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# Design for Cultural Heritage – Developing Understanding in Teaching and Practice

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**Abstract.** This contribution shows how we discovered, by teaching and design, the need for ICT support in the domain of cultural heritage collections. We show examples of current situations with, both, workable solutions and logistic problems regarding the maintenance, documentation, and availability of precious artifacts to keep cultures alive. We point to currently available techniques to incorporate cultural heritage artifacts in a cloud based structure for knowledge and communication that might enable the continuation of cultures in an easy and safe way.

**Keywords:** Internet of Things, Wearable Devices, Cultural heritage.

## 1 Culture is Living is Learning

### 1.1 How we Discovered the Opportunity for ICT support for Cultural Things

We have been developing and teaching university level courses on Design for Cultural Heritage in different countries and in different academic cultures [1]: In Alghero (Italy) in a faculty of Architecture and Design; In Amsterdam (the Netherlands) in a consulting company to experts in designing for cultural institutes; In Dalian and in Liaoning (China) to students of Usability Engineering and students of Multimedia and Animation; in San Sebastian (Spain) to students in Human-Computer Interaction and to curators of museum collections in various domains of Cultural Heritage.

We have been designing ICT support for collections of cultural heritage and developed an ontology for systematic support of scholars in domains of living cultures [2].

We collaborated with curators of a variety of cultural heritage domains: Folk costumes and the history of local dress habits [2]; Folk music, including a collection of instruments, the history, maintenance, documentation, historic recordings, and teaching [3]; A museum institute on the conservation and history of 35 mm celluloid movies [4,5]; A collection of 17<sup>th</sup> – 19<sup>th</sup> century European Art Music Instruments [6].

We visited some large cultural heritage collections where we analyzed documentation and retrieval problems: e.g., a Dutch museum of Natural History that keeps 17<sup>th</sup> – 19<sup>th</sup> century specimen of plants collected mainly in (former) Dutch territory and colonies [7]; a Spanish museum of Folk Musical Instruments around the world [8].

Based on these experiences we developed an understanding of the opportunities that state of the art ICT can contribute to the preservation of cultures and the maintenance, documentation, and accessibility of cultural heritage.

## 1.2 Examples from Teaching

When we teach design for cultural heritage, our introduction always includes examples from our own house where we show artifacts we inherited from our grandparents. These examples represent local or family culture and traditions that support the memories and knowledge as transferred between generations of a community. Figure 1a is an example that represents, for a single family: coat of arms of family members and of cities where family members have been living, the religious environment of this family, a family tradition of celebrating anniversaries of weddings, and the date of the celebration event. After our introduction, the first exercise for our students always is to bring from their own (or their parents') home a comparable artifact that represented the family or community cultural heritage.



**Fig. 1a** Picture of a memory document designed and painted by 3 teen brothers to celebrate the wedding of their father and their stepmother, 1915. **Fig 1b** Picture of a student and her sister wearing a historic dress that has been used in the family for 4 generations.

In a course we taught in a University at Sardinia, department of Architecture and Design, one of our students, member of an international community on the history of folk dresses, brought pictures of a 19<sup>th</sup> century dress owned by her family, see figure 1b. During the course a team of students designed a tablet application to document the costume and to support the growing knowledge about its history and continuing use in a developing culture of celebrating heritage folk costumes, depicted in figure 2.

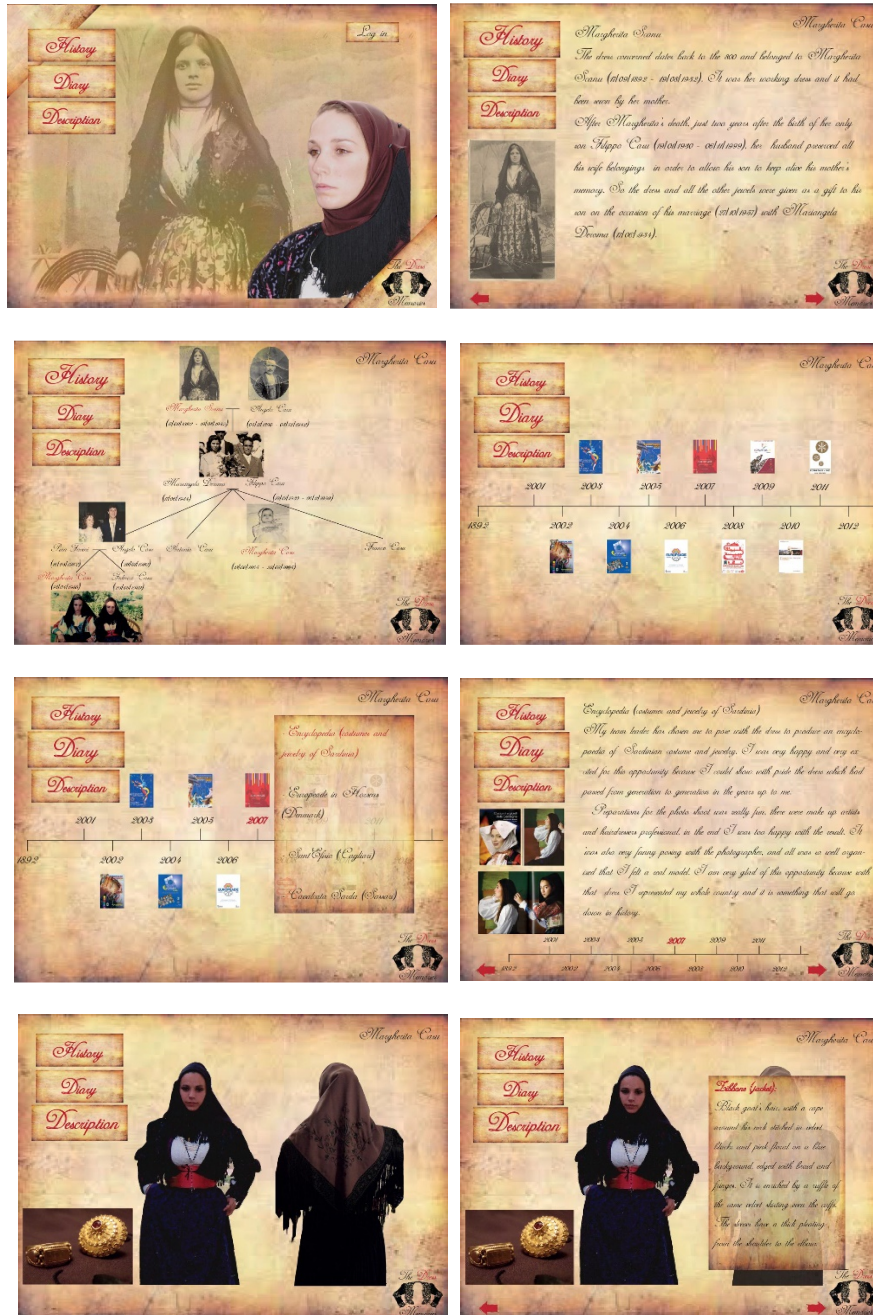
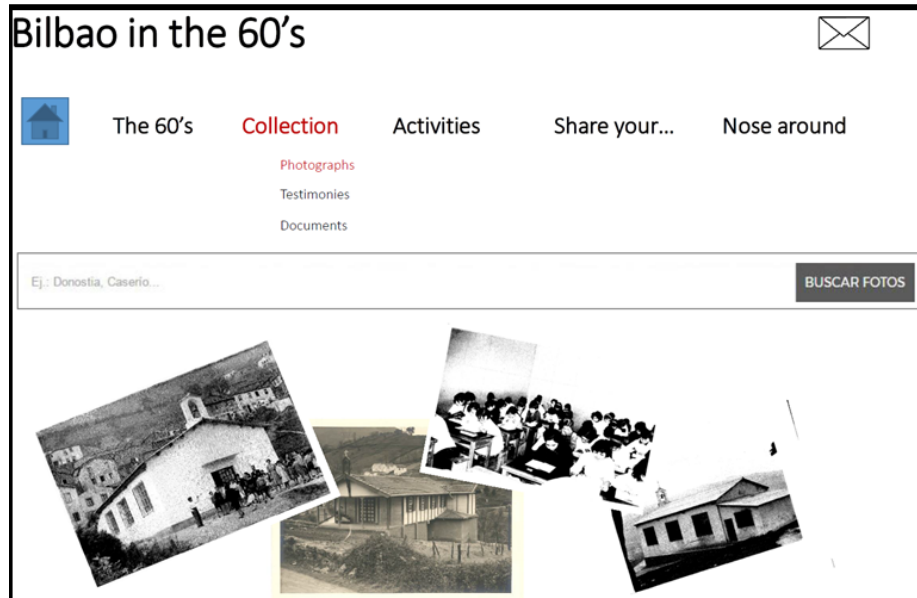


Fig. 2 Interactive tablet application that shows the viewpoints (2a) and their detail navigation on history (2b – 2c); diary (2d – 2f); and description (g – 2h).

Figure 2a illustrates the main structure of the knowledge as used in this community: artifacts are described in 3 different points of view. The history is (for this type of cultural heritage) described along the history of owners / users (Figure 2b and 2c. The diary is a detailed account of what happened to the artifact during its use by the current owner (Figure 2d – 2f), the interactive description part is shown in 2g and 2h.

At a course we taught in Spain for group of computer students mixed with museum curators, one of the students contributed the case of a picture developing collection related to the town of Bilbao during the 60's, see Figure 3. The student group designed a website for a community of citizens of Bilbao to integrate their collection of historic artifacts (mainly old photographs and documents) and related knowledge.





**Fig. 3** Sketch for a website on a picture collection, intended to grow a community that builds the combined historic knowledge that is currently still available, though mainly spread among individual older citizens of Bilbao.

| Types of Stakeholders  |  |   |
|--|--|---|
| STAKEHOLDERS   | THEIR NEEDS  | THEIR CONTRIBUTIONS   |
| Dance and music teachers, as well as children's entertainment groups | <ul style="list-style-type: none"> <li>We provide them with practical learning material for both dancing schools and normal schools. The ideal target group would be students between the ages of 10-13.</li> <li>The contents that are transmitted have a fun factor, which prevails over competition.</li> <li>These games have the advantage of being atemporal and useful.</li> <li>It also gives the opportunity to acquire cultural knowledge on the Basque Country (through music and dance); both to the monitors and teachers, so as to the students.</li> <li>This dance is adequate to work on psychomotricity.</li> <li>Participants could either work on the music (singing or playing) or on the dance (performing it).</li> </ul> | <ul style="list-style-type: none"> <li>The main contribution is to transmit this dance game to the future generations, performing it and bringing it to life.</li> <li>They could give us advice, based on their experiences during the practice of the dances (fi. better ways to perform them, other music that could be used for this dance...).</li> <li>They could also work as informants providing new information on our object.</li> </ul> |
| Dance groups and associations (folklore)                             | <ul style="list-style-type: none"> <li>We enrich their repertoire and make it more diverse.</li> <li>We offer them with a dance which makes their show livelier.</li> </ul>  | <ul style="list-style-type: none"> <li>They contribute to spread the dance and make people aware of its existence.</li> </ul>   |
| Town councils  | <ul style="list-style-type: none"> <li>We fill their cultural agenda.</li> </ul>   | <ul style="list-style-type: none"> <li>Economical support.</li> </ul>   |
| Media  | <ul style="list-style-type: none"> <li>It also responds to culture and identity issues.</li> <li>Reports on local cultural events.</li> </ul>  | <ul style="list-style-type: none"> <li>Broadcasting.</li> <li>Broadcasting and diffusion.</li> </ul>  |

**Fig. 4** Students' sketch for a structure of stakeholders of a local traditional dance collection, their needs, and their possibilities to contribute.

In this case some of the artifacts are in fact old paper documents, original photographs, or original photo negatives. However, sometimes the only artefacts left are electronic documents like PDFs.

Another student group in the same group focused on a collection of historic dances (where the primary artifacts are choreographies, songs, and melodies, with additional artifacts like video and audio recordings, sketches of steps and movements, transcribed scores, and other descriptions). This group (and other design teams that focused their design attempts on historic musical instruments or the performance of local traditional plays and games) elaborated the issue of differences between stakeholders regarding their contributions and their needs of access to the artifacts and to the growing knowledge of their culture. Figure 4 shows an example that they intend to put on

### 1.3 Culture is Learning is Teaching

We adopt the definition of culture from [9], section 5a: “*the integrated pattern of human knowledge, belief, and behavior that depends upon the capacity for learning and transmitting knowledge to succeeding generations*”.

This definition from Merriam-Webster indicates that cultures are patterns of knowledge and behavior shared by a community that transfers the knowledge and behavior to new generations. People involved in such a culture we label in relation their role:

- Scholars: members of the community who are accepted to “know”, and who may, consequently, act as teacher, researcher, restorer, copyist, historian, documenter. Examples in the domain of music: composer, performer, maker or maintainer of instruments, recorder of performances;
- Amateur: member of the community who participates in a meaning full way based on enough knowledge to experience the activities and to share the beliefs, and who aims at continuing to participate. Examples from the domain of music: people who choose the type of performance, the type of music played, the performers, they want to go to, who may keep souvenirs of events in the culture they want to remember.

In many cases these roles may be exchanged: a flute maker, may be happy to travel as an amateur to a performance where the artifact will be used by a performer.

- General public: In any type of culture as we define it, there may be people who do not (want to be) qualified as scholar or amateur. They may be labeled the “general public” or “tourists” – people who perceive a cultural event, performance, or an object of cultural heritage that they do not understand in relation to the knowledge, beliefs, or behavior of the culture.

For this type of audience, the perceived culture as strange, incomprehensible, or surprising.

If the encounter triggers enough curiosity, however, they might be challenged to become an amateur. They might want to learn, and if they find teaching available, they may end up joining the culture and supporting its continuation and its staying alive.

Consequently, a culture that aims at staying alive will have to develop, keep, and provide, documentation and illustration in various levels of detail and depth, various types of representation and modalities, to accommodate both the scholars, the amateurs, and the general public.

And if the culture is alive, the knowledge and beliefs will continue to develop, and the tools of the culture will be used, adjusted, repaired or adapted to new situations and new members of the culture.

## 2 Cultural Heritage is Things

UNESCO [10] defines Cultural heritage as follows:

- *“Tangible cultural heritage:*
  - *movable cultural heritage (paintings, sculptures, coins, manuscripts)*
  - *immovable cultural heritage (monuments, archaeological sites, and so on)*
  - *underwater cultural heritage (shipwrecks, underwater ruins and cities)*
- *Intangible cultural heritage: oral traditions, performing arts, rituals”*

In fact, the things, whether tangible or intangible, are the anchors for people to maintain participation in the culture, and, consequently, these things are essential to keep a culture alive. But the things alone cannot do this. The knowledge of their meaning related to the culture, and the skills needed to use them, are another part that should continually be kept, taught, and learned.

Things, in any culture, are from different types: tangible objects need to be maintained (and during the life of the culture often copied) by using (tangible) tools and (often intangible) prescriptions and standards. The actual use of the tangible objects will follow rules and customs (choreographies, scores, scripts, storylines) that are often itself intangible but may be recorded for memory, for teaching and learning in tangible ways (drawings, sketches, literature).

### 2.1 Collections of Things need Structure

In the different types of cultural heritage collections that we analyzed during our teaching, we mostly found some type of ontology being used to be able to retrieve the objects and refer to them in documentation, in reaching, and in learning. Sometimes, a single cultural collection needs in fact several ontologies, depending on the viewpoint needed for retrieval. In the website of [3] we find what seem to be separate collections for:

- Music instruments (over 1400 artifacts, of which 400 are on display and visible at the virtual museum in the website), where the collection is structured along the standard description ontologies by Hornbostel and Sachs, as published in [11] and along categories of Basque traditional ensembles;
- Library (over 5800 documents);
- Sound library (over 4800 recordings) structures along locations (countries and regions in the Spanish and France bask area) and period of recording;
- Photographs, video, and films (hundreds);



where all these objects are described in documents in a single content management system, where single or multiple elements can be searched through the search page illustrated in Figure 5. The result of a single search may be a single or a series of records, where each record is a description that may well refer to various objects, like a video recording, a sound recording, the instrument being played, a restoration report for the instrument, and a picture of the artist; all to be found in the museum premises, though stored on servers (for the digital recordings) or in different rooms and on different shelves related to the physical type of the artifact.

In [7] the ontology is still a challenge, since the 1000s of collected specimen have originally (often several centuries ago) been categorized according to different ontologies and taxonomies that have been overthrown, developed, or the category or species names translated. In addition, apart from the biological identification the location of origin (related to the Dutch Colonial history) is sometimes a main entry for search. The current labels often are being discussed, and the physical storage shows the characteristics of a collection that is in structural re-arrangement. The collection in [4] is structured along several dimensions: type of movie, location and studio, actors, authors, and date of creation. And the storage of the physical artifacts is related to the flammability of the material (the movies) and the size (of the projectors, which are both historic home projectors, and huge cinema machines).

**Fig. 5.** Example search page, taken from [3], where for several types of cultural heritage a record may be found from the single content management system.

In [6] – a collection of musical instruments, the curators made the decision to label the physical instruments “*primary objects*” (to be searched according to [11], and to refer in their description to different types of “*secondary objects*”:

- Sound and video recordings;
- Restoration reports;

- Other documents like validation reports, proof of purchase or donation;
- Publications referring to the individual primary object;
- Physical objects that were removed during maintenance and restoration;
- Physical objects that were related to playing the individual instrument (original bows or mouth pieces, original spare parts like strings, original cases, etc.)

Some of these secondary objects will not be stored with the primary object, but scholars, when allowed to study or manipulate the primary object, should be able to locate and inspect some of the secondary artifacts.

### 3 Where are our Things

Electronic records of elements in a collection may be nicely stored in a content management system and can be approached through a search facility that is based on a feasible ontology. The physical cultural heritage objects, however, each need their own space in the “real” world. In case of large, or complex, collections like [3, 4, 7, 8] locating the individual objects, and relating them to documentation or entries in the content management system is often a challenge.

The case of [8] shows how the structure and business model of the collection brings a challenge to the storage and handling of the artifacts. The collection is not available in a physical museum, the intention of the curators is to provide selections to specialized exhibitions in museums that are available and interested to do so [12 – 14], where the actual number of instruments displayed, related to the theme of the exhibition, is between 50 and 200. The total physical collection, comprising close to 5000 instruments, is kept in a large store room with cupboards, boxes, and shelves, see Figure 6. Each individual instrument is labeled by paper sticker of 1 square centimeter containing a 5-digit number that refers to a paper card in a card box.



**Fig. 6.** Some pictures of the storage of the physical cultural heritage artifacts from [8]

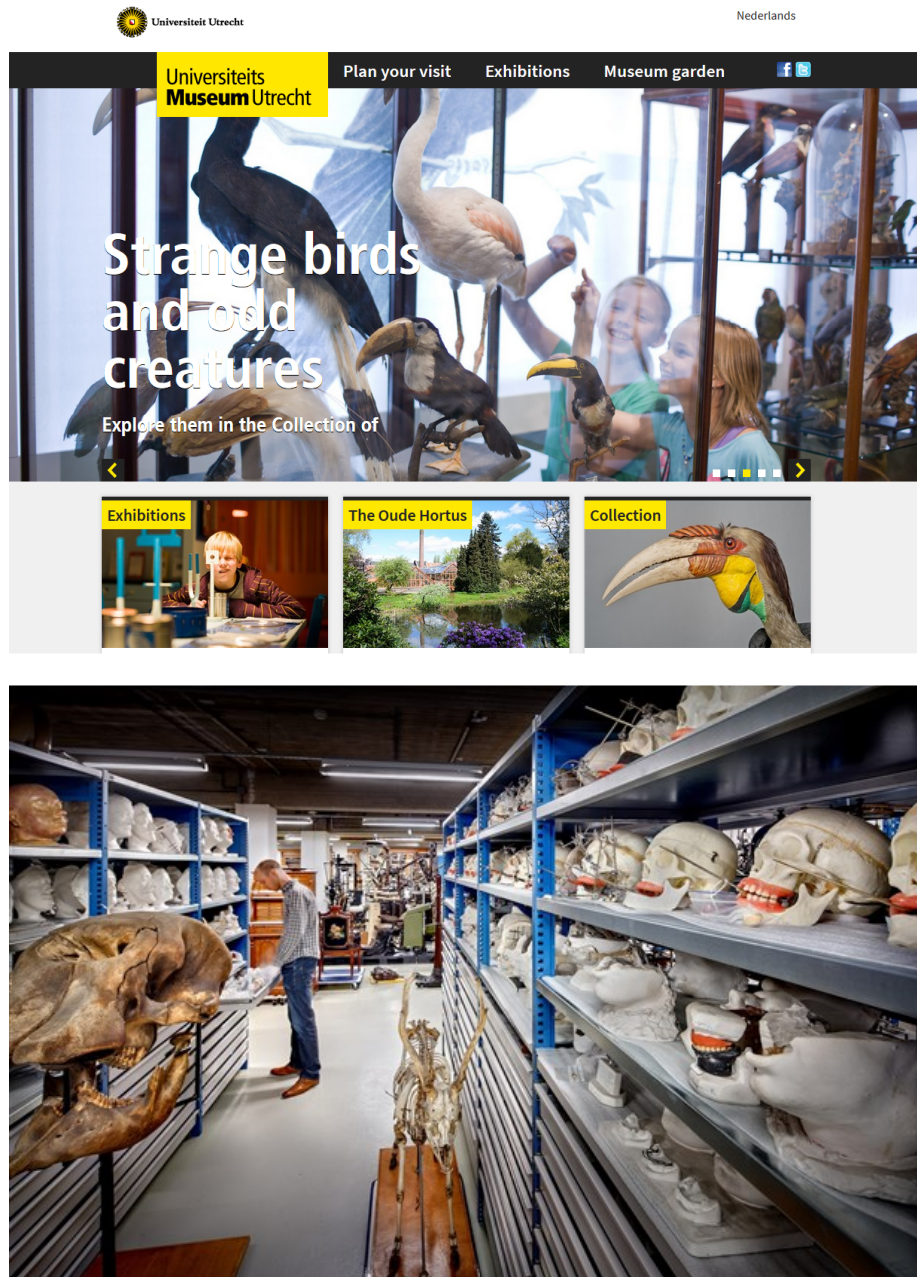


Fig. 7. Website related to collection [7]. And a view into one of the storage rooms.

The case referred to in [7] shows the same type of problem. The University website only provides an overview of the collection and a few examples, the actual depot con-

tains 1000s of artifacts, partly with descriptions in paper documents that are stored in other rooms. In all cases of [3,4,7,8] retrieving a single artifact requires considerable time and the availability of a curator or an expert employee of the collection.

#### 4 Moving our Things into the Cloud

To keep a culture alive, the cultural heritage objects need to be available and need to be related to the knowledge as described in section 2. Current developments in tagging, mobile connectivity, and the internet of things allow us to find solutions for the question from section 3.

The cloud and the internet of things may be conceived to provide locations for a knowledge resource as well as a knowledge storage location (a source and sink) for information related to individual physical cultural heritage artifacts, whether these artifacts are movable or immovable [10].

##### 4.1 Landmarks may have a Virtual Location to Communicate with

Wearable devices like smart phones or their future successors, if they are enabled to identify precise location of the wearer as well as viewing direction (towards an immovable cultural heritage object like a building or a sculpture), can easily relate the artifact to information at the dedicated location for this artifact in the cloud, as well as allow the viewer to comment or upload multimedia recordings to the location (see [15] for an early prototype developed by one of our students).

##### 4.2 Movable Cultural Heritage can be Monitored and Approached from the Cloud

If the number of physical artifacts in a collection gets large, housekeeping is a problem.

Objects may be moved around, be displayed temporarily at a foreign location, made available for research or inspection elsewhere. However, once we connect them to the internet of things, solutions seem available:

**RFID based Identification and Authentication.** RFID tags are available for this in a contactless and passive mode within a short range (current systems allow distances from 10 cm to 100 meter).

And they may be attached to the object in a way that is not immediately visible (even worked into textile fabrics etc. This allows to:

- identify an artifact when encountered;
- authenticate the artifact or establish the status of copy or fake;

though forgeries might include cloning the RFID tag.

**GPS Tracking.** This will enable to locate an artifact within a 1 - 2-meter range almost everywhere on the globe, by retrieving them on any web-connected device. It will work if the batteries are working, so some logistics need to be taken care of. This

allows monitoring artifacts that are on the move, and retrieving lost or stolen artifacts. The latter functionality, obviously, will only work if the thief is not aware of the GOS tracker, or fails in removing it.

**QR code referencing to URL.** QR codes can now be captured by wearable devices, and allow direct connection to web locations that provide access to multimedia information that is relevant and related to the artifact. In the same way, the code can provide access to comment on the artifact and to upload multimedia data that could be used to involve the audience in cultural events or allow them to enrich the connotations of the object.

## 5 Conclusion: How Safe is Cultural Heritage in the Cloud

The techniques discussed in section 4 each provide part of the functionality, and currently the size of the tags and tracker is shrinking to a level where unobtrusive application seems feasible. Still, in case of criminal intend locating a missing artifact, and in case of potential forgery fake authentication is still a problem. There are current attempts to, in some cases, overcome these dangers [16].

However, in case of the current large collections of tangible artifacts that are only loosely connected to the intangible knowledge and the relation structure of a living culture, current technical facilities promise a considerable improvement in supporting a living culture. On the other hand, it requires a change in the logistics of many current collections that seem based on traditional paper index cards and backroom storage. We will need to educate the scholars in our cultures as well as to provide IT solutions that are understandable and usable for them.

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