

Interface Evaluation for Cultural Heritage Applications: the case of FERRUM exhibition

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Abstract

Intuitive access to information in real environments is a challenge for Information Society Technologies. Having this in mind, a new device for Mixed Reality applications called Virtual Showcase has been developed. It has been conceived to be used in museums and exhibitions, due to its compatibility with traditional museum showcases, offering additional information to the public by means of a simple, direct and intuitive interface. This paper presents the real implementation and usability evaluation of a Virtual Showcase passive-stereo prototype exhibited in a museum for three months. Some results concerning the evaluation process have also been included. Although the technology seems to be promising, implementation aspects such as size should be improved.

Categories and Subject Descriptors (according to ACM CCS): I.3.6 [Computer Graphics]: Methodology and techniques

1. Introduction

In the current rapidly changing world, Cultural Heritage is playing an increasingly important role in providing people with a sense of who they are as well as where they are coming from. Heritage has been widely recognized as an essential capital for articulating identity and meaning for local communities, cities and humankind as a whole. At the same time, heritage and culture in a globalized world are exposed to a wide range of people, consumptions and communication demands.

Therefore, new communication and interpretation approaches are required to be able to understand and manage these changes in such ways that they will enhance the cultural value of Heritage. These innovative approaches should go beyond the static object-oriented presentations and views of the past and take into account the wide variety of interests. There is no doubt that emerging technologies offer new opportunities and environments to create, exchange, discuss and diffuse cultural contents.

Interpretation can be defined as a means of communicating ideas and feelings which help people enrich their understanding and appreciation of their world and their role in it. Interpretation has also been described as an educational ac-

tivity which reveals meaning and relationships. Thus, interpreters should achieve presentations that are interesting and catch the audience.

Interpreters are supposed to apply a wide range of available techniques and multimedia content in an attempt to get messages across. In fact, some previous research activities have shown that the best approach for an interpretative presentation is the use of the most effective communication techniques available. However, some authors have questioned the effectiveness of this effort and believe that the power, persuasiveness and significance of the message lie in the story itself rather than in the technology used to communicate it.

The current paper aims at better understanding the attitudes and behaviour of the visitors towards the application of new technologies for Cultural Heritage interpretation. In the domain of users' technology acceptance, the main objective of the current approach is to study whether different factors such as past experiences or technology familiarity can influence the behaviour towards cultural and heritage content when new technological approaches are implemented.

The paper presents an overall introduction to the applied research of the Virtual Showcase for archaeological exhi-

bitions and the methodology used for the evaluation. Section 2 presents the main objectives of the project, both from the technological point of view and from the socioeconomic one. Section 3 describes the evaluation methodology, including the main objectives and a brief description of the most significant methods that have been applied within the exhibition. In Section 4, the real scenario of the FERRUM exhibition is presented, providing also information about the technical features of the Virtual Showcase prototype and the modelling of the reconstructed artworks. Section 5 summarizes the main results obtained by the implementation of the evaluation methodology.

2. Objectives of the project

The main objective of this research project was the implementation of a prototype based on Mixed Reality technologies for the dissemination of Cultural Heritage in a user-friendly way for the visitor. This objective was achieved by the implementation of an innovative prototype and the assessment of the interpretative plan designed for the exhibition.

2.1. Technological and scientific objectives

The main technological objective of this project is the design and implementation of a prototype based on Mixed Reality technologies, including the following issues:

- Data acquisition for 3D models of some archaeological pieces, taking into account the constraints related to their own characteristics. This issue is crucial, because of the unique value of the historical pieces that are in different conditions of conservation and accessibility. It should be mentioned that some of the artworks could not be photographed with flash;
- Implementation of the Mixed Reality technologies for the virtual reconstruction of damaged or non-existent parts of the artworks; and
- Design and development of the Virtual Showcase prototype, that includes the display or Virtual Showcase, the tracking system and the visualization glasses.

Thus, the main aim includes the development and implementation in a museum of a first prototype based on the application of Virtual Showcase technologies to the dissemination of Cultural Heritage.

2.2. Socioeconomic objectives

One of the most important objectives of FERRUM was the evaluation of the behaviour of museum visitors concerning the integration of Information and Communication Technologies (ICTs) in Cultural Heritage (CH) institutions. The evaluation aims at generating a deeper knowledge about the attitudes and behaviour of the visitors towards the application of new technologies for Cultural Heritage interpretation. This is crucial information for cultural organizations,

because they will be provided with a methodology for the evaluation of the acceptance of new ICTs among visitors.

3. Evaluation methodology

Evaluation studies about visitors have already been applied in two different types of centres (museums and exhibitions) for the dissemination of Cultural Heritage in order to assess the transmission of a very concrete type of Cultural Heritage, such as tangible heritage.

Evaluation studies about visitors are a major task for Social Sciences, so researchers have made substantial effort improving existing methods and techniques. The application of these methods should be based on a scientific process in order to gain knowledge. This scientific approach, as it was mentioned by the American Association of Museums in 1991, should allow gaining systematic knowledge from and about the current and potential visitors of cultural institutions. Planning and development of new activities for the public may be based on this knowledge.

Although countries such as United States, Canada, France, United Kingdom or Germany have a long tradition concerning evaluation programmes at a national level, this can not be applied to Spain. Therefore, evaluation studies about visitors are rarely carried out, although different approaches have been adopted especially related to science museums. Some examples could be the Museum of Zoology in Barcelona, the National Museum of Natural Science in Madrid or the National Archaeological Museum also in Madrid.

On the other side, the trend of the evaluation studies about visitors to assess the learning process, which means the acquisition of concrete knowledge, is commonly understood. However, the interpretative theory works mainly on the assessment of different aspects of communication, not only related to the textual contents, but also their meaning for the visitor, his/her relationship with the object or the cultural institution, and the significance of the institution in the city.

The evaluation study about FERRUM's visitors was based on the evaluation of the interpretative plan made on the basis of predefined informal learning, emotional and behavioural objectives. It fits within a definition that describes evaluation as a "systematic approach to judge what is better, more desirable or effective taking into account some defined aims and criteria" [StMo70]. Therefore, objectivity is required because if evaluation techniques are not objective, the whole interpretation plan can be considered as worthless.

The evaluation of an interpretative project such as FERRUM is not only searching for quantitative and socio-demographical data, but for qualitative information above all. The evaluation of the impact of the FERRUM exhibition on the visitor is what really matters, taking into account that this includes the achievement of some learning and emotional predefined aims.

Therefore, both the quality of the communication from the museum to the public and the interest of the visitor about the proposed exhibition from the cultural institution is assessed. It must be pointed out that the future management of cultural institutions is determined by the results of such evaluations.

3.1. General objectives

The main objectives of the methodology that has been developed and implemented in FERRUM exhibition are the following ones:

- Assess the acceptance of the new Information and Communication Technologies as an added value for the dissemination of Cultural Heritage among the general public;
- Analyse the trends of the public concerning the new technologies as general tools and as tools for the dissemination of Cultural Heritage; and
- Determine the way these new technologies could enhance the learning experience of the visitor and the relationship with the cultural institution.

3.2. Evaluation methods

The methods applied in FERRUM have been traditionally used by other disciplines of the Social Sciences. This methodology has allowed quantifying some aspects related to the quality of the visit. Moreover, the choice of the tools has determined the type of information that was going to be gained. This research should allow defining social profiles that could be directly applied to the evaluation analysis about visitors.

Generally speaking, most of the authors divide the evaluation methods into two main types [Marsh88]:

- Qualitative methods. These are the most desirable ones in order to assess the communicative process to visitors. Among these methods, focus groups, in-depth interviews or direct observation can be included.
- Quantitative methods. These are based on statistical data about the use of the services.

Taking into account what has been previously mentioned, a list of the methods that have been applied in FERRUM is presented.

- Phone queries before and after the exhibition. They included a brief questionnaire that was done in the area round San Sebastian to about 1200 people.
- In-depth interview. It is a qualitative method based on in-depth interviews to one or more people, so that different conclusions could be obtained after an oriented interview. The main advantages of this method are the face-to-face interview, a bigger control of the order of the questionnaire or the higher amount of answers due to human dealing with it.

- Questionnaires. The design of the questionnaires was a mixture between the model of the phone and the in-depth questions. For FERRUM, the self-administrative survey was selected.
- Focus group. It is a qualitative method, for groups of five to ten people that lasts no longer than one hour and a half. The members of the group must have some kind of connection (museum curators, technicians).

4. Real experience in a museum environment: the FERRUM exhibition

4.1. Event definition

The first worldwide application of a Virtual Showcase prototype in a real museum was developed in the context of the "FERRUM. Burdina Gipuzkoan. El hierro en Guipúzcoa exhibition", in San Telmo Museum (Donostia-San Sebastián) between March and June 2003. This exhibition must not be considered as an ordinary exhibition but as a real scale laboratory, whose design and methodology were carefully planned.

FERRUM is an applied research project which tries to investigate the way in which visitors take part in cultural environments which make use of new interfaces. Presentation systems were defined according to the characteristics of the artworks and the interest to ease the dissemination of the information of the objects.

Museums are facing increasing competition from theme parks and other entertainment institutions. Some museums, however, have learned that their visitors do not only want to be educated, but also be entertained. Consequently they are investigating new edutainment approaches. Technologies such as multimedia, Virtual and Augmented Reality in combination with appropriate interaction and storytelling techniques may become the new presentation forms of future museums.

FERRUM was designed for the general public that goes into San Telmo Museum alone or in small groups. There has not been a categorization of target public such as elderly people, schools or other leisure groups, in the design of the exhibition.

At the exhibition entrance, the visitor found a Virtual Showcase of great dimensions, placed in a dark space, where virtual objects were projected in a clearer and more impressive way (Fig. 1). The reproduced historical and archaeological pieces have been selected depending on their suitability according to a clear aim: the vision of the real object must not be overcome by the virtual image.

Archaeological treasures related to iron were placed inside closed showcases to guarantee their conservation conditions. Other objects related to more common issues were presented without visible protection.



Figure 1: Situation of the Virtual Showcase in the real exhibition.



Figure 2: Prototype of the Virtual Showcase in FERRUM.

4.2. The Virtual Showcase prototype

The Virtual Showcase has the same form factor as a conventional showcase, making it compatible with traditional museum displays. Inside the Showcase, real artefacts of cultural or scientific interest can be placed [BEB01]. These can be enhanced or augmented by projecting computer generated 3D stereoscopic graphics and animations (Fig. 2). The device can also be used exclusively as a Virtual Reality device, which was the case of the current application.

Several users could look at the Virtual Showcase from different sides and interact with it. Users were located and tracked by means of a tracking system. It allowed the graphic system to generate the adequate view of the virtual object for each user, depending on its position, what would occur if the objects were real. The result is that virtual and real objects are merged correctly, no matter which point of view is chosen.

Another interesting aspect of the system is its support of several simultaneously tracked users looking at the Virtual Showcase from different sides [MSC04]. This feature allows collaborative exploration of artefacts shown in the Virtual Showcase.



Figure 3: 3D model of the reconstructed archaeological pieces displayed inside the Virtual Showcase.



Figure 4: 3D model of the oldest archeological iron piece of Gipuzkoa.

4.3. Modelling the 3D reconstructions

The historical and archaeological artefacts reconstructed in the Virtual Showcase have been selected having in mind that the virtual object must provide additional information that helps to understand the real artwork.

All the artworks of the exhibition have been modelled using Maya. One of the challenges when obtaining 3D models from the art pieces has been the interdisciplinary work of archaeologists, curators, historians and Information Technologies experts. Thus, when 3D reconstructed models have been developed, continuous meetings between the technological experts and the archaeologists that discovered the pieces have taken place in order to achieve scientific validation of the models.

Fig. 3 and Fig. 4 show some of the virtual models that were projected inside the Virtual Showcase. The sickle is the oldest iron piece that has been found in Gipuzkoa. Due to its bad curative conditions, it must remain in the archaeological deposit and cannot be shown in a public exhibition or even be scanned to obtain a detailed model. Therefore, photogrammetric techniques have been used in its reconstruction.

5. Evaluation results

Before analysing each of the methods developed for the evaluation of FERRUM, and according to the data provided by San Telmo Museum, about 7500 people have visited FERRUM exhibition during three months. However, it must be pointed out that these figures are the global amount of visitors to the Museum, although it can be easily assumed that

most of the visitors during this period have also visited FERRUM exhibition.

5.1. Questionnaires

Questionnaires are considered by social scientists as the key technique for Social Science research, due to their great tradition within these disciplines. Nowadays, although being only applied to a sample of the population, this method has reached high accuracy and reliability.

The main difficulty remains in the design of the questionnaires, as it is the basic tool for gathering information. For the evaluation of FERRUM, this design was based on the aims of the research. All the answers to the questionnaires have been stored in SPSS files for further statistical analysis.

5.1.1. Brief questionnaires

Brief questionnaires about FERRUM were placed at the exit of San Telmo Museum. An important amount of valid surveys (over 60) was collected. It must be pointed out that even though it seems to be a very low percentage of the whole amount of visitors, this is a representative amount for a self-administered survey, that is, filling the questionnaires was voluntary. The questions of the questionnaires were mainly focused on the Virtual Showcase.

The average profile of the visitor was a young adult, between 25 and 55 years old, living in the city of Donostia-San Sebastián, who has a direct relationship with San Telmo Museum. Regarding the way of visiting the exhibition, the percentage was quite balanced between "alone" and "in pairs", followed by "with family and friends". Organized visits represented a very low percentage. More than half of the visitors came specifically to visit FERRUM exhibition.

Within the first part of the questionnaire, visitors were asked about the different subjects that were covered by the exhibition. With regard to the selected subject (the iron in Gipuzkoa), about 75 per cent of the visitors agreed that it was an interesting theme.

Regarding the use of the Virtual Showcase, two thirds of the visitors recognized the objects represented virtually inside. However, the 58,6 per cent stated that the virtual reproduction did not add any additional value when interpreting the use of the objects. Moreover, a correlation was found between those visitors who were usual users to Information and Communication Technologies and the positive acceptance of the Virtual Showcase.

When asking for a numeric assessment, the exhibition got an average score of 5,89 along a 1 to 10 value scale. While 43,9 per cent of the visitor evaluated it between 7 and 8, near a third of the visitors failed the exhibition with values under 5.

5.1.2. Long questionnaires for specialized groups

Longer questionnaires were distributed among people that took part in the focus groups or people related to Cultural Heritage. 48 answers were collected, mostly coming from a group of last-year students from the Humanities Faculty of Deusto University (43 per cent) and from employees of VI-COMTech (27 per cent), who was responsible for the technical implementation of the prototype.

Following the same structure as in the previous case, the first group of questions was devoted to the assessment of the different elements of the exhibition. Although the subject of the exhibition has been considered as interesting, the percentage was lower than in the previous case (only 57 per cent).

With regard to the Virtual Showcase, most of the visitors (around 80 per cent) recognized the objects represented virtually. Nearly the same percentage of visitors (77 per cent) were satisfied with the exhibition and most of them would recommend it to their friends.

When asking for a numeric assessment, the exhibition got an average of 5,56 along a 1 to 10 value scale. While 24 per cent evaluated it between 7 and 8, near a fifth of the visitors failed the exhibition with values under 5. It must be pointed out that the assessment was quite balanced, with a lot of punctuations between 5 and 7.

5.2. Focus groups and in-depth interviews

Focus groups are commonly used by the marketing and advertising industry. Its popularity is growing very fast among other research teams, because they allow observing reality from the point of view of the user. They are considered to be one of the most efficient methods for qualitative evaluation [Krueger91]. Therefore, they have been used in FERRUM, where the evaluation objectives aim at knowing the behaviour of cultural users and the learning process in cultural organizations.

A meeting of a focus group includes a variable amount of people (seven to ten) with a moderator that acts as a guide during the session. During the session, participants talk and give their opinion about those subjects selected by the guide, who observes and gathers each of the contributions of the members. As Krueger says, "it is a conversation carefully planned and designed in order to gain information about a predefined area".

On the other hand, in-depth interviews are another qualitative method, mainly concerning a personal interview with representative people in order to achieve some conclusions.

For FERRUM exhibition, focus groups included experts from Cultural Heritage and educational areas, cultural enterprises and ICTs communities. One of the main issues when selecting the groups has been the ability of getting a very focused and specialized view of the exhibition. Concerning the

in-depth interviews, the objectives and methodology have been the same as for the focus groups. The main difference was the number of people involved in each group, but the schema of the questions remained untouched.

All the material generated within the focus groups was written down and recorded in order to make the transcription of data easier. Therefore, two people from the evaluation team joined each focus group and in-depth interview: one acted as the guide and moderator of the group, and a second one observed and listened to the conversation of the group. The sessions did not last longer than one hour in any case.

The obtained results were qualitative evaluations. Even not being expected, it was found out an overall agreement within and among the different focus groups, no matter the different backgrounds and profiles.

Focusing on the Virtual Showcase, one of the main technical challenges was the huge difference between a controlled environment such as the lab and the real environment. Some of the assumptions about the usability and user-friendliness of the Virtual Showcase have been refuted during the evaluation process. This has been reinforced by the fact that the feedback from people that took part on a guided visit was much more positive than "free" visitors.

On the other hand, the graphical reconstruction of the archaeological pieces was largely criticized. Some of the participants of the groups correlated this issue with the lack of relationship between the real pieces and their virtual representation inside the Virtual Showcase. This relationship was not obvious in most of the cases. The quality of the 3D graphics was also strongly criticized, including the textures and the visualization of the reconstructions.

Another conclusion concerning the physical setup of the Virtual Showcase (size, required infrastructure) was the difficulty to integrate the prototype within the exhibition, becoming the main attraction of the whole exhibition. This led to great expectations that were not completely fulfilled in most of the cases.

However, it should be mentioned that the evaluation also showed the positive perception of the potential of this kind of new interface. Some of the cultural managers agreed that Augmented and Virtual Technologies may work in cultural organizations, as they may increase the surprise on visitors or really provide things that could not be provided by conventional means.

On the other hand, reasons for the disappointment with the Virtual Showcase included the difficulty in the vision, the importance of the real object against the virtual reconstruction, the refreshment rate of the graphics, the non-friendliness of the glasses or even motion sickness.



5.3. Observation

Observation is one of the most popular methods in traditional visitors studies. Two different and complementary approaches have been performed within FERRUM: direct observation through camera recordings in order to observe the behaviour of the visitors, their emotions and reactions; and direct observation in the museum to arbitrarily chosen visitors, writing down the itineraries, the standing times and the duration of the visit.



Figure 5: Users around the Virtual Showcase.

The behaviour of a selection of 150 persons was analysed. Even though the central location of the Virtual Showcase, only 20 per cent of the visitors moved directly towards the Virtual Showcase. Concerning the interaction of the visitors with the prototype, a third of the visitors did not even approach the prototype. Among the people that have interacted with the prototype, nearly 45 per cent have tried the glasses on and about 25 per cent have put them on more than once.

On the other hand, among visitors that stopped at the Virtual Showcase and put on the glasses, the stopping time was no longer than half a minute. This means that visitors were not able to watch all the virtual objects, because each object was projected during six seconds. Only a third of the visitors stayed longer than three minutes.

5.4. Learning modules

During the FERRUM exhibition, groups of different ages were selected to take part in learning modules. The didactic materials were adjusted to the different profiles of the

visitors. Although the survey has been carried out in small groups, so that data should not be extrapolated, the modules have provided the researchers with interesting results about the communication approaches among different age profiles.

The general public needs some stimuli during the learning process. For instance, young public demands stimuli that mix learning, discovering and entertaining. Therefore, the learning modules try to encourage the appropriation of different contents depending on the age of the visitors. The learning units of FERRUM were designed to achieve three main objectives:

- Knowledge (cognitive), such as the importance of iron in Gipuzkoa, the elaboration process of iron, its uses and the evolution throughout the history, the introduction of concepts of new technologies and uses, specially related to the Virtual Showcase, and a new vision in the relation between Cultural Heritage and new technologies.
- Attitudes and values (emotional), establishing a property bond with the iron heritage in Gipuzkoa and its testimonies, letting children express their feelings freely and considering the visit to be a positive experience.
- Competencies (behavioural), including the promotion of active participation in visits to cultural institutions and emphasizing the potential of new technologies for this purpose, the development of artistic sensitivity and personal capabilities of appreciation and observation, the increase of awareness of the value of our historical memory and heritage among young population, and the promotion of good practices associate to Cultural Heritage conservation.

The methodology in the development of the learning modules was based on the classification of the activities into phases, which were distributed temporarily (two sessions of one hour each) and spatially (at school and in the museum). In all of the cases, there has been a previous work with the teachers in order to verify that contents were appropriated for each educational segment.

As an example, the results of the evaluation process with 47 children between 9 and 10 years old (26 boys and 21 girls) are presented. The first part of the learning module was presented in the classroom and the second one in the museum.

The work at school included the theoretical explanation about both content and technology, and some activities related to that content. The presentation was mainly focused on the great importance of the iron industry in the past at the region of Gipuzkoa, mainly regarding the mines of Arditurri in the nearby area. Technology was also briefly introduced due to the presence of the Virtual Showcase in the exhibition. The groups were very active asking different questions about the use and performance of a Virtual Reality system. After those theoretical sessions, children were asked to match several iron objects presented both in situ and in images.



Once in the museum, a guided tour was conducted, explaining to children the most important features of the exhibition and the Virtual Showcase. Afterwards, they had free time to visit the exhibition by their own. To finish up, they made some drawings with the features they liked most. These drawings were shown in big panels at the entry of the exhibition.

Furthermore, teachers were provided with some questionnaires to be filled by the children, so that they could evaluate the exhibition as well as the use of the Virtual Showcase. Among the questions in the questionnaires, children were asked about their personal use of new technologies. Although scanners, digital cameras or simulators got a low percentage, they were quite familiar to computers, videogames and mobiles devices.

Focusing on the evaluation about the Virtual Showcase, about two thirds of the children liked it. The acceptance of the Virtual Showcase was reinforced when assessed in a 1 to 7 ranking, with an obtained average of 5.7. These results showed clearly that the acceptance of the Virtual Showcase increased after a guided visit.

Concerning the drawings, the results were very significant (Fig. 6). The most often drawn issue was the war (61,7 per cent), with swords and spurs as the most representative elements. The Virtual Showcase and the 3D models presented by the system such as the sickle, the arrow or the pick, were represented by 42,6 per cent. One important issue that should be highlighted is that about one fifth of the drawings included the sickle, which was only virtually presented.

Furthermore, after having finished the learning modules as well as the guided visit, all of the children agreed that they have learnt something.

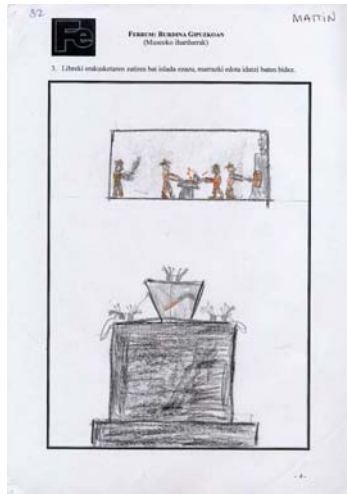


Figure 6: Drawings from some of the children.

6. Conclusions

The implementation of the first passive prototype of a Virtual Showcase in a real museum environment has been successfully achieved. It has made it possible to evaluate the impact of new technologies in the dissemination of Cultural Heritage. Therefore, this research project constitutes a first step towards the integration of these technologies in traditionally not too technologically driven environments.

The evaluation results have shown that the interface of the current prototype should be more intuitive in order to enjoy the whole range of possibilities without any training or further information. This theory has been demonstrated with the change in the degree of acceptance of the interface obtained during guided visits, in which the assessment of the Virtual Showcase has been much more positive.

Another conclusion that was partly foreseen is that the physical dimensions of the current prototype of the Virtual Showcase make it difficult to be integrated in the exhibition space. The Virtual Showcase takes a leading role regards to the rest of the exhibition, generating huge expectations that may not be fulfilled.

Finally, it has also been remarked the great potential of this technological approach. The introduction of real artefacts inside the Virtual Showcase for their augmentation will provide users with new sensations that could not be imagined otherwise. The edutainment potential of the prototype is enormous and should not be refused, taking into account that the Virtual Showcase should not replace the real objects.

Nevertheless, the presented results have not been enough to test whether the prototype changes positively the attitude and behaviour of the visitor toward new means of Culture and Heritage communication. In addition, more research is

needed to understand whether technology may help to better reach human emotions. Research in interpretation has uncovered that people learn better when basic human emotions are aroused. Future improvements of the prototype should consider the ability to capture and symbolise a variety of emotional commitments and values in the audience in order to have a wider persuasive impact.

New technologies should furnish opportunities to enhance interpretative programmes to empower the public by increasing their awareness and understanding, and even to contribute to an attitude-behaviour or behaviour-attitude change. If this is to happen, Cultural Heritage operators as well as interpreters may need to move forwards innovative means and move and motivate the self-righteous into action.

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