# A Critical Examination of Presence Applied to Cultural Heritage

Laia Pujol Tost, Erik Malcolm Champion
CEPAP, Autonomous University of Barcelona; Media Arts, COFA, University of New South Wales
{Laia.Pujol@uab.cat, e.champion@unsw.edu.au}

## Abstract

*This paper surveys current notions of social and cultural presence as they may help the evaluation of cultural heritage projects. We argue that cultural heritage requires specialized evaluation, as key issues both connect and separate the aims of presence researchers and cultural heritage experts. To support this argument, three case studies of virtual heritage evaluations are summarized, and recommendations made as to how experimental design and evaluation may be improved for future projects.*

*Keywords* **Cultural presence, social presence, evaluation, virtual heritage.**

## 1. Introduction

Defining cultural presence as it relates to virtual heritage is of fundamental importance to cultural heritage professionals, because the underlying concepts determine the goals, design, evaluation, and level of success of the final project. And on initial examination it may appear that as presence research [16] has typically evaluated the sense of 'being there", cultural heritage researchers can adopt the methods of the presence research community.

However, there are arguably several distinctions between the traditional or "technological" definition of presence research per se, and the one used in cultural heritage and museum studies. Firstly, cultural heritage cannot accept a definition of presence as simply "being there". For "being" and "there" are problematic terms if the life-experiences of the locals are different to ours [4] and if the "there" is not ostensive (that is to say, we cannot understand a local cultural notion of another place just by pointing to it). Culture is understood by ongoing usage rather than by instantaneous depiction. So at best, there is some potential confusion in terms of terminology; but there are also perhaps different goals and needs between the two academic fields.

Secondly, in order for virtual technology to be accepted and spread commercially, we need to not only evaluate presence in specifically conditioned environments, we also need to evaluate the usefulness of virtual environments *in situ*. And for cultural environments that means replicating, reproducing or evoking responses to experiences that are deemed culturally significant. Such an approach immediately raises an issue in terms of presence research, as a virtual heritage evaluation is thus not of perceived reality, but of perceived *culturally encapsulated* forms of *culturally significant* reality.

For example, Riva etc al. [27] suggested that reality is not the only component of experiencing the real-world, and therefore non-real experiences should be included in virtual environments. Further on, Riva et al. defend the premise (on page 307) that cultural presence involves a "cultural framework" and "the possibility of negotiation." For them this must include recognition that the experience is mediated by digital technology, immersed in a social context, and that it allows for ambiguity.

These claims sound reasonable to the authors, but they create a third problem (at least in terms of virtual heritage environments). For in Riva et al's paper, cultural presence is not clearly distinguished from social presence, and there is room to reinterpret the simulated and collaborative knowledge according to the spontaneous whims of visitors. Is cultural presence possible in a virtual heritage environment where people can meet and greet each other in it without cultural constraints and where visitors have full freedom to interpret, decide, or reconfigure the virtual heritage environment as they wish?

A fourth problem is the extent to which a definition of cultural presence can be usefully applied across varying depictions of content, genres, interaction metaphors, interfaces, audiences, and hardware / software configurations. For example, a paper by MacIntyre et al [21] explains the divergence between traditional presence research and cultural heritage using mixed reality in real places; however, it is still not clear if a standard definition of cultural presence is applicable to cultural heritage using stand-alone virtual environments.

## 2. Defining Virtual Heritage

What is virtual heritage? Do we consider it to have a clear definition and purpose? It is not well established in many academic papers what virtual heritage is, and therefore how evaluation can determine whether its goals have been met. In a special issue of virtual heritage for presence [1], the term is not defined by any of the papers, user trials are not clearly explained, and what is being measured is assumed to be understood. For example, an article on page 291 [30]

declares "users were able to concentrate on the virtual heritage content."

What exactly is virtual heritage content? The paper does not say. Nor does the guest editorial define virtual heritage [1]. To be fair, the guest editorial refers to earlier articles [26] where domains or general reasons for virtual heritage are mentioned. However, what separates a successful virtual heritage environment from a failed one is not apparent. If we do not know what virtual heritage is, it is difficult to determine how successful individual projects are, and perhaps impossible to create evaluations that can be used as a standard method across different projects.

In the article entitled "Lost worlds become virtual heritage" Chan [8] defined the goal of virtual heritage in terms of intangible heritage:

*"Virtual heritage technology aims to recreate a three-dimensional navigable world and also to provide something much less tangible -- a sense of look and feel."*

However, the above goal does not explain the importance of heritage. In our opinion, current definitions of virtual heritage [14], [24], [27], are not comprehensive because they primarily focus on illustration, artistic values or accessibility, while heritage projects also have social, scientific and educational requirements. The unique contextual potential of ICT is not always fully exploited because the definition and therefore the aim of virtual heritage are seldom examined.

## 2.1. Defining in Terms of Cultural Significance

There are at least three international charters that deal with the subject of cultural heritage, and they stress the importance of cultural significance as an aim. The Ename ICOMOS Charter [15] suggests that the aim of digital media (and by extension, virtual heritage), is to facilitate understanding and appreciation, communicate, safeguard, and respect the authenticity, as well as contribute to, promote inclusiveness, and develop technical guidelines for cultural heritage sites. The Ename charter defines a *Cultural Heritage Site* as "a place, locality, natural landscape, settlement area, architectural complex, archaeological site, or standing structure that is recognized and often legally protected as a place of historical and cultural significance."

The ICOMOS Burra Charter [14] defines cultural significance as involving "aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects."

More recently, the London Charter [6] aims to create rigorous guidelines for the use of 3D technology in the creation of virtual heritage. It recommends that 3D visualization methods are applied with scholarly rigor, and "accurately convey to users distinctions between evidence and hypothesis, and between different levels of probability." Further, the last principle of the London Charter, (number 8), says that "consideration should be given to the ways in which the outcomes of 3D visualisation work could contribute to the wider study, understanding, interpretation and management of cultural heritage assets."

Virtual heritage is an extension of both the social sciences and ICT. It can therefore take advantage of the specific features of ICT (interactivity, personalization, immersivity, ubiquity, flexibility, and multimodality) to improve not just the accessibility and comprehension of cultural heritage sites, but also to disseminate and help a scholarly debate of the methods and interpretations which helped to create these reconstructions and recreations.

Given the above charters, the authors suggest that the definition of virtual heritage should be close to the one proposed by Stone and Ojika [37]:

*"[It is]...the use of computer-based interactive technologies to record, preserve, or recreate artifacts, sites and actors of historic, artistic, religious, and cultural significance and to deliver the results openly to a global audience in such a way as to provide formative educational experiences through electronic manipulations of time and space."*

So the purpose of virtual heritage is to record, preserve and recreate objects and processes of cultural significance. According to Stone and Ojika [37], it should present the results transparently to the public, preferably globally as well as locally. They also suggest it should attempt to provide a learning experience. We suggest modifying the above definition slightly, as we wish to create a working definition that helps evaluations improve the goals, production and user experience of virtual heritage projects.

For example, virtual heritage projects cover cultural significance in terms of time and space, but both together are not necessary features; they are descriptive rather than prescriptive. On the other hand, one omission with the above definition regards presentation of, and interaction with, cultural beliefs. ICOMOS, UNESCO, and other organizations are moving towards including within the scope of heritage the preservation and communication of intangible heritage, which include cultural beliefs (similar or dissimilar to our own). There is also the need to aim for authenticity of reproduction, scholastic rigor, and sensitivity to the needs of both audience and to the needs of the shareholders of the original and remaining content.

Given the above, we suggest five major aims. Firstly, virtual heritage should aim to carefully capture objects and processes of cultural significance. Secondly it should present this information as accurately, authentically, and engagingly as possible. Thirdly, it should attempt to distribute in a sensitive, safe and durable manner the project to as wide and long-term an audience as possible. Fourthly, it should aim to

provide an effective and inspirational learning environment that best communicates the intended pedagogical aims.

Fifthly, it should attempt to carefully evaluate its effectiveness regards the above four aims in order to improve both the project, and virtual heritage in general. Virtual heritage researchers have admitted that in this emerging field, proper evaluation methods are still being developed [28]. As the presence research community is arguably the closest in aiming for a standardized measure of engagement in virtual heritage environments, and has a well formed academic community that debate similar issues, it may appear that we can adopt their tools and methods and apply them directly to virtual heritage projects.

## 2.1    Presence and Realism

The concept of presence is a very complex construct, there are many definitions by authors in many disparate fields. These focus on specific aspects or give different names to the same reality; they partially overlap or contradict each other (for example, the debate over immersivity versus presence between Slater [32] and Witmer and Singer [40] and the many definitions of presence recorded by Schuemie et al [31]).

Therefore, the conventional notion of presence [16], [19], [31], as the sensation of "being there", at a place other than the real world, is a shorthand and highly simplified way of expressing an internal perception of the environment and ourselves in relation to it. The more complex explanation is that a sense of presence is dependent on various factors: physical immersion, perceptual realism, naturalness of the interaction (intuitiveness and invisibility of devices, meaningfulness and behavior of the simulated world, possibility of social communication), emotional involvement, attention, unconscious reactions, etc.

From this general definition, the concept of cultural presence arises, stressing the contextual, social and symbolic, communicational aspects of presence, and also, implicitly, a learning aim. This view proposes  interaction and empathy as a potentially powerful way to enhance a cultural heritage experience. Through interaction and collaboration, presence becomes a "being –not only physically but also socially– there and then".

However, in the case of cultural heritage, presence cannot always be defined as a perceptually realistic substitution of the real world (where its effectiveness is judged in relation to its degree of realism), because in many cases the past does not exist anymore, *or* the local shared sense of reality differs significantly from the beliefs and conventions of the people who visit a digital simulacrum. The philosopher Thomas Nagel raised this issue when he asked how we could understand how a bat perceives its world [22]; his conclusion was that bats were so sensorially distinct from our human embodied understanding of the world that no amount of scientific reductionism would allow us to understand the world as they understand it.

This is also an issue for cultural learning regarding distant or extant societies. Any explanation or reconstruction of the past or another culture is potentially a contemporary or western interpretation. Even more than in the case of natural environments, there is no objectively pure reconstruction. And to simplify archaeological interpretations into one clear and simple narrative will also increase the risk of banalization, of satisfying current expedient demands of the tourist and leisure industries instead of communicating cultural significance and the contextual values and beliefs of intangible heritage.

## 2.2    The Value of Cultural Presence

Is cultural presence of value to the presence research community? A recent paper with "Culture matters" in the title [13] seems to conflate cultural differences with ethnic identity, considering Chinese people who live in the Netherlands as culturally representative of people who remain in China. On page 123 of the Lombard et al paper [20] that surveyed patterns in presence literature, cultural presence did not appear even once in the frequency of "presence" terms in titles of works table (Figure 6) and was not mentioned in the paper at all. It has even been suggested that virtual environments have an advantage in NOT providing cultural cues. For example, Rüggenberg et al, [29] suggested:

*"In contrast to video conferencing systems avatar platforms provide additional communication bandwidth without loosing specific degrees of freedom which we much appreciate in CMC, i.e. avatars can convey nonverbal cues without necessarily disclosing the person's identity or triggering prejudices based on physical appearance (e.g., gender, culture, age, attractiveness)."*

Presence researchers may argue that cultural presence is synonymous with social presence, for example, Riva et al [27] propose a *cultural* concept of presence as a social construction" and this is understandable as social presence has received more attention [38]. However, while culture is a projection of society, and the mirror by which society can see its own values inscribed in the external environment and transferred to future generations, we need to separate the two, for social presence does not necessarily lead to cultural presence. If three hundred children rush into cybercafés around the world to meet each other in a virtual heritage environment, they may experience social presence. They may well make new friends, argue, or be bullied by others. Yet that very social engagement with others may destroy their feeling of cultural presence, they may ignore or trivialize the cultural information and setting of the virtual environment.

Culture may be seen as the material inscription and embodiment of social knowledge and values passed onwards to future generations. Yet artifacts by themselves do not give us insight into the minds of past or foreign cultures. To evoke

a sense of another culture requires an idea of how these material items were used to identify, define, and demarcate social roles and privileges. We need to imagine and perceive how they were used and why they were significant to a society. Landscapes, clothing, and even hardware and tools, are all material reflections of a society's immediate goals and long-term ideals, and they are indeed used in social situations, but social use does not necessarily lead to locally situated cultural understanding.

A virtual environment can also be a palimpsest ("products of action"), where past social interactions are layered, echoed, and carved into the fabric of the environment and discernible to future visitors. We can see culture, but we cannot participate in it or with it due to either a lack of culturally constrained creative understanding or because the originators have long since passed away. However, this also means we are not capable of effectively deciding whether the culture depicted in the virtual heritage environment is complete, authentic, or desirable.

Consequently, it is not clear to either author how cultural presence can be evaluated automatically and objectively. Subject experts could mark virtual heritage projects in terms of authenticity, perhaps, but as cultural learning could be considered a spectrum (covering awareness to understanding, and nativity to alterity), the learning abilities of the participants should be incorporated into the evaluation results.

Part of the aim of virtual heritage is to communicate cultural beliefs, cultural understanding, and localized cultural significance; the presentation nature of virtual heritage requires some form of measuring either: subjective comparisons between different methods and content, or, between-group evaluations of what is effectively learnt. Both the machine and the person play a role but it appears that cultural presence can be only experienced and understood by humans: it is a sensation, a state of mind caused and mediated by technology. We are interested in the potential accuracy and richness of a machine to simulate a past world, but we can only judge this through our own opinions and by observing those of others.

Hence, and even though this will complicate evaluation, presence in cultural heritage should involve not only physical but also cognitive and emotional aspects of digitally mediated learning. The evaluations should also determine whether interactive media more effectively delivers content via procedural learning rather than prescriptive information, and to what extent it is appreciated by the audience. Due to the inter-subjective nature of cultural learning, we also need to evaluate whether the virtual learning environment suitably affords exploration, interpretation, collaboration, and communication, and the extent to which these are understood, appreciated, shared, preserved or extended both inside and outside the virtual heritage environment.

## 2.3    Aims of Presence in Cultural Heritage

This point of view appears to be connected with current positions in presence research, such as the ethnographical [35] or the contextual [27]. Based on a more ecological concept of the world and society, they stress the reciprocal contribution of both the environment and the user, and define presence through the central role of the actions allowed by the perceived physical, cognitive and social affordances of the environment. Seemingly, cultural heritage applications should not be limited to just presenting images but also encourage the reflective participation of the audience in both the local and global issues of world heritage.

Therefore, the aims of virtual heritage, which constitute an integration of constructivism ideas in learning, presence current trends and Cultural Heritage aims, are the following:

**Exploration**: Intuitive interaction is of fundamental importance to learning by exploration [27], [28], [35]. From an individual point of view, understanding is achieved through the active construction of meaning with the help of available resources that the user identifies as affordances and takes from the environment. The ethnographic view [35] stresses the contribution of both the environment and the inhabitants in the construction of meaning.

**Interpretation**: The importance of the meaningfulness of the context. In a physical but especially in a cultural environment like the one which characterizes cultural heritage applications, reality is interpreted (the ethnographic view focuses on the process and not the results) according to social and symbolic codes. It is not a physical objective environment; it is a context. Therefore, presence will be related to the possibility of sharing this language and communicating with the human agents. This relates to the notion of cultural and social presence  and its importance has been demonstrated by di Blas and Gobbo [10], [11]. Their experiences showed there is no absolute need for visual realism as opposed to virtual or conceptual presence (referring to the intuitiveness of the social exchange between both environments), because this augments engagement and reinforces the learning process.

**Collaboration/communication/sharing**: The previous actions can be achieved alone but are enhanced (as was demonstrated after Vygotsky's theories [39]) through social exchange. A VE is expected to be populated as the real world, with virtual and real inhabitants who contribute to the learning process and the sensation of presence. The ethnographic view [27] also considers presence is not an individual but a social phenomenon and needs to be analyzed as such. This perspective is also important in the cultural heritage field because we are concentrating on society [4], and social rules are learnt or understood through observation, exchange and imitation (for example, in games).

Thus, presence is not a goal in itself but a means aimed at the maximization of learning or understanding. And consequently, non-mediation or invisibility of the medium,

proposed by some authors as a necessary condition for presence [18], [19] is not absolutely necessary.

On the other hand the idea of "being then and/or there" raises, as previously mentioned, ethnological and scientific ethical issues; therefore it should be used not to learn about the past, but to learn about ourselves through the comparison/conflict with different/similar cultures. In this case, affordances would constitute a key element because not only they would facilitate the accommodation to individual, subjective differences, but they would also make possible the emergence of conflicts between the expected response/use and those the object has/had in another culture. The comparison of both kinds of affordances would ultimately allow the understanding of other cultures and awareness of our own.

Taking into account these ethnological/archaeological problems, the lessons learned through practice or evaluations, and the social-educational role of cultural heritage, cultural presence should be understood as the emotional, physical and intellectual "immersion" in a simulation/reproduction of the research process that leads to some degree of awareness, appreciation and knowledge of the cultural significance of locally situated beliefs and shared practices.

We can better present these ideas through an ideal example of virtual environment in which the user personifies an archaeologist. This kind of application puts together an emotional engagement, a specific learning process (discovery, involving exploration and interpretation), and an optional social construction of meanings (by sharing and discussing interpretations) which also provides the methodological tools. This material is thus designed to comply with ethical and scientific requirements and secondly, to help provide evidence that any explanation about the past is a present construction and should not be taken for granted or natural. Moreover, from the museological point of view, it also has the advantage that it overcomes the isolation of technological exhibits evidenced by previous evaluations [12], [17]: they become a specific solution aimed at communicating a particular part of a single discourse about a cultural content. In this sense, presence transcends pure technology and encompasses the whole visit to the heritage site.

## 2.4    Evaluation and Extensibility

Virtual heritage applications have their own evaluation problems to be solved; their introduction is recent and they have not been totally adapted to the needs of the field and especially to the dynamic and pressing requirements of exhibitions. On the other hand, for the same reason, there has not yet been developed a satisfactory standard methodology of evaluation.

However, the demands of the presence community in terms of both integration of use and suitable evaluative tools match or converge with the needs of adaptation of presence to the cultural heritage as stressed in this paper. Therefore,

the integration of cultural heritage and presence studies can prove very fruitful because the latter has developed a theoretical framework that partially matches museum needs, and especially the methodological tools that are lacking in cultural heritage studies. The question here is what overlaps and what requires change or a new perspective?

Further, and despite our support of the term, the conceptual and general methodological (factors) problems are due to the complexity of the term, which might be trying to label via one single term many different interrelated elements. Can one break this term down into evaluation-friendly and customizable factors or does the notion of cultural presence require a gestalt experience?

An additional issue that may also be problematic due to the changing nature of presence is the fast moving nature of virtual reality technology. Yet virtual heritage is even more complex in what it depicts and which audience or audiences it must satisfy [1]. How can we develop a framework of evaluation that covers varying audiences, shareholders (experts, teachers, indigenous people), locations of performance (museums, homes, classrooms or lecture halls), technologies (augmented, onsite, home-based, networked or Internet based), and depicted sites (which typically feature copyrighted and patented graphical or even geographical information)?

The "technical" problems of questionnaires are not specific to presence research but also to psychology and other social sciences. How can we analyze and/or measure cultural presence, how can this measure be objectively, independently observed if it requires an internal state of mind? Physical measurements of presence may offer fascinating and more accurate insights into subjective presence without being confounded by issues of questionnaires, but how can they be used across vastly differing large audiences, and in a way that measures appreciation and understanding of different cultures?

## 3 Lessons from case studies

### 3.1. Building Virtual Rome

**Figure 1 Building Virtual Rome**

The first case study is drawn from the visitor survey undertaken in Rome at an exposition of over 40 virtual heritage projects. The analyses are detailed in an unpublished internal report and partially published [2]. The project is relevant to this paper because although not directly interested in presence, it tried to determine, according to visitors' opinions and across different kinds of interfaces and contents, the factors involved in enjoyment, immersion, interaction, learning, engagement with the subject, and realism, elements which are considered to influence presence.

The data were collected through the inter-contrasting of direct observation and guided interviews at the beginning, the end and during the visit. These asked about demographic data, experience with computers and archaeology, opinion about the use of technology in the cultural heritage field, usefulness of ICT for learning, immersion and realism (with Likert scales), and finally, enjoyment, immersion, interaction and learning with multiple choice questions referring to the different applications. For each one the reason was asked through and open question. In case of no answer, we tried to statistically relate the choice with the exhibit features and with the rest of the data.

When asked about the meaning of "**virtual archaeology**", visitors answered that it has to do with the reconstruction of the past. In the case of the usefulness of ICT for exhibitions, participants replied that ICT is meant for the improvement of dissemination, understanding and learning. These results led to the conclusion that the public expects to learn rather than just be transported to another time and place.

The factor of **Enjoyment** was related, according to visitors' answers, to novelty and to a sense of presence. For example, the virtual heritage environment of *Appia Antica* was valued for its interactivity and the graphics, which produced in the words of one visitor, "the sensation of taking part in a wonderful trip").

The factors involved in **immersion** were novelty and richness of information as well as graphic realism. This suggested that participants viewed immersion as being both engagement and as a real sensation of presence. Immersion, in other words, was a combination (or even gestalt), of physical, emotional and intellectual factors.

The participants associated **Interaction** with the system's visible capacity of response (especially for the projects *Museo delle Pure Forme, E-Sparks,* and *Appia Antica*), but the quantity of information was also appreciated (especially in the *Virtual Rome Tour* and *Appia Antica*). This suggested that interactivity is not only physical navigation but also a demand on the active physical and cognitive involvement and participation of the user.

The factors the participants associated to **learning** were, as expected, the richness of information but also the quality of the reconstruction when it can be related to previous knowledge or experiences. Nevertheless, this question had the highest number of no answers and this might indicate that people did not have the sensation of having learned any contents, or were not able to express them, maybe because of the number and diversity of applications or the importance of technology.

Participants felt **engaged with the subject** but without very strong results. The primary factors involved in both positive and negative perceptions were: the capacity of exploration or comprehension of the contents, the graphic realism and the usability of the interface.

From a general point of view, these results put together some specific explanative categories established by different authors in the presence research field. Although the survey did not emphasize the social dimension (because of the applications' contents and the conditions of the exhibition) it could be understood as an initial hypothesis about the factors operating in the cultural heritage field. To this extent it initially appears similar to Witmer and Singer's [40] concept of presence as involvement because we were asking about "feeling engaged with the subject". However it also demonstrated the difference between both fields: in presence, some researchers stress the physical aspects, while here the first factor in importance was the capacity of exploration and comprehension; that is, the affordances offered in a symbolically meaningful context.

From a more detailed point of view, the first factor played a positive or negative role in all the applications, irrespectively of the contents or the interface, which indicates that the content is the most important element in technological applications for cultural heritage. Graphic realism, on the other hand, became more important for non-interactive applications. The usability of the interface was related to the intuitiveness and awareness of the possibilities of exploration at each moment.

The conductors of the survey also asked about one of the most current concerns in virtual heritage, which can also be directly related to presence: **realism**. Participants did not find that looking as virtual objects was as natural as looking the real ones, not even in those applications that pretended to be the most realistic, like *Fakespace*, *Virtual Rome Tour* or *Appia Antica*. This can be probably explained by the fact that more elements than visual accuracy are involved in the virtual "substitution" of the world and justify a different aims for presence in the cultural heritage field.

## 3.2. Ename



**Figure 2 Ename Museum**

The empirical results of this second visitor survey are partially published in a forthcoming Museology Journal [3] and described in an internal (unpublished) report. The general goal of the evaluation conducted at the Provincial Archaeological Museum of Ename (Ename, Belgium) was to understand the contribution of computational virtuality in archaeological exhibitions and with that purpose in mind the conductors of the survey compared the *Timeline* (a VR application), the *Feast of Thousand Years* (an immersive multimedia based on empathic approach) and *Archaeolabo*, (a hands-on exhibit) as the three exhibits, constituted different ways to approach Ename's history and singularity. However, the specific questions about easiness of use, engagement, interactivity, group needs and learning can again be connected to issues of presence.

As in the previous study, data were collected through a complementary combination of observation, questionnaires for the visitors and interviews with the guides (as they act as the mediators between the audience and the exhibits). The questionnaires asked very similar questions, but the Likert scale answers were eliminated and more emphasis was put on open questions because, from our previous experience at the Rome exhibition, we considered that they where the key to explain visitors perception and use of technological exhibits. Given the current state of the art, we believe that so it is for presence in the Cultural Heritage field. After collecting the data, we categorized the qualitative answers and tried to find associations and explanations though Chi square, Contingency Analysis and Principal Component Analysis.

The first question asked which exhibit was the **easiest to use**. The *Feast* obtained the best score because the easiness was considered more from a physical viewpoint –"you only press a button and sit to listen"– than from a strictly cognitive point of view (only experts understood the complexity of the exhibit, the rest of the audience were only concentrating on the screen).

The second question asked which exhibit was the most **engaging**. Here again, the *Feast* ranked highest, because of its immersive and empathic effect (it showed people talking about their life). The second main reason for engagement, shared by *Timeline* and *Archaeolabo*, was that they allowed a free, personalized exploration; that is, they shared an interactive component although it was of different kind (hands-on for *Archaeolabo* and computational for *Timeline*).

Another reason given for Timeline was that "it shows in detail what happened". In fact, this affirmation is related to learning but also contains an indirect reference to visual realism because the application contains an empty universe and the explanation of the social dynamics is superimposed by the texts or the guides. Engagement was also related with previous knowledge: this is why only experts or visitors interested in the past found *Archaeoloabo* engaging and interacted with it.

The third question asked which exhibit was the most **interactive**. Only younger participants or those who had been more in contact with computers had in mind the technological definition characteristic of the Information Society and therefore voted for *Timeline*. *Timeline* was considered the most interactive exhibit because it allowed a free self-controlled exploration of the contents. This possibility also existed using *Archaeolabo*, but its special appeal was in allowing the possibility of touching real things. The rest, again a majority, considered it was the *Feast*, because they had in mind different notions of interaction.

In general, participants understood we were talking about physical-cognitive exchange with the exhibit; that is to say, about user controlled exploration. Others understood "interactive" as the adjective coming from "interaction", not "interactivity" (the computational capacity), and they thought about emotional exchange, which made them choose the *Feast* because as a "living performance" it induced an empathic link between the exhibit and the visitor. And yet others in the audience took "interactive" to mean a synonym of "relationship" in general and considered the Feast was the only exhibit purposefully showing a link, in this case, between the characters and the objects.

The fourth question asked which exhibit **accommodated the group needs more effectively**. The answers were related to the possibility of freely watching and exploring at the same time. This is why the small touch screen obtained the worst results.

The fifth question asked which exhibit was the best to **learn about the objects or the past**. In this case, all participants preferred *Timeline* or *Archaeolabo* because they were making a clear distinction between learning (intellectual) and engagement (emotional).

Information technology was appreciated for two reasons. First of all, because it provided more and/or more complete information about the subject and it allowed a flexible, personalized exploration. The second reason was that it allowed people to develop a general, quick idea of the abbey's evolution in time because it was transmitted by

visual means. In this case, the visual reconstruction helped to learn about History (by reinforcing the guide's or the panels' verbal discourse through iconic means) and about Archaeology (by providing a complete, reconstructed image of the ruins). The reason the audience had for choosing the *Feast* was that participants could learn about the past without expending any serious effort, as museum visiting is associated with leisure time and, people want to acquire knowledge without having to work hard.

Ename is a more complicated case because the VR application was located in a museum, as a specific communicational solution, and this introduced a whole range of museographical issues. However, the possibility of comparing the usefulness of the technology against two other kinds of communicational solutions allowed us to make hypotheses about the possible factors involved in presence.

Bearing in mind these results, it may be interesting to conduct a new study in which a more experimental approach is adopted but again, by comparing the three kinds of exhibits, it tries to test which are the involved factors in each kind of exhibit (for example separate three similar groups and let them "play" with the exhibit, using pre and post-tests, observation, etc.).

## 3.3 Palenqué



**Figure 3 Palenqué**

In this experimental study, demographic details were recorded, namely, age, gender, PC experience, 3D experience, and experience with the site and culture in question. There were three groups of participants evaluated separately, a large group of archaeology students, 24 cultural heritage and visualization experts, and ten IT-literate people from Lonely Planet, a travel publication company. Details of this experiment are detailed in a journal article to be published [4]. However the evaluations will be summarized here purely to highlight evaluation issues of cultural presence.

Information collected consisted of five main types of data (Table 1). The case study was designed primarily to assess how different forms or modes of interaction affected subjective rankings of the environment, cultural learning

(understanding and extrapolation of locally acquired cultural knowledge), task performance, and memory recall.

**Table 1 Summary of Evaluation for Palenqué**

| Evaluation | Content |
|---|---|
| Task performance: Compare to understanding | 6 information objects to find per environment |
| Cultural Understanding (multichoice). Compare to preference, task performance and demographics. | 6 multichoice questions on Environment 1. |
| | 6 multichoice questions on Environment 2. |
| | 6 multichoice questions on Environment 3. |
| Presence Survey (rank from 1 most close to 7 as least close for the 3 archaeological and the 4 imaginative environments). Compare to demographics and task performance. | Which did you find the most challenging to explore, find or change things? |
| | Which was the most interesting to you? |
| | Which seemed most interactive to you? |
| | Which did you feel most closely represented the way Mayans saw their own world? |
| | Which most effectively seemed inhabited by real people? |
| | Which felt most like you were in the presence of Mayan culture? |
| Environmental Recall (multichoice). Did participants notice these features? Compare to demographics, to task performance and to understanding. | Shadow? |
| | Real people? |
| | How tall were Mayans compared to modern western people? |
| | How many real or computer scripted people were in the site? |
| | In future, which would you like such environments for? |
| Subjective Experience of Time Passing (ranked from 1 to 3). Compare to subjective preference and to demographics. | In each environment, did time pass by quickest? (Write in descending order of apparent speed). |
| | Rank the environments (1 for fastest to 3 for slowest) for how slow they seemed to be for updating the screen. |

The statistical relation between related sentences asking participants which environment scored highly and why, may be seen to have special value to the understanding of cultural presence, however there were several problems in the experimental design that affected results, and may appear in other virtual heritage environments.

Firstly, the site was too big for the computers to handle, so the site was split up into three sub-sites, called environment 1, environment 2 and environment 3. Three different interaction methods were to be evaluated, therefore a factorial analysis was used, and the participants split up into subgroups, ideally nine.

However, it was found that certain interaction methods were not suitable for certain parts of the site and

consequently a truncated factorial analysis was used, each participant explored each of the three environments, but only encountered one of two interaction methods for each environment. A world was the term given to each specific combination of environment and interaction method. The above issue shows the problem of attempting to create interaction suitable for specific archaeological sites which are also universal enough to apply to other sites.

Secondly, the time taken to complete each task and explore the overall environment was recorded. It was found that some people only wanted to complete tasks because they wanted to score well, while the archaeologists and cultural heritage people wanted to take their time. It is very difficult to evaluate enough different environments and interaction methods while allowing for individual differences in explorative interest.

Thirdly, participants were asked to rank the worlds and the interaction modes against each other. They were ranked in terms of user enjoyment, educational effect, and by which environment most afforded a sense of cultural presence, and inhabitation. The results suggested the type of environment (the digitally simulated buildings, people, and objects) significantly affected preferences for a specific interaction mode, but there were also statistically significant relations between a sense of cultural presence and inhabitation. For the cultural studies people and the Lonely Planet employees, we could calculate how close answers were between the different presence questions (Table 2). Using statistical correlations, the question of whether users felt they were in the presence of Mayan culture, and how closely the virtual world represented the way Mayans saw their own world were significantly similar to each other.

**Table 2: Comparing questions to ascertain shared meaning**

| Presence Criteria (n=34) | Paired Presence Criteria | Correlation | Significance |
|---|---|---|---|
| Which felt most like you were in the presence of Mayan culture? | Which did you feel most closely represented the way Mayans saw their own world? | .860(*) | 0.028 |
| Which did you feel most closely represented the way Mayans saw their own world? | Which most effectively seemed inhabited by real people? | .618 | 0.191 |
| Which did you find the most challenging to explore, find or change things? | Which did you feel most closely represented the way Mayans saw their own world? | .613 | 0.196 |

**Correlation is significant at the 0.05 level.**

Using the same approach (a combination of cultural historians and Lonely Planet employees in a group of 34 people to see which pairs of answers to the questions had a significantly negative correlation), we found two pairs of

near significance and slight significance. The more inhabited worlds seemed less interesting; and more interaction seemed to curtail the sensation of being in the presence of Mayan culture. This seems counter to conventional presence literature, [23] "the greater the level of control a user has, regarding their actions in an environment, the higher the level of presence."

Fourthly, for the cultural understanding part of the evaluation, participants were asked six questions for each of the three environments. Results indicated that navigation through the environment played more importance in their results than how quickly they found the information. People with game experience rushed through the tasks, but did not remember (or understand) as much information. Hence, being able to evaluate learning across different audiences using strict time periods, or to hypothesize that in-world navigation and object manipulation mastery relates to cultural learning acquired, may be a dangerous assumption.

Fifthly, there were no direct and statistically significant relationships between perceived and actual time passing, but this is an interesting way to measure engagement, and may prove more effective in virtual heritage environments with similar interaction, or similar depicted content.

Lessons learnt were various. In terms of experimental design, a pilot study proved invaluable in revealing conceptual issues, but the complexity of virtual environments does not easily support preliminary heuristic analysis or cognitive walkthroughs. Further, navigation issues and subjective differences in navigation between 3D experienced and less 3D experienced partipants may prove major factors in task performance (such as in terms of how many tasks can be completed).

As in the earlier case studies, the audience seems to have an interesting notion of interactivity. Results were broken down into the archaeological environments versus hand-eye and observation games featuring similar recreated Mayan content. The hand-eye games were considered much more interactive in both groups than the observation games. This is interesting: there was not much more actual scripted interaction in the hand-eye environments but there was more interaction the participant could immediately control. It is possible that interactive agency rather than the amount of overall actual scripted interactivity in the virtual environment is of strong importance to the user.

Participants also consistently rated the archaeological environments as more interesting than either type of game environment, but they were least amenable to leaving these game environments by the prescribed time. They also consistently ranked the archaeological environments as more Mayan than the games, when in fact the games had the same level of historical detail of depiction, and were based on Mayan myths. It is possible that while game-style interaction is more accessible to people than thematic archaeological visualizations, they are less likely to convince people of their authenticity. This is a serious concern for virtual heritage design.

It may be rewarding in future to run Pearson coefficient analysis across various terms related to cultural presence to ensure that participants share the designer's understanding of key terms. It may also be possible to create wider heritage questions that can test how well participants extrapolate specific knowledge to other sites, but this also depends on individual learning abilities and does not test cultural presence in anything more than on an individual basis.

## 4. Conclusions

This paper attempted to establish a theoretical basis for the introduction of presence in the cultural heritage field. To that end, it provided some definitions of the key concepts, it proposed some specific goals for virtual heritage and cultural presence, and it debated the major issues arising from these elements with regard to design and evaluation of technological applications.

The choice of the scope is due to the fact that technology and especially the concept of cultural presence have been only recently introduced in the CH field; consequently, we cannot develop fully extensive predictions if we do not establish first the definition, goals and consequent methodology of evaluation. A second reason is that in CH settings, technological devices are introduced in a different environment, where the spontaneity of exploration in a social context is paramount and therefore raises issues that cannot be studied in the artificial context of experiments.

In the light of these ideas and results, we have some immediate suggestions for future virtual heritage projects and how they are evaluated. If we had the opportunity to run the evaluations or even re-engineer the virtual heritage design, we would do several things differently.

Firstly we would invert the typical process of fitting the content around the technology, and instead ask in which way ICT methods are useful given the designer's goals. Then, we could adopt the most suitable technical solution and finally test it. We believe that we are now attending to the construction of a new paradigm, to which some researchers [34] in the presence field are also converging through the adoption of a more comprehensive definition of the concept. This will allow, as we suggested in this paper, a fruitful influence between both fields.

Secondly, we suggest that a clear definition of what is meant by interaction should be clearly explained throughout the development of the project. Case study 3 tried to ascertain the effect of special types of interaction on cultural learning, but did not realize that cultural learning is a mishmash of interaction modes. Interaction is a highly complex term that is not easy to design for in terms of history and heritage, and appears to have different meanings for different people. In this sense, interaction should be predetermined by observation of at least one and preferably two pilot studies — for designers seldom accurately foresee how different visitors perceive, understand, and interact with the site.

Thirdly, we also need to develop a qualitative framework. As we are at the beginning of the introduction of ICT in cultural heritage, it may be more prudent to concentrate, as other authors have pointed out [34], on gathering different kinds of complementary data and revealing what factors are involved instead of imposing them. Therefore studies could start by an inductive approach aimed at building hypotheses and then adopt a deductive approach to verify them through an experimental approach, which allows a full statistical treatment.

Fourthly, we would probably suggest a combination of direct observation and questionnaires for the CH settings (where these applications are mainly used together with formal learning environments) in order to contrast the different data. Large control groups are desirable as it is very difficult to ascertain the effect of demographic differences. In spite of Slater's accurate criticisms [33], questionnaires have the advantage that they can obtain results about intended and emergent knowledge. The statistical problems discussed in a recent debate [34] can be easily "overcome" because we are not interested in measuring and predicting presence accurately (this belongs to the purely technical field) but in explaining the underlying factors of its effectiveness (or lack of it) according to the addressees' perceptions and uses. On the other hand, observation helps avoid interfering directly with the user experience.

How would the above help improve virtual heritage environments and how can we extrapolate guidelines? Clear hypotheses on explicit quantitative data before the virtual heritage project is built would help more clearly show what was learnt, succeeded, or failed. Both discrete and gestalt factors should be evaluated, as well as demographic details, because pre-experience can be a powerful confounding factor. The differences between test and real-world conditions should be clearly outlined, and the sequential order in which different virtual environments are experienced and evaluated should be shuffled. This will help avoid accidentally increasing boredom in the test subjects, or, conversely, increasing their ability to complete tasks, as this may confound the results.

Following these operational guidelines may help us come closer to accurate and transferable evaluation standards in line with the pedagogical aims of virtual heritage. Emphasizing what is required to be learnt, and how it could be best learnt by different people may also help avoid the danger of virtual heritage merely demonstrating the technical artistry and power of new technology, falsely claiming new pedagogical insights through using non-representative test audiences.

For example, video-games seem to be one of the best technical platforms because: they are based on interactivity and exploration [9] they include human agents, they allow a high degree of perceptual and interaction realism, they meet informal learning environment needs; and they are supported by a psycho-pedagogical theory. However, they still have issues in terms of meaningful learning, and as case study 3

suggests, mastery in a game may not be directly related to mastery of cultural knowledge [4]. Further, even though games are a fundamental part of cultural learning, current social attitudes to computer games may affect learning about other cultures and understanding that learning as having scientific relevance and situational authenticity.

Where games have definitely proved successful is in the area of learning through collaboration, and this is an area where virtual heritage is particularly weak. Interaction does not correspond exclusively to physical-cognitive exchange (free, self-controlled interaction), but contains also other aspects: the possibility of establishing an emotional link with human agents and cultural aspects; and also (only for experts) the capacity of the exhibit to relate different elements providing different pieces of information and integrating them into a more elaborated message [25].

Engagement, a major factor in virtual heritage success, is related to three aspects: the most important, a social and emotional connection (not provided by current VR applications); secondly, the possibility of free exploration and control; and third, the possibility of learning about the past through realistic visualization. This relationship between ICT and cultural heritage is potentially rich in the goal of obtaining more information through flexible and personalized exploration; in multimodal visualization of objects and processes and in personalizable ease of use (such as in informal learning environments such as museums).

We suggested virtual heritage must concern itself with the presentation and understanding of cultural significance. More specifically, the capture, creation, distribution, educational value and feedback features of virtual heritage projects need to be improved. To this extent, presence research is of great interest to cultural heritage researchers.

There are however, two caveats. As virtual heritage typically consists of highly localized information and belief systems, attempts in the cultural field to understand and deliver presence as a universal and constant value, are likely to cause problems. For example, the issue of the appearance of digital mediation may be less important in cultural presence than in presence per se, since the aim is more to provide a cultural filter of sort rather than to create the illusion of an experience not mediated by technology.

And as virtual heritage typically aims to communicate and inspire local and global audiences, we also need to improve the pedagogical elements, not just the quality of the technology. So for the time being, at least in the cultural heritage field, we suggest that system immersivity, and presence, per se, should be understood, applied and tested as a means (for learning about ourselves in a personalized, enjoyable way), not as an end in itself. With that in mind, we aim to develop further the usefulness of cultural presence as a term for evaluating the subjective experience of feeling one is aware of, appreciative of, learning more about, or feeling thematically immersed in not just our own past, but also in the belief systems of other people in other societies who have or had different values to our own.

The advantage of the concept of cultural presence presented here is that it tries to take into account the interface, the user and the context rather than extrapolate standard measures of presence based on laboratory test conditions. We do not promise that this is easily achieved, but it does provide an opportunity for creating user-centric content that may be deployed and experienced more widely. Hopefully it will also help us improve the application and comprehension of presence research in a manner more suited to virtual heritage environments as learning environments presenting objects and processes of cultural significance.

## Acknowledgements

## References

[1]    Addison, A. C., Refsland, S. T., & Stone, R. J. (2006). Guest Editors' Introduction: Special Issue: Virtual Heritage. *Presence: Teleoperators & Virtual Environments, 15*(3), iii-iv.

[2]    Forte, M., Pescarin, S., & Pujol, L. (2006). VR applications, new devices and museums: visitors' feedback and learning. A preliminary report. *The e-volution of information technology in Cultural Heritage. Where Hi-Tech touches the Past: risks and challenges for the 21st century*. Short papers volume. Eurographics: 64-69.

[3]    Pujol, L. & Economou, M. (in press). Exploring the suitability of Virtual Reality interactivity for exhibitions through an integrated evaluation: the case of the Ename Museum. *Museology, International Scientific Electronic Journal, 4*.

[4]    Champion, E & Dave, B. (2007). "Chapter 16: Dialing up the Past." In S. Kenderine and F. Cameron, (Eds.). *Theorizing Digital Cultural Heritage: A Critical Discourse,* MIT Press: Media in Transition series, pp. 333-348.

[5]    Champion, E., & Sekiguchi, S. (2004). Cultural Learning in Virtual Environments. *VSMM2004 Hybrid Realities: Digital Partners,* (17-19 November 2004).

[6]    Beacham, R., Niccolucci, F., Denard, H., Hermon, S., & Bentkowska-Kafel, A. (2003). *The London Charter: For The Use Of 3-Dimensional Visualisation In The Research And Communication Of Cultural Heritage*. London: King's Visualisation Lab.

[7]     Biocca, F. and Harms, C. (2002). Defining and measuring social presence: contribution to the networked minds theory and measure. *Presence2002 Proceedings*, 7-36.

[8]     Chan, M. J. (2007, 1713 GMT, May 8). Lost worlds become virtual heritage. *Science and Space* Retrieved 12 June, 2007, from http://edition.cnn.com/2007/TECH/science/05/08/Virtual_Heritage/index.html

[9]     DeLeon, V., & Berry, R., Jr. (2000). Bringing VR to the desktop: are you game? *Multimedia, IEEE, 7*(2), 68-72.

[10]    Di Blas, N., Gobbo, E., et al. (2005a). 3D Worlds and Cultural Heritage: Realism vs. Virtual Presence. *Museums and the Web 2005*. In Bearman, D. and Trant, J. Vancouver, Canada.

[11]    Di Blas, N., Gobbo, E., et al. (2005b). 3D Worlds for education: cooperation and virtual presence. *Virtual reality at Work in the 21st Century. Impact on societ*y. Thwaites, H. Gant, B., International Society on Virtual Systems and Multimedia: 375-384.

[12]    Hsi, H. (2003). A study of user experiences mediated by nomadic web content in a museum. *Journal of Computer Assisted Learning* 19: 308-379.

[13]    Hu, J., & Bartneck, C. (2005). *Culture Matters - A Study on Presence in an Interactive Movie.* Paper presented at the Presence 2005 Conference, London.

[14]    ICOMOS, A. (1999). *The Burra Charter The Australia ICOMOS charter for the conservation of places of cultural significance, 1999* Australia: Australia ICOMOS.

[15]    ICOMOS. (2007). *The ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites (Charter).* Belgium: ICOMOS.

[16]    International Society for Presence Research. (2000). *The Concept of Presence: Explication Statement.* Retrieved 12 June 2007 from http://ispr.info/

[17]    Jovet, V. (2003). Le multimedia dans l'exposition: la double problématique de l'appropriation et de l'intégration d'un media marginal. *ICHIM03: Cultural institutions and digital technology*. Paris, Ecole du Louvre.

[18]    Lombard, M. (2000). Resources for the study of presence: Presence explication. Retrieved 12 June, 2007, from http://nimbus.temple.edu/~mlombard/Presence/explicat.htm

[19]    Lombard, M., & Ditton, T.B. (1997). At the heart of it all: The concept of presence. *Journal of Computer-Mediated Communication*, 3(2). Retrieved February 15, 2005 from http://jcmc.indiana.edu/vol3/issue2/lombard.html

[20]    Lombard, Matthew & Jones, Matthew T. (2005). The Big Picture: Gaining Perspective by Examining Patterns in the (Tele)Presence Literature. *Presence 2005*, 119-124.

[21]    MacIntyre, B., Bolter, J. D., & Gand, M. (2004). *Presence and the Aura of Meaningful Places*. Paper presented at the 7th Annual International Workshop on Presence (PRESENCE 2004).                                                    From http://www.cc.gatech.edu/ael/papers/files/presence04aura.pdf

[22]    Nagel, T. (1974). What is it like to be a bat? *The Philosophical Review, LXXXIII* (4), 435-450. Nagel, T. (1974). What is it like to be a bat? *The Philosophical Review, LXXXIII* (4), 435-450.

[23]    Nam, C. & Johnson, Steve. (2006). Measuring perceived presence in technologically mediated environments: A research framework, *Presence 2006.*

http://www.temple.edu/ispr/prev_conferences/proceedings/2006/Nam%20and%20Johnson.pdf

[24]    Pape, D., Anstey, J., et al. (2001). Virtual Heritage at iGrid 2000. *INET2001 Proceedings*. Stockholm: 5-8 June 2001.

[25]    Pletinckx, D., Callebaut, D., Killebrew, A. E., & Silberman, N. A. (2000). Virtual-reality heritage presentation at Ename. *Multimedia, IEEE, 7*(2), 45-48.

[26]    Refsland, S. T., Ojika, T., Addison, A. & Stone, R. (2000). Virtual Heritage: Breathing new life into our ancient past. *Multimedia, IEEE, 7*(2), 20-21.

[27]    Riva, G., Castelnuovo, G., Gaggioli, A., & Mantovani, F. (2002, October). Towards a cultural approach to presence. Paper presented at the *Proceedings of the Fifth Annual International Workshop PRESENCE 2002*, Porto Portugal.

[28]    Roussou, M. (2002). Virtual Heritage: from the Research Lab to the Broad Public. *Virtual Archaeology. Proceedings of the VAST Euroconference* (Arezzo 24-25 November 2000). Niccolucci, F. Oxford, Archaeopress. 1075: 93-100.

[29]    Rüggenberg, S., Bente, G., & Krämer, Nicole C. Virtual encounters: Creating social presence in net-based collaborations, *Presence 2005*, 97-102.

[30]    Schnädelbach, H., Koleva, B., Paxton, M., Twidale, M., Benford, S., & Anastasi, R. (2006). The Augurscope: Refining its Design. *Presence: Teleoperators & Virtual Environments, 15*(3), 278-293.

[31]    Schuemie, M. J., Van der Straaten, P., Krijn, M., & Van der Mast, C. A. P. G. (2001). Research on presence in virtual reality: A survey. *Cyberpsychology & Behavior, 4*(2), 183-201.

[32]    Slater, M. (1999). Measuring Presence: A Response to the Witmer and Singer Presence Questionnaire. *Presence: Teleoperators & Virtual Environments, 8*(5), 560-565.

[33]    Slater, M. (2004). How colorful was your day? Why questionnaires cannot assess presence in virtual environments. *Presence-Teleoperators and Virtual Environments, 13*(4), 484-493.

[34]    Slater, M., and Garau, M. (2007). The Use of Questionnaire Data in Presence Studies: Do Not Seriously Likert. *Presence-Teleoperators and Virtual Environments, 16*(4), 447-456.

[35]    Spagnolli, A., S, Varotto, D., & Mantovani, G. (2003). An ethnographic, action-based approach to human experience in virtual environments. *Int. J. Hum.-Comput. Stud., 59*(6), 797-822.

[36]    Steuer, J. (1995). Defining Virtual Reality: Dimensions Determining Telepresence. Communication in the Age of Virtual Reality. Biocca, F. and Levy, M. R. Hillsdale, Erlbaum Associates: 33-55.

[37]    Stone, R. and Ojika, T. (2000). Virtual Heritage: What Next? *IEEE Multimedia 7*(2): 73-74.

[38]    Swinth, K. and Blascovich, J. (2002). Perceiving and responding to others: human-human and human-computer social interaction in collaborative virtual environments. Paper presented at the *Proceedings of the Fifth Annual International Workshop PRESENCE 2002*, Porto Portugal.

[39]    Vigotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. Cambridge, MA, Harvard University Press.

[40]    Witmer, B. G. and Singer, M. J. (1998). Measuring Presence in virtual environments: a presence questionnaire. *Presence 7*(3): 225-240.