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Author(s):	Sergi Fernandez (i2cat) Merce Lopez (i2cat) Gabriella Paolini (GARR) Maria Teresa Natale (ICCU) Sabrina Tomassini (GARR)

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Project Co-ordinator

Company name : Istituto Centrale per il Catalogo Unico (ICCU)
Name of representative: Rosa Caffo
Address : Viale Castro Pretorio 105, I-00185 Roma, Italy
Phone number : +39.06.49210427
Fax number : +39.06.4959302
E-mail : rcaffo@beniculturali.it
Project WEB site address: www.indicate-project.eu

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Author(s)	Sergi Fernandez, Merce Lopez, Maria Teresa Natale, Gabriella Paolini, Sabrina Tomassini
Contributor(s)	Antonella Fresa
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Approved by:	

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1 Executive summary

This document is the result of INDICATE Virtual Exhibitions Case Study. The main objective of this case study is to review the current situation of virtual exhibitions processes, the state of the art of the technology used and the relation between cultural institutions and e-Infrastructures.

This document is composed by 13 sections and 1 Annex.

Over the last 15 years museums, libraries and archives had been using the Internet to develop exhibition projects and disseminate their collections. The existing e-Infrastructures let us to think on new exhibitions formats and uses, as the ones that had already been developed on the field of performing arts and that will be explained on this document as an example of the new uses and formats that can also be applied to the cultural heritage sector.

This document is targeted either to cultural institutions and e-Infrastructures providers, to reciprocally learn the state of the art in the field of virrtual exhibitions and virtual performances.

2 Scope of the case study

The INDICATE project mainly focuses on the use of e-Infrastructures for digital cultural heritage in countries all around the Mediterranean. Establishing a network made up of experts, researchers in the relevant fields in Mediterranean, the project helps to share experience, promote standards and guidelines, and seek harmonization of best practices and policies.

This Virtual Exhibition Case Study examines the current situation of virtual exhibitions among the partner countries and how e-Infrastructures can be used to create new projects, taking the virtual performances as example.

Analysing the possibilities that the Internet offers to cultural institutions we often think that "Le musée imaginaire" (André Malraux, 1947) has found its better platform of development. Physical exhibitions are changing and interacting with the virtual world, increasing the information and experiences offered to on-site and remote virtual visitors. We can't anymore consider them separately; institutions should also include their remote and virtual visitors on their strategies and public programs. Thinking about virtual exhibitions, we can not any more consider them separately to the physical environment, mobile applications and tablet uses. The virtual presence of an institution or a single exhibition project should be taken into account on the global sense, mixing virtual and real environments to better reach the main goals: research, dissemination, communication, learning and users experience.

As explained by Erkki Huhtamo at the Nobel Symposium on "Virtual Museums and public understanding of science and culture", "*There is no doubt that the vogue for virtual museums received a powerful impetus from the emergence of the World Wide Web and particularly from its beginning transformation into a multimedia environment with the introduction of the Mosaic browser in 1993. Yet the idea did not originate with the WWW. The invention of the hypertext in the 1960s may, in the longterm, have been a more decisive influence, pointing*

out the possibility of creating huge non-linear data-architectures"[1]. Allowing the cultural institutions to intensify the use of the existing e-Infrastructures can be the first step of new virtual exhibition formats.

The recently published "NMC Horizon Report 2011 Museum Edition"[2] highlights six emerging technologies or practices that are likely to enter mainstream use within three adoption horizons over the next five years, most of them related to the virtual environment: Mobile Apps, Tablet Computing, Augmented reality, Electronic Publishing, Digital Preservation and Smarts Objects.

3 Methodology

To analyse the current status of virtual exhibitions a survey has been prepared in the framework of the INDICATE project (see Annex 1) and carried out in some of the Euromediterranean countries participating in the project (Italy, Greece, Spain, Turkey, France, Slovenia). The results have been discussed by all the partners, in order to have an overview of the state of the art in the various countries.

On the other hand, a workshop on "Virtual Exhibitions"[3] has been organised in Amman at the Department of Antiquities of Jordan last 11 December 2011 to present best practice examples of virtual exhibitions, to discuss how e-Infrastructures can be used to enhance virtual exhibitions applications and to analyse the resources which e-Infrastructures offer, and how they can be deployed to deal with virtual exhibitions implementations.

At the same time, we have considered papers, reports, articles, wiki platforms and other information resources that have been studying the virtual exhibitions phenomenon to provide a global overview on virtual exhibitions technologies and their use by the cultural institutions.

An important contribution to this deliverable was given by a national working group on virtual exhibition, composed of experts and cultural operators from different domains (museums, archives, libraries etc.), set up in 2010 by the Italian Ministry for cultural heritage and activities. After one year of work, this group came up with some guidelines for the realisation of online virtual exhbitions[4], made available in the framework of INDICATE.

4 Introduction

The chance to stage "online virtual exhibitions" boosts the opportunities provided by the digital world and the web to promote cultural heritage above and beyond what the physica, analogic world can do.

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[1] Huhtamo, Erkki, "On the Origins of the Virtual Museum", Source: Nobel Symposium on "Virtual Museums and public understanding of science and culture", Stockholm, Sweden, 2002. Published at: Museums in a Digital Age, Edited by Ross Parry, Leicester Readers in Museum Studies, p. 121-135.

[2] Johnson, L., Adams, S., and Witchey, H. (2011): *The NMC Horizon Report: 2011 Museum Edition*. Austin, Texas: The New Media Consortium, http://www.nmc.org/publications/horizon-report-2011-museum-edition.

[3] INDICATE Virtual Exhbition Workshop, http://www.indicate-project.org/index.php?en/22/events-archive/66/amman-virtual-exhibitions-workshop. Proceedings of this workshop will be published in early 2012.

[4] *Mostre virtuali online: linee guida per la realizzazione*, Roma: Ministero per i beni e le attività culturali, http://www.otebac.it/index.php?it/320/mostre-virtuali-online-linee-guida-per-la-realizzazione

.

In this light, new methods and tools to describe and depict cultural heritage have been developed, communication and information access modalities have been overhauled, and the traditional functions and roles played respectively by the curators and consumers/users of cultural heritage have been reconsidered.

The construction of exhibitions, thematic routes, and annotated galleries with digital content and resources related to the various categories – and thus to the various peculiarities – of cultural heritage represents the emergence of a countertrend aiming to overcome the limits caused by the fragmentation of our cultural heritage, and to reconsider the procedures and methods used in intellectual production and in the communication and dissemination of knowledge.

One of the main goals of the public and private bodies, institutions, and subjects which make up the framework of cultural activities is the promotion and dissemination of knowledge.

They accomplish their mission thanks to tools that include, among others, temporary and permanent exhibitions and performances that follow codified models, whose goal is to expose citizens to the national and international cultural and artistic heritage.

The meeting between languages and methods of traditional cultural promotion (non-virtual exhibitions and performances) and the promotion and dissemination of knowledge through web-based methods (online virtual exhibitions) have made it necessary on one side a better understanding of terminologies, not yet fixed in professional literature, and on the other side to illustrate technologies and good practices which may encourage the use and explore all opportunities offered by Internet and the e-Infrastructures.

Exhibits designed with IT languages and destined for the web are increasingly acquiring institutional relevance and a strong public profile: museums, archives, libraries, and cultural institutions all make recourse to them. They should thus be considered an important strategic activity and as such must be well-planned and supported to foster their long-term growth.

Virtual online exhibitions are not merely aimed at specialists, but rather at an audience that is larger and more heterogeneous than ever before, and which is difficult to frame in traditional profiles. This is the reason why project choices must arise from a careful analysis of models of expression, architecture, and language, calibrated to include even culturally and technologically disabled users.

Virtual exhibitions are also an opportunity for disadvantaged groups as disabled people or aging people with physical impairments, sight or hearing problems, facing mobility barriers or time restrictions to visit real exhibition. With the proper preparation and display of the exhibition they are given chances to visit and enjoy the cultural space when they do not have the possibility to visit real cultural word.

The technology of virtual exhibition should be carefully choosen to be usefull and accessible for disabled visitors. Attention must be given when interpret an artefact for blind, selecting colors (contrast) for background, different level of details of descriptions of the artefacts are recommended, ...

The exhibition's architecture must be designed according to effective management models that can generate diversified virtual routes while keeping production costs acceptable, in order to meet the needs of the various user groups.

5 Definitions and concepts

First of all, it is useful to clear up several recurring concepts, some of which are still being debated in the technical literature, and define the way in which they are used in the present deliverable.

5.1 Virtual exhibitions

5.1.1 Exhibition

Exhibitions are an expression of the activities of cultural institutions, and they partly or wholly represent the promotion of the legacy these institutions preserve. Through these activities, users and cultural contents are put in contact, sometimes leading to commercial exploitation.

The term **exposition,** in its broadest sense, indicates the rational process through which one attempts to divulge a concept or topic by explaining its logical content or linking it to other concepts or topics that help highlight its meaning

The terms **exhibition** and **show** indicate events with a specific venue and time, during which the public can enjoy a series of objects, paper and/or multimedia documents, books, paintings, sculptures, and other items, related to each another and organized according to logical, thematic, spatial, historic, and/or authorial criteria, and made accessible either permanently or temporarily, through one or more narrative routes, with scientific, didactic, and/or promotional goals.

From a **temporal point of view** exhibitions staged by cultural institutions can be:

- **Permanent**, when the exhibition is a stable part of a cultural institution to the point of becoming an integral, essential part of its ordinary activities (i.e. museum or gallery). In non-museum cultural institutes a permanent exhibition sometimes constitutes a stable section aiming to depict – through items chosen from its own collections and documents – the history and cultural and scientific contents of the institute (i.e. Exhibitions Hall of the British Library)
- **Temporary**, when the exhibition has an end date and deals with a specific issue, topic, or author. In these cases, the collections selected by the cultural institute for the exhibition can be augmented and completed through loans or agreements with other public and/or private cultural institutes, and can include the acquisition – on the basis of a costs-benefits analysis (availability, costs, etc.) - of documents, works, or other items deemed necessary to enrich and elaborate on the exhibits.

From a **spatial point of view** exhibits can be staged:

- On the premises of the cultural institutions;
- On other premises, which are related to the institute and represent it;
- Along a thematic route through the local territory, involving various cultural subjects and establishing a historic/tourist/cultural itinerary.

Anytime an exhibition is about to be staged, the possibility of staging an **online version** should be considered from the earliest planning stages.

5.1.2 Virtual Exhibition

Cultural institutions are increasingly recurring to exhibitions that fall outside the traditional space/time parameters, and are instead staged on IT platforms. These can be made available in museums and galleries spaces (**off-site virtual exhibitions**) or via the web (**online virtual exhibitions**).

A virtual exhibition is a **hypermedia collection** made up of digital items which are:

- Linked together by a common threat, an inter-disciplinary topic, a concept, an idea, an anniversary, a special event, or a physical person;
- Displayed in 2D and/or 3D;
- Occasionally stored in distributed networks;
- Made accessible through the potential provided by modern technologies, thanks to a system architecture designed to provide user-centred, absorbing experiences;
- Dynamic products that can offer services and be updated periodically.

Sometimes, virtual exhibitions are called by institutions **digital exhibitions**, but in this report we will always use the term “virtual exhbitions”.

Virtual exhibitions are **often generated by real events**, even though they may result in products that are autonomous, due to the web language they use.

There are also exhibitions that are designed specifically for the web and are staged exclusively online (web generated exhibitions), as is the case for:

- Exhibitions staged by cultural institutions lacking in adequate funds or exhibition spaces, which use the web to promote their legacy;
- Exhibitions staged by private subjects (collectors, artists, musicians, etc.) who stage web exhibitions featuring their own digital items and content;
- “Impossible exhibitions”, where a single virtual space displays works from various institutions that could never be displayed in the same physical location;
- Objects and installations that could never be displayed, since they were born digital.

Online virtual exhibitions can be staged with more or less sophisticated IT tools, depending on the **degree of complexity** and the **goals** in question:

- The most basic exhibitions serve as an **advertising** showcase for real events, including through an ad hoc website. These are often part of a broader set of coordinated marketing actions, whose main goal is to increase the number of visitors to the exhibition. These websites generally comprise a series of informative pages and a photo gallery featuring the exhibition’s highlights.
- One step up on the complexity ladder are **virtual visits** to real exhibitions, based on a specific web project aiming to depict the exhibition’s actual arrangements, and allowing users to approximate as much as possible a real visit, enhanced at times by information pages. Sometimes users need to download specific software in order to access this service.
- The most sophisticated are **complex virtual exhibitions** making full use of the conceptual, instrumental, and linguistic tools provided by new technologies, and using the full extent of their potential.

Can **digital libraries** be considered online virtual exhibitions? They generally contain a series of informative items that are either individually accessible or linked by the applications that support them, but they can only be considered virtual exhibitions in cases where – as for the World Digital Library (http://www.wdl.org) – they display their institutions' "treasures". In these cases, users are encouraged to embark on a route that selects its material on a thematic basis and includes enhanced content, such as, for example, interviews with the curators of the relevant collections.

In any event, digital libraries and cultural portals are often the driving engine behind virtual exhibitions, as is the case for the European culture portal Europeana (http://www.europeana.eu) or TEL (http://theeuropeanlibrary.org), the national libraries portal.

In summary, **a collection of digital items, in and of itself, does not constitute a virtual exhibition**. **It is only when the items are carefully selected to illustrate a topic, and are tied together forming a narrative or a logical itinerary, that they constitute an exhibition.**

In short, content alone is not enough, but rather "the content in a context."

Online virtual exhibitions, independently of the degree of sophistication of the technology used, can and must be put together in such a way that they can provide **alternative experiences to the real event**, which can involve the user in a process of discovery, knowledge acquisition, and learning.

Today, we know that one of the strengths of virtual exhibitions lies in their abilities to fully exploit the potential provided by **media** (text, images, audio, video, and in the near-future augmented reality) and access to **databases**, which make them a useful learning tool. For this reason, interactive virtual itineraries are amply used even in real exhibitions.

What are the advantages of virtual exhibitions?

They:

- Help to **promote** the cultural heritage preserved by the institution;
- Are a **learning** tool that helps enhance knowledge;
- Can make accessible an **amount** of documents and items that is much greater than what any material exhibition could ever manage to display;
- Can make accessible to the public the **most valuable** works and documents, without putting the national and international cultural heritage at risk;
- Help users to **enjoy** documents and works that may not be accessible otherwise;
- Make it possible to **view parts and details** of works that could not otherwise be seen, not even through the direct observation of the original;
- Remain accessible **over time**, since they are not limited to the duration of the actual event;
- If online, can almost always be "visited" **free of charge** by users from **all over the world**, who may not be able to visit the actual exhibition;
- They are **dynamic**, since they can be modified even after they have been changed, both with regards to planning aspects and to their activities and contents;
- Can be enhanced by the **contributions of users**;
- They can be staged even on limited budgets, and are **less expensive** that actual exhibitions;

- They can **serve as an online archive** for information related to the material exhibition;
- They can have positive repercussions on the **tourism industry**.

References:

- David Bearman. *Museum strategies for success on the Internet*. "Spectra", 22 (1995), n. 4, p. 18-24. http://web.archive.org/web/20010211004518/http://www.nmsi.ac.uk/infosh/bearman.htm
- Saul Carliner. Modeling information for three-dimensional space: Lessons learned from museum exhibit design. Technical Communication. "Journal of the Society for Technical Communication", 48 (2001), n. 1, 66-81. http://core.ecu.edu/engl/henzeb/7701s06/ftp/ethnog2.pdf
- Martin R. Kalfatovic. *Creating a winning online exhibition: A guide for libraries, archives, and museums*. Chicago: American Library Association, 2002.
- R.V. Roberto. A critical look at online exhibitions and online collections: When creating one resource is more effective than the other. "DESIDOC Journal of Library & Information Technology", 28 (2008), n. 4), p. 63-71. http://publications.drdo.gov.in/ojs/index.php/djlit/article/viewFile/198/106
- Schubert Foo – Yin-Leng Theng – Dion Hoe-Lian – Jin-Cheon Goh. From digital archives to virtual exhibitions. In: Handbook of Research on Digital Libraries: Design, Development and Impact. Hershey, PA: IGI Global, 2009, p. 88-101. http://www3.ntu.edu.sg/home/assfoo/publications/2009/2009Handbook-DLSF_fmt.pdf
- Werner Schweibenz. How to create the worst online exhibition possible in the best of intention, documento inedito e presentazione a EVA Florence, 2011, 5 May 2011.
- Ministero per i beni e le attività culturali. *Mostre virtuali online. Linee guida per la realizzazione, versione 1.0* (settembre 2011), http://www.otebac.it/index.php?it/327/mostre-virtuali-online-linee-guida-per-la-realizzazione-versione-10-settembre-2011

5.1.3 Virtual thematic route

Within the framework of virtual exhibitions, thematic routes can be used for specific goals as a way to enrich them and to delve into specific topics.

They can also be an autonomous and independent product, whose main purpose is no longer the valorisation of collections - which instead is the goal of a virtual or actual exhibition - for example as an itinerary whose geographic or didactic aspects are the most salient characteristics.

Compared to a virtual exhibition, in which users are faced with rather homogeneous contents, the distinguishing characteristic of thematic routes is the common thread that links contents that are at times quite disparate. As a consequence, the work of a curator of a route consists of linking the contents together and helping the user understand these links. For this motive, thematic routes often have didactic applications, and are widely used for study and orientation purposes.

The topics at hand can be expanded upon independently from the spatial and temporal location and provenance of the various documents: indeed, thematic routes can touch upon literary texts, quotes, multi-media documents such as radio or television programmes, videos,

newspaper articles, anthologies, and any other contribution or link that can help shed light on the relevant topic.

Thematic routes have no pretence of being exhaustive, but they meet the need to "suggest" to users a possible interpretative framework that will help them grasp a particular topic and discover new aspects of it.

5.1.4 Virtual museum

A virtual exhibition is not a "virtual museum". A deep debate on the subject is carried on in: Consiglio Nazionale delle Ricerche - Dipartimento Patrimonio Culturale, *Virtual museums and archaeology: the contribution of the Italian national research council*, edited by Paola Moscati, "Archeologia e calcolatori", suppl. 1, 2007, soi.cnr.it/archcalc/images/VM.pdf.

In particular, this topic is analysed in the following papers of the above mentioned publication:

- François Djindjian, *The virtual museum: an introduction*. The Author explains that for several years now the concept of virtual museum has had an important role among the means being used for the diffusion of cultural information, as it offers an important extension to the traditional museum. In this paper he briefly discusses the concepts of the applications of virtual museums, by studying the transformation of a real museum into a virtual museum. He also introduces the two concepts of "the museum of museums" and that of "the imaginary museum". He also breafly summarizes the technical Internet context implied in the realization of a virtual museum and its main operating principles.

- C. Dallas, *Archaeological knowledge, virtual exhibitions and the social construction of meaning.* The Author makes some general observations on the scope of various approaches to achaeological virtualisation, with particular reference to virtual exhibitions. He examines some interesting fully dynamic, evolving case-studies and, linking the historical development of archaeology to that of different kinds of archaeological knowledge, he highlights the possibilities offered by hypermedia applications on the World Wide Web not only for public communication, but also for archaeological meaning construction and mode of representation. The overall discussion points include virtual exhibition in the context of virtual museums, the notion of virtualisation and some ideas on content, formal representations and affordances.

- Francesco Antinucci, *The virtual museum*. The Author illustrates the positive and negative features of the virtual museum, and the role of visual and new interactive technologies in the cognitive processes. He then defines the concept of the virtual museum as the communicative projection of the real museum. According to this definition, the virtual museum is not a simple copy of the real museum; in fact, the radical re-organization related to the task of communication, also from the point of view of the display structure of the virtual museum, creates the possibility of exploiting powerful and effective visual means, which is the strong point of virtual construction.

Moreover, there is a tentative of classification of virtual museums made by: Anna Lorente i Gall and Ioannis Kanellos[5]. They divide virtual museums in the following carhegories:

[5] Anna Lorente i Gall - Ioannis Kanellos, *What Do We Know about On-line Museums? A Study about Current Situation of Virtual Art Museums*, Communication dans une conférence à comité de lecture, International

- *Real museums websites*. They are the virtual counterpart of real museums, presenting information about the museums, and their collections and events. Their general purpose is the advertisement. The cultural information is rather limited (only a part of collections, restricted documentation, images of low resolution…); nevertheless, in most cases, the information allows to have an idea about the content of the museum. This category is the most important in terms of quantity of on-line museums (currently, nearly 80%).
- *Thematic museums*. This group of museums comprises all websites (not related to a real museum) that exhibit real artworks under a thematic argument. The artworks are real but, in opposition to the previous category, the unity of space is not mandatory; in other words, the artworks are distributed over a more or less large geographic area. The virtual thematic museum offers a place where visitors can access to a collection abolishing physical distance constraints.
- *Conceptual museums*. They refer to art collections that are possible to visit on the Internet but not in the real world. They represent a concept of museum that it is possible to turn into reality thanks to ICT; in other words, artworks are ontologically dependent on ICT mediations. Their collections are essentially made up from digital artworks; but we also find some museums where the artworks are real but not accessible (e.g., coming out from private collections).
- *Meta-museums*. This last basic category represents "museums of museums": its collections come out from collections of other museums (that generally, but not exclusively, are of the first category). Therefore, a meta-museum allows visits through several museums, not necessarily related between them. Metamuseums can offer special virtual exhibitions that are not possible to find in other museums.

See also the same paper, for a list of virtual museums with relevant links.

5.1.5 Digital Object

One of the characteristics of virtual exhibitions is the use of digital items. **Digital items** (or **digital objects, documents**, or **resources**) are units of content made up of bytes of data, an identifier, and a series of information on the item itself (metadata). They are accessible to users through a web browser. Examples of digital items include: documents, articles, books, photographs, audio or video files, and 3D models. Digital items have either been digitized or are born digital.

Digitizing indicates the process through which analog material is transformed into digital material.

There are two approaches to digitizing a source: making an exact copy of the original (through the use of scanners and other similar instruments) and creating an image file, or creating a text file through the optical character recognition of the original source followed by conversion to a set of ASCII characters. These two approaches have different goals, but they complement each other, and are ultimately convergent.

Data bases are organized collections of items. They are the archives that allow them to be stored in a functional fashion.

Conference Transforming Culture in the Digital Age, Tartu, Estonia, 2010, pp. 208-219, http://perso.telecom-bretagne.eu/annalorente-gall/publications/index.php?idpublication=9652.

The data and items that make up a digital archive can be stored in a **digital case** (an effective application for the production, management, publication, research, integrated access, and long-term conservation of resources) and made compatible with portals that can serve as **aggregators** and facilitate the search of resources (for example, Europeana (www.europeana.eu) at European level, or CulturaItalia (www.culturaitalia.it) in Italy.

Identifiers (IDs) are a series of characters that unambiguously identify a specific resource (for example, the URL for a specific image or video clip).

Metadata, associated with field labels, comprise information on the digital item, and are commonly broken down into:

- **Descriptive** metadata, which are of fundamental importance for **recovering** digital items (such as bibliographic or catalogue information and semantic elements);
- **Structural** metadata, on the **logical or physical links** between the parts of a compound object (i.e. the pages of a book, the papers in a file, the various elements of an object);
- **Administrative and management** metadata, on the **management** of the digital item. They include technical metadata, conservation metadata, metadata for copyright management and metadata for long-term conservation).

Metadata are thus "**data about other data**"; that is, structured information about any type of resource, which is used to identify, describe, conserve, manage, and provide access to the resource itself.

Metadata can be associated to any digital item or "abstract" resource: HTML documents, digital images, data bases, books, museum items, archive documents, metadata records, websites, collections, services, physical places, persons, institutions, "abstract" works, concepts, events, etc. It is thus necessary for digitization and digital resource recovery procedures to be accompanied by the creation of metadata.

Metadata schemes differ from one another in terms of structure and content. There are generic metadata schemes (such as DublinCore) and specific metadata schemes for archives, libraries, museums, digital archives. Compatibility between different metadata schemes can be achieved through a **crosswalk**, a table that identifies and maps the semantic relations between individual elements from two or more metadata schemes.

DUBLIN CORE		**MARC 100**
DC.creator	<==>	Architect Artist Creator Source

Example of mapping between elements from two metadata schemes (DC and MARC 100)

In order to favour the re-use of metadata, they can be made available by allowing visualization of XML files.

References:

- MINERVA. Technical Guidelines for Digital Cultural Content Creation Programmes: Version 2.0, 2008. http://www.minervaeurope.org/interoperability/technicalguidelines.htm
- ATHENA. *Persistent identifiers: recommendations for institutions, 2011*, http://www.athenaeurope.org/getFile.php?id=779
- Ukoln. *Metadata mapping between metadata formats*. http://www.ukoln.ac.uk/metadata/interoperability/
- JISC INFONET. *Digital Repositories* http://www.jiscinfonet.ac.uk/infokits/repositories/index_html
- ATHENA. *Digitisation: Standards landscape for European museums, archives, libriaries*, 2009, http://www.athenaeurope.org/getFile.php?id=435

5.1.6 Hypertext, hypermedia, multimediality, interactivity

Hypertext makes it possible to surf the content of virtual exhibitions. In traditional publishing, text is organized according to a **sequential linear model**, to which, at most, a **hierarchical or tree-like structure** can be superimposed. Text is thus read starting from the first page and ending on the last.

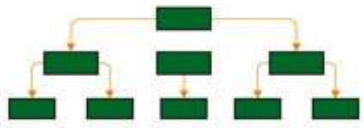
The web makes it possible to organize information according to a **non-sequential reticular model**, characterized by a series of information units (nodes) and links that allow one to jump from one node to one or more other nodes.

This was of organizing information was given the definition “hypertext” by Ted Nelson in 1965.

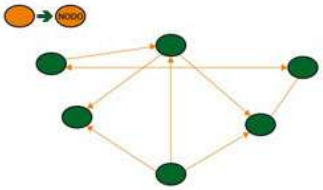
Hypertext allows to browse within the contents of the virtual exhibition.

Here, the information organization models are schematised:

Hypertext: sequential linear model

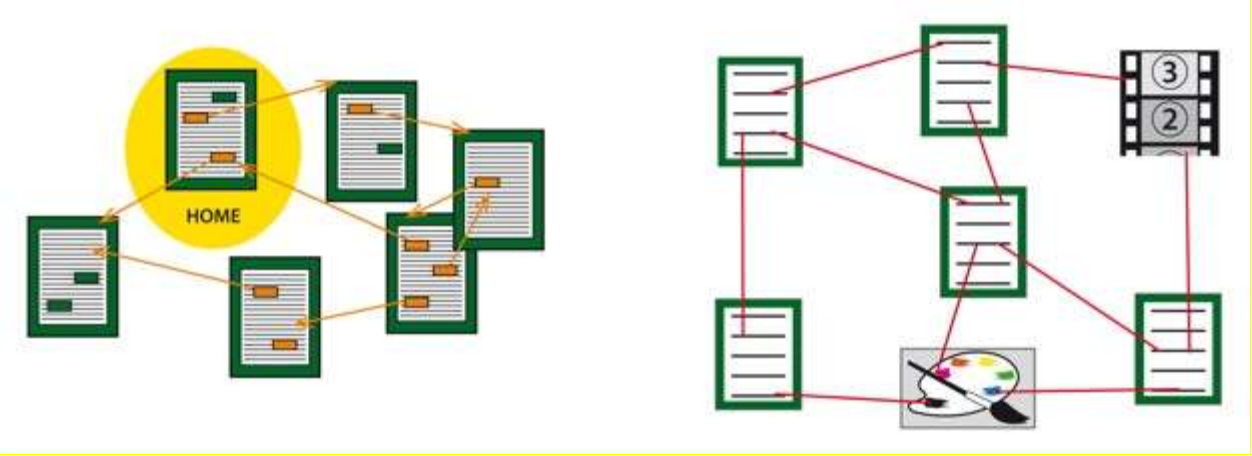


Hypertext: hierarchical or tree-like structure



Hypertext: Non-sequential reticular model

When information that is linked online does not only comprise text documents, but includes information conveyed by different media (text, images, sounds, videos), hypertext becomes multi-media, and is called ***hypermedia*** or ***multi-media hypertext*.**



Hypertext and Hypermedia

Multimediality is the system for viewing digital items via different perception channels (sight, sound, text) through a single support for recording and disseminating information organized thanks to hypertext and/or hypermedia structures, in order to obtain an engaging and efficient representation of said information.

The enormous potential of digital hypermedia and hypertext as a communication tool is driven by its ***interactivity***, which is made possible by the series of components that make it possible to use a given tool and thus interact with it.

Thanks to this, individuals can **interact** with the instrument at hand.

The **meeting between hypertext, multimediality, and interactivity** is the key ingredient for the success of a virtual exhibition project.

Anyway we want to emphasize that interactivity is not only the physical process of "clicking", but also the mental process of connecting to the contents presented in a virtual exhibition. Exaggerated interactivity in a virtual exhibition may be counterproductive and have a negative effect on users' mental activity.

References:

- Theodor Holm Nelson, *The Hypertext*, in: Proc. World Documentation Federation Conf. 1965.
- MINERVA. *Handbook on cultural web user interaction*, edited by MINERVA EC Working Group "Quality, Accessibility and Usability", First edition (September 2008) http://www.minervaeurope.org/publications/handbookwebusers.htm

5.1.7 Information architecture

Any virtual exhibition must rest upon an information architecture that makes up **the logical and semantic organizational structure** of the project's information, content, processes and functionality.

This structure, typical of virtual exhibitions, must be adapted to the website hosting the exhibition, unless the latter has its own autonomous website.

Information architecture is at the heart of any interaction design project.

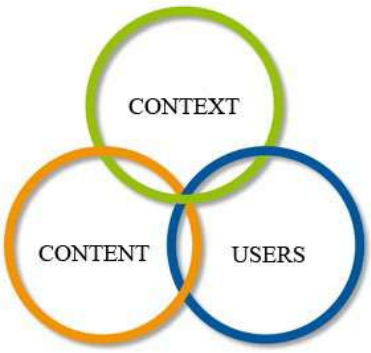
By integrating information and processes, it plays a key role in defining the true degree of accessibility on the part of end users.

It encompasses the analysis, selection, and design of the technical and cultural tools to be used for organizing, cataloguing, searching, surfing, and presenting content and data.

The design of the architecture of the contents of a digital system or services – which applies to virtual exhibitions as well – must take three aspects into account:

- The analysis and planning of the system's overall organization and the model governing interactions between its parts (**architecture**);
- The analysis and planning of the system's various operational flows and processes, starting from an analysis of the users' tasks and objectives (**processes**);
- The analysis and design of the interface that presents data, content, and instruments to interact with users (**pages**).

Information architecture is the virtual space hosting knowledge promotion and dissemination projects aiming to link users and content – including, at times, for commercial purposes – through an IT system or application.



In designing the architecture of a virtual exhibition, one must take into account the fact that users must be free to choose their own itinerary. It is thus fundamentally important to include numerous links between the various information units. Users must be free to choose whether to enjoy the exhibition on a general level, or to delve into its topics in greater detail. It is absolutely essential to divide information into autonomous units that express concise yet exhaustive concepts, by exploiting the possibilities provided by hypertext to present complex concepts.

However, some studies say that user does not always choose its own path, but sometimes prefers to be driven in the content discovery experience.

References:

John Vergo [*et al.*]. *'Less Clicking, More Watching': Results from the User-Centreed Design of a Multi-Institutional Web Site for Art and Culture*. In: Museums and the Web 2001. Selected Papers From the International Conference, Seattle, WA, March 14-17, 2001, Pittsburgh, PA: Archives & Museum Informatics. 23-31, http://www.archimuse.com/mw2001/papers/vergo/vergo.html

During the conception phase, it should be kept in mind that the contents of a virtual exhibition can be aggregated according to thematic relations, which may be more or less prevalent and non-exclusive depending on the objectives to be pursued, such as:

- **Spatial aggregation:** objects are connected by real or reconstructed spatial links (e.g., geographic, environmental, urban, housing, etc.);
- **Temporal aggregation:** objects are connected by chronological links (e.g., historical period, event, celebration, phase, etc.);
- **Typological aggregation:** objects are conected by their typology (e.g., style, manufacturing technique, material, production, etc.);
- **Comparative aggregation:** objects are aggregated on the basis of links arising out of the comparison with other models, thus creating a network of similar contents (e.g., comparisons between civilizations, roles, etc.)

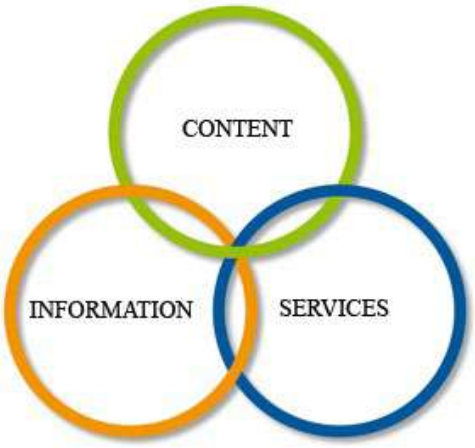
In addition, there are aggregations which take into account the target audience and the relationship with users:

- **Functional aggregation:** function and/or goal which the exhibition can help meet (for example, target users: schools for the disabled, university students or educational/didactic purposes);
- **Behavioural aggregation:** when the exhibition encourages and develops behaviours that can attract other behaviours. This is the case with regards to interactions between multiple communities of users and/or visitors, which bring about broader relationships and new developments (e.g., interactive and community areas, web 2.0 features).

References:

- M. Forte, S. Pescarin, *The virtual museum of landscape*, in: CNR, Dipartimento Patrimonio culturale, *Virtual Museums and archaeology*, The Contribution of the Italian National Research Council, edited by Paola Moscati, "Archeologia e calcolatori", Suppl. 1, 2007, par. 4. http://soi.cnr.it/archcalc/images/VM.pdf

The structure of a virtual exhibition rests upon three macro-areas, independently of the technological solutions chosen: the **content area**, the **information area**, and the **service area**.



The three macro-areas of a virtual exhibition

An exhibition is the result of choises and expressive tools through which the content is organised in order to be communicated.

According to M.R. Kalfatovic, whoever curates an exhbition should use one or more element combinations, based on several approaches:

- **Aesthetic**: organised around the beauty of the object;
- **Emotional**: chosen in order to solicit user's emotions;
- **Evocative**: though to create an athmosphere;
- **Didactic**: built to teach something;
- **Entertaining**: presented just for fun.

References:

- Martin R. Kalfatovic, *Creating a winning online exhibition: a guide for archives, libraries, museums*, American Library Association, 2002, http://www.nyu.edu/projects/sanger/CDH/kalfatovic.pdf

5.1.8 Users

In this report, we think it necessary also to clarify what we mean with the term "user", starting from the definitions included in the *MINERVA handbook on cultural web user interactio*n, First edition (September 2008)[6]. There, the term "user" has different meanings according to specific contexts. All these terms fit very well when applying them to the realization or fruition of a virtual exhbition.

[6] MINERVA. *Handbook on cultural web user interaction*, edited by MINERVA EC Working Group "Quality, Accessibility and Usability", First edition (September 2008), http://www.minervaeurope.org/publications/handbookwebusers.htm.

- **The user for ICT professionals:** A user is a person who uses a computer system. In order to identify oneself, a user has an account (a user account), a username (also called a screen name, handle, nickname, or nick on some systems) and a password. An account is that collection of functions, tools and contents available to a user in certain operational contexts. Through the mechanism of the account, the systems provide the user with an environment with contents and functions that can be customized, as well as separation from other parallel users and their accounts.

- **The user in marketing:** Another approach is that of marketing, classifying users on the basis of their possible quality as consumers. The users are not treated individually, but gathered into consumer market segments, or groups of people that have a similar perception of a requirement, its characteristics and motivations, that brings them to demonstrate an homogeneous behaviour in solving the problem represented by the requirement. The requirements for a successful classification are: homogeneity within the segment; heterogeneity between segments; measurability; identifiability; accessibility of information; enough quantity to be profitable. The variables used for segmentation include:
  - Geographic variables (nation, region, country, etc.);
  - Demographic variables (age, gender, family size, family life cycle, education, income, occupation, socio-economic status, religion, nationality/race, etc.;
  - Psychographic variables (personality, life style);
  - Behavioural variables (product usage rate, brand loyalty, etc.).

  When enough information is combined to create a clear picture of a typical member of a segment, this is referred to as a "profile" (or "type").

- **The user according to MINERVA:** "A user is a professional person or not, a specialist or not, who casually or with specific aims, occasionally or systematically uses the Cultural Web Application. User identity is extremely variable depending on cultural profile, aspirations for cultural growth, professional aims and even momentary curiosity". Therefore, a quality we application must be user-centred, "taking into account the needs of users, ensuring relevance and ease of use through responding to evaluation and feedback".

- **The user in current trends:** Seeing the current trends of the Web, strongly oriented towards the functions of cooperation and advanced interaction, with the movement of applications onto the network, the sharing of social networks, etc. (Web 2.0, by now 3.0) it seemed necessary to update the classical concept of the user as a person who uses an application. As early as 1980, Alvin Toffler introduced the term *prosumer* (producer + consumer), extending a suggestion made by McLuhan in 1972: in a standard and saturated market, the added value would be found in mass customisation guided by users, and the functions of consumer and producer would tend to become mixed and overlap.In short, the classical user is changing into a hybrid individual also defined as a *transceiver* (transmitter + receiver), the addressee of content and the source of his own multimedia productions. In conclusion, a fluid individual, from time to time prosumer, consumer, client, audience, surfer, visitor, viewer, player, clicker, downloader, streamer, etc.

- **The non-human (or automatic) user:** The Web is increasingly an environment of interaction not only between people and organisations but also between software procedures on different computers. It is sufficient to mention search engines, web

services, extraction and reprocessing of XML feeds, mash-ups between functions, harvesting of metadata and data, etc. So, a web application must also satisfy non-human users, which to function must be able to find the right information in the right form and in the right way. These conditions, in short, are what ensures interoperability.

- **The in-home user:** The management of a web application within a cultural institution can be very simple or very complex and involve one or several actors. Web applications give the possibility to define in-home different user types with different roles – for example Administrator, Supervisor, Editor, etc. – with different levels of authorizations. Therefore, the necessity for cultural institutions to grant the co-ordination of internal and external information flow, the cross-over between various channels of communication and to focus on the phase of planning, development and management of the web applications.

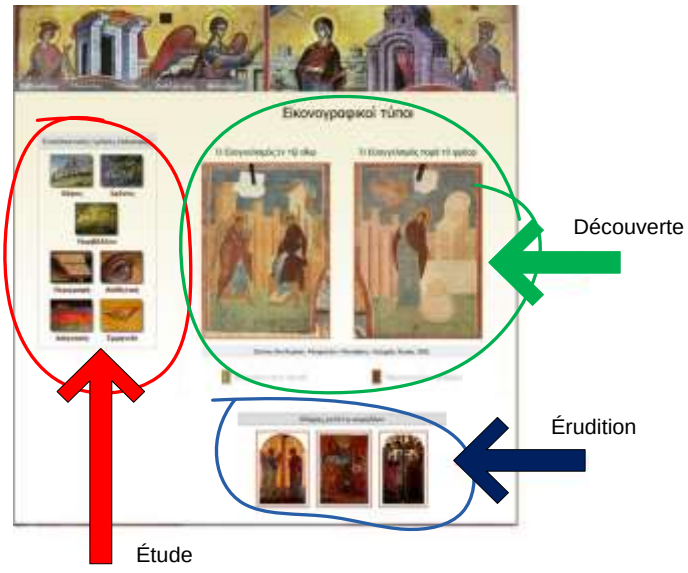
Another very interesting study is that made by prof. Ioannis Kanellos and Sister Danilia for the implementattion of a thematic virtual museum, the Annunciation museum (www.annunciation.gr)[7], which definitely, from our point of view, may be considered a virtual exibitions. The two experts analyse the problem of multi-point of view and of variable depth knowledge representation as well as the need to model the resources in a way that may encapsulate both details and interpicturality relationships. They explain the significance to treat with the notion of a visit of a virtual museum as a special case of a reading procedure. They finally outline the data structure likely to give evidence to strategies supporting three different genres of visit (**fun/discovery, study and erudition**, corresponding to different cathegories of users: general user, school student, expert/researcher).
According to the need of the user, there are different strategies of reading the cultural content, which is organised at different levels and treated from different points of view.

- **The visit "fun/discovery"**: it is built on the profile of the art amateur. The interruption can take place at any time without affecting the overall intent. The entire collection is organized into sub-collections around a prototype. The visitor enters through the prototype and conducts a visit to a part of the thematic museum by moving from one work to another according to his taste and his desire, mainly by association. The concept of this approach in structuring the collection is the similarity, but it remains flexible in the sense that the criteria for its definition and combinations are left to the taste of the visitor. Information on the works here is deliberately reduced, it concerns the place and time of the work, the iconographic cycle in which it belongs, support implementation, the artistic movement, the painter, the type theme and prototypes associated with it. The reconfiguration of the visit according to another prototype or according to other criteria of access is possible at any time. This is the reading step, open to the surprise and the unexpected. Its basic principle is the association; chance plays a role often very important. The amateur tours for fun. It does not attempt a systematization of knowledge, it is not driven by a previously established order. The emotion often is sufficient. Introspection is also frequent and spontaneous aesthetic judgments can quickly deplete all. Research is that of stimulation and discovery. The time spent on the work is like browsing or scanning a page (a few second or some minutes). Consequently, the reading paths implemented are fast and synthetic. In a museum, this is the most common way of reading.

[7] Ioannis Kanellos, Sister Danilia, *L'exemple du musée thématique sur l'Annonciation*, Actes du douzième colloque international sur le document électronique (CIDE.12), Montréal - Canada du 21 au 23 octobre 2009. See also, Ioannis Kanellos, *Ontologies aspectuelles et représentation des connaissances à profondeur variable : deux exigences fondamentales pour des musées virtuels adaptatifs*, Paper presented at CIDOC 2011, not yet available. We thank prof. Kanellos for having provided both articles.

- **The visit "Study."** It is designed on the student profile. Unlike the previous, which is taking place incrementally, here the visitor approaches the works according to classes previously analysed. For example, in this case it is possible to raise questions about the theme of the Annunciation diachronically, diatopically, historically, contextually. In other words, while the previous one, was a personalized visit during which the focus was on the individuality of the work and the idiosyncrasy of the path, here the reading is organised according to the relationships among the different works of art. The visit "Study" is in some way, the reconquest of the identity of the work of art through the forms of its textual and pictorial "sociality", assigning it a place and role in the history of artistic production. The time allotted for such a reading is more important (it may even take some hours). Explorations may bring to compared relationships and analyses of detail. The reader here is not exhausted after the first emotion.

- **The visit "Erudition"**. This visit is built on the profile of the specialist (the painter, the restorer, the curator, the art historian, etc.). Here, the information is intended as rich as possible and always likely to improve by further contributions. In this case physico-chemical studies and more extensive analysis in terms of aesthetics, historical developments and philosophical support are provided. Images may be viewed in very high resolution, so to cover all points of views. The time allotted for such a reading is unlimited. In this case the support of e-Infrastructures could be really effective, concerning authentication, storage, supercomputing.



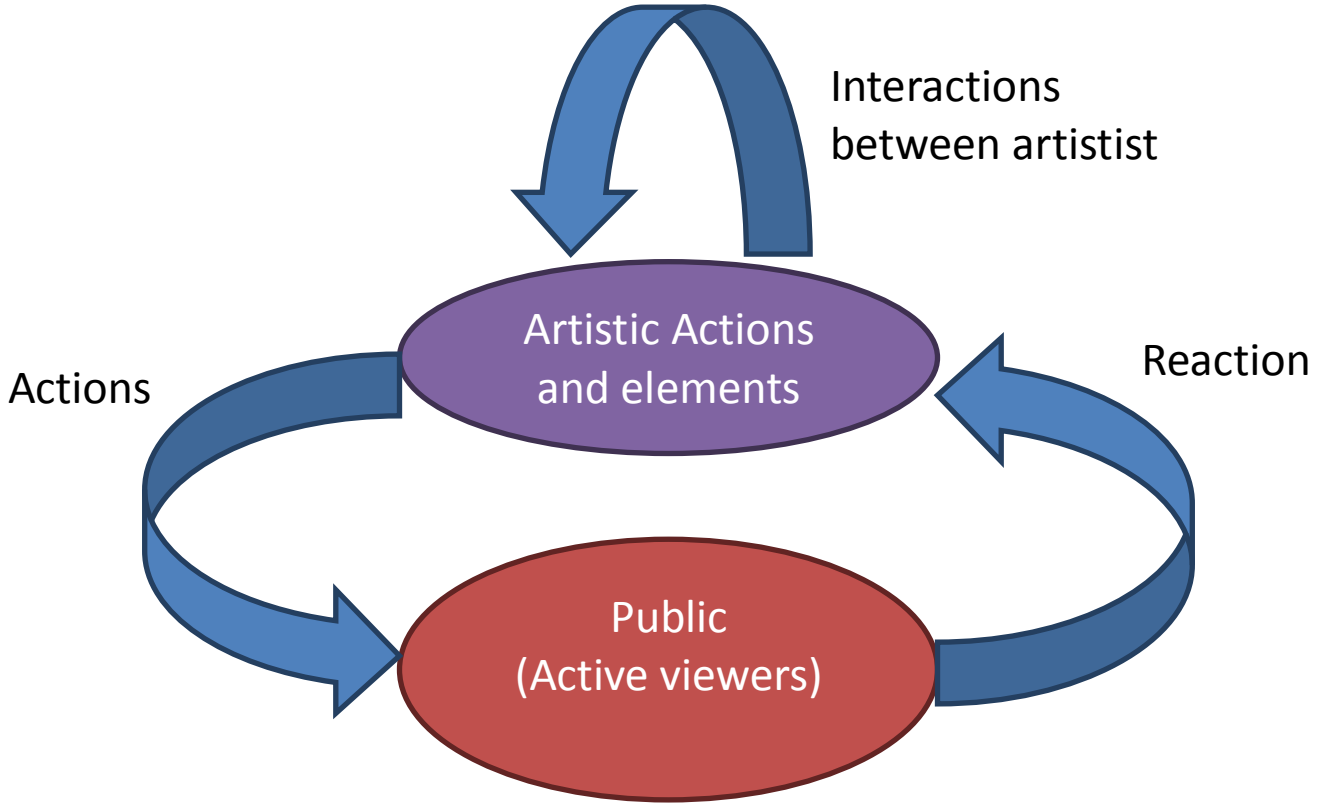
Regions that correspond to amateur, student and expert readings.
Student visit is split into particular study categories; expert visit offers detail investigations of a set of artworks that necessitate particular knowledge background and techniques that enhance the observation conditions

The amateur reading is founded on a gradual discovery path, going from an artwork to another, step by step. In the left, icons represent hints (typical suggestions) for starting an amateur visit. In right the interactive carrousel allows to observe pieces one by one with a great comfort (all images are of high resolution). At any moment, the amateur may select some other prototypical icon and modify the visiting plan (flow list at the bottom)

5.2 Virtual performances

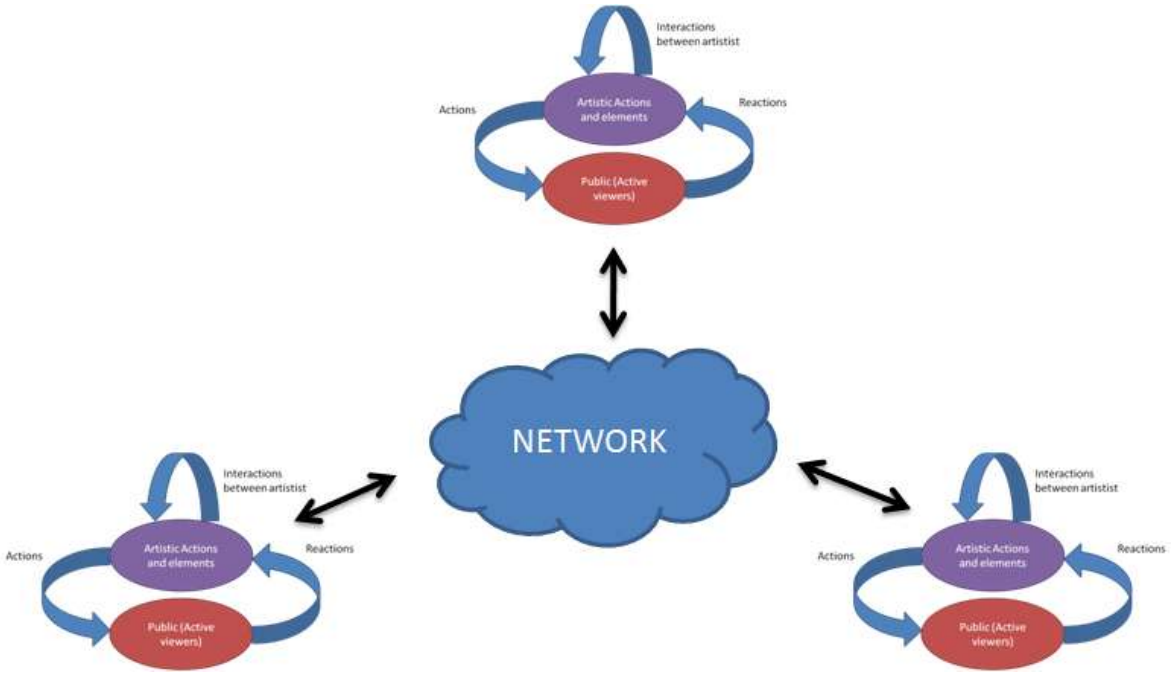
Virtual performances can be defined as **performing arts actions and experiences that use the possibilities of Grid Computing, interactive technologies and virtual spaces**.

In the Virtual Performing world the key element is **the interaction** between the different elements involved in the show. In general terms, a performing art event can be shown as the diagram below:



In this scenario, artists can only interact among them, with local elements and or technologies and the local audience.

The aim at virtual performing arts is to go a step forward, by exploring the limits of the interaction around the networks between several distributed places with similar schemes.



These interactions can be produced in diferent ways:

- End to End (connecting physical spaces);
- Real to virtual world, connecting the real world with on virtual world;
- Multipoint to multipoint, connecting multiple physical spaces in a N to N connection;
- Multipoint to multipoint plus a virtual world, connecting multiple physical spaces in a N to N connection where one point is the virtual world.

Virtual world can be understood as any kind of non-human element able to interact with the event, from twitter, Facebook or similar social tools to advanced augmented or virtual reality applications.

The success of the performance will depend on:

- The specific design of the performance including the interaction;
- The consideration of relevant audio-visual aspects;

The selected technology.

With the term Virtual Theatre it is intended

6 Management

6.1.1 Professional Staff

Depending on its complexity, putting together a virtual exhibition requires a project team made up of more or less specialized professionals, each with their own degree of knowledge, experience, and expertise in their respective sectors.

Human resources to be involved can include:

- Staff from the institution;
- External consultants and experts;
- Specialist firms;
- End users.

Below is a table summarizing the professionals to be identified for each activity and their specific skills.

Obviously, in small projects the same few people – or even just one person – can take on different professional tasks.

Project team: activities and skills

Scientific curator	The exhibition's curator is responsible for its scientific organization. An exhibition's curator (or curators) is an expert in their field (art historian, archaeologist, librarian, etc., depending on the expertise required for each particular exhibition; curators can either be employees of the institution staging the exhibition, employees of another institution, or free-lancers). The curator of the exhibition is responsible for: • overseeing the scientific planning of the exhibition and

	coordinating all related activities • verifying and overseeing the advancement of the project • coordinating project communications, promotion, and advertising • coordinating the planning of educational activities and events related to the virtual exhibition • testing the final product.
Scientific Committee	The scientific committee is made up of experts of proven academic and professional expertise from prestigious national and/or international institutions. The scientific committee's task is to provide general guidelines.
Technical and organizational secretariat	The technical and organizational secretariat, made up of one or more people, provides support to the curators in all phases of the project. The secretariat must be effective, efficient, and must collaborate with the curator to keep activities on schedule. The secretariat must: • update the virtual exhibition's dossier • manage contacts with the institutions providing resources for the exhibition, and if necessary define collaboration agreements • analyse each individual resource • verify whether each resource is in digital format or must be digitized • verify whether each resource meets the exhibition's quality criteria (format, resolution, metadata, etc.) • verify the intellectual property rights associated with each resource • obtain waivers for resource use manage relations with all of the subjects involved, etc.
Administration	The project administration is responsible for: • verifying the preliminary budget with the curator and the technical and organizational secretariat • requesting cost estimates • drafting contracts • paying invoices defining relations with sponsors.
Digitisation	This activity can be carried out by employees of the institution (e.g. photographers) or by an experienced and trustworthy external supplier. It is essential that the subjects involved be briefed about the technical norms and standards in force in the relevant sector.
Information architecture	The information architecture expert is responsible for the logical structure of the virtual exhibition.
Graphic design	For this activity, it is essential to involve a graphic designer with experience in web design. The graphic designer is responsible for the graphic layout of the virtual exhibition. He or she is responsible for: • suggesting one or more logos for the virtual exhibition • designing the layout of graphic interfaces

	managing the image of all activities related to the virtual exhibition.
Drafting of multimedia text and resources	Authors of texts and other multimedia resources (interviews, videos, etc.)
Web editorial office	Experts in editing web content, with expertise in accessibility norms.
Translation	Experienced translators for each of the project's languages.
IT development	This activity can be carried out by employees or by an experienced and trustworthy external supplier. The choice of professionals depends on the complexity of the IT solution that has been selected.
Communications and press office	This activity can be carried out by employees or by an experienced and trustworthy external supplier. The office is responsible for: • press releases • any other communication material • choosing channels for disseminating information (press, radio, TV, web, mailing lists, • events, etc..) • disseminating information.
Didactic services	The person in charge of didactic services drafts educational programmes, oversees their implementation, and identifies communication and mediation modalities, using adequate and functional instruments for the various targets of the educational activities. They are also responsible for managing relations with schools and other subjects who make use of educational services and activities, universities, and research institutes active in training activities related to the relevant fields of instruction. In particular, they: • plan and coordinate educational activities on the occasion of the exhibition, and similar initiatives in partnership with schools and other institutions. • coordinate and oversee the production of material to be used during educational activities.
Sponsorships	There can be various types of sponsors: • financial sponsors, if they contribute funds • technological sponsors, if they contribute technological expertise sponsors in kind, if they contribute goods or services, and material, human, or technical means.
Media partnership	Partners who contribute to disseminating communications about the event.
Quality control	It may prove useful to involve external subjects in quality control efforts, in order to test the accessibility and user-friendliness of the exhibition, along with assessing the quality of its contents.
External consultants	Other professionals who may be needed for specific activities.

Generic users	Generic audience to be involved in testing the exhibition's user-friendliness and audience approval.
Digital curator	Technical expert, responsible for the maintenance and preservation of the virtual exhibition.

6.1.2 Workflow

The process of production of a virtual exhbitions may include different phases, here summarised:

- **Brainstorming:** the conception phase which aims to identify the exhibition's topics, its objectives, the subjects to be involved, the target audience, a feasibility assessment, a timeframe, and potential problems.
- **Planning/design phase**: the ideas that emerged during the conception phase are fine-tuned, and their feasibility is assessed. All the necessary steps for implementing the project are identified and described, in particular:
  - The project team is identified;
  - The available digital resources are selected along with those yet to be digitised;
  - The criteria and relations that will form the backbone of the virtual exhibition are identified;
  - The technology to be used is selected;
  - A preliminary budget – including expected spending, sponsorships, and funding – is drafted;
  - The timeline and project phases are planned.

- **Realisation:** the virtual exhbition is assembled.
- **Testing and publication:** once the virtual exhibition has been put together, it must undergo a series of usability and accessibility tests, which ideally involve a panel of users. When the testing phase has been completed, publication can start.
- **Communication and dissemination:** Much like traditional exhibitions, online virtual exhibitions must also be "communicated" to the public. In an era of "hypercommunications", the most difficult task for an institution is that of reaching its specific target audience. To this end, the institution can employ both traditional instruments and social media marketing tools, and use different communication approaches and channels, linked to content, audience type, intended results, and available time and resources.
- **Updating:** Thanks to current technologies, the content of virtual exhibitions may be amended, increased and updated in time, even with the contribution of user. Some projects could foresee a strategy in this direction.
- **Maintenance** The maintainance of the virtual exhibition include also periodic activities aiming to ensure the correct running of the application, including the management of security procedures, privacy levels and terms of use, Search Engine Optimisation (SEO) procedures, statistic analysis, etc.
- **Digital preservation:** It is "the active management of digital information over time to ensure its accessibility and understandability". It is the set of processes and activities that

ensure continued access to information and all kinds of records, scientific and cultural heritage existing in digital formats. Digital preservation of a virtual exhibition include several issues: the hardware, the memory supports, the software, the vulnerability of all kinds of media (text, images, videos, audio, 3d etc).[8]

6.1.3 Intellectual Property Rights

When planning a virtual exhibition, it is essential to comply with copyright norms for each type of digital resource used (text, images, sounds, videos, graphics, 3D).

It is necessary to verify whether each digital item one intends to use is:

- A work protected by copyright;
- A work for which exceptions of limitations to copyright apply;
- A work in the public domain, "free from those barriers to access and re-use generally associated with copyright protection, either as a work from copyright, or because the holders of these rights voluntarily decided to remove these barriers";
- An orphan work, whose authors are unknown or cannot be contacted, but which is presumed not to be in the public domain.

For each digital resource that has been selected, a request shall be made either to waive the copyright for publication online, or for payment of any usage fees.

In verifying the copyright status of a given work, one must keep in mind that authors may choose to directly manage relations with users, or they can entrust this to an intermediary national organization which issues licenses for the use of protected works, collects copyright royalties, and allocates the profits.

Specific licences can also be applied to use music in the following ways: **streaming on demand** , **streaming download** via **web**, **webcasting**.

Each one of these licenses has a different function:

- The **streaming on demand** license allows users to request access to the multimedia content available on the web server's database. Thanks to this license, users can select the content that interests them and listen to it.
- The **streaming download** license allows users to download files onto their own computer. Thanks to this license, users can download the content that interests them and can listen to it at any time, even offline. Users can reproduce these works, but exclusively for personal use.
- The **webcasting** license (so-called *live streaming*) regards the live broadcasting of multimedia content. Thanks to this license, users can access the content that interests them. They can passively listen to music tracks, as if they were listening to a radio broadcast.

Should the virtual exhibition include user-generated contents, users themselves shall provide the institution curating the exhibition with guarantees that they are in full compliance with the law, and to confer all or part of their author's rights.

[8] On the topic of digital preservation, see also the INDICATE Case study report on Long Term Preservation. The main objective of this use case was to review the current situation of digital preservation processes in Europe, the state of the art of the technology used and the relation between preservation institutions and e-Infrastructure providers: http://www.indicate-project.org/getFile.php?id=277.

With regards to the **re-use of content**, the institution in charge of the exhibition can apply the following models:

- A closed model (*copyright*) that forbids copying and re-distributing content, limiting access and consultation to personal use;
- An open model, based on sharing and regulated by a license that establishes the rights that have been granted and the conditions to be followed. Creative Commons licenses are a good example of this.

"Creative Commons" licenses provide six different types of copyright licenses for authors, journalists, teachers, institutions and, more generally, creators who wish to disseminate their work according to a "some rights reserved" model. The copyright holder can grant baseline rights for non-commercial purposes only (*NC – non-commercial*) or for verbatim copies of the work and not derivative works of it *(ND: no derivative*); for derivative works, they can grant baseline rights under a license identical to the license that governs the original work (*SA: share alike*). The combination of these choices generates the six CC licenses." [from http://www.creativecommons.it/].

Recently, Creative Commons introduced **Public Domain Mark 1.0**, a new tool conceived for works "that are no longer subject to restrictions under copyright laws (and any related rights)", as they have entered the public domain**.** By adopting this tool, the institution will be able to clearly inform users that the work is accessible and re-usable without the risk of copyright infringement, thus contributing to its dissemination and availability. The user will thus be able to copy, modify, distribute, or perform the work, including for commercial purposes, without the need to ask for authorization.

The virtual exhibition, or the website that hosts it, must include a **copyright notice** that clearly sets out the copyright policy of the institution in charge of the virtual exhibition. Should the virtual exhibition include user-generated content, the author's rights that the users grant must be specified.

7 Technologies

7.1 Virtual exhibitions

7.1.1 Platforms

The following technologies are used for virtual exhibitions and thematic routes:

- Static web pages in HTML or XHTML associated with CSS;
- CMS with dedicated modules software applications designed especially for virtual exhibitions (see for example **Omeka** (http://www.omeka.org), the platform currently used for Europeana virtual exhibitions;
- Proprietary platforms, which need to install specific plug-ins.

Current technologies provide a series of other possibilities:

- The **analytical fruition** of digital items from many points of view, including 2D, 3D, or 360°, which makes it possible to see a work of art or a site from points of view that a non-

virtual exhibition would not allow, and in some cases to view the item down to its tiniest details;
- **Different fruition according to user category** (children and adults, students and teachers, scholars and researchers, professionals, etc.). Each user category can be offered different online services (links to data bases, edutainment services, etc.);
- Different **modalities to aggregate content**, on the basis of the metadata available in the data bases;
- **Access through different platforms**: some cultural institutions have already begun to experiment with the implementation of applications through *mobile* devices;
- The **direct involvement of the user**, who can take advantage of web 2.0 technology to enrich the virtual exhibition with self-generated content.

Certain more or less complex software types manage specific functions, which are sometimes useful to highlight some aspects of the virtual exhibition.
Some types of software are based on the aggregation of specific metadata, such as:

- **Timelines** (used to provide a graphic representation of the chronological sequence of a series of events);

Timeline

- **Tagging** (to associate one or more keywords, known as tags, to individual digital items);

- **Tag clouds** (used to visually represent the key words that come up the most often during user searches);
- **Geotagging** (used to associate one or more keywords to a geographic map).

Geotagging

Other technologies are particularly indicated for obtaining image enhancing effects:

- **Slide shows** make it possible to automatically display a series of images at set intervals;
- **Image magnifiers** or super zooms make it possible to appreciate digital items in detail, at varying levels of magnification;

Image magnifier

- **Pageflips** make it possible to flip through documents page by page, as if one were leafing through a book;

Pageflip

- The **measurer** to measure the size of digital objects.

Measurer

Applications that take advantage of 3D technology are becoming more widespread.

- **Panography**, or **immersive photography**, along with time lapse photography, represents the current synthesis between traditional static photography and video clips. Panography, in particular, makes it possible to view the entire surrounding environment, which can be viewed without being subject to visual constrictions (only the point of view of the photographer) or functional constrictions (viewing a clip means being subject to its director's take). All this can be done by surfing at one's own leisure along the vertical and horizontal axes, allowing a 360°X360° rotation (see *infra*);

Panography of the House of the Gold bracelet in Pompei
(coutesy Alfredo Corrao)

- Real-time 3D models still lack realistic photography (see *infra*).

7.1.2 Still Images

Technically, digital images are divided into “raster images” and “vector images”:

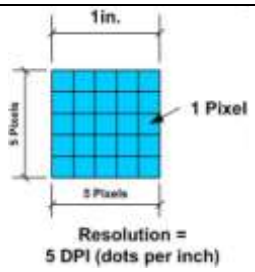
- **Raster images** (or bitmaps) use a grid of square image points known as pixels. Each raster image is made up of a fixed number of pixels, determined by the grid (resolution: pixels on the long side x pixels on the short side), which in turn determines their maximum size. Each pixel is assigned a specific position and a precise colour value.
- **Vector images** are characterized by lines and curves defined by mathematical entities known as vectors. Vectors are segments defined by a point of origin, a magnitude, a direction. They describe an image on the basis of its geometric characteristics. Their size is independent of resolution and they can be used at various magnifications with no loss of quality.

	Raster images	Vector images
		
Advantages	• They are well-suited to reproducing subtle shades of colour. The photos we take with our digital cameras are raster	• They are well suited to reproducing images with few colours (i.e. logos, text, stylized images)

	images • They are easy to modify • They can be read by many software types	• They can be easily scaled, modified, and adapted to monitors, with no loss of resolution • They can be modified with computer graphic programmes, which require certain specific skills • They can be used for web animations, since they are fast to download • They are easily converted into raster images.
Disadvantages	• They are not very scalable. Each modification to a raster image causes a loss of information.	• They are not well-suited to images that require complex colour reproduction • Their quality depends on the software that was used to create them

For a more complete, albeit superficial knowledge on this topic, it should be kept in mind that a digital image is also characterized by three aspects that determine the file's overall size: dimension, resolution, and bit depth:

- The **resolution** of the image indicates the number of pixels visualized per unit of length, and is measured in PPI (Pixels Per Inch). The higher the resolution, the higher the number of pixels. Resolution should not be confused with the **printing resolution** (measurable in DPI, Dots Per Inch), which establishes how many dots of colours a printing device will apply per square inch;
- The **dimension of the file** (weight) is its digital size, measured in multiples of bytes (Kb, Mb, Gb). It is proportionate to the number of pixels in an image (resolution) and the format (compressed or not) in which the image was saved;
- The **bit depth** is the number of available bits, measured on an exponential scale, to represent the maximum number of colours (or shades of grey) of the original. Bit depth is measured in bpp (bits per pixel).

Resolution		Conventionally, for typographic printing (A4 or A3 format) a minimum resolution of 300 PPI is necessary. For viewing on monitors, 72 PPI is sufficient for Macs, and 96 PPIs for PCs. Once the image has been digitized or created at a given resolution, increasing the resolution will not increase quality.

Size		The size of a digital image depends on two factors: • the combination of real size (base per height) and resolution • the level of compression It should also be kept in mind that for images with a high number of pixels but low printing resolution (for example, photos with 4500x3000 px at 72 PPI), the image can be larger than the monitor. To solve this problem, the image should be re-sized by lowering the number of pixels (e.g. to 1200x800 px) or by increasing its resolution (e.g. from 72 to 300 PPI).
Bit depth		Colour depth is categorized on the basis of the number of bits. If one uses more intense colours, the image will contain more colours, but the file size will increase. • 1 bit – Only black and white • bit - 256 shades of grey or 256 colours • 16 bit – 65,536 colours • 24 bit – 16,777,216 colours The number of bits is measured per “colour channel”: colour (RGB) images have three channels, grey scale images have only one. A colour jpg file is thus a 24-bit file (3 channels, 8 bits each). Note that a tiff file saved at 16 bits thus becomes a 48-bit file.

There are many image file **formats** and each has a specific purpose.

Some file formats adopt **compression techniques** to reduce the memory required for image data.

Compression is a mathematical process that reduces file size by removing redundant information. There are two types of compression:

- **Compression without loss of data** (*lossless compression*) aims to maintain the integrity of the original image. When the image is compressed, it maintains the same resolution and image quality as the original, non-compressed image;
- **Compression with loss of data** (*lossy compression*) aims to reduce file size, with a loss in image quality. Files compressed with this method are lighter than those obtained with lossless compression, but when the image is decompressed, part of the original data is lost and cannot be recovered.

There are three relevant image formats for **web publication.** They are identified by their file extension: **JPG**, **GIF** and **PNG**.

Title	JPG - JPEG	GIF – GRAPHICAL INTERCHANGE FORMAT	PNG – Portable Network Graphics
Author	Joint Photographic Experts Group– Independent jpg Group	CompuServe Interactive Services Incorporated	World Wide Web Consortium (W3C)
Producer	International Organization for Standardization (ISO)	CompuServe Interactive Services Incorporated	International Organization for Standardization (ISO)
Date	1990	1987	2003
Identifier	ISO/IEC10918-1:1984	Not available	ISO/IEC15948:2003 (E)
Rights	Open standard	Patent on LZW compression by Unisys	Open standard
Description	Colours supported: 16.777.216 (image at 24 bit). Compression: yes, lossy Transparency: no Animation: no Useful format for raster images	Colours supported: 256 (image at 8 bit). Compression: yes, lossless Transparency: yes Animation: yes Useful format for vectorial images or images with a few colours	Colours supported: 16.777.216 (image at 24 bit). Compression: yes, lessloss Transparency: yes Animation: no Not fully supported by all browsers

The formats that contain all the information necessary for **high-resolution printing** are **BMP** and **TIFF.**

Title	BMP – BitMap	TIFF - Tagged Image File Format
Author	Microsoft Corporation	Aldus Corporation
Producer	Microsoft Corporation	Adobe Systems Incorporated
Date	1987	1992
Identifier	Not available	Not available
Rights	Copyright Microsoft Corporation	Open standard

Description	It is one of the heaviest formats in terms of Kbytes. Despite the inconveniences arising out of the larger file size, several factors have contributed to this format's popularity: it is simple, well-documented, and is not protected by copyright which limits its free use. This last point in particular has led to the bitmap format being supported by almost all graphic application, including many open source programmes. Although the bitmap format is readable on the web, it is poorly suited to the Internet for several reasons: bitmap images take up more memory than their equivalent in other formats, and thus require longer transmission times; in operating systems other than Windows, many browsers and email clients are unable to view bitmap images. The bitmap format does not support any type of transparency, thus limiting web design possibilities.	TIFF images memorize single raster images at any colour intensity. The TIFF format is the most widely used format in the printing sector. It supports optional compression. It is not indicated for browsers since it requires the installation of specialized libraries for online viewing.

When planning a virtual exhibition, it is essential to set a policy for the use/re-use of images on the part of the user.

The sponsoring institution can make available online:

- Only low-resolution images;
- High-resolution images (some or all).

It can also decide:

- To allow the user to download high-resolution images upon request or behind a pay wall;
- To protect the images against improper use.

The most common technical precautions used to protect images include:

Low resolution images	These are images whose size (in pixels) is extremely reduced, in order to publish an image that cannot be scaled without a significant loss of quality (e.g. 400x300 px). It is one of the simplest methods, and is useful for visualization only.

	A common mistake is to believe that a resolution of 72 or 96 PPI is in and of itself a "low resolution" since it coincides with screen resolution. In fact, the concept of resolution is always tied to the number of pixels in the image: a file with 6000x4000 pixels (about the size of a file produced with a modern professional camera) always has 6000x4000 px, whether it is reproduced at 72 or 300 PPI ! The only thing that changes is printing size: at 300 PPI, 6000x4000 pixels make it possible to print 50.8 x 33.87 cm prints; at 72 PPI, print size is 211.67 x 141.11 cm. If one wants to protect their images by publishing them on the web at “low resolution”, it is important to reduce both the number of pixels and the PPI value.
Digital watermarking	This methodology allows the image’s author and/or copyright holder to add a series of identification characters to the image (for example, the author’s name accompanied by a copyright © symbol or the name and the logo of the institution). The advantages of watermarking include: **1. Ease of the watermarking procedure**: It is extremely easy to create a personalized watermark (generally a JPG or PNG image or simple text) and apply it to one’s photos using basic image processing software. **2. Free of charge:** there are dozens of free applications and plug-ins available online that make it possible to add watermarks to entire series of images. **3. Difficulty of removal:** "erasing" a well-constructed watermark from a photo is very time consuming, which makes stealing such a photo an unappetizing prospect. The disadvantages of watermarks include: **1. Reduced readability of the image**: especially when applied in batches, watermarks can cover important parts of a photo (for example, a face or important sentence), and compromise their aspect and readability. Publishing a photo that cannot be correctly interpreted is a contradiction in terms, and can end up being an own goal in terms of communications. **2. Ease of removal**: in order to avoid the above-mentioned problem, watermarks are often placed in the corner of a photograph. This makes it easy to simply crop them out of the photo, making their application useless. The right compromise is easy to reach: a single watermark should be placed at the centre of the image, running parallel with its long side. It should also be long enough to touch both short sides. **Transparency** becomes fundamental for such a watermark: it should be reduced to a minimum (about 10% to 20%) in order to look like a barely visible wrinkle (a watermark). A photo with such a watermark is not modified to the point of

	compromising its readability, but the name and/or logo of its author are visible upon closer examination.  

	 *Images with watermark that does not compromise the viewing of individual details*

Digital signature	This is a safer and extremely sophisticated method, which adds and superimposes another image invisible to the human eye to the pixels of the digital image. When the image is downloaded or printed, however, the digital signature appears, making the file unusable.
SWF	There are many applications – including some free ones – that make it possible to convert one or more images into a Flash (SWF) object. This makes it possible to view one or more images sequentially, as if they were a video, making it impossible to download or grab them. The image can only be reproduced through a screen shot.

There are also online applications that make it possible to verify whether an image has been used improperly. They function as webpages on which it is possible to upload the image to be verified. The search engine uses sophisticated algorithms to analyze hundreds of websites and databases in search of the same image or extremely similar ones. Depending on the services provided, it is possible to set the search parameters, and adapt its results to one's own needs. Many of these services are available as plug-ins for Mozilla Firefox. In this case, one needs only to right-click on the photo in question (already online) and select the relevant search engine to launch the verification.

Links to the current best-tested applications:

- **Tin Eye**, Reverse Image Search: http://www.tineye.com/ [web page and plug-in for Firefox and Chrome];
- **IQDB** Multi-service image search: http://iqdb.org/ [web page];
- **SauceNAO** reverse image search engine: http://saucenao.com/ [web page and Firefox plug-in];
- **GazoPa**: http://www.gazopa.com/ [web page, Firefox plug-in and Apps for IPhone
- and IPad];
- **Who stole my pictures?**: https://addons.mozilla.org/en-US/firefox/addon/who-stole-mypictures/;

- **Image Search Options**: https://addons.mozilla.org/en-US/firefox/addon/image-searchoptions/.

Another image search engine worth mentioning is **GiniPic** (http://www.ginipic.com), which is a non-reverse search engine that makes it possible to contemporaneously search the leading stock image sites such as Flickr, Picasa, SmugMug, etc., on the basis of keywords, dominant colours, etc. This free software can be quite useful when searching for free images to use, or simply to draw inspiration from the thousands of results that can be obtained.

7.1.3 OCR

When putting together a virtual exhibition, it may prove necessary to digitize a book, journal, postcard, etc. or parts thereof. This can be done by acquiring the image of one or more parts of that volume, or through **OCR software**, thus obtaining text conversion.

OCR (Optical Character Recognition) systems recognize printed and typed characters and are used to convert digital images containing text into a digital text that can be modified with an edition programme. The level of accuracy of OCRs is very high when applied to modern documents, but it is much more difficult to use on ancient or handwritten books, for which task adequate technology does not yet exist. OCR scanning, regardless of the programme used (the main OCR programmes currently on the market include Omnipage, FineReader, ReadIris, TextBridge; generally speaking, the performance of open source programmes does not yet approach that of commercial software), includes the following phases:

1) Acquisition of the digital image from the analog object;

2) Definition of areas;

3) OCR scanning;

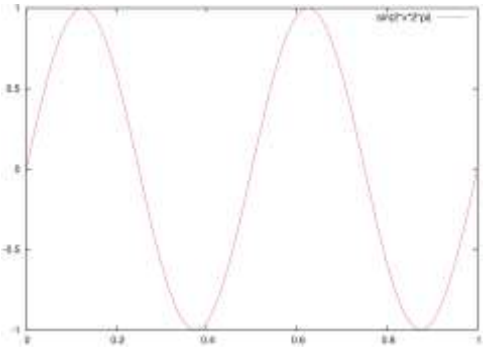
4) Text recognition;

5) Spell checking;

6) Exporting and saving in text format for subsequent editing (.html and .pdf are the most frequently used formats; additionally, they are public formats and thus coherent with a shared approach to web resources. Other possible formats include Microsoft Word, Microsoft Excel, Word Pro, WordPerfect, Clipboard, e-mail, StarWriter, etc.).

7.1.4 Sound

Sound is made up of a series of vibrations over time, each with its own frequency of oscillation and amplitude.



Example of sequence of vibrations
(horizontal axis: time; vertical axis : oscillation frequency)

In order to digitize sound, a sampling process must be activated which implies the subdivision of time into segments small enough to measure the level of intensity that has been transmitted.

During sampling, the strength of the analog signal is measured numerically at set time intervals. The values obtained are recorded in both compressed and non-compressed form, as needed. There are proprietary formats that provide excellent performance in terms of sound quality and speed of transmission (such as AIFF, WAV, WMA, REALAUDIO, AU), but the standard open format for using compressed sounds on the web is **MP3**.

Title	**MP3 – MPEG Layer 3** **Coding of Moving Pictures and Associated Audio for Digital Store Media**
Author	ITU –T (International Telecommunication Union - Telecommunication Standardization Sector)
Producer	International Organization for Standardization (ISO)
Date	1993
Identifier	ISO/IEC 11172:1993, Part 3: Audio ISO/IEC 13818, Part 3: Audio ISO/IEC 14496, Part 3: Audio (Amendment 1: Audio extension)
Copyright	Open standard
Description	MP3 is an audio compression algorithm with a loss of information (lossy), which can dramatically reduce the amount of data required to store a sound.

References:

- MINERVA. *Technical Guidelines for Digital Cultural Content Creation Programmes*: Version 2.0, 2008. http://www.minervaeurope.org/interoperability/technicalguidelines.htm
- ATHENA. *Digitisation: Standards landscape for European museums, archives, libriaries*, 2009 http://www.athenaeurope.org/getFile.php?id=435

7.1.5 Video

The digitization of video files adds a time dimension to the digitization of images. The process is initially similar to the production of raster images, which are then reproduced in an extremely rapid sequence. The number of such images shown per second is known as the **frame rate**.

The quality of a digital video is determined by three factors: **resolution, colour depth** and **frame rate**.

Digitized videos can require an enormous amount of data. For this reason, **compression** is extremely important. Compression is based on the fact that only a tiny proportion of an image changes from one frame to the next.

With regards to **coding standards**, the situation is much like for audio files, with the family of **MPEG** open standards and with proprietary standards that provide particular functions.

A video can be:

- Downloaded and viewed offline at any time;
- Viewed in streaming video or streaming media.

Streaming video is a sequence of images sent in compressed format through the web and shown upon arrival. Streaming media is streaming video with the addition of sound. Thanks to this technique, users no longer have to wait for the video to be fully downloaded before viewing and/or listening to it, since information is sent as a continuous flow (*stream)* and processed upon arrival. In order to access streaming content, users need to download special software , which decompresses the information and sends the video and audio to the monitor and audio card, respectively.

One of the applications of this technique is live streaming. In this case, the video signal is compressed into a digital signal and broadcast online via a special server that can send the same video to multiple users at the same time (multicasting).

In order to be published on the web, a video must be optimized. Currently, the most popular formats include **FLV, AVI, MOV Quicktime, and WMV.**

In order for the video to be accessible off-line as well, other formats can be used, such as **MPEG, MPEG2,** and **MPEG4** and its proprietary version **DIVX**, which guarantee a good compression to quality ratio.

Title	FLV - Flash Video Format	AVI - Audio Video Interleave	MOV - Quicktime	MPEG/ MPEG2 – Coding of Moving Pictures Experts Group and Associated Audio for Digital Storage Media	MPEG4 – Coding of Moving Pictures Experts Group and Associated Audio for Digital Storage Media	WMV – Windows Media Video
Author	Macromedia (New Adobe)	Microsoft Corporation	Apple Computer Inc.	ITU-T (International Telecommunication Union Telecommunication	Moving Picture Experts Group	Microsoft Corporation

				Standardization Sector)		
Producer	Adobe Systems Incorporated	Microsoft Corporation	Apple Computer Inc.	International Organization for Standardization (ISO)	International Organization for Standardizatio n (ISO)	Microsoft Corporation
Date	Since 2002	(?)	Since 1991	2000	1999 (version 1) 2001 (version 2)	(?)
Identifier	Not available	Not available	Not available	ISO/IEC 13818:2000	ISO/IEC 14496	Not available
Rights	Copyright Adobe Systems Incorporated	Copyright Microsoft Corporation	Copyright Apple Computer Inc.	Open standard	Open Standard	Copyright Microsoft Corporation
Descriptio n	Allows the user to fully customize compression , resolution, and quality levels, with benefits for both the user and the webmaster. The FLV format and the integrated use of Flash functions for videos have significant advantages. Flash technology is available for all computers and operating systems; indeed, it is already installed on nearly all computers with Internet access, and is compatible with most of the systems used to publish videos	Audio/video format traditionally run by Windows, it supports various levels of compression . It is often identified with the two most widespread of these: DV and DivX. Although the latter is not well-suited to video grabs, DV is undoubtedly the best one for obtaining quality videos (it is the same format used by the video camera). It is the most suitable video format for those working with Windows and with editing software. If one	MOV is the Apple Quicktime format for Macintosh operating system, and is the equivalent of AVI for Windows. It supports many levels of compressio n and many advanced video functions (including high definition).	The MPEG and MPEG2 formats have the advantage of significantly reducing file size while maintaining remarkable image quality. They are NOT well-suited to complex editing projects because they only memorize certain frames. They are an excellent compromise between file size and video quality, and indeed they have been chosen as the standard format for DVDs and digital television. For those who must transfer video files directly from camera to DVD, this format does not require a recodification process.	MPEG-4 or DivX, currently widely used, offers the same quality as MPEG-2 with a compression three times higher. Ideal for video on the Web and Podcasting.	Microsoft format for multimedia projects, in high definition. Very versatile and "open" for the variety of compressio n levels supported.

	online .	intends to edit their own footage, it is best to grab it directly in MiniDV (AVI) format, which preserves the original quality and frames .				

There are many types of open source software, freeware, and commercial software available online to convert or compress video files (for example, AVS Converter, Imtoo FLV Converter, Total Video Converter, etc.).

Another parameter to be kept in mind is the **screen format** (***aspect ratio***) with which the video is intended to be viewed.

The aspect ratio is the ratio between the width and height of the image. The aspect ratio must be complied with at all times (filming, editing, and transfer). This parameter is always present among the settings of video editing software. The most frequently used screen formats are listed below.

	**4:3 (Four-thirds)** The standard television screen format since its birth. Adopted by almost all television programmes, although it is destined to disappear with the emergence of DVDs and new digital television formats.
	**16:9 (Widescreen)** A wider format than the classic television screen, with proportions that mimic those of cinema screens. There are versions of varying widths.

	**Letterbox** Technique that makes it possible to view widescreen formats on regular 4:3 screens. The height to width ration remains the same, but the image is scaled to fit the screen, with two black horizontal bands above and below the image.
	**Pan&Scan** Technique that makes it possible to view widescreen films on a 4:3 screen. It differs from the letterbox technique by showing only the central part of the image, and cropping the sides.

A video stored on an external platform can be incorporated into one's own website using the **embedding** procedure.

The main websites dedicated to viewing and sharing videos (Youtube, Vimeo, etc.) provide a string of html code associated to each video clip that one intends to embed into one's own site by simply cutting and pasting it into the site's source code. This creates an embedded player, which can be modified with regards to height, width, and the colour of the borders. The video will be played on the site when the user clicks the play button.

Every time of support can be embedded into web pages: RealMedia (for example, RealVideo, RealAudio), QuickTime videos, Flash animation, etc.

7.1.6 3D (Computer graphics, immersive photographs, anaglyphs)

Since 3D technology is acquiring an increasingly important role in communications, it is important to briefly discuss its nature and use.

3D technology generally refers to the possibility of reproducing an image or sequence of images on a two-dimensional surface in such a way as to make it appear three-dimensional. There are numerous technologies than can achieve this, ranging from complex computer graphics reconstruction using mathematical models to the simple (and now old-fashioned) stereo camera.

The first major difference between the various types of 3D lies in these two models: those that provide 3D images that can be viewed without the help of special devices (3D glasses, stereoscopes, etc.), and those that require them.

The nature itself of 3D is profoundly different depending on whether it is computer-generated or photography-generated (whether by video or photo). The two systems can be integrated to provide a product that can be viewed using 3D glasses, a method that is widely used in the cinema industry.

Without getting into technical details on the different types of 3D in use in cinema and television (active, passive, and polarized 3D), and limiting ourselves to the three-dimensional representation of content using a "simple" computer screen, we must nevertheless take into consideration – in addition to computer graphics – **anaglyph images**, which can be easily viewed using glasses where the two lenses are different (with different colour filters) and which can be purchased at low cost or even made at home.

For technical and, to a lesser extent, economic reasons, the use of three-dimensional images, environments and/or itineraries in a virtual exhibition must rely exclusively on these two methodologies.

Before getting into specifics, we must add that there is a third, "false" way to add three-dimensionality to a virtual exhibition, and briefly assess the advantages and disadvantages of these procedures.

Thanks to a photographic technique known as **panography**, one can compose – using specific software – a single image from several overlapping photographs, thus representing a scene as a sphere (or cube) within which viewers are 'suspended' in a central point from which they can observe their surroundings in every direction in a seamless manner. This effect, which is generally also called 3D, is in fact a "false" 3D, since it is based on two-dimensional images united and projected in such a way as to form a planisphere which, once closed, makes it possible for the viewers to observe the entirety of their surroundings, but without giving the illusion of depth.

Since we are dealing with 3D technology to be used in virtual exhibitions, we have purposely refrained from describing the characteristics and potential of laser scanners in building 3D models of a space or object, since their elevated cost and complex functioning make them suitable exclusively for scientific purposes.

	ADVANTAGES	**DISADVANTAGES**
Computer graphics	• Possibility of reconstructing items and environments – including those that have been lost – with a high level of scientific accuracy. • Possibility of showing a cutaway diagram or an exploded view drawing in order for the viewer to better understand a given item's architecture.	• High costs • Texture that looks as if it has been "drawn", or of low-quality if based on photographs: the average viewer, who is unaware of the scientific work behind the construction of the 3D model, may dismiss it as little more than a videogame. • Requires a high-quality video card and a fast processor for optimal use.
Anaglyph images	• Low cost • Possibility of applying 3D technology even to a single archived image. • They are still a novelty online, and if used correctly they can attract	• Use of glasses (with coloured lenses) • Loss of colour fidelity (unsuitable for using images for scientific purposes).

	non-institutional visitors to the exhibition. • Availability of free software that can rapidly create various types of anaglyph images.	
Panography	• A "natural" view of places, as seen through the human eye. • Perfect colour fidelity (if correctly photographed and processed). • Possibility of inserting multi-media content of various types into every scene. • Modularity of the "interactive tour" and consequent costs.	• "Ad hoc" production of images. • Requires a plug-in, generally Adobe Flash Player (standard feature of 97% of PCs) or Quick Time. In some rare cases, proprietary plug-ins are required. • Requires a high-quality video card and a fast processor for optimal use. • Environments that no longer exist cannot be reconstructed.

Computer graphics

3D is a component of computer graphics based on the elaboration of virtual models.

Three-dimensional computer graphics encompasses the science, study, and projection of a **mathematical representation of three-dimensional objects through a two-dimensional image** using techniques such as perspective and shading to simulate the perception of depth of field on the part of the human eye.

Every 3D system must supply two elements: a method to describe the 3D system itself ("**scene**"), which is composed of mathematical representations of three-dimensional objects (known as "primitive"), and a mechanism to produce a 2D image of the scene, known as "**renderer**".

Rendering is the process that produces the final image starting from the mathematical model of the subject (scene). There are many rendering algorithms, but they all imply the projection of 3D models onto a 2D surface.

Shading is the process that determines the colour of a given pixel of the image. It generally includes the **lighting** process, with reconstructs the interactions between objects and light sources.

The diffusion of computerized 3D models online can take place through:

- Images, including 360° images;
- Video clips and animation;
- 3D models accessible in real time.

The use of **3D models through images** is widespread and has an immediate impact.

Obviously, there are no particular indications regarding access and use modalities, because the images generated are equivalent to normal images used online and in multi-media applications.

The open source software Google Sketch up (http://sketchup.google.com/intl/it/) is a useful 3D modelling tool.

A 3D model rendered through an image

Generating **video clips on the basis of 3D reconstructions** is probably the most widespread practice in both online and off-line multimedia use. A characteristic of video clips is that they are not interactive unless they have been specifically programmed as such as part of multimedia application. Video clips can be accessed via all hardware and software platforms and from various media, both online and off-line.

Example of video based on a 3D reconstruction

The artistic quality of the media produced is essential in the generation of video clips and images, as is the scenography and direction of the itinerary to be generated. The video clip's purpose – education, promotion, popularization, etc. – must also be analysed, and on the basis of this analysis, it must be integrated with audio, written animation, 2D graphics or photographs meant to add to the video's informative content. It will thus almost always prove necessary to generate an itinerary though a rendering engine and include a post-production phase to add the information necessary for understanding the video being viewed.

The video will then have to be optimized for web use.

There are formats for the definition and description of **3D models accessible in real time**, but they have had limited market success so far due to their inability to provide realistic photography. There are no programmes to access 3D models in real time (3D players) that have had enough success to be considered as industry standards. Currently, there are only proprietary programmes designed by companies that produce real-time rendering engines, and which require plug-ins.

Example of a 3D model accessible in real time on Second Life (BabelsWarm Project)

The use of 3D animation and imagery may clash with the accessibility of online content. Long download times, the need to download plug-ins, and the fact that search engines consider animation akin to images and thus fail to index them, are some of the negative aspects affecting the usability and accessibility of the applications. Additionally, measures and instruments are needed to allow the (albeit imperfect) accessibility of content on the part of disabled users.

Immersive photography

Panography, or “immersive photography”, is the current synthesis between traditional static photography and video clips. It makes it possible to view the entire surrounding environment, which can be viewed without being subject to visual constrictions (only the point of view of the photographer) or functional constrictions (viewing a clip means being subject to its director’s take). All this can be done by surfing at one’s own leisure along the vertical and horizontal axes, allowing a 360°X360° rotation.

This type of photography, which can also be described as VR (Virtual Reality), provides maximum fidelity to what is being observed, and encourages users to explore the image with their mouse as if they were physically part of the scene that was photographed, and not virtually reconstructed using computer graphics.

This provides a complete panorama of reality in its best-known and most “reassuring” form: as seen through the human eye.

Additionally, the scene is ‘visited’ by users in a fully autonomous manner, without them feeling ‘obliged’ to focus on a particular aspect instead of another, just as they would do if they were physically present in the scene depicted. In simple terms, users can choose to freeze the image and focus on certain particular areas by zooming in or out of the scene, thus following their own interests and looking at a particular aspect down to its smallest details.

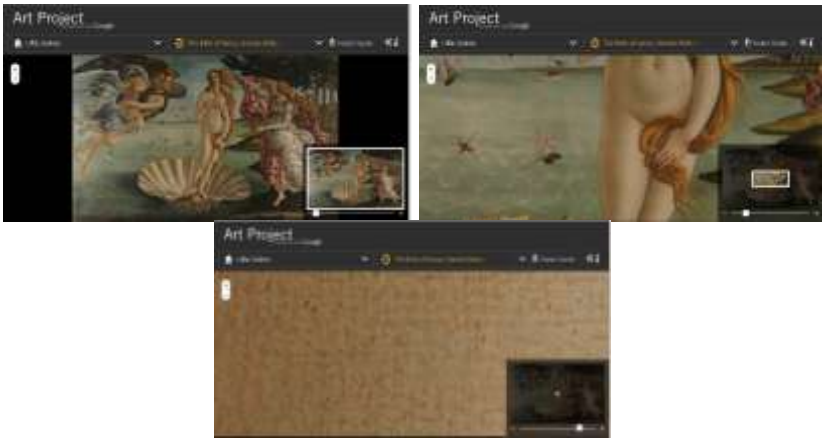
Every single item, known as a “node”, can be linked to other nodes to form a ‘scene’, or ‘interactive tour’, which creates an itinerary that mimics the itinerary that visitors would follow if they were to physically visit the exhibition, and which thus fully reflects its expositive criteria.

Panography of the Caves of Pastena
(courtesy of: Alfredo Corrao)

This first level is equivalent to a visit to the non-virtual exhibition. Additional levels, of various media types, can be added that make it possible to delve into specific topic, share comments, and establish a dialogue with various user types.

For example, it is possible to add visible or hidden links (*hotspots*) located at specific points and which, once activated, open a specific web page or audio/text content which explains what is being observed. In cases in which the non-virtual exhibition provides multimedia stations with educational videos, these same videos can be uploaded (also in Flash) to the virtual exhibition using sprites, thus giving the virtual visitor the feeling of attending the non-virtual exhibition.

One of the most useful hotspots is a link to photo galleries containing a collection of images focusing on the point (or topic) where the hotspot is located. Suppose a wall with frescoes is part of the scene: a photo album could then be created to allow for the detailed visualization of the frescoes' individual figures or scenes. Alternatively, one could provide a link to a single LHR (Large High Resolution) image created using the tiling technique, which makes it possible to view the image down to its smallest details (see the section of the Google Art Project – which the Ministry of Cultural Heritage is participating in – dedicated to the reproduction of works of art such as Botticelli's *The Birth of Venus*: http://www.googleartproject.com/museums/uffizi/the-birth-of-venus).



The tiling applied to the reproduction of Botticelli's "The Birth of Venus"

It should also be specified that each photo album can be viewed – independently from the VR environment which the user has entered – as a slide show, with special effects, transitions, and sound clips, or a series of individual images.

Specific information – ranging from a simple caption to a detailed scientific dossier – can be associated to these images and made visible thanks to metadata. This is essential to differentiate between the various types of users.

Even a single panography can currently be reproduced at high resolution (MultiRes) and – thanks to the HTML5 language– distributed to various mobile devices (smartphones, pads, etc.).

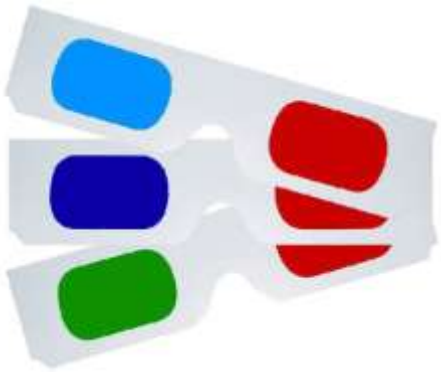
The processing of an immersive photograph begins with photographing the scene from the anterior nodal point of the camera/lens combination used, and the subsequent processing of the files thus obtained in a workflow that can include the use of various types of image processing software, including at least one specific stitching software.

Anaglyphs

Ever since the birth of photography in the first half of the 19th century, and even earlier by using pairs of drawings, humans have tried to capture on paper the sense of three-dimensionality that the human eye perceives. Photographs of the same subject – whether taken simultaneously or not – from two points of view about 6/7 cm apart (the same as average distance between two human eyes) and the subsequent viewing of these images through a stereoscope was the first attempt to give depth of field to a photographic image.

An anaglyph image is made up of two superimposed but offset photographs, one taken through a red filter and the other through a cyan filter, its chromatic opposite. Other colour combinations include magenta and green, and more rarely yellow and blue. The first combination is best for accurate colour reproduction, including those of the stereoscopic image, and is used for printed 3D images (posters, postcards, etc.) and those reproduced on monitors. The green/magenta combination is used for viewing 3D movies at home on television screens and other video devices without incorporated 3D features.

An anaglyph image must be viewed with a pair of glasses whose lenses – either made of plastic or gel – are of the same two colours as the combination in question.



Glasses for viewing anaglyph images

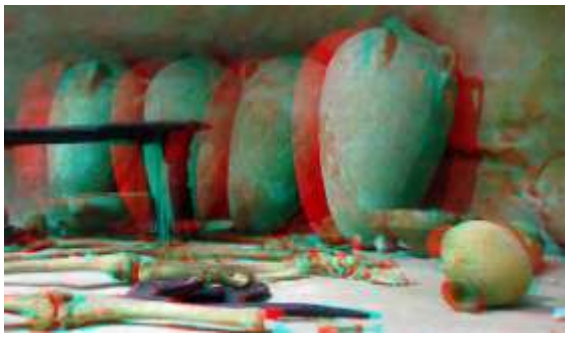
These glasses make it possible to see only one of the two images with each eye, the combination of which gives the impression of stereoscopic vision.

The colour sequence with which the images have been filtered must be followed by the glasses as well: if the left-hand photo was filtered with red and the right-hand photo with green, then the left lens must be red and the right one green. The combination with red on

the right and cyan on the left is patented (Deep Vision), and for this reason many companies produce images, films, and glasses with the reverse combination.

Thanks to the advent of digital technologies, there are now many ways to unite the two images and form an anaglyph: from programs such as Photoshop, which although lacking in a specific feature to produce anaglyph images, can be used with great success given some experience with the software, to dedicated applications, many of which are free. Some of the latter provide multiple options for superimposing images and/or for choosing the colour combination.

Anaglyph images of objects (courtesy of Alfredo Corrao)



Anaglyph image of a scene (courtesy of Alfredo Corrao)

Anaglyph image: Urbania (PU), Piazza San Cristoforo, the Teatro Bramante (courtesy of Alfredo Corrao)

Stereophoto Maker (http://stereo.jpn.org/eng/stphmkr/index.html) is particularly noteworthy. Along with the traditional .jpg format, it also makes it possible to save images in the .jps

format, which is now universally acknowledged as the most widespread and practical format for 3D images.

Programs that are simpler to use but offer fewer settings include Z-Anaglyph (http://rosset.org/graphix/anaglyph/zanag_en.htm) and Free 3D Photo Maker (http://dvdvideosoft.com/it/index.htm).

In order to obtain a 3D effect, one must either photograph with a single camera, which is moved – taking care not to change the settings - along a micropositioning plate for a distance equal to the distance of the subject closest to the camera divided by 20, or using a pair of identical cameras, with identical lenses, positioned on special brackets. The use of a single camera makes it impossible to photograph moving subjects, since the subject itself would have changed position during the time necessary to move the camera. A pair of cameras, shooting synchronously with the help of simple accessories, makes it possible to photograph without limitations.

Digital photography offers the extremely interesting opportunity to create an anaglyph image from a single archived image, thus making it possible to use archived material in a new, exciting way. In this case, the post production procedure is slightly more complex, and almost invariably beyond the reach of free 3D photography software.

Photoshop or Gimp are the ideal solutions, since they make it possible to work on the colour channels making up an RGB image. There are dozens of tutorials and how-to's available online, but our basic advice is that once the basic mechanism – which always begins with the duplication of the photo - has been mastered, it is best to experiment in order to reach the most suitable transfer percentage for duplicate images for each subject type (portraits, urban and rural landscapes, etc).

In summary, anaglyph images are easy to use, inexpensive even when made using two cameras – two good compact cameras are quite sufficient – and have a strong impact.

Offering the possibility of seeing images or videos that seem to jump out of the PC screen – either at the click of a mouse or in a specific section – could prove to be a good way to increase the number of visitors to a virtual exhibition.

The cost of a pair of anaglyph glasses is about 50 cents if purchased in bulk, which in some cases may justify their free distribution to visitors to the non-virtual exhibition, in order to encourage them to re-live their visit online, or directly to web users one particularly wants to attract.

In any case, it is best to clearly state which colour combination has been used to produce the anaglyph image, so that users can choose the same combination for their glasses, or understand why the 3D effect is faulty if using a different pair of glasses. It should also be kept in mind that although this type of 3D has numerous applications, including in the scientific field, colour reproduction is not faithful enough for the art field.

7.1.7 Geographic Information

Geographic information system (GIS) is an information system for the capture, editing, storage, analysis, management, integration, presentation of geographical data (i.e. data linked to a location on the Earth's surface). GIS can be used in different areas such as archaeology, urban and landscape planning, navigation, and cultural tourism. Geographical information may also be very useful in the field of virtual exhibitions.

Relationships between Geocoded digital cultural content and e.infrastructes will be illustrated in D5.3 Case study report and during the workshop that will be held in Ljubljana in February 2012.

7.1.8 Virtual reality

Virtual reality (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, and some simulations include additional sensory information. (Source: Wikipedia).

We overexpected results and applications from the VR technology fifteen years ago, but now an evolution of those primary developments are completely installed in the market. Their applications have pentrated into military, health and gaming sectors. Psicologysts have used them to treat anxyety problems through virtual exposition to specific situations, doctors use it to train themselves on complex procedures, and soldiers train their missions with these systems. The gaming industry has achieved exits on multiplayer online gaming (World of Warcraft, Second Life) based on avatars of real world users; motion capture based platforms have irrumped on our conception of game console (Wii, XBox). Finally, the CAVE technology, as a research oriented infrastructure, that provide a growing toolbox with open source and commercial libraries, has allowed the research community to introduce new visualziation and interaction concepts. [9]

Progressively, cultural heritage intitutions are becoming more interested into VR systems, which are creating an impact beyond the frontiers of the traditional scientifical and military sectors [3][4]. There is a potential innovation on the creation of Hi-Tech applications for cultural heritage with academic or entertainment purposes, and the consequent narrative perspectives are the current horizon of the cultural sector. The use of VR technologies in a museum or in a cultural heritage scenario can allow visitors to travel through space and time without moving out of the site or through the web, allowing an enhanced interaction with the content and the concept that is explained in an exhibition.

Immersive virtual reality allows the museums to offer more personal and close experiences to their visitors, but complex immersive cultural experiences need dedicated hardware and dedicated exhibition spaces. VR is a research demanding field with unsolved milestones and can be a potential contributor to the dissemination of the culture and an evolution on educational methodologies, but research is still required to focus on the propagation of 3DModels as method to present and preserve the cultural heritage.

Low cost scanning devices, 3D acquisition methods based on digital photography for cheaper laser-based solutions and open source 3D data tools are the key factors for the popularization of VR for cultural heritage purposes, and are the substrate of the virtual heritage research area. e-Infrastructure providers, offering computation, storage and network resources at affordable costs to cultural institutions, should trigger the explosion of these kind of technologies for their use with cultural and educational purposes.

In the construction of a virtual exhibition by means of VR technologies, a deep analysis of the exhibition objectives must be performed in order to choose the adequate technologies. The main technological discussions will be about modelling, rendering and interaction interfaces.

3D Scanning

Best modeling accuracy is acquired by means of 3D scanning techniques. The work described in [5] used a laser scanner and MeshLab [18], an open source software for 3D Data Management. Laser scanner based techniques require complex hardware devices that tend to be expansive. Some alternatives are the photo-based scanning techniques, like ARC3D [19] that can be combined with open source 3d data model manager, as [7] detail.

Modeling

If we focus on details and high quality or high fidelity modelling, 3D model construction will be supported by hand work design, using 3D modellers of general purpose such as 3dsMAx, Maya or Blender, or even specific CAD applications [8]. In virtual reality, simulation of multiple buildings and environments require procedural engines, such as CityEngine [21], which can build huge and detailed 3D models simulating specific building features. An application of these engines is one of the most realistic representations of the ancient Rome, presented in [21].

Rendering

In a virtual exhibition, interaction is a key point, and real-time rendering is needed in order to create model views according user navigation through the model. Concerning real-time rendering, two main options are possible [8]: using off-the-shelf technologies, mainly game engines, like Torque, Unreal or Quake, or using VR engines, like Virtools or XVR. In [14] we can see a list of projects that use XVR as base technology. On the field of city or building reconstruction, there are examples like the 3D interactive exploration of Piazza dei Miracoli in Pisa [12], or the Appia Antica project realized with virtools [15].

Desktop captiure in of the 3D interactive exploration of Piazza dei Miracoli in Pisa [12]

In addition, an interest has recently arisen in dedicated internet-based platforms such as Second Life or Open Sim for interactive scenarios with several users. The Uruk Project [10], where the ancient city of Uruk was recreated from the period around 3000 B.C, or the Virtual Preservation of Seventh Street's 1950s Project, which developed a virtual reconstruction of an Ocklahoma street in the 50s, used Second Life as exhibition platform. Others, like The

Laconia Virtual Archaeology Project [1] used OpenSim to simulate an ancient Byzantine basilica excavated by the British School of Athens.

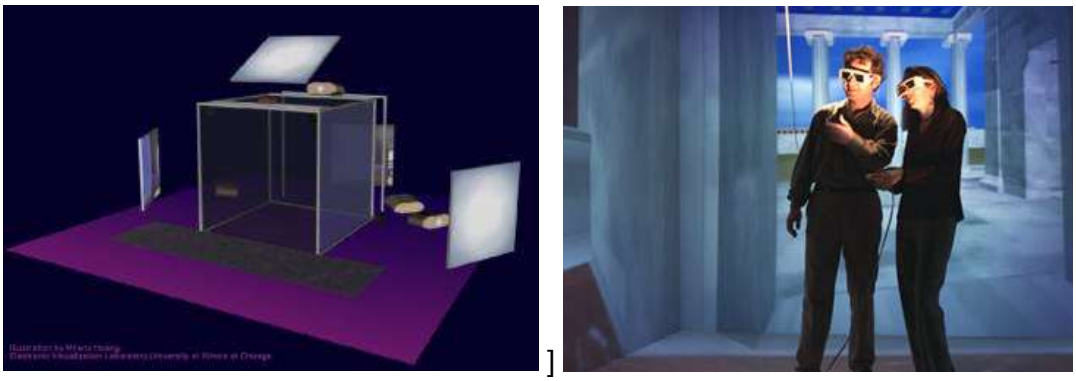
SecondLife simulation in Uruk Project [10]

Immersive interfaces

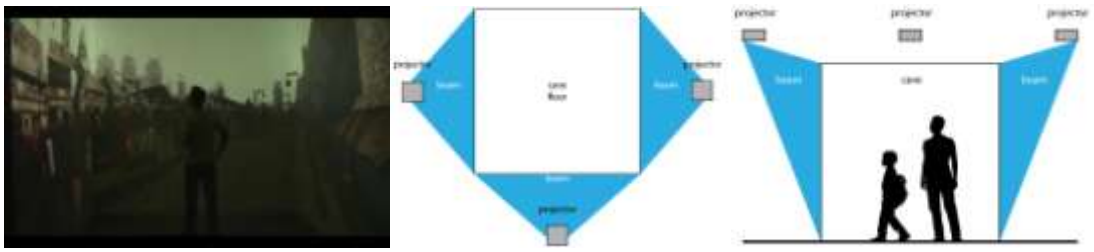
Immersion is the illusion of being in the projected world, being surrounded by the image and sound in a way, which makes you believe that you are really there [4]

Immersion is the feeling of being in a virtual space, and Virtual Reality is the integration of lower-level technical areas that, combined, allow the user to be immersed in a virtual scenario and interact with it. There are multiple configurations in high performance immersive platforms, each of them characterized by the devices used, the user workspace and the experience provided.

We can distinguish between projection based systems, like CAVE, Immmerse Desk or Powerwall, or traditional VR systems, like Head Mounted Systems (HMS), or Binocular Omni-Orientational Monitors (BOOM). The projects presented in [3][4][11], among many others, used CAVEs as VR technology in their exhibitions. A CAVE (Cave Automatic Virtual Environment) is an immersive virtual reality environment where projectors are directed to three, four, five or six of the walls of a room-sized cube.

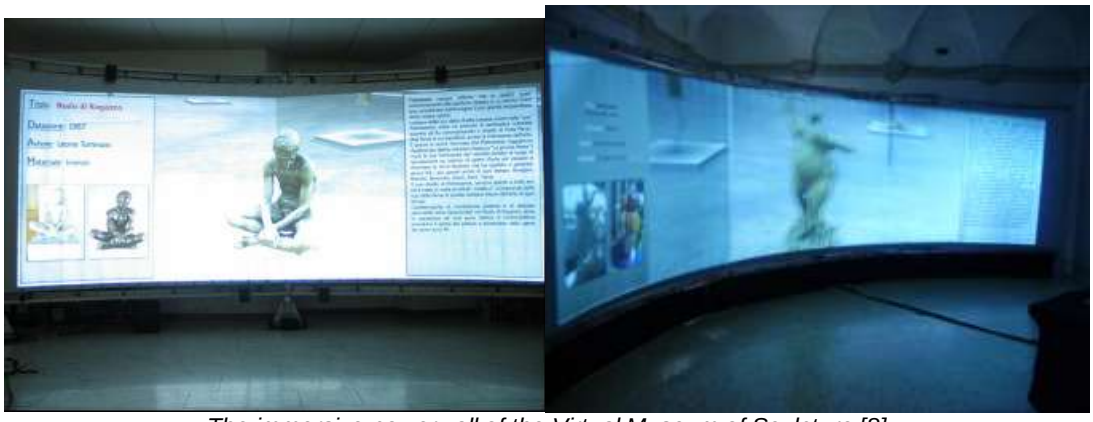


Visitors immersed in the Kivotos System, presented in [3][4]



Images of a low cost CAVE system presented in [11]

In [8] present the immersive visualization of the urban development of the town of Livorno, in the Italian region of Tuscany. The project involved the realization of a 3D model of the town in ages, aiming to show its evolution and development in time. The results have been demonstrated in the context of a dedicated exhibition, making use of a powerwall, an immersive stereoscopic installation conceived for large audiences.

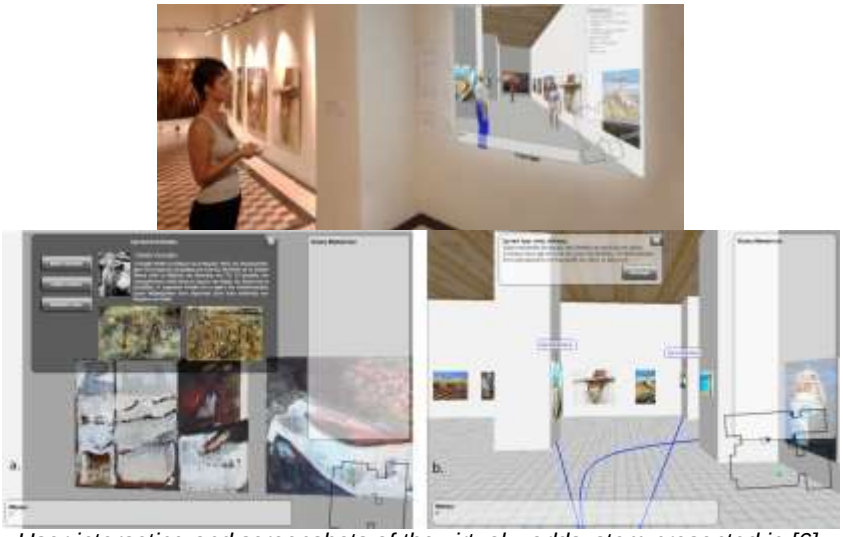


The immersive powerwall of the Virtual Museum of Sculpture [8]

Other VR solutionused for smaller groups and higher interaction are the immersive tables. In [3] present the reconstruction and virtual journey through the ancient city of Miletus by the coast of Asia Minor, the Temple of Zeus at Olympia, as a series of interactive educational environments by means of a CAVE system and an Immersadesk [2]. Stereo viewing is achieved using lightweight liquid crystal shutter glasses. The system provides head and hand tracking, user input through a lightweight hand-held device, called a wand, for interaction and audio from loudspeakers.

Children exploring heritage sites [3] on an Immersadesk [2]

In [6] they introduce a single projection device with an museum guide application accessible from web and from the exhibition site where users at coth sides can interact through a 3D model of the exhibition.

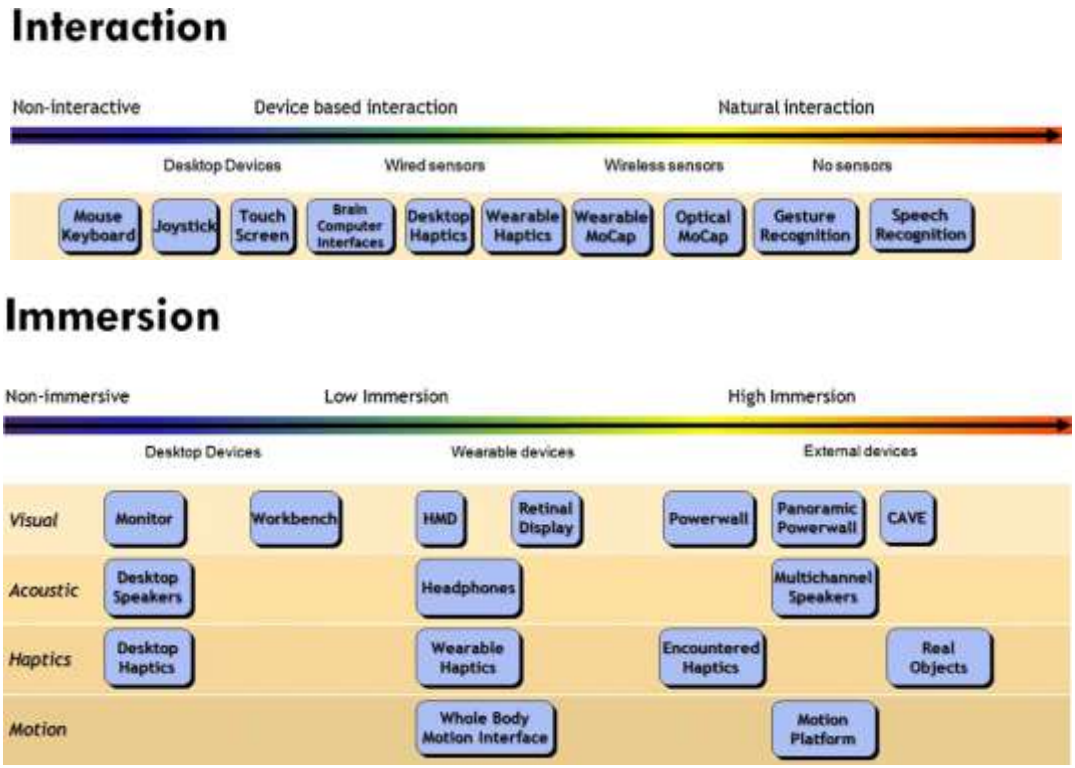


User interacting and screenshots of the virtual worldsystem presented in [6].

Haptic devices are a tactile feedback technology that takes advantage of a user's sense of touch by applying forces, vibrations, or motions to the user [16] normally by means of a robotic arm. In [17] describe the Museum of Pure Form system, developed in collaboration with many cultural institutions that evaluated and hosted exhibitions with a complete haptic system based in robotic arms as immersive interface.

Interaction with digital models of sculptures through the sense of touch at The Museum of Pure Form.

The following graphics gives us an idea of the devices used in VR platforms and how interactive and immersive they are. In [14] represent different components used in VR installations categorized according increasing levels of non-invasive immersion and natural interaction, and classify different exhibitions according these parameters.



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7.1.9 Augmented reality

Augmented reality technology consists of adding a layer of computer-generated virtual reality to the actual reality perceived by the user, whose perception of the world is “augmented” by virtual items that provide additional information on the surrounding environment.

Augmented reality technology also makes it possible to **"read" the landscape**, by visualizing on the display screen of one’s mobile device the name of the places in its field of view. In practical terms, the device uses information from its GPS, electronic compass, and accelerometer to calculate which are the points of interest in the camera’s field of view, and superimposes their names on the display.

It provides an alternative to traditional illustrative panels, with several advantages: it can work anywhere, independently of its location; it is not subject to wear and tear; it provides links to

detailed information describing points of interest and large photos that make it easy to recognize salient features of the landscape.

Augmented reality has already been used in virtual exhibitions. New York's MoMA's six floors – plus a seventh, virtual one - recently hosted a virtual exhibition based on augmented reality technology. The exhibition was only accessible to those who used a free smartphone application. The former criteria according to which works of art were exhibited in a museum are no longer valid today. The virtual masterpieces of "non artists" mix freely with the works of official museums. The museum provides the walls and the exhibition space, and the visitor decides what to see, while the role of the curator becomes secondary.

Once an exhibition is staged using augmented reality techniques, there is no longer any need to free up virtual space, and indeed the curators have decided to add the virtual exhibition to the MoMA's permanent collections. There is nothing stopping them from hosting an infinite number of additional parallel virtual exhibitions…

http://site.layar.com/company/blog/uninvited-diy-exhibition-at-moma-nyc/

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  A system that allows museums to build and manage Virtual and Augmented Reality exhibitions based on 3D models of artifacts is presented. Dynamic content creation based on pre-designed visualization templates allows content designers to create virtual exhibitions very efficiently. Virtual Reality exhibitions can be presented both inside museums, e.g. on touch-screen displays installed inside galleries and, at the same time, on the Internet. Additionally, the presentation based on Augmented Reality technologies

allows museum visitors to interact with the content in an intuitive and exciting manner.

7.1.10 Mobile technology

The potential provided by mobile technology, along with the birth of new types of applications and the evolution of new IT solutions – some of which are already available for virtual exhibitions – creates new opportunities to promote and valorise cultural heritage.

The enormous diffusion of mobile devices, including PDAs and mobile phones, that can process multimedia content both offline (multimedia guides, immersive systems in Virtual Reality, multimedia kiosks and so forth) and online (images, videos, maps, web) greatly facilitates the feasibility of virtual exhibitions aiming to ensure personalised, round-the-clock access: smartphones, netbooks, laptops and other devices that provide Internet access, either with Internet keys or through other wireless networks.

The future of mobile interpretation

In the near future, mobiles may become an indispensable interface for accessing cultural heritage. They can be exploited using innovative approaches, as explained in an article by Koven J. Smith, interpretative technology manager at the Metropolitan Museum of Art.

However, it is necessary to eschew traditional approaches modelled on museum tours, with selected stops where the narrative content is presented in both a sequential and random manner to replace a human guide (this is also the system traditionally adopted in the audio guides available in museums and exhibitions). The traditional model has the following specific characteristics:

- content is created specifically for the mobile device
- content is tied to specific stops along a physical route (generally objects, monuments, or architectural elements)
- items from permanent collections are under-represented, in favour of objects on display
- except for brief introductory texts, contextual material is largely absent.

It would be best to eschew this author-based (one or more authors) model in favour of a model on which basis the entire collection is available for research, viewing, and study, even during physical visits.

- Although in-depth studies on the type of audience that accesses cultural content through mobile devices are still lacking, Smith encourages the use of mobile devices for:
- **making available** the entire collection on the mobile device, so that visitors are not constrained by what the museum curator offers, but can personalize their visit on the basis of their interests
- **pinpointing** objects, so that users can easily find them
- **suggesting** alternative routes based on the topics that most interest the visitor. The end of one route can thus be the beginning of another. The mobile device would

need to include a recommendation engine operating on the basis of content, location, and preferences
- **contextualising**, thus helping the visitor compare objects that are not necessarily on display
- **generating content** (bookmarks, tags, guestbooks) that can be enjoyed by other visitors or that can support the curators themselves.

Reference

- Koven J. Smith, *The future of mobile interpretation*, paper presentato a *"Museums and the Web 2009"*, http://www.archimuse.com/mw2009/papers/smith/smith.html

Below we discuss the most widely used devices and applications:

The **QR code** is a two-dimensional bar code that can contain data or links. In order to read this code and visit the content at the encrypted address, users can scan the image of the code with a camera phone, which will open the URL and reveal details, events, schedules, news, and multimedia content on a virtual exhibition or display venue.

Use of code is particularly widespread in the publishing world (for example, *Panorama* magazine), and is beginning to take hold in tourism promotion as well, with projects such as "QR-coding Genova" managed by the Città Digitale Campus on behalf of the Municipality of Genoa, or the project run by IBM on behalf of the Municipality of Venice, which has peppered the city's monuments with white tiles containing QR codes.

QR codes can be used as a marketing strategy to attract attention through contests or the distribution of virtual gadgets related to the exhibition.

	
Qr-coding Genova Project managed by the Città Digitale Campus on behalf of the Municipality of Genoa	*N Building in Japan. This is a commercial structure where advertising billboards have been replaced by QR codes, while preserving the facade*

The development of mobile applications for exhibitions must take into account which mobile devices are most in use:

PDA (Personal Digital Assistant): also known as a palmtop, its potential as tool for stimulating visitors during an exhibition has been tapped especially in the museum field. Its advantages include flexibility, wi-fi access, multimedia interface, and audio and video streaming.

Mobile phones: new generation mobiles – also known as smart phones – are now very widely used. They serve as mobile terminals, with increasingly large, high-resolution screens, and are extremely functional in terms of accessing and exchanging multi-media content. They are very well suited to a youthful audience, since they promote informal, flexible, and participatory communication and learning processes.

Android: developed mostly by Google, this is an open source operating system.

iPod, iPhone, iPad: developed by Apple, they use the same "OS iPhone" operating system, and the interface is generally the same for all three devices. There are millions of free applications available on iTunes' AppStore. The versatility of Apple's mobile devices makes it possible to use them for various purposes: utility, games, multimedia, music, productivity, teaching, etc.

Mixed Reality

According to Wikipedia [1], mixed reality refers to the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. A mix of reality, augmented reality, augmented virtuality and virtual reality.

In previous chapters we presented an overview of VR technologies used in virtual exhibition environments. We can consider that the same scanning, modeling, rendering and visualization technologies, but introducing the use of real images and virtual-real object mapping processes constitute the basis for a virtual exhibition based on mixed reality systems. The following graphic, provided in [2] define the Virtuality Continuum, a concept used to define the mixture of classes of objects presented in any display situation where real environments (real images) and virtual environments (3D objects) are merged.

Representation of a "virtuality continuum".

The explosion of the AR technology has introduced a new level of mixed reality that we consider important to distinguish here because it can be a low cost solution for highly interactive applications in the virtual exhibitions sector: mobile-based mixed reality. In this area, in addition to 3D rendering capabilities on mobile devices that are still a research topic, precise localization or image detection are needed in order to superimpose virtual objects and real images

In [3] it is presented a mixed reality system that used data from The Gargas cave organization (French Pyrenées) containing images from caves depicting animal engravings as well as the interpreted drawings of an expert. This paper gives an idea of what can be done with cultural data and image recognition or micropositioning services on mobile devices.

References:

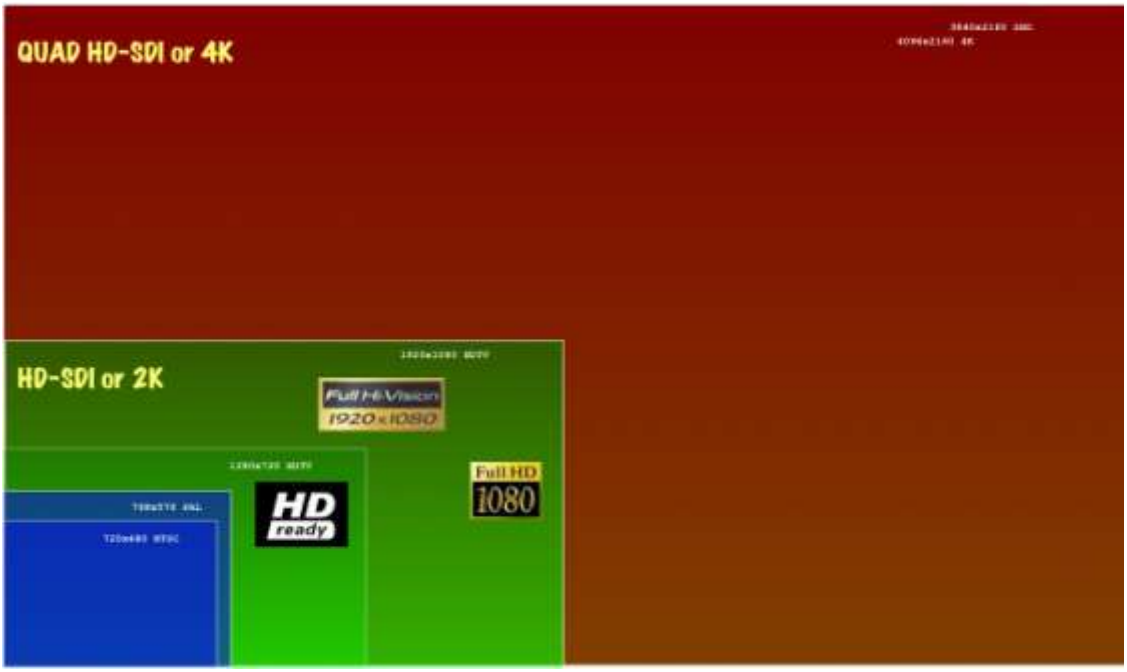
1. http://en.wikipedia.org/wiki/Mixed_reality
2. Milgram P., Kishino F., "A Taxonomy of Mixed Reality Visual Display", IEICE Transactions on Information Systems E77-D (12): 1321-1329, 1994; http://web.cs.wpi.edu/~gogo/hive/papers/Milgram_IEICE_1994.pdf
3. Omar Choudary, Vincent Charvillat, Romulus Grigoras, and Pierre Gurdjos. MARCH: Mobile Augmented Reality for Cultural Heritage. http://www.cl.cam.ac.uk/~osc22/docs/p1023-choudary.pdf

7.2 Virtual Performances

7.2.1 Video resolution

The video resolution will determine the number of pixels per image we are capturing / transmitting / displaying, and will influence significantly in the quality of the image.

Most common resolutions used are shown in the next figure.

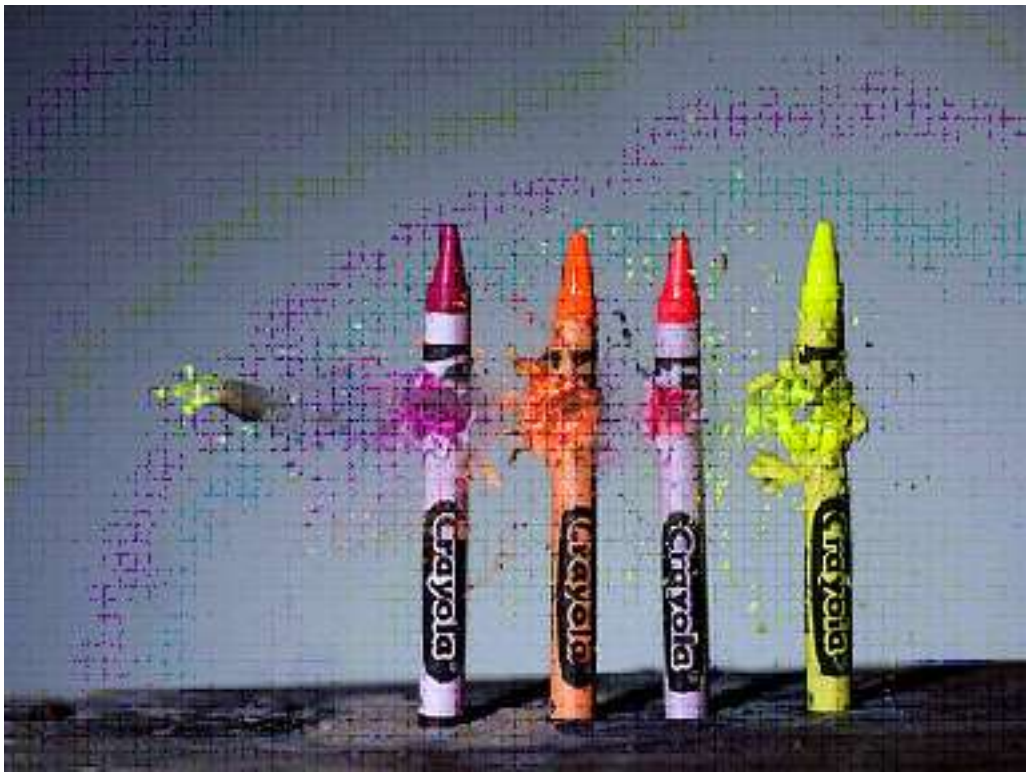


7.2.2 Colour coding

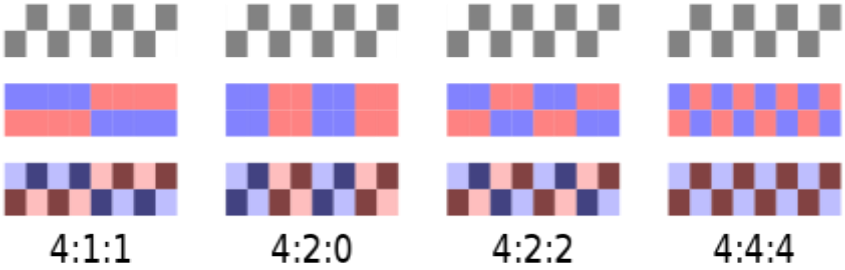
Colour coding will determine the number of bits per colour used in the digitisation of the image.

The RGB colour model (Red Green Blue) is an additive colour model in which red, green, and blue light is added together in various ways to reproduce a broad array of colours.

The main purpose of the RGB colour model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB colour model already had a solid theory behind it, based in human perception of colours.



However, due to transmission limitations, normally required bandwidth is limited, there is always a desire to reduce (or compress) the signal. Since the human visual system is much more sensitive to variations in brightness than colour, a video system can be optimized by devoting more bandwidth to the luma component (usually denoted Y'), than to the colour difference components Cb and Cr. In compressed images, for example, the 4:2:2 Y'CbCr scheme requires two-thirds the bandwidth of (4:4:4) R'G'B'. This reduction results in almost no visual difference as perceived by the viewer.



Most frequently used colour coding in distributed virtual performances will be Y'CbCr in a 4:2:2 or 4:2:0 reducing 1/3 and 3/4 respectively from the conventional RGB.

7.2.3 Video compressions

If the use of uncompressed audio/video transmission over the network is not always possible due to the fact that guaranteed network bandwidth normally becomes a limitation of the system, digital information needs to be compressed. Digital data compression has been studied in deep during last few years. (http://en.wikipedia.org/wiki/Data_compression)

Video compression has evolved a lot in the last 30 years, from H.120 that appeared in 1984 to DIRAC / JPEG2000 from last years, although not all compressions algorithms will work for real time performance as introduce some delay that makes the interaction not possible.

When talking about virtual performing arts, **a trade-off** between image **quality**, **compression** ratio, **computing power** and **latency** should be found to ensure the performing success.

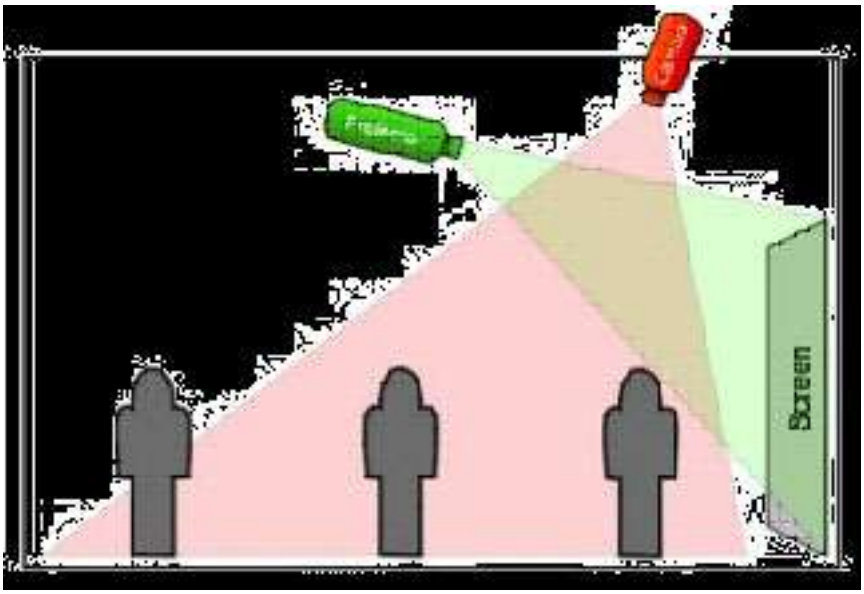
Most used images codifications for transmission over the network are:

1. Uncompressed images:
    a. High quality;
    b. No extra latency due to the codification;
    c. No computing power required for compression;
    d. 0 compression ratio / high required bandwidth;
2. Independent image based codifications (JPEG, DXT, Dirac, JPEG2000,etc.):
    a. Medium / High quality;
    b. High computing power required;
    c. Between 1/4 and 1/6 compression ratio, medium bandwidth required;
3. Low latency H.264 family:
    a. Medium quality;
    b. Medium computing power required;
    c. Up to 1/100 compression ratio.

7.2.4 Projection

Often the representation of the “other side” of the performance is done by a projection, converting the screen in an important piece of the event.

As an important part, projection possibilities/needs should be taken carefully into account.

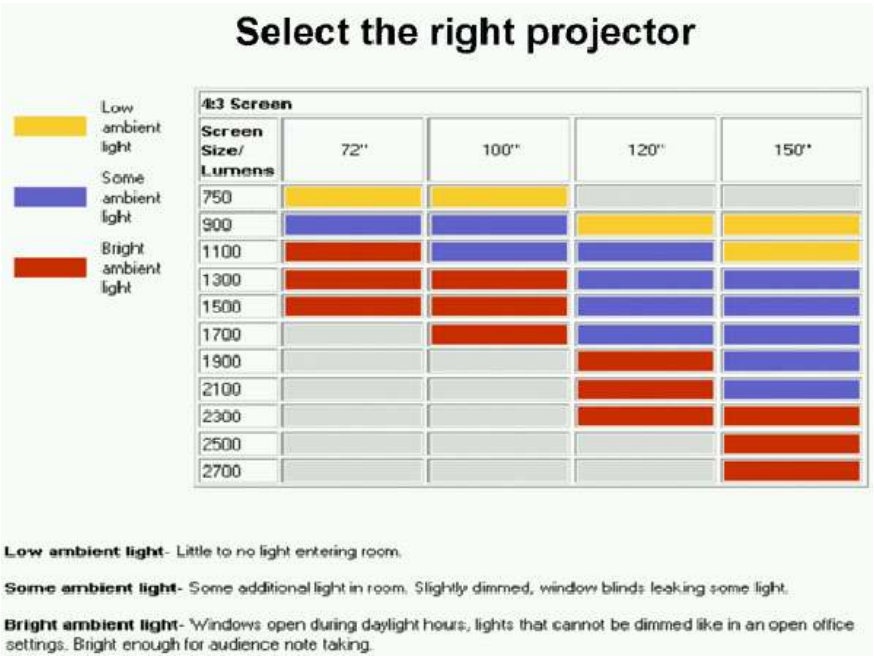


The first thing to take into account will be the position of the projector. As usually local artists should interact with the screen, the projector beam should not be overlapping the artists' field of action.

Projector's beam area of influence will be determined by the projector optics, projector position and screen size. It is important to consider, whenever possible, the use of rear projections.

Another key element to be considered when selection the appropriate projector for each virtual performance that needs projection, is the power (in lumens) of the projector.

As shown in the figure, required lumens power will be based on screen size and the level of light required in the performance.



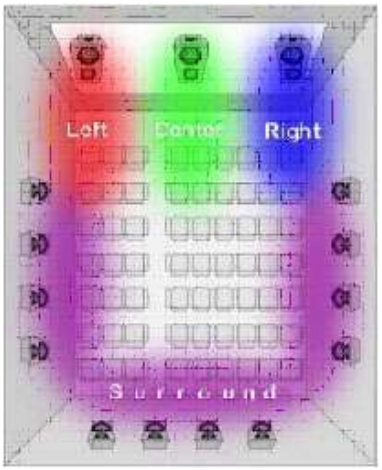
7.2.5 Audio

Subjective human tolerance to errors/artefacts in audio systems is quite lower than in video systems (ears are logarithmic “devices”). As in all events, in virtual performance events, audio quality always becomes a key element.

Also when working in distributed scenarios, the complexity of the audio configuration increase considerably as there is not only local audio, but also remote audio, that normally should be treated independently in order to avoid possible echo problems. Local audience and artists should listen what’s coming from the “other side” of the event, but **received audio can not be sent back to the sender**, so audio routes, microphones and speakers should be defined, selected and positioned in the scenario according to that.

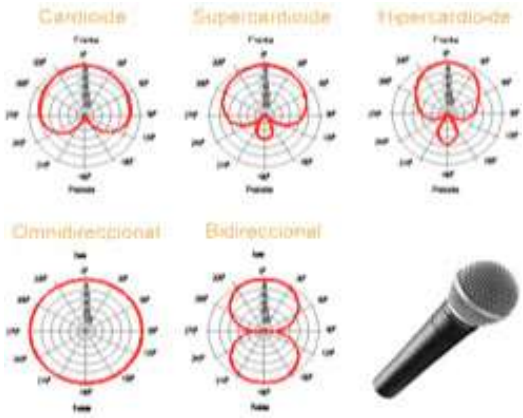
Microphones and speakers

In traditional scenarios, the speakers are located to cover all the scenario and audience, and adjusted to give a confortable volume. Also microphones are selected to maximize the action range, to ensure that all audio information will be amplified and sent to the speakers, by normally using omnidirectional microphones.



There are so many different microphones in the market, depending on:

- The technologies used to capture the information (Condenser, electret condenser, dynamic, etc.), with different properties that should be taken into account depending on the kind of event is going to be performed (you can get more information in http://en.wikipedia.org/wiki/Microphone)
- The polar patterns, as can be seen in the next picture, it is possible to find different polar patterns for the audio acquisition. This is a very important element when working in a bi-directional audio communication, when trying to avoid remote audio feedbacks.



8 Services

8.1 Edutainment (education through entertainment)

Museums have started to realise the potential of new technologies for the development of edutainment content and services for their visitors.

8.1.1 Thematic routes

The possibility of using virtual exhibitions and itineraries for educational purposes, and the implications of this for the definition of the architecture, contents, and tools to be selected deserve a specific discussion. The close links between history, geography, and narration made possible by virtual exhibitions and thematic routes make such a didactic experience unique for users. As a consequence of this, although virtual exhibitions and cultural itineraries used for didactic purposes do not stand out for abstract substantial or technological differences, they do stand out for the emphasis they place on certain elements, either the contents of the exhibition or itinerary, or the language and instruments used.

A good example of this is using a thematic route to educate the audience about the history or geography of a given area. In such a context, the route becomes a natural extension of the local history; in fact, the route and local history support each other through a dense network of semiotic relations linking urban planning, land management, local cuisine, cultural heritage, and more. Pupils are thus encouraged to embark on a virtual journey through past eras and cultures, evoking itineraries from the past and symbolic elements along the way, and valorising unusual aspects and points of views of the educational path they have taken.

Of course, much like in the closely related field of e-learning models, one can envisage adopting different types of training models for which the use of exhibitions and itineraries can be an effective tool. The specifications of the educational product to be developed depend on the type of model adopted.

Below we describe some training model types:

- Using an exhibition or a thematic route **to support educational activities** in kindergartens, primary, or secondary schools; in this case, they complement classroom learning, and can be introduced by teachers in class, form the basis for IT lab work, or be used by children to delve into specific topics during their own study time;
- Using an exhibition or a thematic route **for university, post-graduate, or managerial training**; that is, within the framework of training courses designed for highly motivated beneficiaries with a strong sense of belonging to a learning community, and with the capability of autonomously managing the interactive content;
- Using an exhibition or a thematic route **for lifelong learning and training** in the field of culture or related sectors, and using the interactive content for awareness-raising and continuous learning;
- Using an exhibition or a thematic route **as part of individual learning programmes** that are different from those listed above, but which make the individual use of routes not only possible, but also desirable.

Why is it important to define the educational goal of an exhibition?

The different educational and cultural goals are the main criteria to define the contents and instruments to be included in the exhibition or thematic route. Once these aspects have been clearly identified, the author is free to choose the relative importance of community instruments – which are necessary if the aim is to make pupils feel they are part of a larger group, but less important if the exhibition or thematic route is to serve as a classroom tool – or of interactive and recreational elements, which are characteristic of thematic routes targeting children and schools, but of marginal importance for lifelong training models. A careful analysis of these aspects will help the author achieve the right balance among the structural elements making up the virtual exhibition.

8.1.2 Games

Especially in the case of museums that offer edutainment, virtual reality can help create an environment where users will be able to learn by exploring, to get acquainted with the use of objects, guided by virtual agents through an exhibit's history or even assemble and disassemble it into pieces.

Virtual and augmented reality technologies promise to offer a vivid, enjoyable experience to museum guests. In [1] a case study on the application of games to cultural heritage is reported. Several examples of gaming on cultural contexts for edutainment are provided and categorized into three types of computer-game-like applications: demontrators/prototypes, virtual museums and historical games.

Demonstrators and prototypes, like the already-mentioned Rome Reborn project [2], are enormous and costly virtual reproductions that normally are used in academic or research environments, never released to wider public. On the other hand, virtual museums are interactive applications that use VR and web technologies to show exhibitions in a game-like manner to a wider public. In [1] some examples of gaming on virtual museums using a CAVE to explore an imaginarie temple in the faraonic Egypt and 3DWeb to walk through the ancient Olimpia are reviewed. Another interesting example of virtual museums is described in [3], a detailed description of the creation of a virtual exhibition and its application through CAVE and desktop displays.

References:

1. Eike Falk Anderson, Leigh McLoughlin, Fotis Liarokapis, Christopher Peters, Panagiotis Petridis, Sara de Freitas. Serious Games in Cultural Heritage. http://www.coventry.ac.uk/ec/~fotisl/publications/VASTSTAR2009.pdf

2. B. Frischer: *The rome reborn project. how technology is helping us to study history*. OpEd, November 10, University of Virginia, 2008. http://www.romereborn.virginia.edu/rome_reborn_2_documents/papers/Frischer_OpEd_final2.pdf

3. George Lepouras. Costas Vassilakis, *Virtual museums for all: employing game technology for edutainment*, 2004, http://hci-vr.cst.uop.gr/papers/%5BJ12%5D_VirtualMuseumsForAll-EmployingGameTechnologyForEdutainment_VRJ_Vol8.pdf
   The authors propose the use of 3D game technologies for the purpose of developing affordable, easy to use and pleasing virtual environments. To this end, they present a case study based on an already developed version of a virtual museum and a newly implemented version that uses game technologies. The informal assessment indicates that game technologies can offer a prominent and viable solution to the need for affordable desktop virtual reality systems.

8.2 e-Commerce

The term "e-commerce" is generally used to indicate the set of transactions for the marketing of goods and services between producers (supply) and consumer (demand) , made through the Internet.
E-commerce may be associated to big projects of virtual exhbitions or to portals hosting virtual exhbitions.
Successful marketing, whether it be via e-commerce solutions or a more traditional approach, is always about a cultural institution plans to better meet his customers needs and grow his business and customer base.
Concerning virtual exhbitions, e-commerce projects may also include e-ticketing procedures.

References:

- Barbara Ciaramitano. Virtual Worlds and E-Commerce: *Technologies and Applications for Building Customer Relationships*, Ferris State University, USA, 2011. 398 pages.

  This work presents various opinions, judgments, and ideas on how the use of digitally created worlds is changing the face of e-commerce and extending the use of internet technologies to create a more immersive experience for customers.

- Museums Libraries Archives Council (MLA), Planning for e-commerce, http://www.mla.gov.uk/what/programmes/renaissance/regions/east_midlands/info_for_sector/~/media/East_Midlands/Files/2009/Part%201%20-%20Ecommerce%20for%20museums%20-%20planning

  The paper proposes a "Six Step Plan to help you decide if e-commerce will work for your museum". It can be a useful reading to analyse if E-commerce can be a useful addition to the way in which a cultural insitution does business.

- Lesley Ellen Harris, Libraries and E-Commerce: Improving Information Services and Beyond, http://www.sla.org/content/Shop/Information/infoonline/2000/mar00/harris.cfm

  How do you go about incorporating e-commerce in your library.

9 e-Infrastructures

9.1 Virtual exhibitions

This chapter lists services provided by e-Infrastructures which may be used by cultural institutions building virtual exhibitions. Cultural institutions which filled in the INDICATE survey on virtual exhibitions said that they don't widely use these services. Museo Galileo in Florence is an exception. Survey pointed out that there is a gap between e-Infrastructure users community and DCH community: usually DCH users do not have in-depth knowledge about advance e-Infrastructures capabilities.

9.1.1 Bandwidth

The bandwidth is the rate of data transfer, bit rate or throughput, measured in bits per second (bps). In the case of virtual exhibitions using complex or heavy digital objects, a larger bandwidth may increase the speed for browsing or downloading the cultural contents.

9.1.2 Hosting and storage capacities

E-infrastructures may provide storage service to cultural institutions proposing virtual exhibitions. Storage service may be of different types:

- Grid or Cloud storage;

- Peer-to-peer storage.

9.1.3 Authorization and Authentication Infrastructures

NREN operate identity federations and provide services to a large number of users within academic and research community. Based on open standards, these national identity federations are focused on providing access to web-based resources (such as repositories and e-Journals). Authorized communities belonging to cultural institutions could access to specific contents provided in the framework of virtual exhibitions.

References:

Consortium GARR, *e-Infrastructure Glossary*, http://www.dc-net.org/getFile.php?id=323
Glossary made available in the framework of the DC-NET project

9.2 Virtual performances

This section lists several services provided by e-Infrastructures in the framework of virtual performances.

9.2.1 HD Streaming

High Definition can be useful also for other branch of learning. There are many options to achieve HD Streaming for broadcasting purposes and SD high quality videoconferences. These set of tools are open source based softwares and take the advance of the continuous developing from the community. Below one can see a list of them:

DVTS

Quality: SD videoconference;
Latency: Good enough for conversation (600 ms);
Technical details:

- Platform: Linux/Windows/Mac;
- Audio: 48 kHz/16 bit uncompressed;
- Video: Standard definition, DV25 compression, 720x576;
- Standard: PAL/NTSC;
- Bandwidth: 30 Mbps;
- Capable of IN/OUT hardware intarfaces (ieee1394 ports).

VLC

Quality: SD/HD streaming;
Latency: Between 1.5 and 3 seconds, depending of the compressions settings;
Technical details:

- Platform: Linux/Windows/Mac;
- Capable of capturing of any card installed on the system;
- Coding capabilities: MPEG1, MPEG2, H.264;

- Standard: PAL/NTSC;
- Bandwidth: 1-8 Mbps;
- High quality output signal only supported in a screen, does not capable to output on hardware interfaces.

ConferenceXP

Quality: SD/HD videoconference;
Latency: 800 ms;
Technical details:

- Platform: Windows;
- Capable of capturing of any card installed on the system throught DirectX API;
- Coding capabilities: WMV;
- Standard: PAL/NTSC;
- Bandwidth: 1-5 Mbps (compressed) and 1-30 Mbps (uncompressed);
- Output signal only supported in a screen, does not capable to output on hardware interfaces;
- Works with compressed and uncompressed signals.

Ultragrid

Quality: HD videoconference;
Latency: 100 ms;
Technical details:

- Platform: Linux/Mac;
- Capture from Blackmagic, DVS, XENA and some V4L based cards;
- Coding capabilities: DXT, CUDA based JPEG;
- Bandwidth: 50 - 980 Mbps (uncompressed)
- Output signal only supported in a screen and throught hardware interfaces (SDI and HD-SDI).

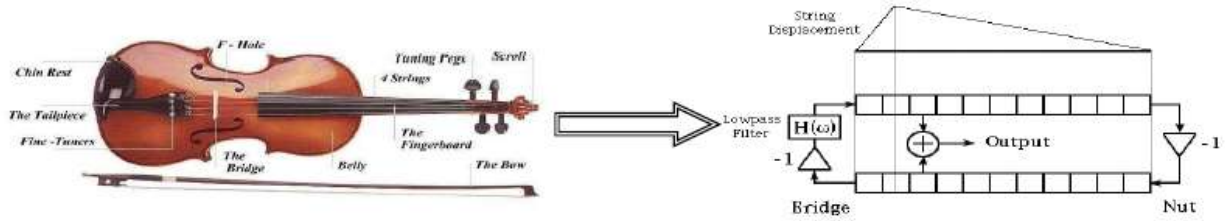
HD Gaudi, 2002: First compressed HD live transmission
between Europa-USA over Internet at 270 mbps by i2CAT-Research Channel

9.2.2 Physical modelling synthesis

(Text from Astra Project website: www.astraproject.org).

The Physical Modeling Synthesis (PMS) is a complex digital audio rendering technique that allows to recreate a model of the musical instrument and produce the sound by simulating its behavior as a mechanical system.

Physical modeling synthesis is the synthesis of sound by using a set of equations and algorithms to simulate a physical source of sound. Sound is then generated using parameters that describe the physical materials used in the instrument and the user's interaction with it, for example, by plucking a string, or covering tone holes, and so on. For example, to model the sound of a drum, there would be a formula for how striking the drumhead injects energy into a two dimensional membrane.



Thereafter the properties of the membrane (mass density, stiffness, etc.), its coupling with the resonance of the cylindrical body of the drum, and the conditions at its boundaries (a rigid termination to the drum's body) would describe its movement over time and thus its generation of sound. Similar stages to be modeled can be found in instruments such as a violin, though the energy excitation in this case is provided by the slip-stick behavior of the bow against the string, the width of the bow, the resonance and damping behavior of the strings, the transfer of string vibrations through the bridge, and finally, the resonance of the soundboard in response to those vibrations.

Although physical modeling was not a new concept in acoustics and synthesis, having been implemented using finite difference approximations of the wave equation by Hiller and Ruiz in 1971, it was not until the development of the Karplus-Strong algorithm, the subsequent refinement and generalization of the algorithm into the extremely efficient digital waveguide synthesis by Julius O. Smith III and others, and the increase in DSP power in the late 1980s that commercial implementations became feasible.

Reasons for gridification: the physical modeling is a really computing intensive technique since the complex models of the musical instruments are solved by integrating numerical coupled differential equations. To have an idea of the needed time for simulation, on a Pentium IV1.6 Ghz, 512MB RAM Personal Computer to correctly reproduce a sound lasting for 30 seconds it could be required more than 4 hours.
The PMS offers great potentialities both to:

- Musicians searching for the most convincing real-world sound emulations;
- Musicians searching for unique, never-heard-before sounds by changing the instrument geometry.

9.2.4 Data sonification

Data sonification is the representation of data sets by sound signals. It can be considered as the acoustic counterpart of data visualization.
Data sonification is currently used in several fields, for different purposes:

- Science and engineering;
- Education and training.

Although most data analysis techniques are exclusively visual in nature, data presentation and exploration systems could greatly benefit from sonification technique: studies have shown that people are quite more confident in recognizing patterns audibly rather than visually.

Sonic representations are particularly useful when dealing with complex, high-dimensional data, or in data monitoring/pattern recognition tasks where it is practically impossible to use the visual inspection: in fact, It is quite impossible to distinguish a blinking light flashing 100

times a second from another one flashing 200, 1000, or 10000 times a second; while it is much easier to recognize and differentiate periodic signals from 20 Hz to (almost) 20000 Hz.

Sound can immediately make clear and recognizable transitions between random states and periodic phenomena.

In practice, anything could be sonified (ancient palnets, volcanoes, earthquakes, a painting, a moving image, etc.).

10 Examples

10.1 Virtual exhibitions

In this chapter, we shortly describe several examples of virtual exhibitions collected through the INDICATE surveys. All survey are available in the reserved area of the INDICATE website (case studies section).

10.1.1 Le phare de Cordouan (France)

French project aiming a realizing a virtual tour provided by different technologies: panoramics of the monument today, outside and inside; 3D models of the monument at different past periods which allows visitors to be completely immersed in the site. Other sequences offers history of the monument, and give access to a a large selection of documents, including archives, photographs, video sequences, sound recordings, 3d animations…. The project, managed by French Ministry of Ecology and the Museum of Royan, is targeted to the general public, schools, university students, children, tourists. This project, which includes a virtual exhibition in a physical environment, makes use of 3D polarizing stereoscopic glasses and tracking technology. It is realized partly in-house partly in outsourcing, in English, French and the sign language. The content is valorized through augmented reality, zooming, timeline and moving pictures. Digital resources are protected via SWF.

Technlogies used: augmented reality, image magnifiers, timelines, moving pictures

Digital resources (video, text, images). The user need plug-in to access some content (Flash ; 3Dvia).

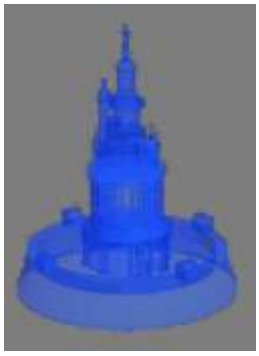
Information retrieval features: Browsing by themes/topics/titles; Browsing by thumbnail images; Browsing by interactive maps and images

Searching options: keywords and phrase search.

Several services are offered: educational packages, games, sharing with social networks, application for smartphone.

The project is hosted on a server in-house. Supercomputing performances are needed. It will be finalised in June 2012.





10.1.2 Lascaux (France)

The project (www.lascaux.culture.fr) realised in 2008 a three-dimensional digital version of the cave, allowing visitors to go from room to room of the cave of Lascaux. As the users travel from the Great Hall of the Bulls all the way to the Shaft of the Dead Man, they can stop at each of the many images, read descriptions, play video sequences and examine overlay lines that helpfully reveal some of the more difficult to identify figures. A zoom feature enables visitors to get as close as possible to the walls that these talented Neolithis artists decorated.

The virtual tour is only one part of the visitor's experience: other video sequences reveal the secrets of the artists who painted and engraved Lascaux's bestiary some 19,000 years ago, and present current trends in archaeological research on the cave, Other chapters of the site explore different ways of considering the site, including Lascaux's natural environment in the Vézère Valley, a rock art timeline, a database.

Visitors of the site have access to more than three hundred documents, including photographs, site drawings, video sequences, sound recordings, 3D animations.

The project, coordinated by the Research, Higher Education and Technology Department, in cooperation woth the Centre national de préhistoire, is targeted to the general public, schools, university students, children, tourists.

It is realized partly in-house partly in outsourcing, in English, French, Spanish, Gewrman and the sign language.

The content is valorized through augmented reality, zooming, timeline and moving pictures.

The user need plug-in to access some content (Flash).

It includes educational packages and an application for smartphones. It is hosted in a server inhouse.

10.1.3 Romanorum Vita (Spain)

A history of Rome: a project of historical promotion, targeted to the whole public of la Obra Social “La Caixa”, allowing to know daily life of an Imperial town active in the I century a.C. The project includes: a website (www.romanorumvita.com), a virtual visit of the enriches exhbition; the online catalogue; the blog Romarorum Vida (with educational packages, interactive proposals, itineraries, news); links to social networks (Flickr, Youtube, Del.icio.us, SketchFu, Woices).

A moving physical exhibition completes the project.

The project, coordinated by the exhibitions department of the Obra social La Caixa, is targeted to the general public, schools, university students, children, tourists.

It is realized partly in-house partly in outsourcing, in Spanish, Catalan, Basque and Galician.

Technlogied used: tagging, tag clouds, geotagging, slideshow, pageflip, panographies, Timeline.

Digital resources (video, audio, images) provided in high resolution. The user need plug-in to access some content (Adove Flash Player, Acrobat reader).

Searching techniques: browsing by themes/topics/titlesm by thumbnail images, by Google maps.

Searching options: keywords and phrase search.

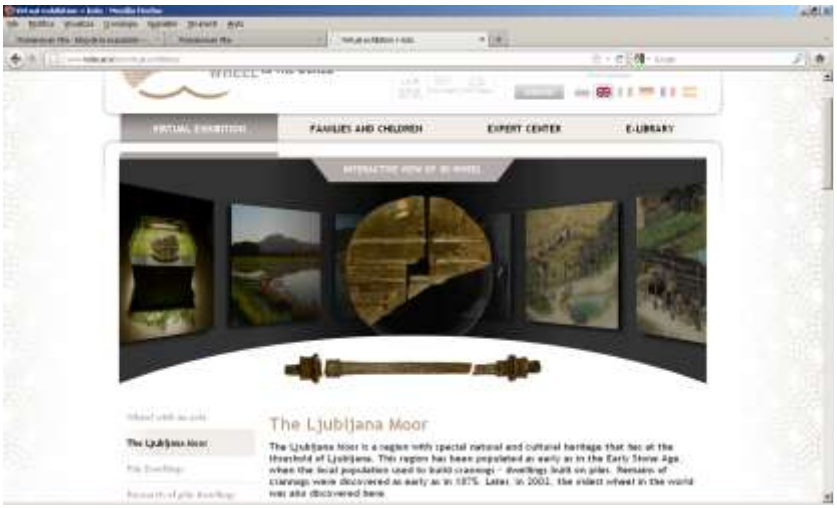
Some interaction features are included: create and save digital comments, share. No specific techniques are used to protect digital items.

The project is hosted in a server in house.

As regards management, some strategies have been set up concerning backup, security, terms of use, dissemination and promotion, search engine optimization.

10.1.4 The oldest wood wheel in the world (Slovenia)

Web portal (www.koliscar.si), which is in working order since the beginning of October 2010. The main protaginist of this new virtual space of prehistoric time and territory of the present day Moor (Barje) is the oldest wooden wheel with an axle in the world. This virtual exhbition is targeted to general public, schools, children, tourists, families. It is connected to a permanent exhbition. It was set up by the communication department of the Mestni muzej in Ljubljana, and funded by European regional Development Funds. It is realised partly in-house partly in outsourcing. It is multilingual (English, Italian, German, French, Spanish). The presentation standard is Flash, browsing options: through thumbnails. Non completely accessibile.



10.1.5 Anatolian Civilisations Virtual Museum (Turkey)

Turkish Anatolian Civilizations Museums is one of the most important and major museums in Turkey, built in the early stages of Turkish Republic. In early 2000 a virtual museum project has been realised. This project is targeted to the general publich, researchers, schools, university students, children, tourists. It was realised by the education department, ICT department and exhbitions' department, completely in-house. The project is not multilingual. Digital content is composed of texts, images and videos, valorised thropugh the following technologies: slideshow, image magnifiers, pageflip, panographies. Specic intallations are required: Active-X, Java Applet, Flash.

Information retrieval features include browsing by themes/topics and maps. Searching options include: keyword and phrase search, boolean search, truncation, natural language search. Accessibility standards are only partially respected. Digital resoursed are protected with watermaks.The project is hosted in a server in-house. Capacity required is 10 tb. The minium bandwith needed to distribute and give access to the project is 10 mb.

As regards the management, several strategies has been set up concerning: periodical pack-ip, secutiry, privacy levels, SEO, statistics analysers.

10.1.6 Princess from far lands. Catalonia and Hungary in the middle ages (Spain)

This project offers an interactive multimedia experience of all the contents related to the exposition that took place at Museu d'història de Catalonya in the year 2009.

It is targeted to the general public. It was commission by Museu d'història de Catalonya and developed by a private company.

The main language is Catalan, but there is partial transalation in Spanish and English.

Among technology used: slideshows, image magnifiers.

Presentation standards: Flash, Java Applet.

Information retrieval features include browsing by themes/topics, thumbnail images, and maps.

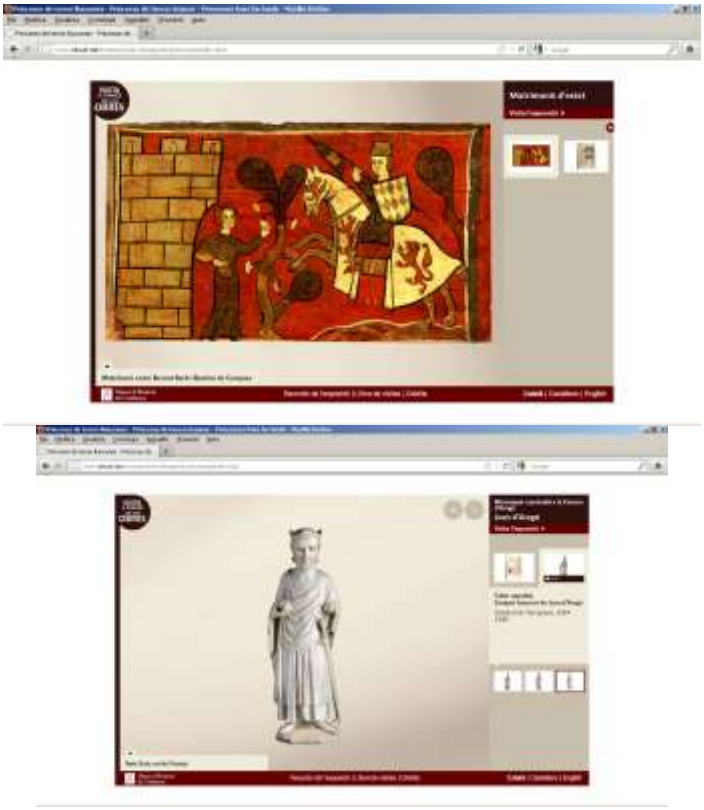
Accessibility standards are only partially respected. Digital resources are protected via SWF.

During the realisation of the project, the staff used cloud computing middleware, like Google documents, Dropbox, Videoconferences.

As regards the management, several strategies has been set up concerning: periodical pack-ip, secutiry, evaluation plan, terms of use, SEO, statistics analysers, dissemination and promotion activities.


Princeses
de terres
llunyanes
Catalunya i Hongria
a l'edat mitjana
Saltar la introducció
Records de l'exposició | Llibre de visites | Crèdits
Català | Castellano | English


Princeses
de terres
llunyanes
Matrimonis d'estat



10.1.7 Museo Galileo. Online didatics. The science tools (Italy)

Some of the most representatives instruments preserved in Museo Galileo may be explored through several web applications. Videos, 3d reconstructions, interactive sections and original documents tell their stories and explain how they work.

The project is connected to a permanent exhbition, but it includes richer content.

http://www.museogalileo.it/en/explore/onlinedidactic/scienceinstrumentsseries.html

It is targeted to the general public, schools, university students, children families.

The project was realised by the Education Department and the ICT department, partly in-house, partly in outsourcing.

Most of the content is either in Italian either in English.

Technlogied used: slideshow, 3d interactive reconstruction of instruments

Digital resources (text, video, audio, images, 3d). The user need plug-in to access some content (Flash, Schockwave, Acrobat reader).

Searching techniques: browsing by themes/topics/titles

Accessibility is respected only in part.

Digital resources are protected by watermarking.

The project is hosted in a server in house. The minimum bandwith to distribute digital content is 100 kb/s.

Services provided: educational packages; downloading/printing PDF. Content available also in CD-rom.

As regards management, some strategies have been set up concerning backup, dissemination and promotion.

Museo Galileo is connected to Italian NREN managed and operated by Consortium GARR.

10.1.8 Progetto Corsini (Italy)

The project (http://www.grafica.beniculturali.it/progetto%20corsini/index.htm), coordinated by Istituto nazionale per la grafica, was born from the need to restore the original integrity of the fifty-two volumes containing drawings belonging to the *Corsini* Fund of the *Accademia dei Lincei*. In 1895 they were assigned to the *Gabinetto delle Stampe* and now preserved at the *Istituto Nazionale per la Grafica*. The drawings were partially removed from the volumes and moved into boxes in order to make preserving and arranging easier. This operation caused the loss of the volumes' original unity and the primary objective of this project is to restore the integrity of the volume virtually reconstructed.

It is targeted to university students and researchers.

It is realized partly in-house partly in outsourcing. Content is only provided in Italian.

Technlogies used: pageflip, magnifiers.

Digital resources (text, images, videos) provided in high resolution. The user need plug-in to access some content (Adobe Flash Player).

Searching techniques: browsing by themes/topics/titles

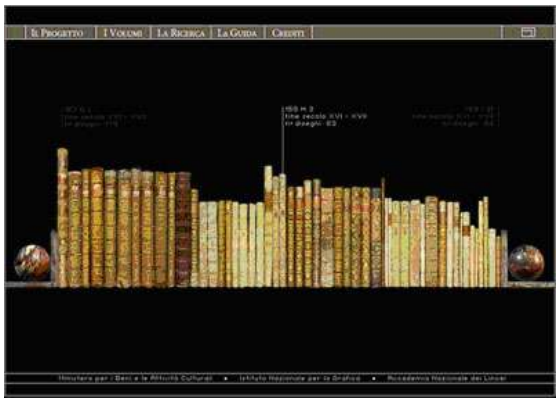
Searching options: keywords and phrase search.

The project does not respect accessibility standards.

Services: downloading/printing PDF.

The project is hosted in a server in-hosting. Storage capacity is 2GB.

As regards management, some strategies have been set up concerning backup, dissemination and promotion, search engine optimization, statistics analyser.



10.1.9 The Virtual Museum of Iraq (Italy)

The Iraq Virtual Museum (IVM; www.virtualmuseumiraq.cnr.it) is a multidisciplinary research project promoted by the Ministry for Foreign Affairs and under the scientific supervision by the Italian NationalResearch Council (CNR). The project, shown online in 2009 after four years by activity, is designed to create a content, rich website, free to the general public – based on the archaeological collection of the one of the most important museums in the world. As known, the Baghdad Museum has been looted, stripping it of a priceless collection of cultural artefacts which are important historical treasures not only for Iraqi people but also for all humanity. The creation of an Innovative Virtual Museum shows the need to explore new digital communication systems to access into an impressive archaeological collection, currently not available yet. The IVM project exploits different new integrated digital technologies for virtual heritage, focusing on the use of photo-modelling, interactive streaming video, laser scanning and 3D digital advanced technologies. The virtual journey, through Eight Thematic Halls set up in chronological order, includes the principal stages of the Near East history, from the emergence of the first State-cities until the Islamic Period. A Chronological Timeline completes the general informative framework. The web site, available in Italian, English and Arabics, can be viewed in approximately in seven hours of navigation.

It is targeted to the general public, researchers, schools, university students, tourists.

It is connected to a real exhibition, compared to which it includes richer content.

The virtual exhbition is also available in a phisical environment, where it can be visited using glove and head-mounted display.

It is realized partly in-house partly in outsourcing. Content is provided in Italian, English, Arabic.

Technlogies used: tagging, augmented reality, image magnifiers, anagliph images, timeline.

Digital resources (text, images, videos, audio, 3D) are partially georeferenced and provided in high resolution.

Some contents are embedded from sharing platforms (Vimeo, Eargear).

The project foresees User Generated Content.

The user need plug-in to access content. Presentation standard is Java Applet.

Searching techniques: browsing by themes/topics/titles

Searching options: multilingual search.

The project respect accessibility standards only in part.

Services: downloading of high resolution images; downloading/printing PDF; creating and saving digital comments. Content also available in CD-Rom.

Digital resouces are protected by digital signature.

The project is hosted in a server in-house.

Cloud computing middleware was used to realise the project, in particular document repositories and streaming download.

As regards management, some strategies have been set up concerning dissemination and promotion.

10.1.10 Elsa's room (Italy)

Digital version of the exhibition held in National Library of Rome and the University Library of Naples in 2006. A rich path, coordinated by the Italian Ministry for Cultural Heritage and Activities, illustrating the life of the Italian writer Elsa Morante through autographs of her novels, books, images, drawings.

(http://www.internetculturale.it/opencms/opencms/it/pagine/mostre/pagina_972.html

It is targeted to the general public, researchers, secondary schools, university students.

It was connected to a temporary exhibition, compared to which it includes the same information.

It is realized partly in-house partly in outsourcing. Content is provided in Italian, English, French, Spanish.

Technlogies used: tagging, image magnifiers.

Digital resources (text, images) not provided in high resolution.

The user need Java Applet to access.

Searching techniques: browsing by themes/topics/titles

The project respect accessibility standards.

The project is hosted in a server in-house. The storage capacity required is 300 megabytes.

As regards management, some strategies have been set up concerning back up, security, terms of use, dissemination and promotion, statistics analyser.

10.1.11 Annonciation virtual thematic museum (France, Greece)

It is a thematic virtual museum on Annunciation in Byzantine iconography, directed by Telecom Bretagne in cooperation with Ormylia Foundation in Greece). This museum is the first implementation of an adaptive exposition paradigm of highly digitised reproductions of artworks. It proposes three levels of investigation (discovery, study and scholarship) and envisages the artworks through five complementart points of view (contextualization, description, aesthetics, physic-chemical investigation and interpretation). This was an explanatory project, wanting to prove some adaptation ideas underlying a visitor-centreed museology.

http://www.annunciation.gr

It is targeted to the general public, researchers, secondary schools, university students, tourists.

It is realized completely partly in-house, partly in outsourcing. Content is provided in Greek.

Technlogies used: Image magnifiers; 3D interactive modules.

Digital resources (text, images, videos, audio, 3D), some of which provided in high resolution. Digital items are not georeferences, but a Google script gives in real time the exact position of the institutions where the artefacts can be found.

The project was produced using a propietary platform.

Searching techniques: browsing by themes/topics/titles

Searching options: thesaurus search.

The project does not respect accessibility standards.

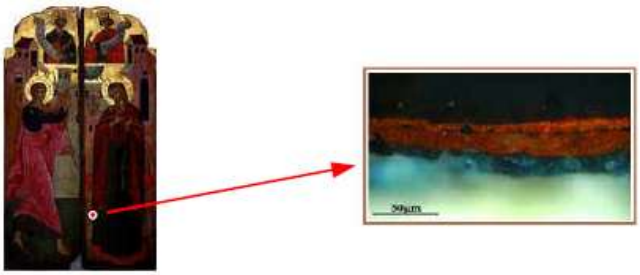
Services: downloading of high resolution images; educational packages, downloading of high resolution images; downloading/printing PDF.

The project is hosted in a server in-house. The storage capacity required is 100 GB.

Supercomputing performances are needed for this project.

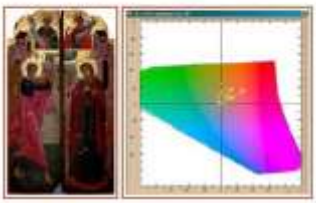
As regards management, some strategies have been set up concerning back up, security, privacy levels, terms of use, statistics analyzes.

Some aspects of the study reading. On up left, the visit is realized on subcategories of the context classifications; the choice concerns, in particular, the support in which selected artwork is realized (wood, wall, tissue, etc.). Down left, the choice concerns a particular narrative cycle in which the artwork belongs (the 12 great feasts) by means of an interactive carrousel. In the right, the visitor investigates some such cycles; the left part of the page gives numerous examples of different iconographic cycles and even videos giving expanded information concerning the place and the function of the theme in the iconographic program of a church.



The point under investigation is localized at the painting surface; the stratigraphy (an image of high resolution as well) allows to precisely study the specificities of the painter, noticeably, the colour layers. The visitor/reader can find here elements that may help her/him to understand the painting mixtures; or issues helping to the identification of the painter and/or the school and/or the period and/or the origin of the artwork, etc.

Images of very high resolution extend the observation abilities in the visible spectre (face of the Mother of God and lips of the Archangel Gabriel, respectively).



Technical images give also important information concerning invisible parts of the artwork. In 5c we can see an aspect of the first underlying sketch of the artwork (where we find traces of an engraving material, used over a pattern, a usual technique that offers a guide for preliminary drawing lines of the painting). On the right image we have a representation of the visible effect of the painter's palette, obtained from measurements over the indicated points.

10.1.12 The wire-drawing bench of prince-elector Augustus of Saxony (France)

Among the collections of the Musée national de la Renaissance, it is a unique and fascinating object: a 4.40m long wire-drawing bench created by Leonhard Danner, adorned with magnificent marquetry decoration. While such objects were dominant features in 16th century goldsmiths' workshops, this bench was designed in 1565 for the Kunstkammer of prince-elector of Saxony, Augustus the Great, in Dresden, Germany. This object has long been a source of questions and conjecture until a recent study shed some light on how it worked and revealed a real masterpiece of technology. Today, this major piece from the German Re1naissance is unveiled in a new exhibit with an interactive multimedia interface.
The result of a multi-disciplinary inquiry, combining the expertise of engineers – through a partnership with the Ecole nationale d'Ingénieurs de Metz (ENIM) –, curators, historians of science and technology, as well as conservators, the way this object, that is both a machine and a work of art, operated can now be appreciated in all its sophistication. Now visitors of the museum can learn about this object through a touch-screen multimedia device specially designed for a wide audience with no specific knowledge about mechanical engineering. Employing new technologies (3D representation, film animation, etc.), the working process is explained and presented in 3D videos produced by the ENIM. Moreover, the exhibit also provides a richly illustrated evocation of the historical and artistic context, and a detailed exploration of the exceptional marquetry decoration. This project was made possible thanks to the "Innovative Cultural Digital Services 2010" programme launched by the Mission for Research and Technology in the French Ministry of Culture and Communication. This innovative multimedia exhibit was developed by Mosquito Web Design Agency. It forms part of the display area's new, clearer layout. Exhibited in the centre of the room, along with the beautifully etched and partly gilded tools that accompanied it, the wire-drawing bench of Augustus the Great is now returned to the public in all its magnitude, where Art and History meet Technology.

http://www.musee-renaissance.fr/bancdorfevre

It is targeted to the general public, schools, university students, tourists, families, disabled people.

It is connected to a permanent exhibition, compared to which it includes the same information level.

It is realized partly in-house partly in outsourcing. Content is provided in French, English, German.

Technlogies used: tagging, augmented reality, image magnifiers, anagliph images, timeline.

Digital resources (text, images, video audio, 3D), provided in high resolution.

The user need plug-in to access content (Flash)

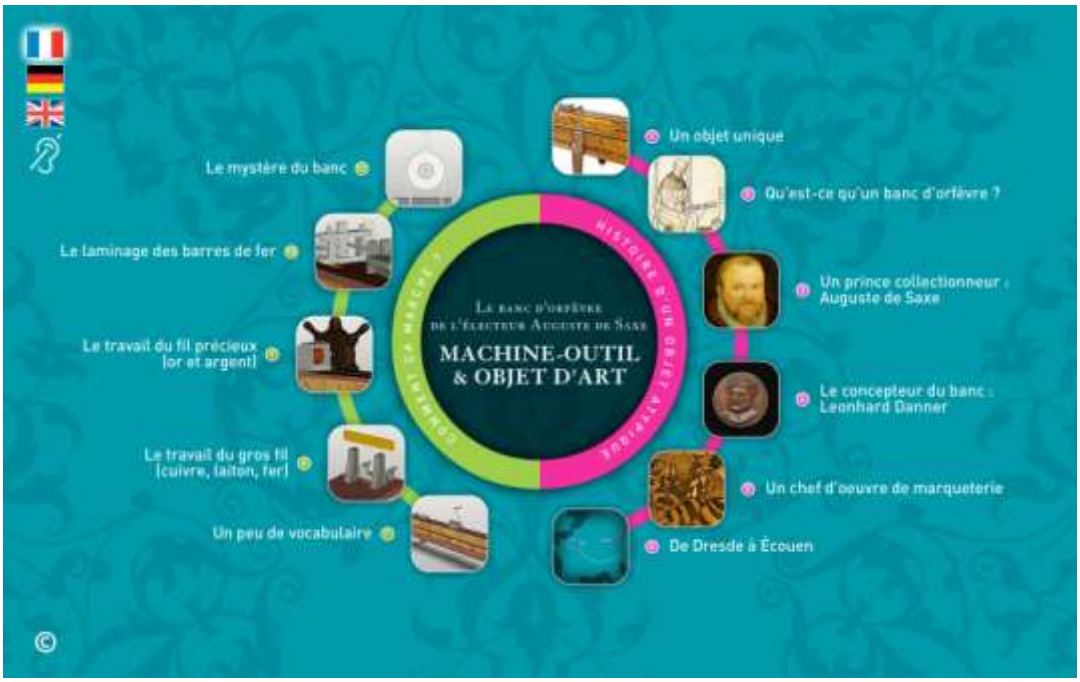
Searching techniques: browsing by themes/topics/titles

The project respect accessibility standards only in part.

Services: educational packages, downloading/printing PDF.

The project is hosted in a server in-hosting.

As regards management, some strategies have been set up concerning securiry, evaluation plan, terms of use, dissemination and promotion, statistics analysers.



10.2 Virtual performances and cooperation projects

Over the last 15 years, museums, libraries and archives had been using the Internet to develop exhibition projects and disseminate their collections. The existing e-Infrastructures let us to think on new exhibitions formats and uses, as the ones that had already been developed on the field of performing arts and that are presented as an example of the new uses and formats that can also be aplied to the cultural heritage sector.

10.2.1 Virtual exhibitions using e-Infrastructures. Museu de Badalona. A sensorial experience

The *Museum of Badalona* is an institution created in 1955 by the Town Council and is administered by a Board of Governors.

The main aim of the Museum is to gather, preserve, study and display those objects from the town which are representative of its different historical and artistic periods. It also carries out the ongoing excavations of the town's archaeological remains and surrounding area, and is in charge of the preservation of pieces coming from dig sites, most of them from Roman times, which belong to old *Baetulo,* present-day Badalona, which was declared *Site of National and Cultural Interest* by the *Generalitat de Catalunya* in the year 1995. The Museum is also responsible for the administration and management of the art funds and historical archives of the town of Badalona.

Today, below street level, the Museum offers a visit to the *Roman Thermae* and *Decumanus*, which is are two of the most important archaeological complexes in Spain dating from Roman times. The Museum's permanent exhibition houses a collection of important objects from Roman times.

The Museum of Badalona belongs to the *Diputación de Barcelona Network of Local Museums* since the year 1990, and to the *Net of Catalonian Archaeological Museums* since

the year 2010. Besides, it will soon become a section of *National Museum* integrated in the Museum of *Catalonian Archaeology*.

A part from the main building, the museum offers the visitor other venues and sites. At short distance from the museum site we find the following Roman sites: *the House of the Dolphins, the Garden of Quintus Licinius and the Water Conduit*. At some distance from the town centre we can visit the remains of a walled Iberian village, *the Turó d'en Boscà* (Boscà's Hill), which is considered the first urban settlement within the terms of Badalona. Finally, *Can Miravitges*, a country mansion house in *the valley of Pomar*, houses a permanent exhibition which describes life and agricultural transformations in the eighteenth century. It also includes some rooms which display the works of painter and last owner of the house, *Antoni Ros i Güell, 1877-1954*.

The sensitive experience project

The Museum of Badalona was built upon *the Baetulo Roman Thermae,* which was discovered by archaeologist and historian *Josep Maria Cuyàs i Tolosa* in 1955, when the area was undergoing urban development. The construction of the Museum's current location finished by the end of 1957 both the underground and ground floor areas had been built. From then on, the Museum opened its doors to the public although the actual totality of the building would not be finished and officially inaugurated until January 30, 1966.

In more recent times, the Museum has gradually incorporated new sites from the archeological site of *Baetulo*, which has made it possible to document what everyday life was like in roman times. Among these sites we can find *the Garden of Quintus Licinius, the House of the Dolphins, the Conduit of Water*s or the monumental complex around the *Decumanus*, located near the *Forum,* on the same site as the *Thermae*.

Until 2004 the Museum has changed his museogaphy project three times, each one approaching to the museological standard of that period. The last project was from 2005 to 2010. In 2005 the *Roman Thermae* reopens with a new project that changed entirely his face. The discuss change focusing now in the daily life of the inhabitants of *Baetulo*, and the museological project change in order to involved the visitor in an atmosphere that gets a sensorial experience. That meant change the lights from an exhibitions work to a "theatral work", and get a look as if the actual architecture was disappeared. Also, in the new project were introduced sounds from the *Beatulo* town.

In 2007, the Museum could open to the public the *Garden of Quintus Licinius*, an archeological site in the basement of a private proprietary building. That project was proposed with the same museological concept as the *Thermae*, and included, for the first time, a virtual reality projection. With a four screen view the public can observe a day of a patrician family in a roman garden. That projection was created mixing a virtual reality of the garden in a 3D architecture and real characters moving and acting as the patrician family.

The next year, the Museu de Badalona open to the public the *Domus of the Dolphins*, a *Domus* or a wealthy Roman villa dating from the late 1st century AD and located in the upper part of the old town of *Baetulo*.

In March 2008 the Domus was opened to the public with the same museological concept. Also, in this case an over screen projection with virtual reality and real characters show the reconstructed roman house and the tasks of the upper class family and the slaves. We could see it in several rooms surrounding the atrium, other rooms around the *peristyle* or garden, and a work area involved in wine production.

Furthermore, the same light and sound effects, and an accurate reconstruction with objects and furniture offer a unique insight into Roman life. Tactile displays for visitors with visual impairments are also available.

Finally, in 2009 the Council bought with funds from the government and the State, the basement of the neighboring properties that were between the roman bath and the archeological site known as Font i Cussó. That permitted the connection at the below street level of 3500 m2.

The last project in Baetulo archeological site was a connection to the thermae, in the museum basements- an archeological piece of 3.000 m2 from the same era as roman remains. In 2009 starts the civil work that culminates at the end of 2011. The museum of Badalona opens to the public with 3500 m2 of roman town. In all these area the visitor can live the experience through all his sense, in order to relive the daily life in a roman city.

As in the other projects, the museography not only provide information, also create an atmosphere that involve the visitors and give to themselves the necessary elements to understand the archeological site without previous knowledge.

The visitors start an itinerary where the different areas of the roman city appear with an involving light, sound and the information panels. In the middle of this itinerary, there is the permanent exhibition dedicated to the roman city of *Baetulo*. In this area a seven meters screen shows the evolution of Roman Empire in our country and the construction and development of *Baetulo.* This projection was created mixing a virtual reality of the town in a 3D architecture and real characters. Also the projection recreates part of the archeological tour that the visitors do in the museum.

Casa dels Dofins. Realitat Virtual Museu de Badalona.
Fotògraf A.Guillen

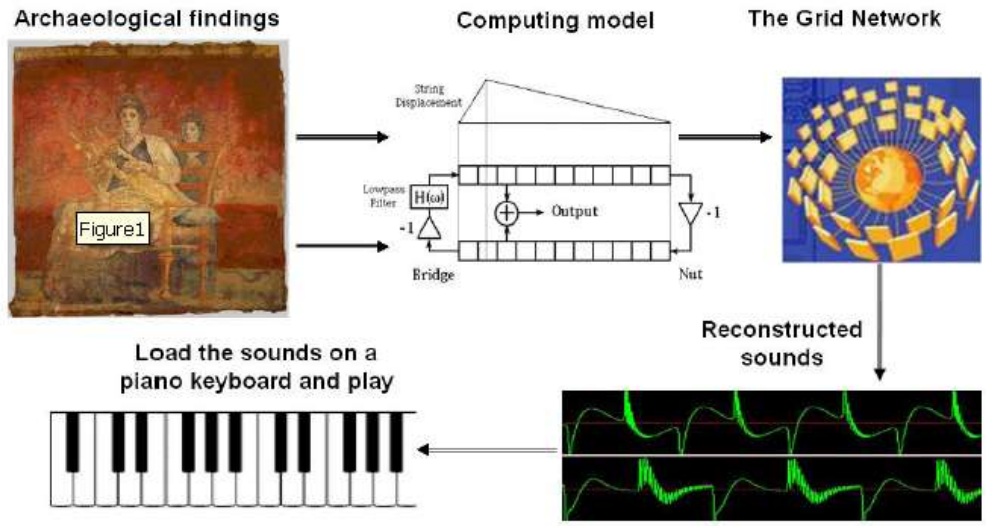
Casa dels Dofins. Realitat Virtual Museu de Badalona.
Fotògraf A.Guillen.

10.2.2 The Astra project

The ASTRA (*Ancient instrument Sound/Timbre Reconstruction Application*) project (http://www.astraproject.org) aims at reconstructing the sound or timbre of ancient instruments using archaeological data as fragments from excavations, written descriptions, pictures, etc.

The technique used is the physical modelling synthesis, a complex digital audio rendering technique which allows modelling the time-domain physics of the instrument.

In other words the basic idea is to recreate a model of the musical instrument and produce the sound by simulating its behaviour as a mechanical system. The application would produce one or more sounds corresponding to different configurations of the instrument (i.e. the different notes).



ASTRA computations are quite demanding in terms of network and computing requirements. The extremely high reliability of the GEANT2 network, its performances in terms of number of institutions connected and thoughput, made the ASTRA project possible.

Here, some technical information:

- 30 s of reconstructed sound need ~ 90 min on a 3.73 Ghz CPU with 2 GB RAM;
- GEANT and EUMEDCONNECT provide the needed network infrastructures to speed up the overall computation time;
- ASTRA can count on more than 500CPU cores and the support of more than 20Grid sites both in the GILDA (a part of EGI) and EUMEDGRID infrastructures.

The project is running since 2006 thanks to the GEANT backbone, allowing researchers, musicians and historians to collaborate, communicate and share experiences on lost instruments and sounds ASTRA brings again to life.

In Dec. 2008, a unique concert was staged using the digitally reconstructed sounds of the Epigonion alongside the Sonora Network Ensemble's performance of the Czech composer Jan Dismas Zelenka's Psalm "Laetatussum".

In Dec. 2009, the sound of the Barbitos, an ancient Greek instrument similar to the double bass, was also reconstructed.

The music was sent across GEANT and TEIN3 networks 9,300 km far from the venue in Stockholm to let dancers from the Arts Exchange of Asia dance in real time in Kuala Lumpur (Malaysia).

The performances may be downloaded: http://www.astraproject.org/download.html

The Lost Sounds Orchestra is the ASTRA project orchestra:

- It is a unique ensemble all made of reconstructed ancient instruments coming from the ASTRA research activities;
- It is the first orchestra in the world composed only by reconstructed instruments;
- It plays sounds being lost in time due to instruments too complex both to build and play;

The ASTRA project is currently finishing modelling other ancient instruments: the *Chitara*, the *Salpinx* and the *Lyra*.

10.2.3 Sonification of volcanic seismograms

Currently, no definitive method to predict volcanic eruptions has either been discovered or implemented;

Data sonification of seismic data aims at discovering a sort of "signature tune" of an imminent eruption:

- By the identification of musical patterns that might indicate the preparation of an eruption; it would then be possible to implement civil protection measures, hours of even days before the event.

Converting seismic data into sound waves, through the sonification process, involves substantial computer processing:

- 1second long seismic sample generates 120 MBof data, filling a CD in just 6seconds and a DVD in 40seconds;

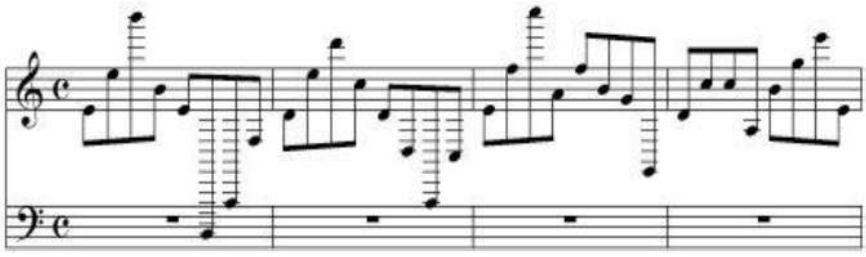
- This amount of information, combined with the complexity of the sonification process, requires dedicated high bandwidth and capacity research networks and advanced Grid infrastructures.

The melodisation of a data set allows to convert into aural signals almost any kind of information.

Starting from a list of **"m"** elements to be sonified the process provides a list of notes chosen among a set of **"n"** notes.

The standard **(Musical Instrument Digital Interface) MIDI** code has been adopted to convert data in notes: "C" note corresponds to integer 60;"C#" note corresponds to integer 61; and so on...

The lowest acceptable MIDI value is **0** and the highest is **127**; the number of possible notes is then 128: Z_m ---$Z_{128.}$



«Melodisation» of Mt. Tungurahua

On the 14th of March 2009 a modern dance company, choreographed by Jason Garcia Ignacio, performed in the US to music generated from seismic data recorded from four different volcanoes belonging to three continents

10.2.4 Education: music and drama

Some remarkable examples are described in this section.

Viola Master Class (Rome-Miami, January 30, 2006)

Viola lesson made by the Maestro Luigi Alberto Bianchi, one of the greatest violists in theworld, in Rome to a student of the New World Symphony remotely connected from Miami (USA).

DVTS technology had been used in order to provide HD transmission quality and low latency between the Auditorium of Caspur in Rome and the Lincoln Theatre in Miami.

In collaboration with New World Symphony
a master class and examination with maestro Luigi Alberto Bianchi between Rome and Miami

GARR Conference Network Humanitatis (Rome, 29-31 October 2007)

GARR_07 Conference focus was about the application of advanced telematics services to traditional knowledge. Innovative technologies have been explored such as the remote presence, virtual reality, collaboration tools, remote teaching and learning and research in a geographical distributed environment. During the conference there was a stage show by University of Rome3 and University of Cassino demonstrating remote interaction between the Teatro Palladium in Rome and the University of Cassino.

UbiQuiLab - Evidence of ubiquity and teleportation (Rome-Cassino, 25-27 May 2007)

As part of the event promoted by Regione Lazio "Open your mind. Lazio. Place of Science ", GARR organized a drama workshop which was held simultaneously in Rome and at the University of Cassino. The real-time interaction allowed the creation of a writing stage simultaneously generated by the participants although physically located in two stages away one from each other.

During GARR Conference 2007 an exhibition performed by three different actors groups located in different sites

Third University of Rome / Vite3.
A live performance with actors in different locations

10.2.5 Music collaboration: LOLA project

The Low Latency (LOLA) project (http://www.conservatorio.trieste.it/artistica/ricerca/progetto-lola-low-latency) has been developed by the Conservatorio di Musica Tartini, Trieste, and GARR, the Italian Research and Education Network. It uses completely re-written audio and video transmission software to reduce latency and jitter, sending pictures and sound in real-time to give the impression to both performers and the audience that all musicians are in the same venue. The aim of the project is to enable greater musical collaboration and save valuable time and cost when bringing together musicians to rehearse and play together.

Achieving this level of performance requires high speed, reliable and very stable networks providing guaranteed bandwidth of up to 500 Mbps. The public Internet cannot deliver this level of quality, introducing significant latency into the process – disastrous for successful performances. These demanding requirements can currently only be met by using research networks, such as GARR in Italy, RedIRIS in Spain and the pan-European GÉANT network, which links the two together.

The 10 minute concert featured Sebastiano Frattini and Laura Agostinelli. The two sites were connected using an end-to-end link that used the Conservatorio Tartini LAN, the Trieste Lightnet Metropolitan Optical Network, the GARR backbone, GÉANT, the Spanish RedIRIS research network backbone, the AnellaCientífica network, managed by the Centre de Supercomputació de Catalunya (CESCA) in Barcelona, and the Gran Teatre del Liceu link to Anella Científica. The performance was routed via Madrid and to provide these links all the research networks involved worked closely together to create a reliable connection to ensure a seamless performance.

The combination of advanced software and high speed research networks provides the perfect platform to allow those separated by distance to work together. In this case LOLA helps musicians collaborate effectively, meeting a pressing need, while demonstrating the potential to be extended to many other applications and areas.

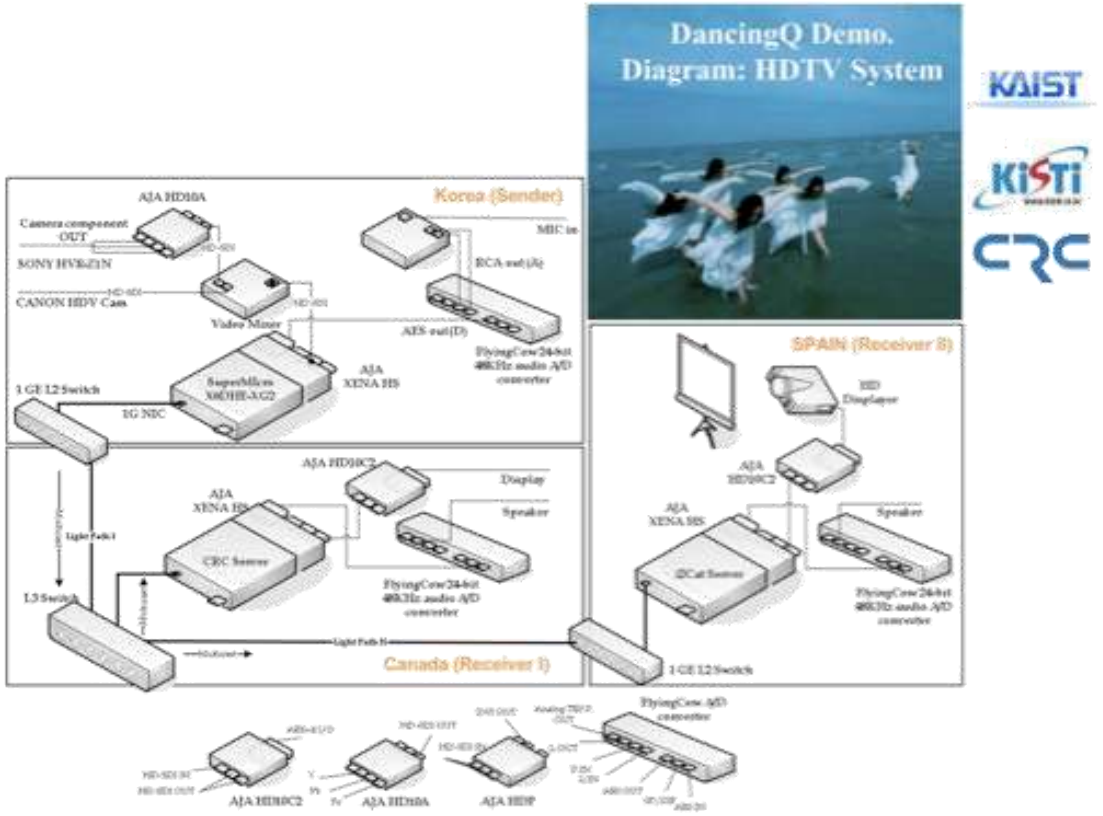
The technology behind LOLA has applications far beyond music, and is already being used at Stanford University in the US as part of studies into human perceptions of latency. Other performing arts which can benefit from real-time collaboration, such as dance and theatre, can also use the software. In the field of medicine, LOLA could enable surgery to be carried out remotely in real-time by experts hundreds of miles away as well as enabling the teaching of new techniques across Europe.

10.2.6 DancingQ 2006

Was the first live transoceanic (Korea-Montreal-Barcelona) transmission of uncompressed HD-SDI (Digital Cinema format) over IP networks using a required bandwidth of around 1 Gbps only available in research networks. The system transmission was based on UltraGrid (http://csperkins.org/research/ultragrid/) a low latency high quality audio and video transmission over IP.

The audio and video format used were:

- Audio: uncompressed PCM at 48.000 Hz and 16 bits per sample
- Video: uncompressed 1920x1080 pixels in a color coding of YUV 4:2:2 (Digital Cinema Format)

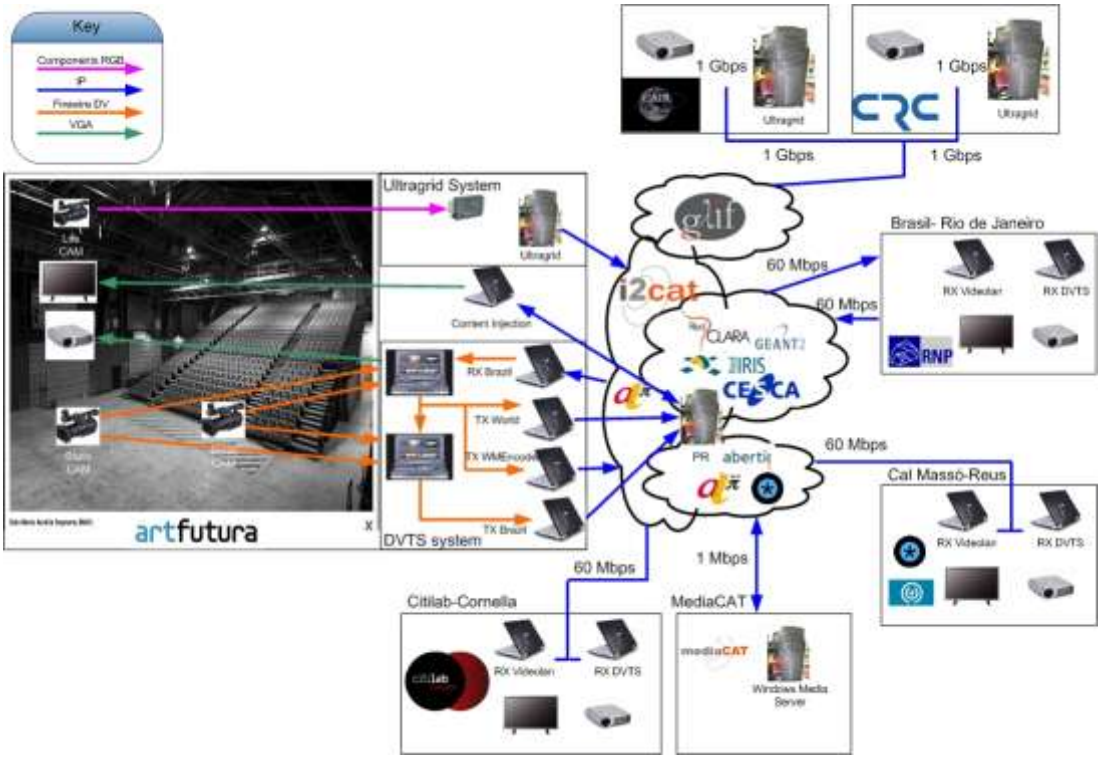


During the performance a traditional Korean Dance was transmitted simultaneously to Canada and Spain.

10.2.7 Art Futura 2007

During the Digital Cultural festival Art Futura in 2007, i2CAT participate in collaboration, between others with the Catalan Cultural Ring, CRC (Canada) RNP (Brazil), in a distributed Cultural event where some the events, speeches and performance where distributed along the globe by using heterogeneous technologies according to the individual capabilities of each collaborator.

It was the first time we combined several technologies (Ultragrid, DVTS, Windows Media Server…) and research and commercial networks in order to democratize the technology reaching as much users as possible.



In the picture above you can see the heterogeneity of the network, having:

- Research Networks with high capacity (GLIF, Red Iris, Red Clara, GEANT and RNP) with granted bandwidths between 60 Mbps to 1 Gbps
- Commercial Networks (Abertis and Alpi telecom), giving connections from 1 Mbps to 60 Mbps

During the event we had as special guest Gilberto Gil, in those days Minister of Culture of Brazil (http://www.youtube.com/watch?v=SoKgV9u75lc), and we created a distributed “party” between Brazil and Barcelona where a Video DJ and a DJ located in Barcelona where creating music and images (coming from Brazil and from Barcelona) with very good results.

10.2.8 DIBA 2009

In 2009, i2CAT in collaboration with Apuntolapospo, OVIDE, the University Pompeu Fabra and the Gran Teatre del Liceu, performs the first 3D 2K live transmission following the Digital Cinema Initiative (DCI).

Within the framework of the fifth edition of the DiBa Festival, Apuntolapospo in collaboration with Ovide BS and i2CAT, between others, carried out a pioneering experience broadcasting over the Internet 2 a trial of 3D images of the Opera *Fidelio* in a production of the Metropolitan Opera House in New York premiered last night at the Teatre del Liceu of

Barcelona. It is a pioneering event, unique in the world as it has been the first retransmission live, with 3D technology, and film quality 2 k x 2.

In addition to stereoscopic monitoring and compression to JPEG 2000 live, the team converted the signals into IP to send over the network via the Internet 2 (Broadband provided by the Fundación i2CAT) directly to the Auditorium of the Campus of the communication of the University Pompeu Fabra, enabled for stereoscopic projection by Kelonik. Already in the room, the information was unpacked from IP to convert them into JPEG dual standard 2000, discretizing the 6 audio channels to be able to project 3D work with film quality.

The challenge of this experience has been to get a HD transmission overcoming the strict standards of the film world JIU. Ovide BS was in charge of precision of all the equipment settings for retransmission in 3D it is necessary to pairs of identical equipment. Among the used equipment highlights several couples Thomson LDK Studio camera 8000, a couple of mini HD cameras ICONIX and twelve optical Canon Confederacy. Monitoring has been carried out with monitors of Grado1 adjusting them in pairs according to the incoming signals will avoid subsequent distortions in generating 3D signal.

Sergi Maudet, the team of Ovide BS, It has also highlighted the need to adapt a mixer Grass "to make the entry of the different signals of the pairs of cameras viable since the market does not yet exist a mixer to meet this need".

This pioneering experience in the world has been framed within the Techroom organized by DiBa and Apuntolapospo, and he has counted with the participation of Montse Martí (Director of the DiBa), José María Aragonés (Apuntolapospo Technical Director), Lluis M. Güell (filmmaker), Sergi Maudet (Ovide B.S. Director), Artur Serra (Director of the Fundación i2CAT), as well as Joan Francesc Marco (Director-general of the Gran Teatre del Liceu).

10.2.9 TEIN3 Application Workshop: Cultural Heritage of Performing Arts over Future Internet

This event was held between the Korea Advanced Institute of Science and Technology, Daejeon, Republic of Korea and i2CAT-Citilab, Barcelona on 20th and 21th of October in 2010. It was mainly focused on the cultural application over broadband networks, cultural exchanges among countries, and technical issues on advanced networking. The event was divided in two parts:

- A series of speeches where every topic was deeply discussed in the speech sessions and global cultural round tables;
- An artistic performance with a welcoming performance that not only show genuine Korean traditional music, but also networked performance linked to Spain, which was a typical instance of performing arts over future internet.

The workshop was based on the actual situation where mutual exchange of global culture occurs frequently, in various ways. One of the most efficient and effective way to achieve sound collaboration is using computer network. However, all tasks of collaboration cannot be done online, especially at the initial stage of the collaboration, for example. Socializing party members or establishing community is essential part of the whole project. This consortium, which is interested in building cultural exchange linkage over the world, tries to hold workshop on cultural heritage over future internet. And the workshop will be the first step of that goal. Beginning with the workshop, this consortium will make consistent effort to expand creativity of performing arts and derive cultural commonality from diverse activity. This workshop contributed to future internet by creating and operating new applications regarding

human culture.

The objectives of the workshop were:

- To establish a global collaborative structure for culture and arts interchange;
- To perform collaborative arts based on future internet such as TEIN3 and its associated services;
- To initiate progress of network technology and related service, based on real users requirements and necessities;
- To demonstrate application based on high speed network and to contribute in the standardization of performing arts over internet;
- To initiate a persistent international community, combining technicians and artists;
- To bring closer traditional performing arts, as Flamenco and Pansori among others, to the Cultural heritage environment, and remark its importance in this field;
- To enhance the traditional cultural content by sharing experiences between countries via new technologies and infrastructures as TEIN3, improving collaboration and understanding between them;
- To establish a first approximation protocol (social and technical), about how to carry out this kind of distributed events;
- To initiate a new research in user's perception in this new kind of performance over high speed and low latency networks.

The technical scenario (shown in the picture below), was designed to created a fully interactive scenario with different players could created a Flamenco-Pansori fusion in Real Time.

Thanks to the workshop and the event, it was possible to understand both cultures and find the musical synergies between Flamenco and Pansori rhythms, and create a unique music composition. Results can be found at http://citilab.eu/en/node/3973.

Furthermore, by using Chroma Key techniques, it was possible to create the illusion to put both players distributed over more than 9.700 km, virtually in the same scenario.

In order to have the final result completely in sync recorded and mixed in Barcelona, we had to send the audio and video created in Barcelona and get it back in order to add the network delay as shown in the next figure.

Technology and passion for music made it possible to share a magic moment of discovery between two musical traditions that were not known, the Mediterranean rhythm of flamenco roots and pansori (the traditional Korean music).

Pansori singer sang and Flamenco players played the rhythm, creating a great harmony through the gigabit-per-second connections.

In conclusion, we can remark that the demonstration of the networked performance, directly suggested the possibility of cultural application over future Internet by establishing strong bonds among artists, engineers, scholars, and even the public.

10.2.10 Anella Cultural

The Anella Cultural is an innovation project that aims to intensify the use of the advanced Internet to generate cultural productions and exchanges and to contribute to the innovation of formats. It is a project that explores how technology can help improve the realization of the traditional aims of cultural community. It constitutes a pioneering proposal in the field of research, innovation and development (R+I+D), as it is the first time that it is based on cultural activities.

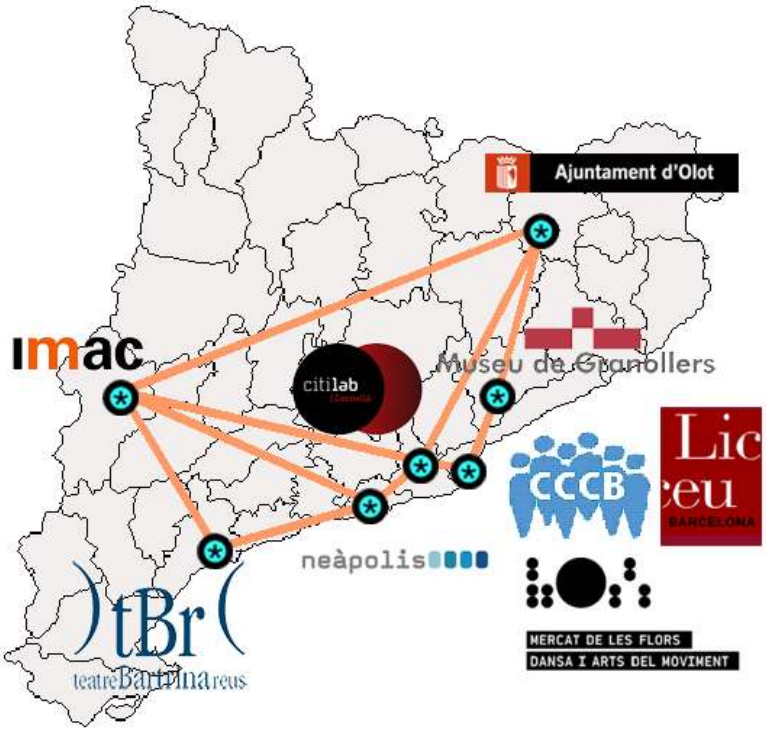
The project is an initiative of the i2cat Foundation, the Centre for Contemporary Culture of Barcelona and the Transversal Network of Municipalities, with the support of the Generalitat de Catalunya (Departament de Cultura and Secretaria de Telecomunicacions i Societat de la Informació), and the Institut de Cultura of Barcelona.

The project consists in the development of a digital cultural network -Anella Cultural- which, with the intensive use of the new possibilities of second generation Internet, activates the exchange of contents and the co-production of events *on-line* and promotes research activities about new uses of the net in the cultural production field, while improving their diffusion and offering to creators a new platform to experiment with applications in digital art.

The implementation of the optical fibre network in the region will be developed in two phases. The initial phase connected the CCCB and four cultural centres of the Xarxa Transversal (Lleida, Granollers, Olot and Reus). In its second phase, the fibres will also connect the rest of the cultural centres of Transversal (Manresa, Figueres, Tortosa, Sant Cugat del Vallès, Mataró, Vilanova i la Geltrú, Girona, Vic, la Seu d'Urgell and Perpinyà). Eventually, the net will be an exchange tool available to every cultural centre of Catalunya.

Additionally, the very nature of the project offers to each of the centres new tools to channel the collaborations with other groups, creators and international institutions beyond any geographical limits.

The Anella Cultural is a project initiated in 2006-2007 for the Catalan country that is part of the strategy of the Generalitat de Catalunya to connect all the territory through optical fibre net for different uses (such as sanitary, industrial, educational...) in order to make all services available to the entire population, especially the people from those places far from the capital. The cultural use, sometimes spectacular, of new technologies will be a great sample that will decisively promote its application in other fields.



Culture and Innovation

During decades, Science and Technological community developed their own research networks in support of ther work. Today, advanced science is a global endeavour done through these networks.

Anella Cultural aims to do the same between the Arts and Culture communities, the creative communities around the world. This is the meaning of the Cultural Ring: building the first dedicated advance network for the creative community worldwide.

Even though creativity and adaptability are the main elements of the cultural field, artistic creation, culture and especially their diffusion have not fully adopted the possibilities offered by technological innovations. The reason for this is the continuous lack of economic resources, which has impeded culture to exploit the high technology equipments necessary to pursue this innovation.

The Anella Cultural project hopes to stimulate the spirit of innovation among the different agents - creators, cultural managers and local politicians - who use this net in their day-by-day tasks. This represents a big novelty in the field of public culture: for the first time, a project of research, innovation and development (R+I+D) uses cultural activities as a row material. This will open several lines of development, as we will see below.

The main aim of the Anella Cultural project is the exchange of cultural contents. But its innovative components will open up new contexts, new formats and new uses that will very soon even modify the contents themselves. The speed, the quality and the multidirectionality of the transmission of contents allows us to think of the activities outside of their original location and, therefore, they become more accessible, more affordable and more socially cost-effective.

A first look at the uses of the Anella Cultural helps us establish the following developing lines:

Live. Bi-directional live transmission of activities (lectures, debates, performances, etc.) from one centre to other cultural centres. This possibility requires the sender to be enabled to produce the audiovisual signal and to send it through the network, and the receiver to have the necessary technological media to project it and visualize it on a large screen. Some examples of this could be:

The broadcast of lectures, courses and other events with the possibility of the participation of the public from any of the centres. The interactivity of the connection permits a wide typology of live courses: dance master classes, drama classes, participative reading of stories, etc.

Round tables and debates with participation of speakers from any city in the net or, in connection with the scientific ring, from any connected university.

Festivals that could be broadcasted partially or entirely. The opening act will give a new dimension to the festival HIPNÒTIK, held at the CCCB, as it will include the participation of artists from Granollers, Reus and Lleida who will interact with the activities being celebrated at the CCCB. In this way people will experiment an artistic exchange, while side-venues of the festival will be established in these cities. Later on, ANIMAC in Lleida, PNRM in Olot or Now in Barcelona can represent new events that will make possible the participation from any point of the net.

Broadcasting of performances. Any centre connected can send, after its digitisation, the activity to the other centres of the net, which can then project it on a large screen. The pioneering initiative of the Gran Teatre del Liceu, which broadcasts in live some of its opera performances to universities through the Anella Científica (scientific ring) in a project called Opera Oberta, will increase its magnitude through its participation in the Anella Cultural.

Files on demand. The development of this last line opens up the possibility of making all the materials and multimedia files accessible to the public. This option requires the different centres to have their own server with their own multimedia files. The centres will have to make these files accessible through the site of Transveral and will also have to provide public points of access to them.

Anilla Cultural is currently working on establishing the archival protocols to make the multimedia contents accessible and, at the same time, to guarantee their safety and permanence.

Interaction/exchange/research. The daily use of the audiovisual technology and of the connection from wide band will make possible new formulations of conventional activities. These new formats could represent:

Net projects to visualize exhibitions. Audiovisual formats are more and more common in the design of the exhibitions. Therefore, it is possible to think of an exhibition in the net made of contents issued from different points and viewed from a single point.

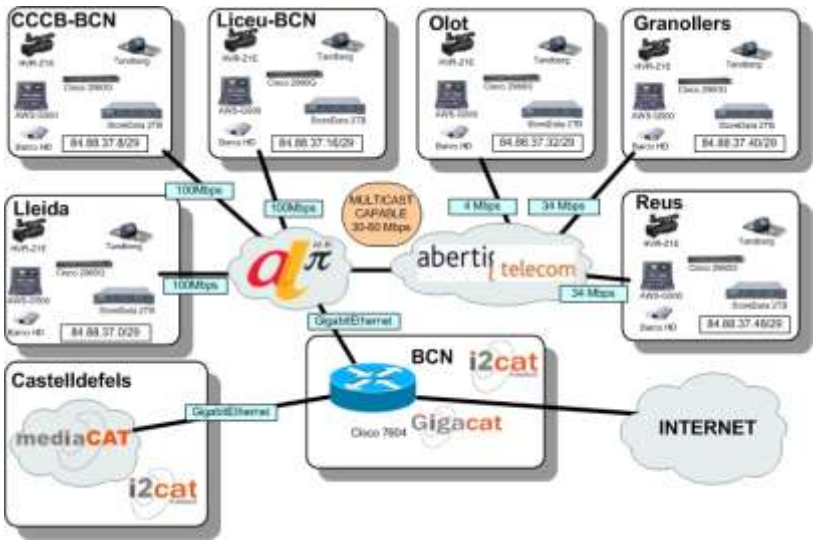
Audiovisual programs laboratory. The participation in the Anella Cultural imposes as a common practice the digitisation of most of the activities generated by the cultural centres. Through the creation of audiovisual departments or the agreement with local producers, the equipments connected will be the optimal place to collaborate with universities and other educational centres, to accommodate students in practices and to carry out research and innovation proposals that need a laboratory for experimentation.

Creative multimedia applications of original projects. The contemporary artistic creation that uses informatics and multimedia supports could use the resources offered by the net project and its advanced technology. This is an area of special interest for centres such as the Mercat de les Flors, which has since the beginning explored new ways of exchange with other similar centres.

Creation and application of new tools and formats for publications. Communication in the net is fundamentally audiovisual. This audiovisual format makes possible to redesign the classic education and communicative tools through specific TV channels, videografic capsules, or multimedia publications. The combined use of several technologies - mobile phones, IP TVs, connections in streaming - open an unlimited range of possibilities in the research of new formats for the interactive transmission of information.

Specifically, the functioning of the Anella Cultural unfolds itself in three aspects:

- **Connectivity:** Facilitated by the net of the operators of telecommunications Al-Pi Telecomunicacions, Abertis Telecom and the experimental net of Fundació i2Cat, an optimum flow of 30-100 Mbps is guaranteed. In the cases of Lleida and the CCCB, the infrastructure of optical fibre achieving a capacity of 100Mbps is used, while the other centres use radio electrical infrastructure - in Reus and Granollers, they have a capacity of 34 Mbps and, in Olot, the capacity is 4 Mbps. The Fundació i2Cat, after examining the real state of the connections in the cultural centres, has got the connection for all centres through agreements with the telecommunications operators. Likewise, it administers and manages the use of the central unit of connection. The centres of the net have computer equipment that allows coding and decoding of the signal and the transmission and reception of the information.



Connectivity Chart – Anella Cultural

All centres are equipped with devices to record, project, edit and store the activities (video cameras, projectors, screens, table of edition, videoconference, etc). Thanks to the experience of more than ten years of the Departament d'Audiovisuals of the CCCB, the material is of good quality but of simple use and easily portable, so as to adapt itself to the multiplicity of contents that is expected to transmit through the Anella Cultural. Likewise, a series of protocols, catalogs of good practices, or training have been established in order to ensure the quality of the recording. By incorporating the activities transmitted by the Anella Cultural into the cultural programming of each city, we ensure its maximum social exploitation. The Xarxa Transversal, in coordination with several cultural institutions and Catalan Town Councils, has promoted for eight years the distribution of cultural services throughout the Catalan territory. In its turn, the Anella Cultural coordinates and establishes the programming of the contents that can be interesting to the net and makes sure that the transmission flows in all directions.

- **Cultural Ring web portal:** Web portal for the audiovisual content interchange over Internet2. This web portal should naturally turn into a window where the user can follow at any time what is happening in the "Anella Cultural" project. The main topics that the project should cover are: the content storage and off-line user consumption of the cultural content generated in the "Anella Cultural" project, live streaming of any project event, events information spreading as well as the internal project organization between the participants in the "Anella Cultural" through web 2.0 and its associated collaborative tools. The project is focused in the innovation applied to the cultural sector understood through a wide viewpoint, considering the culture as a social good that should be promoted over the network for a wide amount of users. The project born at the same time that the "Anella Cultural" as a digital repository of the audiovisual content generated by cultural programmers on the network. As an important technological innovation point it should be mentioned the implementation of a distributed storage and file system (based on LustreFS) and the development of offline transcoding techniques that will enable the user to save time in the audiovisual content adaptation to the network and its intrinsic characteristics. The "Anella Cultural" web portal mainly contributes to the society with a social benefit, as its main objective is based on the creation of a big archive of these activities carried out through the "Anella Cultural" project. But it also wants to offer an internal organization tool for the events, embedding the different needs involved in this kind of events. Technically, the web portal introduces new storage and automatic content processing methodologies thanks to its audiovisual content transcoding and adaptation capabilities, improved for their consumption through Internet.

10.2.11 ICT in emerging cultural industries

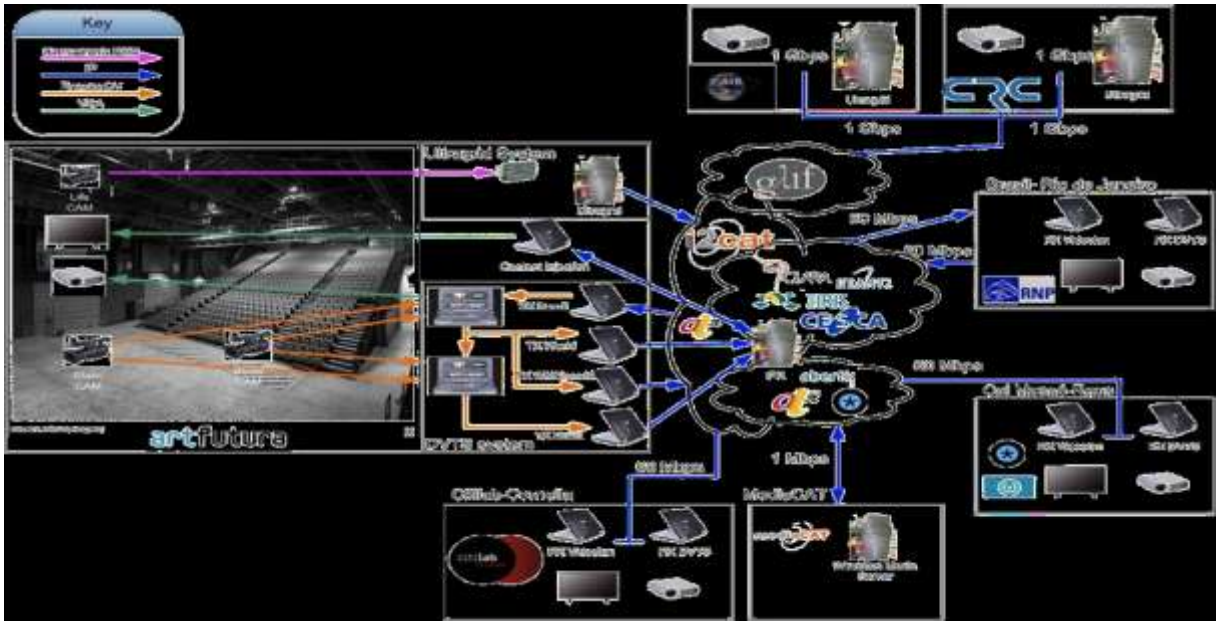
"ICT in emerging cultural industries" is a project that pretends to train and show the possibilities of ICT to the people from the traditional cultural sector (Dance, Theatre, Poetry, etc.) with the objective to generate a new platform of knowledge and experiences in the field of performing arts and e-Culture. The project is focused on enabling a set of technological tools and protocols for the creation of innovative audio-visual events together with the traditional ones, for the cultural sector. The project has introduced to this community concepts as videoconferencing, real time interaction over IP networks, streaming and the related issues for a good communication.

This project, from the innovation point of view, introduces new technological know-how, mainly focused on IP networks and interactive audio-visual environments, to technicians and

artists from the cultural sector (normally with experience in lighting, scenography, audio, etc.). At the same time, project partners have been introduced to the audio-visual production process and the artistic research focused on the new conception of distributed events by using ICT.

In is important to point out the link between all activities of the project with the production of a final event that integrates all new concepts introduced during the project by the e-Learning sessions and the Master Classes. All with the objective to show the viability of this project and its associated necessary elements: conception-production-exhibition.

Main benefits that this project provides, from the industry point of view, are the incorporation of technological interaction tools at any level (between remote artists, between artists and remote audience, between remote audiences, etc.). It is also important to point out the fusion of audio-visual technology with the new possibilities of IP networks in the real time distribution of content, enabling new possibilities in the conception of distributed scenarios and even virtual spaces for content consumption and interaction.



In the social schema, it offers to the public a new way of accessing the culture and a new way of interaction with contents. The introduction of remote environments out of the traditional local scenario, offers new ways of interaction that can be used to bring closer new publics with different interests. It is also important to remark the possibility to increase the number of potential participants able to join the cultural events using streaming services.

11 EC projects

Technologies and new applications that are being developed through other EC projects can integrate these new virtual exhibitions by the use of the e-Infrastructures.

These are some of the ongoing projects that can establish synergies with INDICATE developments and create new projects in the Digital Cultural Heritage sector:

11.1.1 3D-COFORM

The 3D-COFORM project will advance the state-of-the-art in 3D-digitisation and make 3D-documentation an everyday practical choice for digital documentation campaigns in the cultural heritage sector. The project addresses all aspects of 3D-capture, 3D-processing, the semantics of shape, material properties, metadata and provenance, integration with other sources (textual and other media); search, research and dissemination to the public and professional alike. A strong technical research program is complemented by research into practical business aspects: business models for exploitation of 3D assets, workflow planning and execution for mass digitisation, socio-economic impact assessment; and above all the creation of a Virtual Centre of Competence in 3D digitization. The VCC-3D will act as a catalyst in enhancing the sector's capacity for mass digitization of 3D assets - the tangible artefacts of the physical cultural heritage of the world. The 3D-COFORM consortium brings together 19 partners, mainly former core partners in the EPOCH NoE, to form a world class team on 3D-digitisation complemented by an equally prestigious group of Cultural Heritage organizations, with the Victoria and Albert Museum as a full partner and signed-up collaborations from the Louvre, the Florentine Museums authority, the Museum of the Imperial Forums in Rome, World Heritage Sites in Cyprus and the Staatliche Museen zu Berlin. The consortium also contains organizations tasked at a national level with helping museums move in these directions: CNRS-LC2RMF, the research arm of the French National Museums and CultNat the digitization body for cultural and natural heritage funded by the Egyptian Government. The combination in 3D-COFORM of research and take-up activities (VCC-3D) will contribute decisively to reinforce 3D-digitisation capability and to the realisation of the objectives of the European initiative on digital libraries and its flagship project Europeana (European Digital Library).

http://www.3d-coform.eu/

11.1.2 DECIPHER

DECIPHER (Digital Environment for Cultural Interfaces; Promoting Heritage, Education and Research) proposes new solutions to the whole range of narrative construction, knowledge visualisation and display problems, with a high degree of future proofing. It will produce a

step change in the process by combining much richer, event-based, metadata with causal reasoning models. This will result in a reasoning engine, virtual environment and interfaces that can present digital heritage objects as part of a coherent narrative, directly related to individual searches and user contexts. This will allow users to interactively assemble, visualise and explore, not just collections of objects but the knowledge structures that connect and give them meaning.

Digital heritage and semantic web technologies hold out the promise of nearly unlimited access to cultural knowledge. The problem is that cultural meaning does not reside in individual objects, but in the patterns of knowledge and events, belief and thought that link them to each other and to the observer. This is why narrative is so important to the communication of, and meaningful understanding, of culture.

http://www.decipher-research.eu/

11.1.3 CHARISMA

Cultural Heritage Advanced Research Infrastructures: Synergy for a Multidisciplinary Approach to Conservation/Restoration is an EU-funded integrating activity project carried out in the FP7 Capacities Specific Programme "Research Infrastructures". The project provides transnational access to most advanced scientific instrumentations and knowledge allowing scientists, conservators-restorers and curators to enhance their research at the field forefront.

Scientific research significant contributes to the conservation of our heritage. Several methods are used to explore the bulk, microscopic and surface properties of artefacts, including both traditional and advanced analytical techniques. The artworks studied include paintings, sculptures, metal works, ceramics, manuscripts, printed books and archaeological items and others.

In a program that covers joint research, transnational access and networking, the planned challenging activities require a combined effort and commitment of an high-level partnership of twenty-one organizations to provide access to advanced facilities and develop research and applications on artwork materials finalised to the conservation of cultural heritage and favoring the opening of larger perspective to the heritage conservation activities in Europe.

The CHARISMA transnational access (TA) programs, offer European scientists to carry out their experiments utilizing 3 different and complementary groups of facilities (ARCHLAB, MOLAB and FIXLAB) through a service embedded in a multidisciplinary environment involving material science and artwork conservation/restoration.

- **FIXLAB** provides access to large and medium scale European installations, including the beamlines of one synchrotron radiation, one neutron source and two ion-beam analytical facilities;
- **MOLAB** offers access to a portable set of advanced analytical equipment, for in-situ non-invasive measurements on artworks, without any movement of the artefacts from their location and any contact with the surface;
- **ARCHLAB** permits the access to the structured scientific information and analytical data, stored in the archives of the most prestigious European museums and conservation institutions.

The access activities are supported by 3 outreach programs as networking (NA) cooperation

activities, with the intent to achieve a permanent interoperability among the European institutions of the CHARISMA consortium and those external to it. The activity fosters the culture of international cooperation, providing harmonisation of methodologies, sharing knowledge and best practices on conservation projects, adopting progressive standard compatibility, and providing education, training, users' awareness events, technology transfer and dissemination of project results.

3 Joint Research activities (JRA), intend to exploit advanced technologies & techniques as well as most promising applications and integrated solutions, to complement the project scheme providing innovative instrumentations and methodologies tailored to the user's needs.

http://www.charismaproject.eu/

11.1.4 STACHEM

STACHEM (Science and Technology for Archaeology and Cultural Heritage in the Eastern Mediterranean) is a project funded within the European Union Seventh Framework Programme Capacities Specific Programme, Research Infrastructures. STACHEM will contribute to the development of a regional strategic plan for research infrastructures devoted to archaeological sciences and digital heritage in the Eastern Mediterranean.

The Eastern Mediterranean region, including Greece, Cyprus and the Middle East, is probably one of the richest areas of the world as far as archaeological heritage is concerned; and undoubtedly one of the most investigated, however scientific analysis of finds and documentation, preservation and communication services lack a regional strategy. There are excellent research centres in the region (some of which are members of the **STACHEM partnership**) and certain elements of advanced research infrastructure, but coordination and policies are indeed lacking. This has several adverse effects; such as duplication of efforts; lack of interoperability at the data level, and in general missed opportunities for collaboration among research institutions. In addition there is a clear shortage of scientific and technical resources, such as laboratories of applied chemistry and physics for archaeology, multimedia communication centres, digital libraries, etc.. So those analyses and data processing very often have to be carried out far away from the region.

In this context, the Cyprus Institute has launched the **Science and Technology in Archaeology Research Centre** (STARC), which is designed to become a significant scientific and technological resource for the regional archaeology and cultural heritage communities. It is important to ensure that, from its earliest design and planning phase, STARC is adapted to the needs and demands of these communities, and that its development is integrated in European and regional strategies for the build-up of research infrastructures in the relevant fields.

The goal of the STACHEM project is to contribute to a regional strategic plan for research infrastructures devoted to archaeological sciences and digital heritage in the Eastern Mediterranean, and simultaneously to support and complement the design and planning process of STARC, ensuring that it is embedded in the said strategy, closely adapted to the regional needs and integrated in the Euro-Mediterranean environment of archaeological sciences and digital heritage. The STACHEM project has been focusing on the following areas:

- Natural and materials science approaches to the study of archaeological remains and sites;
- Technologies and infrastructure for underwater archaeology;

- Applications of information and communication technology to cultural heritage.

http://starc.cyi.ac.cy/stachem/stachem

11.1.5 V-MUST.NET

V-MusT is a new EU FP7-funded network of excellence that aims to provide the heritage sector with the tools and support to develop virtual museums that are educational, enjoyable, long-lasting and easy to maintain. Virtual Museums (VMs) are personalized, immersive, interactive experiences that enhance our understanding of the world around us. The term 'VM' is a general one that covers various types of digital creations including virtual reality and 3D.

Although the concept of VMs is not new, in Europe, they have yet to be widely implemented. Despite sharing many similar qualities with the cinema or gaming industries, VMs have not yet reached the same level of maturity or ubiquity. There is also a lack of connection between the researchers who are developing new interpretative tools and the industry practitioners who are creating long-term plans to engage audiences and markets. Yet some of the most notable and excellent developments in the VM field have been created in the EU. The V-MusT.net partners believe that Europe has the capacity to become the worldwide leader in the domain of VM.

This leadership can only be achieved if we solve the problem of research fragmentation and share the knowledge required to integrate VMs into the broader museum domain in a sustainable way. We can achieve this by connecting different technological domains, integrating social and cognitive sciences, providing state-of-the-art digital preservation and authoring tools, proving the socio-economic impact of VM and establishing sound methods of quality assessment.

http://www.v-must.net

11.1.6 F-MU.S.EU.M

F-MU.S.EU.M portal provides access to the **"Virtual Museum of the European Roots**", where the visitor can explore the most remarkable items of several European museums together with selected thematic routes, that will guide visitors to the discovery of the European prehistoric culture and heritage. The "Virtual Museum of the European Roots" documents how Europe is founded upon a common ancient matrix, which is consequential to the absence of rigid boundaries, to continuous migrations and interactions and to a plurality of cultural roots and imprints.

Four e-courses, available in four different languages, guide experts and museum professionals in achieving the skills needed for establishing and managing a Virtual Museum.

F-MU.S.EU.M. is based on the results of the MU.S.EU.M. project and its online learning model. It is realized under the Leonardo Da Vinci Programme framework.

The Virtual Museum has been realised through digital environments and 3D images so as to give visibility to a few of the most remarkable artefacts included in the collections of the Museums involved in the project. Thematic routes and touristic-cultural itineraries created on

purpose have been linked to these artefacts. The overall resources valorised by this innovative product, demonstrate the common ancient matrix on which Europe is founded since prehistoric times, guiding visitors to the discovery of our shared European cultural heritage. The various thematic routes available design a unique experience of a friendly, highly accessible visit of the Virtual Museum. Visitors are made free to choose objects, themes, language and criteria on which they want to base their virtual journey.

www.europeanvirtualmuseum.net

11.1.7 ECLAP – eLibrary for performing arts

The richness and value of the European performing arts heritage is unquestionable. Even though these collections are now being digitized and published online, they remain scattered, and coordination is lacking between digital libraries and the performing arts field. However, there is a high demand for access this content. ECLAP, a best practice network, is trying to fill this gap by creating a considerable, and hitherto missing, online archive for all the performing arts in Europe, and providing solutions and tools to help performing arts institutions to enter the Digital Europe by building a network of important European performing arts institutions and archives and publishing content collections on Europeana. ECLAP will bring together Europe's most relevant performing arts contents never before accessible via the Internet, coming from major institutions: performing art material coming from theatre, dance, music, cinema and film, etc. representing performances, lessons, master classes, teaching material, etc., in the forms of videos, audio, documents, images, animations, playlists, annotations, interactive content, etc. available through the ECLAP portal and published on Europeana.

www.eclap.eu/drupal/?q=en-US/node/3727.

12 Conclusions

Considering virtual exhibitions from a general point of view:

- Virtual exhibitions are important tools to represent the identity of the cultural institutions and valorise cultural heritage. They permit to go beyond their physical limits and provide their users with complementary experiences, out of the traditional museum circuit.
- Through virtual exhibitions, cultural content may be disseminated to ensure different degrees of learning, from the simplest to the highly complex. Technology allows cultural institutions to design personalized exhibitions, centred on the single user experience, working on the proximity to the cultural consumer.
- Educational aspects are important criteria to define content, instruments, and services.
- Whenver possible, multilingual virtual exhibitions should be encouraged, in order to reach a large number of users.
- User interaction through hypertext and hypermedia is strategic, and the user's possible involvement as a supplier of content must be taken into consideration. Anyway, cultural institutions are still reluctant to UGC.

- Copyright rules must be respected with regards to individual documents and to the final product, publishing online the copyright regulations and terms of reuse.
- Narration should be lively through effective graphic design and the use of diverse media (text, images, audio, video, 3D, etc.), selected to enrich it.
- Virtual exhibitions and virtual performances can have a significant impact on the touristic and cultural industries and merchandising. By means of these technologies, cultural institutions should attract consumers that are not used nor seduced by traditional exhibitions. Digital born demand this kind of services.
- It' important to design an easy-to-use product and ensure maximum accessibility to information and the services offered, in compliance with existing norms and guidelines.
- Design the exhibition using scalable system architecture, which makes it possible to enrich online content and services over time.
- Technology should be put at the service of contents, and not vice-versa, so that the cultural message can prevail over the use of IT systems as an end in itself.
- Re-usable technology must be used for subsequent projects, and IT languages that allow interoperability.

Considering relationships between virtual exhibitions and e-Infrastructures:

- E-infrastructures offer great opportunities to make virtual exhibitions more performing and attractive, since they offer high capacity services that institutions cannot afford in-house.
- E-Infrastructure providers and cultural institutions are not really aware of the potential of their collaboration. Only little collaborations have been detected.
- It does not exist a pan-european framework of collaboration between e-Infrastructures providers and cultural institutions. Most of current collaborations have arisen from the requirements of non-traditional cultural institutions.
- Infrastructure providers are more concerned with services oriented to preservation of digital content by means of huge repositories than other services more related to technical requirements on virtual exhibitions.
- The provisioning of innovative services from the e-Infrastructures sector can be an inflexion point on the virtual exhibitions area as a high-tech consuming sector.
- e-Infrastructure providers are currently offering what we can consider "traditional" services: computation, storage and connectivity. The cultural sector and, particularly, the virtual exhibitions sector, can be a potential demander of innovative and more complex technologies that can be incorporated into the e-Infrastructure provider portfolio such as 3DRendering on demand, video transcodification, 3D Image reconstruction, and other software modules generally installed in-house, not as software as a service (SaaS).

As regards virtual performances, current analysis show that they are not yet much exploited by cultural institutions, but mostly by universities, academies and research centres for research purposes. Virtual performances normally demand interaction between different actors or actions happening or acting at the same time in different locations, that is, parallel performances in distributed scenarios. Interaction put on the top of the technical requirements the maximum reduction of latency.

Virtual exhibitions and virtual performances represent big challenges for cultural institutions, also in the framework of the European Digital Agenda, the priorities of which include the digital and knowledge divide, digital awareness, the development of high band networks, open data and activities for the realization of smart cities.

Moreover, virtual exhibitions and virtual performances have also a big impact on creative industries, defined at European level, as “activities which have their origin in individual creativity, skill and talent and which have the potential for wealth and job creation through the generation and exploitation of intellectual property”.

We can conclude that there is a high potential in the collaboration between the culture and e-Infrastructure sectors, and this collaboration must be fostered given the impact that will have in the next years the technology here reviewed, especially in the virtual exhibitions area, that appears to be a high-tech consuming sector. Furthermore, e-Infrastructure providers should address their services to specific sectors, given their specific requirements, and offer complex services, a step beyond the current service levels. Finally, one of the major impediments for the explosion of virtual exhibitions as a communication channel between culture institutions and their public is the cost. Efforts should be made to reduce the cost to provide services and hardware dedicated to virtual exhibitions.

Workshops and training sessions should be organised by cultural institutions and e-Infrastructures providers in the near future to present each other experiences and best practises, that could stimulate cooperation actions.

13 Glossary

The following **associated with virtual exhibitions and performances.**

Term	**Synonym or related term**	**Description**
Virtual exhibition	digital exhibitions	A virtual exhibition is a **hypermedia collection** made up of digital items which are: Linked together by a common threat, an inter-disciplinary topic, a concept, an idea, an anniversary, a special event, or a physical person; Displayed in 2D and/or 3D; Occasionally stored in distributed networks; Made accessible through the potential provided by modern technologies, thanks to a system architecture designed to provide user-centred, absorbing experiences; Dynamic products that can offer services and be updated periodically.
Virtual performance		Performing arts actions and experiences

		that use the possibilities of Grid Computing, interactive technologies and virtual spaces.
Virtual theatre		
Virtual thematic route		Within the framework of virtual exhibitions, thematic routes can be used for specific goals as a way to enrich them and to delve into specific topics. They can also be an autonomous and independent product, whose main purpose is no longer the valorisation of collections - which instead is the goal of a virtual or actual exhibition - for example as an itinerary whose geographic or didactic aspects are the most salient characteristics.
Virtual museum		A virtual exhibition is not a "virtual museum". Researchers include in this cathegory: *Real museums websites*: the virtual counterpart of real museums, presenting information about the museums, and their collections and events. *Thematic museums*: group of museums that exhibit real artworks under a thematic argument. *Conceptual museums*: art collections that are possible to visit on the Internet but not in the real world. *Meta-museums*: "museums of museums": Its collections come out from collections of other museums. A meta-museum allows visits through several museums, not necessarily related between them. Metamuseums can offer special virtual exhibitions that are not possible to find in other museums.
Virtual reality		Term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Most current

		virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, and some simulations include additional sensory information.
Augmented reality		Technology consisting of adding a layer of computer-generated virtual reality to the actual reality perceived by the user, whose perception of the world is "augmented" by virtual items that provide additional information on the surrounding environment.
Virtual library	Digital library	Library in which collections are stored in digital formats (as opposed to print, microform, or other media) and accessible by computers. The digital content may be stored locally, or accessed remotely via computer networks. A digital library is a type of information retrieval system.
Digital object	Digital item Digital document Digital resource	Unit of content made up of bytes of data, an identifier, and a series of information on the item itself (metadata). It is accessible to users through a web browser. Examples of digital items include: documents, articles, books, photographs, audio or video files, and 3D models. Digital items have either been digitized or are born digital.

14 Annex: Survey Template

SURVEY ON VIRTUAL EXHIBITIONS

PART ONE: GENERAL INFORMATION

1. Organization:

2. Type of Organization:

3. Country:

4. Website:

5. Date of the survey:

6. Contact person:

7. Email:

8. Telephone:

9. Is your organization working on: (see glossary)

	Online	Physical environment
Virtual exhibitions		
Virtual tours		
Virtual performances		
Thematic routes		
Other (specify)		

10. Which are the topics of your virtual exhibitions/performances?

- □ Science
- □ Archaeology
- □ Architecture
- □ Art history
- □ Technology
- □ History
- □ Literature
- □ Philosophy
- □ Performing arts (music, dance, theatre etc)
- □ Visual arts (design, photography, etc.)
- □ Ethnology/anthropology
- □ Landscape
- □ Other. Specify:

11. Are your virtual projects related to "physical exhibitions/performances"?

	Permanent	Temporary
Always		
Never		
Sometimes		

12. Do you have an annual budget for virtual exhibitions/performances? If yes, how much is it?

- □ Yes
- □ No

13. How much is your global annual budget? (Specify in euros)

14. When did your organization begin to realise this kind of projects?

15. When did you realise the last project?

16. May authorised community of users reach the virtual exhibitions?

- □ Yes
- □ No
- □ No, but I would need it

17. Is your organization connected to a National Research & Education Network (NREN)? (Please find a comprehensive list of existing NREN's at the bottom of this page http://www.terena.org/activities/compendium/)

PART TWO: DESCRIPTION OF A SINGLE PROJECT

GENERAL INFORMATION

1. Name of the project:

2. Year of realization:

3. Short abstract of the project:

4. URL:

5. Specify the category of the project:

	Online	Physical environment
Virtual exhibition		
Virtual tour		
Virtual performance		
Thematic route		
Other (specify)		

6. To which audience is your project targeted?

□ General public

□ Researchers

□ Schools

- □ Primary
- □ Secondary

□ University students

□ Children

□ Tourists

□ Families

□ Disabled people

□ Other. Specify:

7. Is your project connected to a real exhibition/performance?

□ Yes, to a permanent exhibition

□ Yes, to a temporary exhibition/performance

□ No

8. If yes, compared with the real one, your virtual project include:

□ Less content

□ Same information level

□ Richer information

9. If yes, did you make available your virtual project:

□ Before the real exhibition/performance

□ At the same time

□ After the real exhibition/performance

10. Is your project a virtual exhibition in a physical environment (kiosks, etc)?

□ Virtual reality exhibition

Devices used:

- □ 3D polarizing stereoscopic glasses
- □ Glove
- □ Head-mounted display
- □ Other:

Software tools used:

□ Augmented reality exhibition

Display techniques:

- □ Head–mounted displays
- □ Handheld displays
- □ Spatial displays
- □ Tracking technologies used

Software tools used:

□ Mixed reality exhibition

11. Who is responsible for this project?

□ Communication department

□ Marketing department

□ Education department

□ ICT department

□ Exhibitions department

□ Other. Specify:

12. Is this project realized together with other institutions?

□ Yes, at national level

□ Yes, at European level

□ Yes, at international level

□ No

13. If yes, which are the institutions involved?

14. Is this project realised:

□ Completely in-house

□ Completely in outsourcing

□ Partly in-house partly in outsourcing

15. Professionals involved

	Internal	External experts	External institutions	Private companies
Scientific curator				
Technical and organizational secretariat				
Administration				
Digitization				
Information architecture				
Graphic design				
Drafting of multimedia text and resources				
Web editorial office				
Translation				
IT development				
Communications and press office				
Didactic services				
Sponsorship				
Quality control				

CONTENT

16. Is your project multilingual?

- □ In total
- □ In part
- □ No

17. Main language:

18. Other languages:

19. Which types of digital items does your project include?

- □ Text
- □ Images
- □ Audio
- □ Video
- □ 3D
- □ Other. Specify

20. Are your digital contents georeferenced?

- □ All
- □ Partially
- □ No

21. Do you embed contents from sharing platforms?

- □ Youtube
- □ Vimeo
- □ Issuu
- □ Slideshare
- □ Eargear
- □ Other

22. Does your project foresee user generated content? If yes, which are the objectives and how they can proceed?

- □ Yes
- □ No

TECHNICAL INFORMATION

23. Which platform did you use to produce your project?

- □ Simple web pages
- □ Proprietary platform
- □ Omeka
- □ Other (specify)

24. Which technologies did you use to present and valorise your content?

- □ Tagging
- □ Tag clouds
- □ Geotagging
- □ Slideshow
- □ Augmented Reality
- □ Zoom. Image magnifiers
- □ Pageflip
- □ Measurer
- □ Panographies (360° degrees)
- □ Anagliphs images (3D)
- □ Timeline
- □ Other (specify)

25. Which standard media format were used?

Text

- □ PDF
- □ DOC
- □ TXT
- □ RTF
- □ HTML
- □ SGML
- □ DjVu
- □ XML
- □ Other (specify)

Image

- □ JPEG
- □ PNG
- □ BMP
- □ GIF
- □ DJVU
- □ TIFF
- □ Other (specify)

Video

- □ MPEG-2
- □ MPEG-4
- □ MPEG-1
- □ H264
- □ FLV
- □ MOV
- □ RM
- □ SWF (flash movie)

- □ WMV
- □ Other (specify)

Audio

- □ MP3
- □ WAV
- □ FLAC
- □ OGG
- □ AIFF
- □ WMA
- □ REALAUDIO
- □ AU
- □ Other (specify)

26. Which presentation standards did you use?

- □ Flash
- □ CSS
- □ HTML
- □ Java Applet
- □ Others

27. Did you use high resolution videos and images and high quality audio?

- □ Yes
- □ No

28. How the user accesses to the virtual exhibition?

- □ Web browser. Specific installation required
  - □ Plug-in based (specify)
  - □ Active X
  - □ Java Applet
  - □ Other (specify)

- □ Specific program that requires to be installed in your computer
- □ API
- □ Widget

29. Which are the information retrieval features in your project?

Browsing options:

- □ Browsing by themes/topics/titles
- □ Browsing by thumbnail images
- □ Browsing by other visualization techniques (ex. map browser). Specify

Searching options:

- □ Keyword and phrase search

- □ Boolean search (and, or, not)
- □ Truncation (*)
- □ Multilingual search
- □ Thesaurus search (guided-searching through term dictionaries and/or vocabulary control tools)
- □ Linguistic search (search term and linguistic variations)
- □ Natural language search
- □ Related queries (helpful related queries after a user's query, allow expand their search)

30. How do you have designed the user interface?

- □ One single interface
- □ Personalised interfaces
- □ Personalisation features. Specify:

31. Does your project include user interaction features?

- □ Yes
    - □ Create and save digital comments
    - □ Share
    - □ Create personalized exhibitions
    - □ Other. Specify:
- □ No

32. Did you respect accessibility standards (according to W3C and national guidelines)**?**

- □ Completely
- □ No
- □ Only in part

33. Do you use specific techniques to protect your digital resources rights?

- □ Yes
    - □ Watermarking
    - □ Digital signature
    - □ SWF
    - □ Other. Specify:
- □ No

34. What's the strategy about the records which have copyright? Ex. Creative Commons...

SERVICES

35. Which services does your project make available?

- □ Educational packages
- □ Games
- □ Ticketing
- □ E-commerce
- □ Downloading of high resolution images
- □ Feed RSS
- □ Sharing with social networks
- □ Sending to e-mail
- □ Downloading/printing PDF
- □ Podcasting
- □ Other. Specify:

36. Are other distribution supports available?

- □ CD
- □ DVD
- □ Pendrive
- □ Downloadable files

37. Has your project been personalized for mobile devices?

- □ Smartphones
- □ Tablets
- □ PDA

38. Which applications have you developed for mobile devices?

- □ App for iphone
- □ App for Android
- □ App for iPad
- □ Web App
- □ QR Code application

- □ Other. Specify

MANAGEMENT

39. Where is your project hosted?

- □ Server in house
- □ Server in hosting
- □ Cloud
- □ Grid
- □ Other

40. Which storage capacity is required for your project? ***In terms of gigabytes, megabytes, terabytes…***

41. Do you need supercomputing performances for your project?

- □ Yes
- □ No

42. Which is the minimum bandwidth that you need to distribute and give access to your project? ***In terms of gigabits/sec.***

43. Do you use cloud computing middleware to realize your project?

- □ Document repositories
- □ Programs like Google documents
- □ Programs like dropbox
- □ Videoconferences
- □ Streaming on demand
- □ Streaming download
- □ Webcasting
- □ Shared/federated databases

44. Have you set up strategies for your project about these topics?

- □ Back up
- □ Security
- □ Privacy levels
- □ Evaluation plan
- □ Terms of use
- □ Dissemination and promotion
- □ Search Engine Optimisation (SEO)
- □ Statistics analysers (specific on this project)

45. Any other additions, comments, issues missing in this survey?

46. Please, attach some images of your project: