Els Vilars: A Study of a Cultural Heritage
Augmented Reality Device

Liou Yamane
Multimedia & Culture
Faculty of Exact Sciences
Vrije Universiteit Amsterdam
De Boelelaan 1081a, Amsterdam
Netherlands
lhyamane@cs.vu.nl

Jesus Lorés
Computer Science Department
Universitat de Lleida
69, Jaume II St., 25001
Lleida, Spain
int-34-973-702714
jesus@eup.udl.es

ABSTRACT
This paper illustrates how to apply human-computer interaction (HCI) paradigms such as augmented reality (AR), context awareness and adaptivity in an area of cultural heritage. Our current project consists in creating a functional prototype of a multimedia artefact used for an archaeological site in Catalonia, named Els Vilars. The aim of this device is to provide the visitor with cultural and educational multimedia content and offer him some AR and context-aware functionality by tracking his current position and orientation. To construct this prototype an iterative and user-centred design approach is used. The general goal of this research is to investigate how HCI paradigms are useful in the context of cultural heritage and which can be reused in similar archaeological or cultural applications, setting an example for future projects.

Keywords
Augmented reality, cultural heritage, context awareness, adaptivity and tracking.

1. INTRODUCTION
The development in the media used by cultural institutions is proceeding at a fast pace. The introduction of modern technologies offers a vast amount of new possibilities for museums, cultural centres or other educational organisations. Virtual Reality has been used for a significant period in order to make realistic reconstructions of past eras. It is now common to find multimedia kiosks in various museums. Experimental research has been conducted in creating smart devices that react to the visitor’s presence or to other devices, and even in robots that can offer guided tours [11][17].

AR represents the latest and most promising technological innovation. Various researches have been conducted in domains such as engineering, medicine, the army or maintenance. Even though the area of cultural heritage seems an equally appropriate area to apply this technology, relatively little investigation has been done in this field. In fact we know only of one project with similar interests to ours [12]. Our project will therefore seek to discover how AR and other HCI paradigms can be applied in a cultural context.

This article will continue by describing the archaeological site, the main aims of this project, the applied HCI paradigms, past achievements, the outline of the design process for our prototype and finally will end with a conclusion and a description of future work.

2. ELS VILARS SITE
This project evolves around an archaeological Iberian site of the Early Iron Age with a superficies of 8.000 m² and located near Lleida, in the province of Catalonia (Spain). Due to specific features such as its massive defensive system and high level of organisation for its epoch, it is a unique site within both the Iberian Peninsula and Europe (see Figure 1) [10].

The site was discovered in 1975 and excavations started in 1985 and are still being conducted at the present moment. A distinctive characteristic of the fortress is its exceptional collection of protective structures, which consists of a 5 meters thick wall with twelve attached towers, a barrier of stones dug into the ground (chevaux-de-frises) and a ditch of 13 meters wide and 3 meters deep.

Inside the wall we find a village organised around one circular street and a central space containing a well preserved cistern.

Figure 1. View of Els Vilars.

The chronology of the site can be divided into five phases: Vilars 0: 750-650 BC; Vilars I: 650-550 BC; Vilars II: 550-425 BC; Vilars III: 425-350 BC; Vilars IV: 350-325 BC.

The Els Vilars site has been declared a cultural good of national interest by the Generalitat de Catalunya (the government of Catalonia), the highest legal category for cultural patrimony. For this reason a directive plan (Plà Director) has been elaborated, of which the main aim is to propose how to adapt the site for visits by the public, i.e. by adding the necessary infrastructure and an
adequate management model for the involved institutions\(^1\). A provisional contribution to this has been to position several fixed panels containing text and images at Els Vilars.

### 3. AIMS OF THE PROJECT

The guide plan of Els Vilars, as described above, has the general objective of socialising the archaeological patrimony, i.e. to disseminate its knowledge throughout the population. This forms the direct stimulus for starting this specific project with its specific characteristic residing in following an HCI approach. In order to achieve this, a cooperation has been formed between the Grup de Recerca de l’Interacció Persona-Ordinador (GRIHO) and the Grup de Investigació Prehistòrica (GIP). The Spanish Department of Sciences and Technology awarded Els Vilars with a grant for the year 2004\(^2\).

The more traditional methods to provide information to the visitor consist of text panels, audio guides, videos and advanced interactive stands. In addition to or even possibly substituting these representations, the research groups opted for a multimedia artefact that is portable, interactive, adaptive and context-aware of the user’s surroundings. These characteristics will insure "(...) a type of visit that allows greater precision in the information depending on the needs of a user, greater interactivity for the visitor, who is the one who determines the quantity and quality of desired information about a point in question, in this way adapting the visit to his/her own profile"[9].

Hopefully in this way the visitor will be able to conduct a personalised visit that conforms to its specific needs and interests. This agrees with the pedagogical aim of the guide plan mentioned above: if the visitor will leave the site satisfied and with more knowledge about the history and cultural meaning of Els Vilars, albeit partial, the artefact will have reached its goal. In order to achieve this, specific paradigms of HCI will be applied; these will be described and explained in the following section.

### 4. USED PARADIGMS OF HCI

This project will form a generic example for applications within cultural contexts. Using well-established as well as new paradigms of HCI, we can lay out the principal components of the approach to follow to create this specific prototype and more generic applications.

#### 4.1 Augmented reality and context-awareness

##### 4.1.1 Theoretical concepts

According to current researches, Augmented Reality (AR) denotes a form of interaction where computer generated images (CGI) or more accurately computer generated information, be it 3D objects or 2D information such as text or pictures, are laid upon views of the real world, thereby combining existing and virtual scenes. The aim of this type of interface is to enhance the user’s perception of the world and therefore his performance [2]. We could also broaden the scope of AR to include other senses such as touch or hearing. Essentially its main characteristic would be to blend real and virtual information seamlessly. Until now however, the majority of the applications has been of a visual nature.

There are various contexts in which this technology can have a use, such as medicine, the army, engineering, entertainment or maintenance, among others. For example, the last domain could benefit from this technology by replacing extensive manuals with graphical cues highlighting the elements to repair or with online context-relevant documentation (see Figure 2). In this case, it would greatly diminish the cognitive workload of the user by providing the required information automatically.

Most of the AR systems form part of mobile computing as they consist of portable systems – it is also possible to combine real and virtual images onto a desktop computer but the use of this is limited (except if for example the camera would be remotely controlled). An additional category to which our artefact belongs is context-awareness, which denotes the ability to consider the user’s physical or emotional context and use it as additional input [6]. In our case this refers to the detection of the user’s position and orientation.

#### 4.1.2 Application at Els Vilars

Azuma quotes Robinett stating that AR might be useful in any application that requires displaying information not directly available or detectable by human senses, by making that information visible [2]. In our case this is relevant for a spectrum of information varying in degree of abstractness, ranging from concrete representations such as 3D reconstructions, drawings and photographs to more thematic background information of Els Vilars. For example, a regular visitor is not able to visualise the former edifices based on the few remains left. Therefore a reconstruction would benefit the user significantly. But a more abstract type of representation could also give him more insight into the subject; all of this depends on the type of visitor.

This type of representation is situated between the domain of AR and context-awareness. Not only are the former, historical buildings obviously invisible in the real environment, but neither is the thematic information associated with them. The position and the orientation of the user form the real world data that triggers the access to relevant data. This last characteristic is representative of location-aware systems, a subset of context-aware systems. It is evidently present in our application from the automatic localisation of the visitor inside Els Vilars.

---

\(^1\) Ayuntamiento de Arbeca, Diputación de Lleida, Institut d’Estudis Ilerdencs, Fundació 700 de la Universidad de Lleida, Consell Comarcal de les Garrigues and the Universidad de Lleida.

\(^2\) Spanish grant number: DIF2003-10370-E
The question remains whether this is a true application of AR. In any case, the condition of context-awareness is always fulfilled as there is an automatic detection of the user’s environmental context. The answer to this problem however depends on one’s interpretation. In all past AR-projects and researches there always has been a superposition of existing and computer-generated information (mainly video) inside the interface. In the final product, the user will see a virtual interactive model that is related to his position and orientation. When the visitor will look at the device and move with it, he will see how Els Vilars appeared in the selected period from his current point of view, a sort of virtual panorama. This will not make use of any visual input though and there will be no combination of real and virtual visual information within the device. After contacting Ronald Azuma he replied to us saying that “This is spatially-based information access, at the actual location and is certainly related but AR brings on additional issues”. Piekarski also feels it depends on one’s interpretation to call it AR or not. Referring to Milgram’s well-known reality-virtuality continuum (see Figure 3) we can situate our problem at the borderline of AR and the real environment. In any case it forms part of Mixed Reality [19].

![Mixed Reality](image)

**Figure 3. Milgram’s Reality-Virtuality Continuum**

### 4.1.3 Technical issues

The proposed virtual panorama function is the part of our project that technically forms the biggest challenge. For that reason it will be one of the last features to be implemented. We have created a futuristic scenario use case in the form of a video simulating this function.

To implement this functionality and the requirement of context-awareness we will have to track the user’s position and orientation. Accomplishing this in an outdoor environment is definitely not a trivial problem. Numerous publications about tracking have appeared and show that this is a field of intensive research; various problems still have to be done [8][13][14][15]. We can divide the known tracking methods into three main categories: vision-based, inertial-based or through positioning systems. Most of the current research is striving for greater accuracy by combining two of these options, e.g. optical and inertial tracking [21].

The first option uses visual recognition techniques to locate either natural features in the environment or artificial ones, so-called fiducials, which are strategically placed predefined shapes or infrared LED’s (respectively used by [26] and [24]). The system can deduce the user’s location comparing these elements with a known set of marks located in a matrix representing the map of the environment – and might even add new ones automatically [3]. So far we have not encountered any readily available applications for the recognition of natural features; this is the area in which most of the research still has to be done [13].

Inertial tracking combines electronic instruments of measurement such as gyroscopes, accelerometers and magnetometers. This technology is able to generate information about orientation, inclination or acceleration. The difference with the two other categories is that this information is complementary: it can not be used as the only source of information. Alone it allows determining the user’s orientation for example, but not its absolute position. Using methods such as dead-reckoning it may calculate a probable location relative to a known starting point, but this is not an accurate technique.

The third option can be divided into two subcategories: global and local positioning systems. The first one of course is better known as GPS. The regular version has an accuracy of between 100 and 5 meter [25]. This can be enhanced by using an additional base station with a predetermined and static position. In this way the delays in the satellite signals can be computed and compensated for, increasing the precision of the localisation to between 5 m and 50 cm. This method is called differential GPS (DGPS) [27]. Accuracy can also be improved to 1 m – 20 cm using a Real-Time Kinematic (RTK) satellite navigation system [29]. This uses a phase-corrected signal from a known position. Instead of using satellite signals local positional systems (LPS) make use of radiofrequencies and local beacons and sensors. For example, according to Ubisense its system delivers a precision of 15 cm [30].

With so many different methods the question remains which is the most appropriate for our case. After some literature research and contact through the ARTToolkit mailing-list, we came to the conclusions depicted in Table 1.

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-cost</td>
<td>Only fiducials (so far)</td>
</tr>
<tr>
<td>Accurate (at small distance)</td>
<td>Obtrusive (especially at large distance)</td>
</tr>
<tr>
<td>Portable</td>
<td>Dependent on lighting and weather</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inertial</th>
<th>Pro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-cost</td>
<td>Complementary</td>
</tr>
<tr>
<td>Small</td>
<td>Drifting</td>
</tr>
<tr>
<td>Portable</td>
<td>Relative</td>
</tr>
</tbody>
</table>

The vision-based system is easy to implement and is of low cost, but for the current moment works only with fiducials. The bigger the distance, the larger they must be and this is not acceptable in an archaeological site. The inertial system is merely complementary but will be useful to determine the user’s orientation by using a digital compass. Finally, the positioning systems remain the only options to establish the visitor’s location. LPS seems rather extensive as it requires various sensors and tags or beacons, which might prove difficult to place in Els Vilars. A system as DGPS should suffice for the final product and for the prototype we can use the less accurate GPS.

### 4.2 Adaptivity

As Dix explains, customizability – sometimes also called personalization – is “(…) the modifiability of the user interface by the user or the system” [6, p.171]. This consists of two elements: adaptability and adaptivity. The first term denotes an interface
which the user can change and configure. The second type refers to customisation of the interface by the system.

Our aim is to adapt the interface to the user profile. This will occur both on a level of adaptive presentation as on one of adaptive navigation support, as defined by Brusilovsky [5]. The first indicates that the appearance of the content may adapt itself to the user. The latter is more concerned with which content is made available through the navigation, in other words which links are formed between the information items. Nevertheless, the user will always have the possibility to gain access to a specific item not corresponding to his profile if he desires so. Therefore we can say the adaptivity is more of a suggestive nature than that it completely confines the user’s access of the information.

The aspects that will change in the interface depending on the type of user might consist of different use of image and text such as icons and fonts or special features like voice synthesis for persons with hearing impairments. Equally important is the form the navigation will take: narrative, explorative or restricted. The interface can mix any of those structures to adapt itself to the user’s characteristics. A linear, narrative introduction to a theme allows the visitor to calmly follow the discourse without any active browsing, akin to an audio guide. If the user wants to expand on a certain subject, a web-like navigation is more adequate. Offering some users too many options might result in a reduced span of attention and discourage him; limit the available information can prevent this. A final opportunity for adaptivity resides in offering different content for the same subject corresponding with the different user profiles. Again this need is obvious when comparing for example the needs of children and adults.

We can distinguish between manual and automatic methods to implement adaptivity. An example of the first approach is to ask the user to answer a set of representative questions when starting the application. The system will then be able to induce the profile of the user. Automatic detection is of a more advanced nature and makes use of artificial intelligence or other complex algorithms to infer the user profile from his navigational behaviour. Since this is complicated and outside the scope of our research we will be making use of the first technique.

A final note concerns the similarity and differences between our application of adaptivity and the plasticity paradigm [18]. This denotes the capacity of adaptation to different contexts of use, such as available system resources, the used platform or the user’s current environment. This latter includes the user’s location and thus the condition of context-awareness. This alone however is not enough to fulfil the requirements of this paradigm, as there is no change of platform. It would be the case if the same application would have to run on other devices than the TabletPC, such as a PocketPC.

5. PAST ACHIEVEMENTS

The Els Vilars Augmented Reality project started in 2001 and several steps have been undertaken since then. The first initiative was to create a 3D model forming a reconstruction of Els Vilars during period 0. The archaeology department of the University of Lleida provided the necessary topographic data for this representation. This was later transformed into an animation used in a video presentation of the prehistoric site intended as an educational tool [23].

The next step was to apply the technique of envisioning design by creating a futuristic use scenario, also in the form of a video [20]. It displays a scene in which a visitor arrives at Els Vilars, receives a multimedia device and walks around with it while interacting with it (see Figure 4). This device appears like a tablet activated by touch screen and pen. One of its main features is the virtual panorama described previously. This design was subsequently evaluated in focus groups consisting of representative potential users. Comments were made about the interface, content form, device’s casing, language and accessibility. In the meantime several articles have been published presenting our project and summarising its results [4][9]. All these findings form the basis for continuing the project and can be seen as the first iterative cycle in the design process, which will be elaborated upon in the following section.

![Figure 4. Envisioning design.](image)

6. SECOND DESIGN CYCLE

As explained above the performed envisioning design acts as a starting point for the second iterative cycle, which consists in creating a functional prototype. This will try to implement a restricted set of the required characteristics such as AR, adaptivity or multimedia retrieval as well as a partial amount of the indexed content, all within the available resources. The prototype will be mainly horizontal, implementing most functions in limited detail and restricting the amount of content covered, limiting it to one or two zones of the site. This phase and a subsequent evaluation will form a significant step in the development of the Els Vilars project.

The form of the design cycle will follow the standard HCI methodology such as described by [6] or [16] consisting in requirements analysis, design development, implementation and evaluation.

6.1 Requirements analysis

The data-gathering techniques used here for this phase consist of literature research – articles and the final thesis of the past Els Vilars project- and conducting focus groups and interviews with archaeologists and users. Methods such as questionnaires and naturalistic observation are hardly of any use in our case, since Els Vilars does not possess an infrastructure yet. Current visits to the site consist of occasional, guided tours and therefore are irregular, unpredictable and difficult to investigate.
There are two input categories for this device: shocks or other minor accidents. The device will have to be robust enough to withstand some of the device during less favourable weather conditions. Finally, the need for water-resistance against rain or in general the availability of the environment. Secondly, the weather raises questions such as the possibilities of rain or other adverse weather conditions.

Using the device outdoors means that the screen must stay readable, even if the surrounding daylight varies in intensity and possesses a different nature than the light in an office environment. Secondly, the weather raises questions such as the need for water-resistance against rain or in general the availability of the device during less favourable weather conditions. Finally, the device will have to be robust enough to withstand some shocks or other minor accidents.

There are two input categories for this device: user-activated and augmented. The first one will be achieved through the use of the touch screen and in the future possibly through voice recognition for visually impaired persons. The second type applies the AR paradigm by providing the system automatically with the user’s position and location, thereby making the interaction more fluid and transparent. As mentioned before we have chosen for a combination of a GPS system and electronic compass to implement this, for reasons of feasibility.

For this specific prototype, putting all data locally will be sufficient. In future design cycles, several devices will run and possibly allow for cooperation between them. Furthermore, a bigger amount of information and frequent changes to it indicate the future use of a client/server architecture with the TabletPC acting as a client connected to a server-based multimedia database. To keep the data up-to-date on all machines, a central database is essential. In this case, it is obvious that to maintain the portability of the devices, a wireless protocol such as WLAN will be necessary.

6.2 Developing the design

A relevant interaction mode in the case of our design is exploring and browsing [16]. One of our underlying principles is to present an inductive, bottom-up interaction to the user by providing him representations of the elements of interest in the site. These are offered in a context-aware mode and the visitor can select one of the elements in order to request information and start exploring the available content. Adaptivity will be able to adjust their presentation according to the user’s needs and interests. However, we do not want to restrict the user unnecessarily and prohibit him completely from exploring the information as he desires.

As in all user-centred design projects, prototyping will play an important part. As noted before this is in fact the second cycle in a more global design lifecycle and its aim is to create a functional prototype – within feasibility constraints. A second important feature is that is a throw-away type. Its main aim is to develop the adequate interface using the mentioned paradigms; further design cycles will take care of the correct implementation. In the meantime we also have created mock-ups to evaluate various interface alternatives with the help of potential users and experts.

6.2.1 Information architecture: terminology and structure

The information structure or architecture is central for a good design of the device. The way in which we connect the topographic elements of Els Vilars with items of information and content, coupled with models of the user forms the basis for the interaction. We have opted to change the terminology used in the past, as it contained several ambiguities and gave opportunity for confusion. It consists of the following elements:

**Figure 5. Fujitsu-Siemens ST4221 TabletPC.**

As shown in the ARCHEOGUIDE project, there are various mobile computing devices that can be used for archaeological projects such as ours [12]. In this case we will be using a TabletPC, to be precise a Fujitsu-Siemens ST4221 (see Figure 6). The reasons for choosing this particular device are that it is a compromise between the heavy laptop (1.4 vs. 3 kg), the reduced screen and graphics of the PocketPC and is not as cumbersome as a Heads Up Display (HUD). With this we can offer the visitor a portable and interactive artefact that can be made even more convenient equipping it with a bump case wearable around the shoulders [28].

Using the device outdoors means that the screen must stay readable, even if the surrounding daylight varies in intensity and possesses a different nature than the light in an office environment. Secondly, the weather raises questions such as the need for water-resistance against rain or in general the availability of the device during less favourable weather conditions. Finally, the device will have to be robust enough to withstand some shocks or other minor accidents.

Zone of interest (Z.I.): a part of the map which has a central viewpoint and contains several elements of interests grouped into observed locations; viewpoint (V.P.): a specific point from which the visitor can look around at one or more elements of interest grouped into observed locations; observed location (O.L.): a part of a zone of interest which the visitors looks upon from a specific element.
viewpoint and direction. It may hold one or more elements of interest; element of interest (E.I.): an object, an architectural unit or other distinguishable entity worth of interest. All of this is illustrated in Figure 7 – note that the arrows indicate an itinerary connecting viewpoints with each others.

In general we can say that there are two main categories for the visit: thematic and chronological. The first one is dominant and forms the base of our information architecture. The second is reflected after choosing a subject, for example by showing the same house in various epochs.

Figure 7. UML notation of the information structure connecting the topographic and thematic elements.

The information structure consists of two connected parts forming a lattice (see Figure 8 for an UML notation). At one end we find the topographic elements of the site as described before: Z.I., V.P., O.L. and E.I. The composition relationships and the multiplicity attributes indicate a strong ownership and top-down hierarchy. At the other end we find the thematic items, which consist of the categories of content. These are related with each other through associations asserting that one E.I. is at least linked to one subject (i.e. its own description). In addition a subject can be connected to one or more E.I., other subjects and various themes, but this is not obligatory. The key point of this structure is the E.I. since it acts as a point of intersection between the two dimensions of information, i.e. those of location and of content. In other words, an information tree of location is mapped onto one of content through the most atomic element that both structures share. The most global component at the top in our specific case is Els Vilars, but is generic enough to be used for any cultural site.

After linking the various elements of interest to related subjects, we concluded that we can use a generic ramification to achieve this. The elements of interest can all be associated to their introduction (dimensions, method of construction, function, etc.) and to a combination of other topics such as: functional generalisation (topics that are related in function, such as the defensive system regarding the city wall), contextual generalisation (the same element in a broader chronological and geographical context: e.g. chevaux-de-frise in the Iberic Peninsula and Europe during the Iron Age) and human factors (the warriors defending the fortification, the habitants of the city, peasants, etc.). The abstract themes include items such as religion, politics and agriculture. The transitions between these different content elements are event-driven and can be one of the following two: AR related (automatic detection of location and position) and browsing (standard interaction and navigation through the computer).

An important aspect to consider is the creation of a consistent and logical discourse for the user. For example, repeating the same elements of interest too often will probably bore the visitor. Obviously we are limited in creating the itinerary by the current remains and the possible routes. Inside this problem space however we will try to find a balance in offering a variety in content according to the user profiles. Finally, the user will always be free to consult all available elements if he desires.

Figure 8. Dialog structure.

These thoughts have resulted into what Dix calls the dialog structure, which distinguishes itself from the global information structure described above (Figure 9) in that the first shows how the user can move between the various states indicated in the latter, but not by necessarily following the same path [7]. It is a combination of a linear and a tree structure: the main elements are the zone of interest and can only be consulted in a sequential manner, corresponding to the visitor’s real-world path. Inside each zone however, the subjects and themes described previously can be consulted directly in any given order. In other words, the nested position of the themes in the information structure has been flattened out to improve its accessibility. Otherwise, these abstract but essential pieces of information might result to deep and difficult to find for the visitor.

6.3 Implementation

A clear distinction has to be made between the implementation requirements for this project and those for the future design cycles. During this specific study, the underlying information
structures and the interface are the most important issues to investigate. As noted before, we will create a throw-away prototype, so the choice of software will be driven by representation aspects more than future feasibility. Due to the high number of graphics and animations we will use a multimedia authoring tool such as Macromedia Director\[2\]. An important requirement is the compatibility with GPS and orientation devices in order to have access to the information needed for the location-awareness.

Later implementations will have to use a more robust and standard software architecture, i.e. a client/server architecture through a wireless network. This will also allow the use of DGPS. An idea is to use web-based technology due to its platform independency, readily available standards and ease of learn and application. Such languages as HTML, PHP or Java could be used to deliver the dynamic, adaptive content and navigation, and the connection to the localisation components. A central database would ensure access to the necessitated data, while XML could be used to encode thematic information and meta-data such as user-specific features.

An objection to this approach could be the instable connection to the position and orientation modules. A more conventional language such as C++ or Java provides more secure access, but has less to offer on the level of interface design. Future research is needed on this topic.

A final note regards the restrictions imposed on the prototype. Firstly, we will limit the amount of content to be implemented in the prototype. The amount of information available about Els Vilars is enormous and will have to be reduced and adapted to the purpose of this project. Due to limited resources we will first try to implement one zone of interest and evaluate how much effort and time this requires from the different involved parties. If this is not excessive, another zone could be added to demonstrate the location-awareness. Secondly, we will adapt the information for the profiles of the family and the expert user. Finally, if the resources needed for creating the virtual panorama prove to be too costly, we will use reconstructive drawings instead; they will be sufficient to visualise the former aspects of Els Vilars.

All in all, this necessitates an organisation to provide for the archaeological discourse, the use of location-aware devices, the possible extra 3D models and the graphical design of the interface.

6.4 Evaluation

As in every multimedia and usability project, evaluation forms one of the most important parts of the design process. Firstly, we have conducted an evaluation through a focus group session of intermediate low-fidelity prototype – mock-ups – to test out alternative interface designs. The participants consisted of two members each of the GRIHO and the GIP and four potential users with various backgrounds in order to get a view as broad as possible of the subject. There were a lot of useful, concrete commentaries on the mock-ups, as well as some general remarks about the feasibility of the project. Although most participants had to admit this is an idealistic study and it will have to be transferred on cheaper and more robust devices to be applied on a wider or commercial basis, they were all enthusiastic about the project and saw its use in visualising otherwise too esoteric content.

The functional prototype resulting from this study will be evaluated using standard methods such as cognitive walkthroughs, focus groups and informal field experiments using thinking aloud and cooperative evaluation. Its results will form the basis and impetus for the next design cycles of Els Vilars.

7. CONCLUSION AND FUTURE DEVELOPMENTS

Using specific HCI paradigms such as context awareness, AR and adaptivity offers the visitor new modes of interaction that will hopefully increase his amount of knowledge and satisfaction. The aim of this research is to investigate how to combine these paradigms with a user-centred design process, in this study with the aim of creating a functional prototype. This involves various issues such as overcoming technical challenges, sketching user profiles, creating an adequate information structure, indexing the cultural content, using the right software architecture, prototyping and evaluating. A key factor for the success of the project is the close collaboration with historical experts as well as users.

Future prototypes of the device could incorporate functionalities such as logging of the user’s behaviour for immediate or later adaptation of the interface and content, gaming aspects including solving puzzles or quests and collaboration between different users. One anticipated function is to make the artefact available for archaeologists, historical experts as creators of content. However, this requires a whole new design cycle to establish the requirements of these stakeholders and to create a satisfactory design.

Ideally the current and future work on this project will benefit anyone working in the same field, i.e. those creating multimedia artefacts in cultural contexts and applying the paradigms mentioned in this article.

8. ACKNOWLEDGMENTS

The authors would like to especially thank Enric Tartera and Ares Vidal Aixalà of the archaeological department of the University of Lleida and the GIP for their extensive collaboration in categorising the topographic and thematic elements of Els Vilars, making design proposals, discussing ideas and collaborating for the whole of the project. Their assistance has been essential for the conceptual part of the study.

We are also grateful to Núria Piqué Campos, guide of the Seu Vella, for her cooperation, to COMPSA for delivering us the TabletPC, to Montserrat Sendín for advising me on the topic of adaptivity and to Alexander van den Bosch for making a final revision.

9. REFERENCES


