Chapter 1
Digital Heritage and Virtual Archaeology: An Approach Through the Framework of International Recommendations

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Abstract Undoubtedly today, 3D technology (either virtual reality, augmented reality or mixed reality) helps us in the representation and interpretation of reality, present and past, so it has become a powerful ally of the social sciences and humanities, especially cultural heritage and archaeology. The digital 3D representation of reality around us has opened a world of possibilities—possibilities which grow each day with the emergence of new challenges and concepts such as 4D or 5D. Emerging technologies applied to the field of cultural and archaeological heritage have resulted in the emergence of new concepts such as virtual heritage, digital heritage, digital archaeology, virtual museums, cyberarchaeology or virtual archaeology, amongst others. New concepts to describe new realities, which in turn generate new challenges.

In this scenario, we are witnessing the first steps of what may soon be a new discipline, for which there is still no consensus on its name. This new field of knowledge demands a theoretical corpus to support it but also new recommendations and guidelines, internationally accepted and able to guide research and ensure the quality of new projects.

Keywords Cultural heritage • Virtual archaeology • Standards • Professional guidelines • Digital heritage

1.1 International Recommendations in Cultural Heritage

Since the mid-twentieth century, a number of charters, conventions, principles, recommendations, protocols, standards and other documents have been adopted in parallel to the creation of various international organisations linked to cultural heritage [1–3]. Those documents form an interesting theoretical corpus, and

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knowing more about them can be very useful to those professionals who work in the new field of digital cultural heritage. The origins of these documents are as diverse as the people and the institutions behind them (from international organisations to teams of professionals).

1.1.1 The First Steps

One of the first legal documents to lay the foundations for the management of archaeological and cultural heritage in modern times was the Antiquities Act passed by the US Congress and signed into law by President Theodore Roosevelt in 1906. This pioneering document was used to protect not only monuments but also historic and prehistoric sites. In fact, one of the main reasons for its creation was the US Congress's desire to protect a number of very significant archaeological sites in the southwest of the country. One of the ways to do this was to create the figure of "national monuments" (subsequently made into national parks) to protect vast extensions of land. This helped promote the preservation of archaeological heritage (both fixed and movable assets). The Antiquities Act was an interesting and relevant document at the time, but it was not until 1931 that a truly international document was born: the Athens Charter.

The idea for the Athens Charter for the Restoration of Historic Monuments emerged a decade after the end of World War I, during which many historic monuments throughout Europe had been destroyed or damaged. The restoration or reconstruction of those monuments prompted a serious debate amongst the specialists: what were the most appropriate methods and techniques to be used for the reconstruction work? It was in that context that the Athens Charter was written and approved during the First International Congress of Architects and Technicians of Historic Monuments in Athens in 1931. Its main goal was to unify criteria for interventions on architectural heritage. Although architectural heritage is discussed, throughout the document there is a strong focus on archaeological heritage. This would become even more evident later on in the Venice Charter, with ten articles covering different topics, from guidelines for intervention to the importance of conservation and education and avenues for international cooperation. Its main contribution was the rejection of physical reconstruction as a type of restoration and the emphasis on a minimum degree of intervention on the original remains. Although the final version of the document was not ratified by any countries, the Athens Charter contributed to the development of a vast international movement for the protection and conservation of cultural heritage and laid the foundations for all the national and international documents that subsequently appeared, such as the Italian Carta del Restauro of 1932. It has had such an impact that even today, more than 80 years later, many professionals in the field of cultural heritage back their actions by referring to the principles of the Athens Charter.

1.1.2 ICOMOS's Major International Charters

The success of the Athens Charter led a large number of heritage professionals to organise the Second International Congress of Architects and Technicians of Historic Monuments, similar to the one held in Athens 30 years earlier. This second congress set out as one of its fundamental goals to update the Athens Charter by drawing up a new document which not only would lay the foundations for the modern practice of cultural heritage conservation but would also herald the birth of ICOMOS exactly one year after, in 1965. And so in 1964, the Venice Charter came to life. Its principles are still very much valid today, as Piero Gazzola, one of the authors of the charter, predicted back in 1971, seven years after the document was published and officially adopted. Gazzola wrote that "the Venice Charter is a piece of work that nobody will ignore in the future and all specialists will need to follow its spirit if they do not want to be considered as cultural outlaws". The Venice Charter emphasised the need to respect the original monuments and remains and reiterated the objections to any physical reconstructions. It also included relatively detailed guidelines for the restoration of monuments. As regards archaeological heritage, it included an article specifically dedicated to archaeological excavations which was very much in line with the recommendation adopted by UNESCO in 1956. All in all, the charter has a strong focus on archaeology, as is evident throughout the document.

Fast-paced changes in the world of heritage during the 1960s and 1970s and the work of researchers and experts from very diverse areas (both geographically and culturally speaking) led to new documents being drawn up with much more innovative approaches than that of the Venice Charter. In 1979, the Australian National Committee of ICOMOS, during a meeting in the town of Burra, approved the ICOMOS Charter for Places of Cultural Significance. In it, the notion of the importance of monuments was replaced by a new one: the importance of places or sites. This concept is much more relevant for, say, archaeological sites whose sheer dimension means it is more appropriate to think in terms of sites, not monuments. The Burra Charter overruled the hitherto prevalent Eurocentric approach to cultural heritage by introducing a completely new idea: significance is more important than fabric. In other words, a historic site is not historic just because of the material remains in it but also because of the meaning it holds, because of the history (or histories) kept in it and because of the intangible heritage that is hidden behind the material remains. The Burra Charter also included a whole series of definitions in its first article. This was a very interesting development, as the meaning of some words can vary between different countries and even between different professionals. This contributed to create a more objective, clear and precise text. The introduction of the concept of cultural significance meant this charter is much more tolerant on the subject of physical reconstructions and attributed much more importance to the question of use and public enjoyment of heritage. In Article 25, the notion of heritage interpretation is introduced:

> The cultural significance of many places is not readily apparent, and should be explained by interpretation. Interpretation should enhance understanding and enjoyment, and be culturally appropriate.

The Burra Charter also helped to emphasise the importance of the actual applicability of international documents, as evinced by the fact that, towards the end of the text, a chart was included with proposals for developing decision-making processes about cultural heritage. This eminently practical approach in a theoretical document opened a debate about the need to do more work on the applicability of all international recommendations, both past and future.

In the 1980s, two new ICOMOS charters were approved, although neither of them was particularly relevant in terms of archaeological heritage, as they dealt with the subject in a tangential and non-explicit way. This trend changed in 1990, when the Charter for the Protection and Management of the Archaeological Heritage was approved in the city of Lausanne. All professionals in the fields of archaeology and related disciplines are expected to be familiar with this charter and implement its criteria. One of the many aspects worth highlighting in connection with the document is that it is a staunch advocate of on-site conservation and presentation. In other words, archaeological heritage must be preserved and displayed in its original location, as described in Article 6:

> The overall objective of archaeological heritage management should be the preservation of monuments and sites in situ, including proper long-term conservation and curation of all related records and collections etc. Any transfer of elements of the heritage to new locations represents a violation of the principle of preserving the heritage in its original context. This principle stresses the need for proper maintenance, conservation and management. It also asserts the principle that the archaeological heritage should not be exposed by excavation or left exposed after excavation if provision for its proper maintenance and management after excavation cannot be guaranteed.

Another valuable piece of content can be found in Article 7 (“Presentation, Information, Reconstruction”), which introduces a key recommendation in order to understand the latest developments in the management of archaeological heritage:

> The presentation of the archaeological heritage to the general public is an essential method of promoting an understanding of the origins and development of modern societies. At the same time it is the most important means of promoting an understanding of the need for its protection. Presentation and information should be conceived as a popular interpretation of the current state of knowledge, and it must therefore be revised frequently. It should take account of the multifaceted approaches to an understanding of the past. Reconstructions serve two important functions: experimental research and interpretation. They should, however, be carried out with great caution, so as to avoid disturbing any surviving archaeological evidence, and they should take account of evidence from all sources in order to achieve authenticity. Where possible and appropriate, reconstructions should not be built immediately on the archaeological remains, and should be identifiable as such.

Although underwater heritage is de facto considered an integral part of archaeological heritage, the truth is that its peculiar characteristics made it necessary to treat it in a different and specific way. This was done by means of a specific charter: the International Charter on the Protection and Management of the Underwater Cultural Heritage, initially designed as a supplement to the Lausanne Charter and

published 6 years later, in 1996. It focuses on the need to protect a type of heritage which is seriously under threat due to the fact that it is in unguarded or international waters. As in the Lausanne Charter, there is an emphasis on the importance of on-site conservation (Articles 1 and 10) and the promotion of, and public access to, underwater heritage (Articles 1, 10 and 14).

Another ICOMOS Charter that can be considered as directly related to archaeological heritage is the Cultural Tourism Charter. It was approved in 1999 and, although it does not mention archaeological heritage explicitly, virtually all its principles are applicable to archaeological sites that are open to tourism. In line with the growing diversification process in the tourism industry, some authors have detected an emerging trend within the field of cultural tourism which has been named "archaeotourism" or "archaeological tourism". In this case, the visitor's main motivation, or at least one of them, would be an interest in finding out about the archaeological offer in a given area. The emergence of this new type of tourist explains to a certain extent the phenomenal growth experienced in accessible sites throughout the world. These places have become a preferred destination for a massive number of tourists who bump up the visitor figures in those cultural sites. Precisely for that reason, the International Cultural Tourism Charter must necessarily be included amongst the international documents used as a reference when working with archaeological heritage.

In 2008, a new document with close links to cultural tourism was approved: the Charter on Cultural Routes, which aims to go beyond concepts such as those of touristic route and historic/archaeological site. Cultural routes do in fact help to illustrate the modern social concept of cultural heritage values as a resource for sustainable social and economic development.

It is evident that modern notions of cultural heritage demand new approaches from a much wider perspective in order to explain and preserve all significant relations directly associated with the historic and cultural environment, as well as with the physical environment (whether natural or man-made). Aside from the progress achieved on the conceptual front, cultural routes have a complex, innovative and multidimensional nature, as they provide a significant contribution to the theory and practice of heritage conservation and dissemination.

Cultural routes, however, cannot be seen as mere tourist routes connecting heritage sites: because of their very nature, they are historic events which cannot be created out of thin air or out of a desire to fabricate cultural ensembles in present times. Because they correspond to past historic realities and are entities in their own right, in-depth research is required to properly comprehend them. In a way, we could say that a cultural route cannot be invented, but it can be brought back to life by respecting the individual value of all its elements as substantive parts of an ensemble. If this is done, the end result will ultimately be of far greater value and significance than the sum of its elements.

The ICOMOS Charter on the Interpretation and Presentation of Cultural Heritage Sites, approved in 2008 and very much related to the International Cultural Tourism Charter, is also of interest as a new document dealing with the dissemination of cultural and archaeological heritage and its accessibility by the public.

Finally, it would be interesting to draw attention to a set of principles regarding different material elements. These include the Principles for the Preservation and Conservation-Restoration of Wall Paintings (which can be applied, for instance, to fresco wall paintings found in many Roman archaeological sites), the Principles for the Preservation of Historic Timber Structures (which can be applied to numerous cases involving underwater archaeology or extremely humid or dry environments) and the Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage (which can be applied, amongst others, to the archaeological study of architecture).

1.1.3 The UNESCO Conventions

The United Nations Organization for Education, Science and Culture (UNESCO) is a United Nations agency founded in 1945 to contribute to peace and security in the world by means of education, science, culture and dialogue.

Over the course of its extensive existence, the UNESCO has promoted the approval of numerous international conventions. These conventions, synonymous with treaties, designate any agreement reached between two or more states and represent the parties' shared desire for the agreement to yield legally binding agreements. With the adoption of the Convention on the Protection and Promotion of the Diversity of Cultural Expressions, the UNESCO today already possesses, in the area of culture, a "complete set of regulatory instruments made up of seven Conventions".

Amongst all these conventions approved by UNESCO one is of special note: "Convention Concerning the Protection of the World Cultural and Natural Heritage", approved by UNESCO General Conference on 16 November 1972. This agreement would mark the culmination of a process initiated several years prior and, at the same time, the starting point for a new phase in the identification, protection and conservation of heritage elements, both natural and cultural. The 1972 Convention included important advances and contributions in the field of heritage, managing to encompass in one document the conservation and preservation of both cultural and natural heritage, which until that time always had been addressed in a differentiated way. The idea was also firmly established that there are assets whose meaning and value transcend the borders of the country in which they are located and whose disappearance or deterioration would represent an irreparable loss for humanity as a whole. Following the recognition of the importance of an asset, to ultimately be considered world heritage requires an awareness of a shared inheritance and a common commitment to its conservation and legacy for future generations. In this regard, the Convention can be considered an instrument to promote respect for cultural diversity, international cooperation, understanding and peace between nations.

The World Heritage Convention is considered to be the most successful of all those approved by UNESCO, as demonstrated by the fact that it was ratified by

188 member states. Its most significant contribution was the creation of the World Heritage List, which currently includes 1031 sites located in 163 member states, including 802 cultural sites, 197 natural sites and 32 sites of a mixed nature. ICOMOS has played a key role in the application of the Convention, along with the UICN and the ICCROM. These three entities make up the consultative organs of the World Heritage Committee, a body formed by 21 member states charged with applying the Convention.

As defined in Article 11, the World Heritage List includes cultural, natural or mixed assets possessing exceptional universal value, in accordance with the criteria adopted by the World Heritage Committee. ICOMOS is the consultative organisation responsible for evaluating proposals for cultural and mixed assets (in this case, along with the UICN), to later make the appropriate recommendations to the World Heritage Committee, which ultimately makes the final decisions.

Once the sites are placed on the list, ICOMOS participates in the process, following up on its state of conservation and management. ICOMOS also contributes through the execution of comparative and thematic studies on specific heritage categories for the purpose of providing a context for evaluations. In recent years, ICOMOS actively participated in the creation of tools and specialised manuals, such as "Managing Disaster Risks for World Heritage", "Preparing World Heritage Nominations" (2010) and the "Guidance on Heritage Impact Assets for World Heritage" (2011).

Although the Convention's best-known aspect is the World Heritage List, the document also encompasses all of the cultural and natural heritage located in the territories of the States Parties, as established in its Article 5: "Each one of the States Parties to this Convention shall strive, whenever possible: (a) to adopt a general policy aimed at attributing cultural and natural heritage a function in the collective life and to integrate the protection of that heritage into general planning programs; [...] (d) to adopt the adequate legal, scientific, technical, administrative and financial measures to identify, protect, conserve, value and rehabilitate that heritage".

Of great interest was the approval of the Convention for the protection of underwater cultural heritage in 2001. A long and detailed text that served to improve and fortify the validity of the ICOMOS Charter on the protection and management of underwater cultural heritage approved in 1996.

1.1.4 Other International Documents

Along with the main ICOMOS charters and the UNESCO conventions, there have arisen, over the course of the twentieth century and the start of the twenty-first century, a set of regulations, recommendations, principles, protocols, declarations, codes, etc. which, although considered in many cases to be secondary to the charters, contribute interesting new features and ideas.

With regard to archaeological heritage, we have at least three European and one American document totally dedicated to this area. This involves, first, the European Convention for the Protection of the Archaeological Heritage, signed in London on 6 May 1969, which served as the basis for the drafting, 20 years later, of the European Convention on the Protection of the Archaeological Heritage signed at Valetta (1992). Between the elaborations of both documents stands the Recommendation of the Committee of Ministers to the Member States Concerning the Protection and Enhancement of Archaeological Heritage in the Context of Town and Country Planning Operations. During these years, outside of Europe, worthy of note is the Convention on the Defense of the Archaeological, Historical and Artistic Heritage of the American Nations, also known as the San Salvador Convention, although this document was actually approved in Santiago de Chile via an Organization of the American States (OAS) resolution on 16 June 1976 in the sixth ordinary period of General Assembly sessions.

Another set of documents of great interest for its connection to the world of archaeological heritage and reconstructions is that which arose in the middle of the 1990s regarding the question of authenticity—a concept that until that time, in accord with clearly Eurocentric viewpoints, had been very restricted to a purely material plane and scope. Thus, on 1–5 November 1994, 45 experts from 28 different countries were convened in the town of Nara by Japanese authorities. The conference there made it possible to analyse in depth the concept of authenticity based on cultural diversities and the different categories of properties. A result of that conference was the drafting of the Nara Document on authenticity, also known as the Nara Charter, which would lead to the elaboration of new documents, including regional Southern Cone Document on Authenticity (Brasilia Charter), fruit of the fifth ICOMOS regional meeting, held in Brazil in 1995. One year later, in 1996, came the San Antonio Declaration at the Inter-American Symposium on authenticity in the conservation and handling of cultural heritage in America.

Also of great interest is the European Landscape Convention, also known as the Florence Convention, which, though drafted in the year 2000, would not take effect until 2004. This agreement has a clear connection and utility in the field of cultural landscape.

From that same year dates the Charter of Krakow, Principles for the Conservation and Restoration of Built Heritage. An effort was made to update the latter by means of the Venice Charter, though without obtaining ICOMOS support. Despite this it is a document of great interest that essentially takes the terms of the Venice Charter one step further.

Although of a more generic nature, the 1997 UNESCO Declaration on the Responsibilities of Present Generations Towards Future Generations includes two noteworthy articles that merit study, as they represent the ultimate expression of the ethical code that should guide the actions of all professionals in the field of heritage. Its Article 7, on cultural diversity and cultural heritage, states: “With due respect for human rights and fundamental freedoms, the present generations should take care to preserve the cultural diversity of humankind. The present generations have the responsibility to identify, protect and safeguard the tangible and intangible cultural

heritage and to transmit this common heritage to future generations". Article 8, meanwhile, addressing humanity's shared heritage, states that: "The present generations may use the common heritage of humankind, as defined in international law, provided that this does not entail compromising it irreversibly".

In relation to the field of the Cultural Heritage and Information and Communication Technologies (ICTs) we could say that arrives on the scene at the dawn of the new millennium. More specifically, thanks to the inclusion of Article 5 of the Krakow Charter 2000: Principles for the Conservation and Restoration of Built Heritage that indicates: "In the protection and public presentation of archaeological sites, the use of modern technologies, databanks, information system and virtual presentation techniques should be promoted". This reference, never seen before in other previous charters, marked an important turning point in the use of computers as one more tool in the regular work to conserve and present archaeological heritage. In fact, the Krakow Charter would pave the way for the writing of new international texts aimed at regulating the use of new technologies in the field of cultural heritage. For example, in 2003 UNESCO approved the Charter on the Preservation of Digital Heritage, with the objective of protecting, conserving and improving access to products "of digital origin". This UNESCO declaration came about in the face of the real danger of losing of an immense wealth of cultural heritage existing in electronic format. This heritage includes virtual reconstructions, 3D digitisations and a whole set of products derived from the practice of virtual archaeology, rendering this document of great interest. Less momentous with regard to new technologies, although also of interest, would be the approval on 4 October 2008 of a new international charter officially named the ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites, also known as the Ename Charter. Article 2.4 of this new international text would feature the following recommendation: "Visual reconstructions, whether by artists, architects, or computer modellers, should be based upon detailed and systematic analysis of environmental, archaeological, architectural, and historical data, including analysis of written, oral and icon-graphic sources, and photography. The information sources on which such visual renderings are based should be clearly documented and alternative reconstructions based on the same evidence, when available, should be provided for comparison".

These three previous recommendations would serve as both the foundations and reference points for the documents that thus far constitute the most important theoretical texts on Cultural Heritage and ICTs: the London Charter and the Seville Principles.

1.2 London Charter

The London Charter for the computer-based Visualisation of Cultural Heritage seeks to establish the requirements necessary to verify that a 3D visualisation of cultural heritage is intellectually responsible and solid, as would be incumbent upon any other research method [4–8].

This initiative was born in an international scientific context in which the question of the transparency of the different 3D visualisation applications for cultural heritage became a highly charged and vital issue, in as much as scientific transparency is a fundamental requirement in the process of these applications' development as a research method, that is, to say, as a scientific discipline.

Logically, it is necessary for this research method to enjoy widespread acceptance amongst the international scientific community, which is why the London Charter features, in addition to an Advisory Board, an Interest Group made up of researchers hailing from a range of different countries.

The main objective and accomplishment of the London Charter was to overturn the principle of authority in the creation of virtual models according to which, depending on the inventor of a given model, it enjoyed more or less scientific standing. The authority principle has been replaced by the scientific method, according to which all virtual models must feature a set of data and information (metadata and paradata) facilitating their verification and evaluation by independent experts.

1.2.1 The Scope of the London Charter

It is important to point out that the London Charter is not limited to a specific discipline but rather aims to serve a whole range of disciplines and branches of knowledge, spanning the Arts, the Humanities and Cultural Heritage, provided that they employ 3D visualisation in the development of their respective research and diffusion projects. To this end, the London Charter adopts the format and style of the Ename Charter (ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites) in both its internal structure and its dimensions, while also adopting a very broad definition of the concept of "cultural heritage," encompassing all areas of human activity related to understanding and conveying material and immaterial culture. Such areas would include, but would not be limited to, museums, art galleries, monuments, interpretation centres, archaeological sites, research institutes in the field of cultural heritage, educational institutions of all kinds and tourism.

The London Charter was not undertaken to launch new and radical proposals but rather to consolidate the main principles already advanced in publications by numerous authors, but which still have not been fully assimilated by a large portion of the international scientific community. This is the reason why the "Charter" format was used, rather than drafting a new article, as it seemed the most suitable instrument to guarantee its diffusion and discussion amongst the numerous communities of experts who use 3D visualisations in their daily work.

Although, as was already made clear in our discussion of this issue above, the term "Charters" is reserved for those documents officially approved by ICOMOS, the importance and breadth of the subject addressed in the London Charter is such that the use of the term seems reasonable—even though it has not been ratified by

the ICOMOS General Assembly. In fact, we are probably dealing with a visionary document here, one that is ahead its time, as the use of new technologies in the area of cultural heritage is still viewed by many as a secondary issue in traditional discussions pertaining to this field. Nevertheless, it is evident that the growing impact and interest in the 3D visualisation of cultural heritage seem to augur the ratification of this document (or one very similar to it) by ICOMOS, as it is becoming increasingly necessary to have recommendations and guidelines governing this new field of knowledge.

1.2.2 The Charter Principles

All the principles behind the London Charter aim at improving the levels of scientific transparency present in 3D visualisations of cultural heritage, since improving the levels of scientific transparency of such models is an imperative step prior to reaching a greater level of academic recognition that will propel more consolidated and ample research and studies.

1.2.2.1 Principle 1: Implementation

"The principles of the London Charter are valid wherever computer-based visualisation is applied to the research or dissemination of cultural heritage". The chances of implementation of the London Charter are directly conditioned by the development of more specific guidelines and recommendations based on the fields of knowledge: Such is the case with virtual archaeology, for example, where the application of the London Charter is totally impossible since it has been designed to be too general and therefore makes its applicability too difficult. It therefore needs to be adapted for more specific fields of knowledge (Principle 1.1).

While the mentioned guides or more specific recommendations that will allow for the standardisation of work methodologies are developed, "Every computer-based visualisation heritage activity should develop, and monitor the application of, a London Charter Implementation Strategy" (1.2); in other words, every 3D visualisation of cultural heritage should foresee the specific manner in which the recommendations established by the London Charter will be complied with.

"In collaborative activities, all participants whose role involves either directly or indirectly contributing to the visualisation process should be made aware of the principles of the London Charter, together with relevant Charter Implementation Guidelines, and to assess their implications for the planning, documentation and dissemination of the project as a whole" (1.3). In this sense, all parties involved in 3D visualisation projects for cultural heritage must bear in mind the importance of the development, in a practical and efficient manner, of the principles derived from the London Charter. These principles must not be considered as an appendix to the project or as a source of reference at a particular stage of the project.

It would obviously be less expensive and more practical to obviate the principles from the London Charter, since complying with them means an extra expense due to the time needed to develop the paradata and metadata, amongst others. However, the implementation costs for this strategy must be justified in relation to the added intellectual, explanatory and/or economic value resulting from producing results with a high level of intellectual integrity; in other words, scientific quality (Principle 1.4), in this case, should be enough to justify the increase in production costs of the 3D models, though as we have previously mentioned, it is now important to develop mechanisms that would allow the certification of such quality, since the sources requesting this 3D visualisations (generally public institutions) lack the necessary knowledge to undertake this task.

1.2.2.2 Principle 2: Aims and Methods

"A computer-based visualisation method should normally be used only when it is the most appropriate available method for that purpose". In this sense "It should not be assumed that computer-based visualisation is the most appropriate means of addressing all cultural heritage research or communication aims" (2.1) since other conventional methods can turn out to be more effective, from the financial, temporal or qualitative point of view, than 3D visualisations when it comes to achieving specific objectives. This is why "A systematic, documented evaluation of the suitability of each method to each aim should be carried out, in order to ascertain what, if any, type of computer-based visualisation is likely to prove most appropriate" (2.2). It makes no sense to develop complex and expensive 3D visualisations if their final use and location is in standard panels where, obviously, it will not be possible for the end user to manage or handle 3D models. In such cases, a simple traditional drawing or a computer-generated photograph can be more than enough.

"While it is recognised that, particularly in innovative or complex activities, it may not always be possible to determine, a priori, the most appropriate method, the choice of computer-based visualisation method (e.g. more or less photo-realistic, impressionistic or schematic; representation of hypotheses or of the available evidence; dynamic or static) or the decision to develop a new method, should be based on an evaluation of the likely success of each approach in addressing each aim" (2.3). Or in other words, the first step to be taken in any 3D visualisation project for cultural heritage should be to set the objectives to be achieved in a clear and concise way. That done, one can choose the best methodology to develop and achieve those mentioned aims.

1.2.2.3 Principle 3: Research Sources

"In order to ensure the intellectual integrity of computer-based visualisation methods and outcomes, relevant research sources should be identified and

evaluated in a structured and documented way". "In the context of the Charter, research sources are defined as all information, digital and non-digital, considered during, or directly influencing, the creation of computer-based visualisation outcomes" (3.1). As such, for example, good source of information would be scientific articles or books used to give shape to the model, other projects and other 3D models used as examples, archaeological data retrieved directly from the field, available historical documents, old photographs, audio or audiovisual archives, oral or written testimonies, etc.

"Research sources should be selected, analysed and evaluated with reference to current understandings and best practice within communities of practice" (3.2). That is why it would be useful to fit the project within a consolidated field of knowledge such as contemporary history, mediaeval history, anthropology, etc., since these disciplines already have soundly developed classifications of research resources.

Finally, "Particular attention should be given to the way in which visual sources may be affected by ideological, historical, social, religious and aesthetic and other such factors" (3.3), since the intellectual integrity of any model can only be guaranteed when there is an attempt to provide objective information free of any sort of manipulation. In the cases where, due to ideological or other interests of the hiring institution, it is not possible to offer an objective final product, the aim should be to at least keep such objectivity in the information sources (meta- and paradata).

1.2.2.4 Principle 4: Documentation

"Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed". Generally speaking, "Documentation strategies should be designed and resourced in such a way that they actively enhance the visualisation activity by encouraging, and helping to structure, thoughtful practice" (4.1). Along the same lines, "Documentation strategies should be designed to enable rigorous, comparative analysis and evaluation of computer-based visualisations and to facilitate the recognition and addressing of issues that visualisation activities reveal" (4.2). The utilisation of a single documentation system for all cultural heritage 3D visualisation projects would help to perform objective comparisons and evaluate models; it would also help avoid having to reinvent the wheel over and over again. Unfortunately, such a system is, to date, a utopia, and therefore it is necessary to continue working in the design of such documentation systems.

"Documentation strategies may assist in the management of Intellectual Property Rights or privileged information" (4.3). This topic is capital, particularly in regard to the copyrights, where there are legal loopholes that are having negative effects.

The end users of cultural heritage 3D visualisation projects usually see how their rights to information are limited, that is, the right to know the degree of reality or

objectiveness shown in the 3D models, since in general no project pays attention to those particular aspects. This is why "It should be made clear to users what a computer-based visualisation seeks to represent, for example the existing state, an evidence-based restoration or an hypothetical reconstruction of a cultural heritage object or site, and the extent and nature of any factual uncertainty" (4.4). End users have the right to know what is hidden behind a 3D visualisation, since this information is key in guaranteeing that they will be able to reach their own conclusions and have their own opinions.

On the other hand and for the sake of scientific transparency and to favour the right to information, not so much that of the conventional users but that of those in research, "a complete list of research sources used and their provenance should be disseminated" (4.5). Additionally "Documentation of the evaluative, analytical, deductive, interpretative and creative decisions made in the course of computer-based visualisation should be disseminated in such a way that the relationship between research sources, implicit knowledge, explicit reasoning, and visualisation-based outcomes can be understood" (4.6); in other words, the dissemination of the documentation or paradata processes must be promoted. As such, "The rationale for choosing a computer-based visualisation method, and for rejecting other methods, should be documented and disseminated to allow the activity's methodology to be evaluated and to inform subsequent activities" (4.7). "A description of the visualisation methods should be disseminated if these are not likely to be widely understood within relevant communities of practice" (4.8). "Where computer-based visualisation methods are used in interdisciplinary contexts that lack a common set of understandings about the nature of research questions, methods and outcomes, project documentation should be undertaken in such a way that it assists in articulating such implicit knowledge and in identifying the different lexica of participating members from diverse subject communities" (4.9).

Apart from disseminating documentation processes and methodologies, there should also be importance given to dependency relationships. In this sense "Computer-based visualisation outcomes should be disseminated in such a way that the nature and importance of significant, hypothetical dependency relationships between elements can be clearly identified by users and the reasoning underlying such hypotheses understood" (4.10).

Finally, when carrying out the dissemination of all documentation used and generated during a cultural heritage 3D visualisation project, it is important that "Documentation should be disseminated using the most effective available media, including graphical, textual, video, audio, numerical or combinations of the above" (4.11). Bearing in mind the number and diversity of the professionals that participate in cultural heritage 3D visualisation projects, "documentation should be disseminated sustainably with reference to relevant standards and ontologies according to best practice in relevant communities of practice and in such a way that facilitates its inclusion in relevant citation indexes" (4.12). One must not forget that every cultural heritage 3D visualisation project performed in a professional manner constitutes in itself a valuable contribution to scientific knowledge of our

heritage, and therefore its dissemination must also be performed using scientific means and formats.

1.2.2.5 Principle 5: Sustainability

"Strategies should be planned and implemented to ensure the long-term sustainability of cultural heritage-related computer-based visualisation outcomes and documentation, in order to avoid loss of this growing part of human intellectual, social, economic and cultural heritage". This principle has become one of the main priorities of the European Union in the last few years, under the name of "long-term preservation". The EU is financing new projects within the field of Information and Communication Technologies. The concerns regarding sustainability in cultural heritage 3D visualisation projects has its roots in the continuous loss of useful and valuable information that has been taking place over the last few years. Such is the case of temporary exhibitions, so common at present that once finalised do not normally have a preservation plan, whereby the digital models or 3D visualisations can be reused, even though a great deal of money and resources have been dedicated to their design and implementation. It would only require a small amount of organisation to guarantee that that information would continue being useful in interpretation centres, museums or websites.

On the other hand, it is important that "The most reliable and sustainable available form of archiving computer-based visualisation outcomes, whether analogue or digital, should be identified and implemented" (5.1). "Digital preservation strategies should aim to preserve the computer-based visualisation data, rather than the medium on which they were originally stored, and also information sufficient to enable their use in the future, for example through migration to different formats or software emulation" (5.2). However, experience shows that to date digital preservation is still a risky way of preserving digital content, and therefore even though it is less precise and it can only safeguard a part of it, preservation in conventional formats such as paper or physical replicas (2D or 3D) is more suitable; "where digital archiving is not the most reliable means of ensuring the long-term survival of a computer-based visualisation outcome, a partial, two-dimensional record of a computer-based visualisation output, evoking as far as possible the scope and properties of the original output, should be preferred to the absence of a record" (5.3).

Likewise, it is recommended that "Documentation strategies should be designed to be sustainable in relation to available resources and prevailing working practices" (5.4), since it would be absurd to establish expensive or complex digital preservation strategies, especially when dealing with low cost or limited budget projects.

1.2.2.6 Principle 6: Access

"The creation and dissemination of computer-based visualisation should be planned in such a way as to ensure that maximum possible benefits are achieved for the study, understanding, interpretation, preservation and management of cultural heritage"; in other words, these should be oriented, in as much as possible, to improving research, preservation and dissemination of cultural heritage, particularly when they are financed with public funds. Therefore, "The aims, methods and dissemination plans of computer-based visualisation should reflect consideration of how such work can enhance access to cultural heritage that is otherwise inaccessible due to health and safety, disability, economic, political, or environmental reasons, or because the object of the visualisation is lost, endangered, dispersed, or has been destroyed, restored or reconstructed" (6.1). There are many cases in which access to cultural heritage is impossible for both researchers and the public in general. For such cases, the creation of virtual replicas can play an important role in the work carried out by research, preservation and dissemination, since the said replicas can be consulted and enjoyed by experts and users from anywhere in the planet, provided they are accessible via the Internet.

"Projects should take cognizance of the types and degrees of access that computer-based visualisation can uniquely provide to cultural heritage stakeholders, including the study of change over time, magnification, modification, manipulation of virtual objects, embedding of datasets, instantaneous global distribution" (6.2). Thanks fundamentally to the use of Internet. Logically, this potential can only be developed when the 3D visualisation projects are prepared with time and with suitable strategies that will put no barriers to the access to their information; the use of 3D models through the Internet would usually require a reduction of the geometric complexity of the models or an adaptation of the contents to be more useful and attractive to the general public and researchers. Adopting policies and strategies that facilitate the access to cultural heritage 3D visualisations through the Internet can generate important economic and social benefits thanks to its ties with other industries such as education and tourism.

1.3 The Seville Principles

The International Principles of Virtual Archaeology, also known as the Seville Principles from the city where they were forged, represent a specification of the London Charter [9–11]. While the London Charter includes a set of recommendations applicable to cultural heritage in general, the Seville Principles focus their attention solely on archaeological heritage, as a specific part of cultural heritage. Thus, the London Charter maintains its "charter" designation, and the Seville Principles fall into the category of "principles", a level below charter, following the nomenclature commonly used by ICOMOS. Despite following the structure and

common nomenclature used by ICOMOS, it is important to note that neither the London Charter nor the Seville Principles have been approved so far by the organisation, though these are the only recommendations available at the international level in this area.

From a formal point of view, the Seville Principles are structured following the same pattern as the London Charter, which has four main sections: preamble, objectives, principles and definitions.

The heart of the document is made up of principles, a set of recommendations that seek to improve the applicability of the London Charter in the field of archaeological heritage. In total there are eight principles that follow a logical sequence structured according to the phases of development and implementation of a project of virtual archaeology. This structure aims to facilitate the implementation of the principles in actual projects.

1.3.1 Principle 1: Interdisciplinarity

"Any project involving the use of new technologies, linked to computer-based visualisation in the field of archaeological heritage, whether for research, documentation, conservation or dissemination, must be supported by a team of professionals from different branches of knowledge". "Given the complex nature of computer-based visualisation of archaeological heritage, it can not be addressed only by a single type of expert but needs the cooperation of a large number of specialists (archaeologists, computer scientists, historians, architects, engineers etc.)" (1.1). Logically, this recommendation is limited by the available budget for each project. In some cases, there are sufficient specialised publications on a monument or archaeological site to deal with security a virtual reconstruction or a digitalization without having to add to the team to all specialists. However, whenever possible, the participation of various experts will help to get results with higher scientific quality. Such participation should be active insomuch as "a truly interdisciplinary work involves the regular and fluid exchange of ideas and views among specialists from different fields. Work divided into watertight compartments can never be considered interdisciplinary even with the participation of experts from different disciplines" (1.2).

Given that virtual archaeology is archaeology or is nothing at all, "among the experts who must collaborate in this interdisciplinary model, it is essential to ensure the specific presence of archaeologists and historians, preferably those who are or were responsible for the scientific management of the excavation work or archaeological remains to be reconstructed" (1.3). In the case of 3D digitisation of an archaeological site, only the archaeologist who has excavated or knows in depth the site can tell which areas should be scanned with greater precision and which have a secondary character. This information will be crucial to conduct a thorough and efficient work; otherwise we run the risk of insufficiently documenting areas of high historical interest or spending too much time and resources on areas that lack

scientific interest. On the other hand, many archaeological sites that have been excavated have no visible structures for the public, having been reburied for conservation reasons. Before scanning, a site should be evaluated in collaboration with the archaeologist responsible for the uncovering of those areas. Obviously, this work can only be done by a professional archaeologist.

1.3.2 Principle 2: Purpose

"Prior to the development of any computer-based visualisation, the ultimate purpose or goal of our work must always be completely clear. Therefore, different levels of detail, resolutions and accuracies might be required". Given the limited nature of virtual archaeology budgets, it is very important to set clear objectives to pursue. Funders or contracting entities, generally public administrations, rarely are able to set such targets. However, the researcher should have the responsibility to find a proper balance between the objective and the means necessary to achieve it.

"Any proposed computer-based visualisation will always aim to improve aspects related to the research, conservation or dissemination of archaeological heritage. The overall aim of the project must be encompassed within one of these categories (research, conservation and/or dissemination). The category concerning dissemination includes both educational projects, whether formal or informal education, and recreational projects (cultural tourism)" (2.1). However, sometimes some projects do not pursue a specific purpose but a global objective, such as the case of some 3D scanning projects whose results can be useful for any category (research, conservation or dissemination). After all, the documentation of heritage forms the foundation on which the building of comprehensive management is constructed.

"In addition to clarifying the main purpose of computer-based visualisation, more specific objectives must always be defined in order to obtain more precise knowledge of the problem or problems to be resolved" (2.2). "Computer-based visualisation must be always at the service of archaeological heritage rather than archaeological heritage being at the service of computer-based visualisation. The main objective of applying new technologies in the comprehensive management of archaeological heritage must be to satisfy the real needs of archaeologists, curators, restorers, museographers, managers and/or other professionals in the field of heritage and not vice versa" (2.3). It seems unreasonable that large amounts of public money should be invested in solving problems that no one has raised, while key issues in the management of archaeological heritage remain unanswered.

"Ultimately, the main purpose of virtual archaeology will always be to serve society as a whole and contribute to increase the human knowledge" (2.4). Precisely for this reason, as far as possible, it should promote open access to all content generated by virtual archaeology projects, whether virtual reconstructions or 3D scans. The democratisation of culture is also an objective of virtual archaeology.

1.3.3 Principle 3: Complementarity

"The application of computer-based visualisation for the comprehensive management of archaeological heritage must be treated as a complementary and not alternative tool to other more traditional but equally effective management instruments". To this effect, "Computer-based visualisation should not aspire to replace other methods and techniques employed for the comprehensive management of archaeological heritage (e.g. virtual restoration should not aspire to replace real restoration, just as virtual visits should not aspire to replace real visits)" (3.1). The clashes and controversies that have sometimes arisen between supporters and opponents of the use of new technologies in cultural heritage have their origin in this point. The most classically oriented heritage experts have seen in new technology an enemy whose purpose is to replace time-tested traditional systems. Far from that vision, reality shows that virtual archaeology is complemented by classical techniques and methods, which often remain much more useful in the relationship between value, time and money.

"Computer-based visualisation should seek forms of collaboration with other methods and techniques of a different nature to help improve current archaeological heritage research, conservation and dissemination processes. To do so, compliance with 'Principle 1: Interdisciplinarity' will be fundamental" (3.2). "Nevertheless, computer-based visualisations might be an alternative approach when original archaeological remains have been destroyed (e.g. due to the construction of large infrastructures), are placed in areas with difficult accessibility (e.g. without roads) or at risk of deterioration due to the huge influx of tourists (e.g. rock paintings)" (3.3).

1.3.4 Principle 4: Authenticity

"Computer-based visualisation normally reconstructs or recreates historical buildings, artifacts and environments as we believe they were in the past. For that reason, it should always be possible to distinguish what is real, genuine or authentic from what is not. In this sense, authenticity must be a permanent operational concept in any virtual archaeology project". This principle does not only affect virtual reconstructions but also the 3D digitisation. For example, in 3D digitisation projects, it is often the case that occlusions occur, which must be filled artificially using various algorithms. However, it is rarely possible to know which areas have been artificially filled. This information is key to determining the authenticity of a 3D model. A small occlusion may be hiding an important detail for an investigation on a particular type of object or monument.

"Since archaeology is complex and not an exact and irrefutable science, it must be openly committed to making alternative virtual interpretations provided they afford the same scientific validity. When that equality does not exist, only the main

hypothesis will be endorsed" (4.1). "When performing virtual restorations or reconstructions, these must explicitly or through additional interpretations show the different levels of accuracy on which the restoration or reconstruction is based" (4.2). Unfortunately, there is no internationally accepted system. The representation of uncertainty in visualisations is one of the great challenges that face virtual archaeology. Nevertheless, there are few publications and projects that have attempted to address this issue. Generally, the solutions proposed to date have used colour, transparency or texture to show levels of uncertainty.

"In so far as many archaeological remains have been and are being restored or reconstructed, computer-based visualisation should really help both professionals and public to differentiate clearly among: remains that have been conserved "in situ"; remains that have been returned to their original position (real anastylosis); areas that have been partially or completely rebuilt on the original remains; and finally, areas that have been virtually restored or reconstructed" (4.3). This principle not only applies to virtual reconstructions but also to 3D digitisations. Many buildings and objects that are digitised today have been subjected to various restorations and physical reconstructions over time. Being able to know the areas, on the 3D model, that have been affected by these interventions means moving forward on the path of authenticity.

1.3.5 Principle 5: Historical Rigour

"To achieve optimum levels of historical rigour and veracity, any form of computer-based visualisation of the past must be supported by solid research, and historical and archaeological documentation". We must not forget that virtual archaeology is a scientific discipline that has its base and meaning in historical science and archaeological practice. Its social significance is greater than we might think as it helps to set images and feelings about the past. The way we understand our past affects our present and often justifies our actions in the future. Precisely for this reason, historical accuracy is essential in creating these images, especially when we talk about virtual reconstructions.

"The historical rigour of any computer-based visualisation of the past will depend on both the rigour with which prior archaeological research has been performed and the rigour with which that information is used to create the virtual model" (5.1). "All historical phases recorded during archaeological research are extremely valuable. Thus, a rigorous approach would not be one that shows only the time of splendour of reconstructed or recreated archaeological remains but rather one that shows all the phases, including periods of decline. Nor should it display an idyllic image of the past with seemingly newly constructed buildings, people who look like models, etc., but rather a real image, i.e. with buildings in varying states of conservation, people of different sizes and weights, etc". (5.2). Generally, it should pay close attention to details because one thing is what we want to convey and quite another what we actually convey.

"The environment, landscape or context associated with archaeological remains is as important as the ruin itself. Charcoal, paleobotanical, paleozoological and physical paleoanthropological research must serve as a basis for conducting rigorous virtual recreations of landscape and context. They cannot systematically show lifeless cities, lonely buildings or dead landscapes, because this is an historical falsehood" (5.3). The incorporation of human figures to 3D models probably is one of the most recurrent issues. Different researchers have different solutions ranging from the incorporation of figures in a cartoon style to the incorporation of real actors using the technique of chroma keying. Intermediate solutions have also been used as dark silhouettes of real actors or dark silhouettes of human figures modelled in 3D. Anyway, the humanization of digital spaces helps increase historical accuracy; for that reason this issue should be the subject of a much deeper debate.

"Archaeological heritage recording is extremely important not only for archiving, documentation, analyses and dissemination but for management. New techniques such as photogrammetry or laser scanners can be used to increase the quality of the scientific documentation. In the way that better metric documentation of archaeological heritage is carried out higher will be the chance to monitor and obtain historically and valuable replicas" (5.4). However, at this point it should be to reflect on the digitisation policy that continues today, with some monuments and archaeological sites that have been the subject of countless digitisations, while others remain forgotten and untouched.

1.3.6 Principle 6: Efficiency

"The concept of efficiency applied to the field of virtual archaeology depends inexorably on achieving appropriate economic and technological sustainability. Using fewer resources to achieve steadily more and better results is the key to efficiency". "Any project that involves the use of computer-based visualisation in the field of archaeological heritage must pre-screen the economic and technological maintenance needs that will be generated once installed and operative" (6.1). "Priority must be given to systems that may initially require high investments but long term profit, with minimum maintenance cost and high veracity, i.e. low-consumption resistant, easy to repair or modify systems will be preferred" (6.2). "Whenever possible, draw on the results obtained by previous visualisation projects, avoiding duplicity, i.e. performing the same work twice" (6.3). The results achieved by some projects should be the basis for future work, as starting from scratch is a poor use of already scarce resources. For that reason, it is essential to move forward in creating global databases (Principle 7), incorporating a clear policy of access and use of information stored by using, for example, the creative commons system.

1.3.7 Principle 7: Scientific Transparency

"All computer-based visualisation must be essentially transparent, i.e. testable by other researchers or professionals, since the validity, and therefore the scope, of the conclusions produced by such visualisation will depend largely on the ability of others to confirm or refute the results obtained".

"It is clear that all computer-based visualisation involves a large amount of scientific research. Consequently, to achieve scientific and academic rigour in virtual archaeology projects it is essential to prepare documentary bases in which to gather and present transparently the entire work process: objectives, methodology, techniques, reasoning, origin and characteristics of the sources of research, results and conclusions" (7.1). They should logically be public authorities responsible for promoting and sustaining these databases through their respective ministries or directorates of culture.

"Without prejudice to the creation of such databases it is essential to promote the publication of the results of virtual archaeological projects in journals, books, reports and editorial media, both scientific and popular science, for information, review and consultation of the international scientific community and society in general" (7.2). Unfortunately, many virtual archaeology projects remain unpublished, especially those that have been developed by private companies, whose interests are usually different from the interests of academic researchers. Greater effort should be made to bring the publishing of field work closer to private companies, facilitating publication channels adapted to their abilities and interests.

"The incorporation of metadata and paradata is crucial to ensure scientific transparency of any virtual archaeology project. Paradata and metadata should be clear, concise and easily available. In addition, it should provide as much information as possible. The scientific community should contribute with international standardization of metadata and paradata" (7.3). Undoubtedly, metadata and paradata standardisation systems are one of the great unfinished tasks of the international scientific community. The challenge is to achieve a system that will be not overly complex or costly.

"In general, the registration and organisation of all documentation relating to virtual archaeological projects will be based on the Principles for the recording of monuments, groups of buildings and sites ratified by the 11th ICOMOS General Assembly in 1996" (7.4). "In the interests of scientific transparency, it is necessary to create a large globally-accessible database with projects that offer optimum levels of quality (Art 8.4), without undermining the creation of national or regional databases of this type" (7.5). These databases should store all kinds of 3D models as virtual reconstructions or 3D digitisations. Sometimes it would be advisable to have databases that, in addition to storing the final results of the projects, also include raw data. For example, in the case of photogrammetry, it would be especially useful to store not only the final 3D model but the photographs used to obtain the 3D model, as the algorithms currently used to process these images certainly will be improved in the future. With new algorithms, one will be able to obtain much better results

with the same data. On the other hand, we cannot forget that the archaeological heritage is seriously threatened by whether the documentation obtained in the field can be invaluable in the future against the risk of destruction of the documented asset.

1.3.8 Principle 8: Training and Evaluation

"Virtual archaeology is a scientific discipline related to the comprehensive management of archaeological heritage that has its own specific language and techniques. Like any other academic discipline, it requires specific training and evaluation programmes". "High-level postgraduate training programmes must be promoted to strengthen training and specialisation of a sufficient number of qualified professionals in this field" (8.1). The future of this discipline is inexorably joined to formal university education. The higher the education, the better the results obtained by the projects of virtual archaeology. "When computer-based visualisations are designed as instruments for edutainment and knowledge of the general public, the most appropriate method of evaluation will be visitor's studies" (8.2). "When computer-based visualisations are intended to serve as an instrument for archaeological research and conservation, the most appropriate archaeological evaluation method will be testing by a representative number of end users, i.e. professionals" (8.3). "The final quality of any computer-based visualisation must be evaluated based on the rigour of the measures and not the spectacularity of its results. Compliance with all the principles will determine whether the end result of a computer-based visualisation can be considered or not 'top quality'" (8.4).

1.4 Conclusion

Despite the efforts made so far by researchers, many challenges remain to be addressed in the field of international recommendations applied to cultural heritage and ICT. The largest challenge is to have ICOMOS write or approve an international charter on digital heritage. The London Charter should serve as a basis for drafting such a document, because it has the scientific strength and sufficient consensus to fulfil that mission.

For its part, the Seville Principles, born originally to meet the demands of scientific rigour of virtual reconstructions, need to incorporate a greater number of case studies intended for the field of 3D digitization. A more solid and sustained collaboration with CIPA-ICOMOS would guarantee the successful revision of the document.

Meanwhile, the community of experts should work on drafting new principles to address the needs of the emerging fields of knowledge, such as virtual museums or industrial digital heritage.

This is a challenge that will only be possible to achieve with the collaboration and generosity of all those who work to build the future of cultural heritage.

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