performances are traced.

Content Multi-Rendering: is devoted to the rendering of delivered contents. It allows for a flexible and effective delivery on different mobile output devices: notebooks, tablet PCs, PDAs, mobile phones, etc. It automatically re-engineer (e.g. re-sizing, re-sampling…) learning objects composed by a single media according to the different devices features and learner's context.

3.2 The Mobile Media Delivery Subsystem

3.2.1. Description

Emblaze developed and commercialises a platform suitable to enable the delivery of media content to mobile users. This platform uses advanced compression technology, real-time streaming technology and advanced bandwidth adaptation techniques to enable the delivery. The Mobile Multimedia Delivery Platform (MMDP) incorporates the following elements:

- Encoding capability for creating media content;
- Streaming server capability to deliver the media content;
- Software players allowing access by handheld devices via cellular technology

Emblaze Mobile Multimedia Delivery Platform is designed in a way that allows the delivery of Media by a variety of applications. Each MMDP component is supplied with an API layer that allows flawless integration to any application within service solutions that will require delivering media by a mobile application.

3.3 The Adaptive Human Interface Subsystem

An adaptive user interface can be defined as “*a software artifact that improves its ability to interact with a user by constructing a user model based on partial experience with that user” (Langley, 1999, 358) . This kind of focus has not been possible in The Adaptive Human Interfaces development team, because the overall development focus in the project has been in optimising content (and user interface) for different devices and scenarios. It can also be noted that adaptive user interface development requires a lot of research on user models and finally lot of data about user’s behaviour and its changes.*

The task of the Adaptive Human Interfaces development team has been to identify and document the basic components of the adaptive human interfaces subsystems and to define the interfaces with the other subsystems. Additionally, the user interface (UI) prototypes have been designed to evaluate personal navigation services by the users in different contexts of user and in different devices. The overall research and implementation challenge has been: How to adapt the user interface to different terminals, scenarios (Museum, MBA, Health), user needs, task models and evolving user skills.

3.3.1 Description

The first user interface versions were created in Flash and HTML and they were optimised for PDA. These prototypes where then evaluated and a storyboard with function calls were illustrated. This was done to visualise UI both for technical and non-technical people. Next prototype versions were created for Jetspeed environment utilising XML-structure files, XSL-stylesheets, Javascript and Velocity templates in portlets. Architectorally speaking, the Adaptive Human Interfaces Subsystem consists of Personalisation, Customisation and services which are in connection to Portal and Context Awareness Services.

The functionalities:

- To provide a consistent look and feel
- To provide support for navigation and for memorisation
- To provide enable an enjoyable user experience
- To support different devices (optimised for a Compaq iPAQ, Tablet PC and Nokia 6600) and optimise usability for them
- To enable different functionality, navigation logic and menu structure in 3+1 scenarios (MBA, MBA game, Museum, Health)
- To enable menu structure changes on the fly based on context awareness information. This requires multiple XML parsing phases (like DOM-tree is parsed with XSL files)
- To provide information on the screen about the changing context to the user (like informing about new users in chat or informing about a space or room facilities)

Additionally, some functionalities are common with CA Context Awareness subsystem.

3.4 The Context Awareness Subsystem

3.4.1 Description

The University of Birmingham, partner of the MOBILearn project, has developed a context awareness module (CAM) designed to facilitate context dependent content delivery for learners using mobile devices such as phones, PDAs, and tablet PCs. The CAM is intended to provide learners with a way to access appropriate content on their mobile devices without having to pay too much attention to searching and querying the set of all available content. The CAM incorporates the following elements:

- An object-oriented software architecture that allows the creation of customised listener objects that respond to the learner’s current context of use
- A set of exclusion and ranking algorithms that provide a rating for each item of content currently available, matching the current context with meta-data on the learning content
- An inspectable and modifiable display of the current inferred context that allows the learner to view and change assumptions made by the module

The CAM and its underlying architecture are designed to support flexible re-use by non-expert users by providing a generic, re-usable architecture with the means to define customised listener objects using a structured textual description. The CAM itself is designed to sit below a delivery module, providing recommendations for content delivery. The CAM also addresses the need to provide learners with recommendations about *resources* (e.g. local data stores and personal files) and *services* (e.g. communication links to other learners and more remote data stores).

3.4.2 Functionalities

Context Awareness Architecture

The context awareness architecture is a software architecture implemented in Java. This architecture provides a framework for the creation of customised context awareness functionality through the provision of context feature listener objects that respond to the learner’s current context. These features use elements in the current context to determine which content is most appropriate for the learner at the current time. This process is driven by a set of exclusion and ranking algorithms.

Exclusion and Ranking Algorithms

The CAM uses a process of exclusion and ranking to determine appropriate content. Exclusion is typically driven by technical constraints, e.g. the display capabilities of the learner’s device, whilst ranking is more typically driven by learner goals and preferences. The system can be set-up to provide default exclusion and ranking capabilities, but these processes can be inspected and modified by both content providers and the learner themselves.

Context Awareness Interface

Whilst the CAM itself does not provide a graphical user interface, it is designed to interact with an interface module that can display the current inferred context and the assumptions made in inferring that context. This display also allows the learner to change the values of the context features, thus changing the inferred context and altering the content recommendations. In this way learners are given a way to inspect and control the context awareness module.

4. Running the Trial

4.1 Trial: execution and context

In parallel with the final refinement of the technical prototype the next step was to organize the User Trials. Three trials were carried out on December 6, 2004 in Florence's Uffizi Gallery. During these trials, "real" users tested the MOBILearn system. The trials took place in two galleries (Fig.1): **-The "Leonardo Gallery",** containing 11 canvases including "The Adoration of the Kings" and "Annunciation", by Leonardo Da Vinci; **-The "Botticelli Gallery**", containing 19 canvases including "Allegory of Spring" and "The Birth of Venus" by Sandro Botticelli. Altogether, 28 participants took part in the trials. Each trial lasted about an hour. For logistical and security reasons, the trial was carried out on a day when the Museum was closed to the public. This clearly changed the participants' experience: the museum would normally be full of tourists. Each trial consisted of the following phases:

- MOBILearn project presentation and introduction to the trial. Before the trial began, participants received a brief presentation about the MOBILearn system, the project's objectives and the trial. The presentation lasted about 15 minutes. It took place in the first room, the Leonardo Gallery.
- Device distribution and an introduction to system capabilities In the next phase, the devices that would be used by participants to access MOBILearn services were distributed. Each participant received one of the following devices: mobile phone, PDA, notebook or pocket PC. Technical support staff then showed participants how to use their devices to access the MOBILearn system. The support team gave special attention to those participants using PDAs or notebooks. (This team was composed of project partners. The team provided technical support throughout the trial.)

- Execution: Once the devices were distributed, and the necessary information provided, participants began their tour of the two galleries.

4.2 Specific characteristics of the Uffizi

Some of our findings of our study are valid for any form of mobile learning in a museum or art gallery setting. However, it is important to bear in mind certain specific characteristics of the Uffizi and of the two galleries used for the trial.

- The Uffizi provides very little information for visitors (just the name of the painting, the date and artist’s name);
- The Uffizi is a spacious environment that does not always appear to have a rational layout. Most galleries are larger than 100 m2;
- The Uffizi displays a very large number of artworks in each gallery, this is especially true for the Botticelli Gallery;
- The gallery displays a huge number of works which, although well-known to the general public, are complex and hard to interpret.

4.3 User recruitment

On December 6th 2004, the MOBIlearn users trial took place at the Uffizi Gallery in Florence. Università Cattolica del Sacro Cuore undertook a long and thorough process of selection in order to gather as many students (both foreign and Italian) as needed for this trial. At the end, six schools with a total of 80 students took up the challenge and accepted to test the MOBIlearn system. Unfortunately, two working days before this test the Uffizi Gallery administration informed us that due to security problems only 10 ‘external’ people (basically those who do not have any inside ties with the Gallery) were allowed to enter the museum. Therefore, from 80 students it became necessary to select only 10 people and the choice fell on the Middlebury College. The Uffizi Administration chose two groups of people from the Association “Amici degli Uffizi” and from the School of Restoration in Florence, which joined the afternoon session of the trial. The test then involved three groups of people for a total of 28th users, with an interval of 1 hour and a half between one and the other: the Middlebury College, all foreign students coming from various parts of U.S.A., the ‘Amici degli Uffizi’, who played the part of art experts, and students from a Restoration School in Florence. The group of users participating to the trial was composed by: female (33%) and male (67%) of which 33% between 18 and 25, 11% between 26 and 30, 45 % were aged between 31 and 60 years, and 11% over 60. Most of the participants (54%) had a high familiarity with new technologies since the rest of the group was composed by participants with low familiarity with technology (46%). Grouping the participant by age (two groups: the first "young" composed by participants with age lower than 31; "adult" the second over 31) the familiarity with technology was higher in the "young" group: here most of the participants (70%) reported a high familiarity with new technologies, in the adult group 40% of the participant reported an high familiarity.

4.4 Research methodology

The qualitative research conducted for this study took the form of **participant observation**. This methodology is borrowed from anthropological research. In it, researchers observe subjects in a natural setting. In this trial, researchers observed the interaction and relationships between trial participants, the MOBILearn system, the devices used and the museum environment. The advantages of participant observation are immediately clear when we compare this option with other methodologies. Surveys and interviews use eye-witness accounts, opinions and impressions. These responses tend to be filtered by memory or by the perspective of the interviewee. However, anthropological research gathers information on the same subjects using direct observation. This avoids the *noise* produced when obtaining the same opinions through an interview. Another important advantage is that interviews and questionnaires typically gather information from individuals isolated from their social environment. Participant observation allows researchers to consider (and collect data on) individuals as actors and integrated components in their social environments. From this point of view, anthropological methodologies allow researchers to study and respond to individuals not as "atoms" but rather as "molecules" (Coleman, 1990).

4.4.1 The Participant observation

The results reported in the following paragraphs were gathered using "participant observation" (Murelli, Brugnoli, 2004). In this methodology, borrowed from anthropology, the role of the researcher is that of "investigator", observing participants in a real-life situation, and taking note of what happens in this situation and how it happens. The observer is not necessarily engaged in the activity being observed, but he or she is visibly present and is collecting data with the knowledge of those being observed. In the Uffizi Museum trial it was impossible for observers to be anonymous and/or hidden because of logistical constraints; at the same time, it was necessary to provide participants with technical support: some researchers took on the role of technical support staff in the event that participants needed assistance in using the system. Given these constraints participant observation was the only option available. The research was carried out in two different modes:

- **Non structured observation**, in which researchers observed participants in a completely “open” manner without the use of timetables or checklists. This form of observation allowed researchers to gather information flexibly, and to extract the richest possible data from the field.

Fig. 1. “Researcher taking notes during the trial”

- **Structured observation**, in which researchers took a note of participant behaviour using an “observation card”. This tool was composed of a checklist containing pre-defined items. The observation card helped researchers to reduce the volume and complexity of the data they were collecting. The card also assisted the structuring and organization of the results of observation. The observation card that was used during the Uffizi Museum trial is available in the appendix. Alongside questionnaires were used to collect specific information from the users: although they are not the focus of this paper a brief summary of the outcomes of this quantitative study are summarised here in 5.2 and detailed in (Taylor and Bogdan, 1984).

5. Running the trial

5.1 The experience

Most participants seemed satisfied with the trial. The vast majority immediately became involved, becoming so “absorbed” by the system that they seemed to “forget” about the world around them. The initial reaction of participants was one of curiosity and strong interest in the project. When they first entered the galleries (after taking a quick look around them and listening to a brief introduction from program coordinators) they took to the devices with enthusiasm. Participants were of various ages. Age seemed to play an important role in determining their experience during the trial.

- **Young participants**: Participants in this group appeared to be the most satisfied, using the system extensively, and adopting a playful, interactive approach. The general feeling of these participants was that the trial provided an opportunity for dynamic learning. They frequently returned to works they had already seen, exploring first the rooms and then the system. They were interested in "*harnessing…making the most of* " the content offered by the system. *"I really like it, I want to find out about everything*!"
- **Adult participants**: Older participants were more critical of the system, especially where they had relevant experience and/or considered themselves "art experts". Criticisms were not motivated by a lack of satisfaction with the MOBILearn system but rather by the presumed "sacredness" of a museum like the Uffizi, which participants saw as a "special place". These perceptions became weaker as the trial went on, and a positive appreciation of, and interest in, the system began to emerge. The "art experts" were also highly critical of the information provided by the system, even when they were completely satisfied with the way it worked. The way that they used the information was, however, different from that of other participants. For example, all participants listened to audio files giving information about the artworks. However, the art experts (unlike most other participants) did not use this information to learn about the works but as a starting point for discussion, a way of kicking off a debate on artistic issues.

Not all participants were equally familiar with new technologies. Two groups emerged:

High level of familiarity with technology: Once introduced to the system, and having understood its structure and capabilities, this group of participants interacted with the system confidently. Most had little need of technical support. These participants explored the system extensively before asking for technical support. Technical support was used not so much to resolve problems, as to find out more about the system's capabilities.

Fig. 2. "Art expert listening audio file during the trial"

- **Low level of familiarity with technology**: People in this group were not familiar with the technological devices they received. They turned to fellow participants for help, often guided by a member of the support team. These participants saw the group environment as a place to learn about the system, and to share their discoveries with others. Despite having little familiarity with new technologies, not a single user abandoned the trial or expressed any dissatisfaction with the service. The system generated interest and curiosity in participants, who proved very willing to take on board new information.

5.2 MOBILearn system functions

Below we describe participants' responses to the most important elements of the system, their needs with respect to these elements and their suggestions for improving the system.

Accessing the system: Some participants found it took too long to register. The length and complexity of the registration process created high expectations. Such expectations were fostered by the vast quantity of information the participants were required to provide "in exchange" for system services. Many participants expected a greater – or at least comparable – quantity of information from the system. In some cases, this set off psychological mechanism whereby users *wanted something in return* for what they were giving. "The more information I provide to the system, the more I expect in return." Due to such expectations, a number of participants were left feeling disappointed and dissatisfied. Other participants were completely unwilling to provide the system with information. They felt that the purpose of the system was to provide, not request, information. Some people were frustrated with this dynamic, asking each other "are you getting any information?"

Fig. 3. "Technical support during the trial"

Some participants were worried that, if the service was made commercially available, data provided for log-in purposes might be used for commercial gain. Many suggested that the authentication and log-in procedures should be faster and simpler. These findings confirm the results of a number of studies which clearly show that a log-in process that takes more than a few minutes (or indeed any requirement to provide information before accessing a web-based service) leads many users to abandon the service (Nielsen, 2000).

- **Navigating**: Some participants felt that the navigation functions were neither simple nor intuitive. When they used the system for the first time most participants had difficulties in exiting applications or moving from one application to another. On subsequent occasions, participants were able to use the system more quickly and experienced no such problems. Taking this factor into account, we can thus define the accessibility and usability of the system as quite good. The learnability of the system, defined as the ease with which users can recognize and use various functions after using the system once, can be defined as good.

- **Conducting searches**: Participants perceived the search function as very useful. Some participants, however, found the experience of carrying out a search unsatisfactory, frequently complaining that the search criteria were not flexible enough: “I put in Da Vinci and I didn’t get any results!”. Participants also indicated that they needed to carry out more advanced searches than the system allowed.

Fig. 4. “Search function picture captured during the trial”

For example, in addition to carrying out a search by typing in the title of a given work, participants also wanted to use other search criteria, such as period, artist’s name, the name of the room in which specific works are located, the theme of the picture, painting techniques, etc. In certain cases, the search tools were seen as unresponsive, with some participants even asking for technical support to allow them to understand what sort of information needed to be inserted as search criteria.

- **Chat** : At first, participants failed to identify the chat function. In many cases the technical staff had to suggest that participants use the function, and then explain how it worked. Most people were surprised and impressed by the function and immediately understood how it worked and wanted to use it. All participants enjoyed using chat for the first time and were satisfied by the service. There was little or no need to deploy chat as a communications tool due to the limitations of the trial environment, an empty museum with a group of no more than 8 participants. Despite this, people had fun using the facility and appreciated chat as facilitating enjoyable exchanges. In many instances, participants were enthusiastic about the idea of being able to use chat if they were visiting the gallery in a large group. Participants thought that the ability to share information and to chat would be practical and thus popular. Many, especially younger participants, were keen on the idea of using the service to save, download and print conversations. They would thus have a textual photograph to remind them of their visit to the museum.-

- **Feedback**: In certain cases, the system failed to provide feedback allowing participants to understand what was happening inside the system. Some people felt confused by the system: “what happened?!” The participants also commented that it was unclear, and difficult to check, whether or not the system was connected.
- **Audio files**: The audio files were widely appreciated and frequently used by all participants, especially those with PDAs. In many cases, it was this facility that played the most important role in evoking a sense of presence and of participation. It was particularly important for participants using PDAs, which were sometimes under-used due to accessibility and usability problems (see below).

5.3 Experiences with devices

Participants received a variety of devices (either a mobile phone, a PDA, a pocket PC or a notebook) and so had different experiences during the trial. Moreover, the interface of each device was slightly different, meaning that accessibility and usability changed between devices. The pocket PC and notebook interfaces featured better usability than the mobile phone and PDA interfaces. Therefore, participants using these devices had not only inferior accessibility regarding their device, but also in terms of the MOBILearn system as a whole. People allocated PDAs or notebooks typically sought technical support only to confirm that they were using their instrument or the system correctly. Those with a general familiarity with new technologies who were using the more accessible interfaces typically needed little training or support from technical staff. Below, we describe participant responses to the three different types of device and identify user needs.

- **Mobile phones:** Mobile phones were the least popular and least used devices. Most participants had to repeatedly ask for assistance from technical staff. Participants found it difficult to navigate the system and to understand its capabilities. This meant that the vast majority of participants tended to interact very little either with the MOBILearn system or with the museum exhibits themselves.

- **PDAs:** These devices were quite popular. PDAs were much more than a “compromise between an audio-guide and a mobile phone”. They were perceived as providing attractive multimedia information. The only criticism participants had was that navigating the system proved difficult. Many people asked technical staff for help with navigation. It is worth highlighting that people using the PDA responded enthusiastically to the MOBILearn system. They thought that MOBILearn services offered a “little something extra”. The device, however, was generally considered not particularly useful.
- **Pocket PCs and notebooks**: These were the most popular devices. Participants given pocket PCs and notebooks used them more than users with PDAs and phones used their devices. Participants explored the functions of these devices extensively. People using pocket PCs and notebooks spent longer on their tour and had a more intensive experience than those using other devices. Young people and especially young women, were particularly enthusiastic. They saw the devices as an extension of their personal diary or calendar, a place to write, note down appointments, play games and exchange messages.

Fig. 5. “Young girl using notebook during the trial”

This tendency to associate the best interfaces with an object as personal as a diary, meant that notebooks and tablet PCs were well appreciated by participants. People liked using the system and were quick in learning how to use the functions provided.

Participants using pocket PCs and notebooks were the most sociable, sharing their device with others and exchanging information and opinions. People with these devices worked well together thanks to the devices' ease of use, larger screen and accessible interface.

5.4 Quantitative results in brief

Alongside the qualitative studies about 600 visitors were briefly interviewed in Florence Museums and at the Duchy of castles in Parma and Piacenza (Italy) to establish their real requirements, needs and expectations. The visitors interviewed are part of a relatively young public (31% between 18 and 25 years old - 23% between 25 and 30); they visit museums and castles 2 or 3 times a year in their spare times or during holidays; almost of all of them have a mobile phone and 55% of those have a Nokia; few people (15%) have a palmtop. The results of this first part of the questionnaire are satisfying: the tourists find the services proposed that are accessible before entering the museum very interesting and useful. In particular, they are interested in booking the tickets in advance, in receiving information about the museum opening times and any related changes and in viewing the shortest route to reach the destination. The services proposed are appreciated by tourists because they see the possibility to find their way around an unknown town and they would like to avoid any type of inconvenience (changes in the timetables) especially during their holidays or a week-end. In the second part of the questionnaire dedicated to the specific requirements faced during the visit inside the museums, the results analysis highlighted the following issues. The services: "Viewing museum plan", "Planning the visit according to personal interest and requirements" and "Reaching the area of interest as quickly as possible" made a good impression on tourists. Opinions were positive about "viewing a catalogue of works by a particular artist and understanding the artist's techniques. Few people want or have time to make notes or comments during their visit except for those that visit museums for work or for study purposes. Opinions were positive on the use of an audio guide (32% of the persons interviewed gave a mark of 4 and 32% gave 5) as it is considered a good alternative to the traditional guide especially for those that usually make the visit alone. Finally, from a general point of view, it is possible to say that the tourists interviewed expressed positive opinions and interests on the use of mobile technologies and their applications.

6. Conclusion and key findings

Observing trial participants, it became clear that most were keen to interact with the MOBILearn system and were satisfied using the system. Indeed, participants in all three trials responded positively. Clearly the system can be improved, but considering that the trial took place in a real-life setting and that the system is a prototype, we can consider the results most encouraging. Most participants found the system was a *plus* compared to usual museum facilities. In a number of cases, in fact, the system was perceived as *the* actual museum facility, making the ability to benefit from the real physical environment (by looking at paintings, etc.) a secondary consideration. This response was common to various groups of participants, especially young people who, from the very beginning, approached the system positively and were keen to interact with it.

6.1 MOBILearn: differentiating what the museum has to offer

While participants were using the MOBILearn system, they interacted less with the museum environment. However, it is worth noting that, in most cases, the MOBILearn system was responsible for reintroducing interaction with the museum environment, putting the focus back on the artworks. Often, the system directed participants towards certain artworks, perhaps suggesting works that participants had not noticed, or which had not caused them to pause when they did notice them. In some cases, participants chose independently to focus on the artworks, often because they were irritated with the system or tired of using it. This happened most frequently in the case of participants given PDAs or mobile phones. The system modified participants’ interaction with the museum, creating or changing their expectations and needs. For example, they sometimes approached a work only to discover that it was not featured on the MOBILearn system, and it was not possible to find out any additional information about it. The participants’ reaction in such cases was always deep disappointment. When this happened, participants immediately withdrew from the canvas, even if was an important work. This illustration reported in the paragraphs below (realised by observing and tracking user’s paths during the MOBIlearn trial and the paths realised by a control group visiting the museum without using the MOBILearn system) confirms that the participants perceived the real service on offer as the possibility of exploring the museum with MOBILearn rather than the museum itself.

6.1.1 "Augmented" itineraries

Normally, visits to the museum tend to follow a "rational" itinerary. Visitors' itineraries often depend on the location of well known works, or on the physical organization of the museum. Figure 6 shows a typical itinerary: the different lines (blue, green and red coloured), indicate different itineraries usually covered by the visitors. The pictures in the figure indicate the different canvases; the structure and the shape of the room is based on the "Botticelli Gallery".

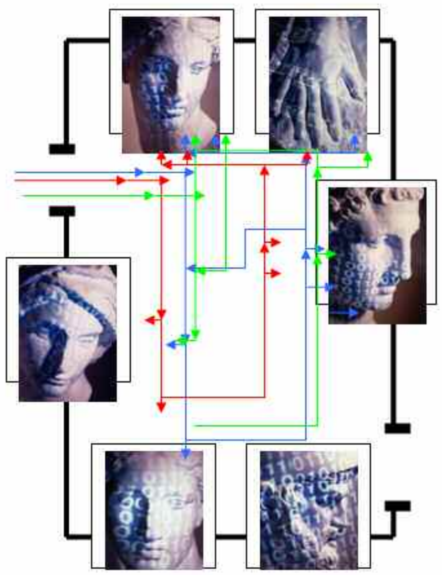

Fig. 6. "Rational itinerary"

Normally, visits to the museum tend to follow a "rational" itinerary. Visitors' itineraries often depend on the location of well known works, or on the physical organization of the museum. Figure 6 shows a typical itinerary. When using the MOBILearn system, itineraries and the experience of visiting the museum changed dramatically. Participants ceased to follow simple, linear itineraries and began take more complex routes through the museum. The route selected was no longer so strongly influenced by the museum's physical structure (and by the location of specific works). Instead, participants allowed themselves to be guided through an "augmented" itinerary suggested by MOBILearn (see figure 7). In this way, the museum transformed itself into a complex environment that could be controlled and monitored indirectly.

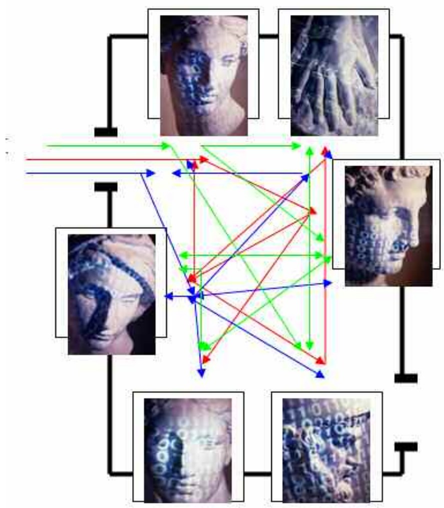

Fig. 7. “Augmented itinerary”

This is a significant finding for those involved in managing museum activities and organization (Griffin, 1987) since it allows staff to improve the management of visitor traffic. Using a system like MobiLearn, museum personnel could, for instance, reduce excessive flows of people into a particular gallery or limit the number of visitors accumulating in front of a particular painting. The support offered by a system like MOBILearn makes it possible to offer a rich and flexible service to museum visitors. The MOBILearn system also allows museum staff to monitor and manage routes taken by visitors. The system can thus be compared to the service provided by the Minneapolis Institute of Art which offers its visitors the option of using the Internet to access a vast amount of information that helps visitors “to plan a deep, organized visit”.

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