PRODUCTION

RECOMMENDATIONS

DEFINITIONS

# Handbook on virtual exhibitions and virtual performances

version 1.0 (august 2012)

MiBAC MINISTERO PER I BENI E LE ATTIVITÀ CULTURALI

INDICATE International Network for Digital Cultural Heritage e-Infrastructure

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MINISTERO PER I BENI E LE ATTIVITÀ CULTURALI

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International Network
for Digital Cultural
Heritage e-Infrastructure

# Handbook on virtual exhibitions and virtual performances

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# Foreword

[1] http://www.indicateproject.org

INDICATE[1] is an European Union FP7 project which aims to establish a network of common interest made up of experts and researchers in the field of e-infrastructures and digital cultural heritage at Euro Mediterranean level. Through this network, the participants share experience, promote standards and guidelines, seek harmonisation of best practice and policy. One of the objective of this project was to carry out a case study on virtual exhibitions.

This *Handbook on virtual exhibitions and virtual performances*, edited in the framework of the INDICATE project, represents the synthesis of all the results achieved by the project in this field.

It is targeted to cultural heritage professionals (curators, archaeologists, art historians, archivists, librarians, designers and web designers, information scientists, communication managers, etc.) working in the valorisation and dissemination of knowledge also through exhibitions and performances made available online.



This handbook intends to provide a useful conceptual tool for the digital transition process regarding cultural heritage, which must be tackled with the right infrastructure and adequate conceptual, theoretical, organizational, and management tools, along with an awareness of the deep changes in prospects arising out of the chance to separate the governance of culture preservation from the strategies to promote cultural heritage, which strategies are often aimed at local tourism marketing and the exploration of new forms of cultural tourism.

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 guardians and consumers/users of cultural goods 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 the intellectual production and the communication and dissemination of knowledge. Moreover, the e-infrastructure capabilities behind the building of virtual performances open new scenarios, not yet fully explored by cultural institutions.

The drafting of this handbook on online virtual exhibitions represents an additional tool in this scenario. Indeed, in spite of the many difficulties they face, cultural institutions – archives, libraries, museums – are digitizing their cultural contents to improve their access and conservation. However, in order to be valorised, the digitized items must be able to "tell a story" through virtual exhibitions and interactive, hypertextual, and hypermedia thematic routes, which attract the attention of either a generic or more specialized audience by offering informative, didactic, and in-depth material that can capture the interest of an increasingly "digital" audience, while enhancing the visibility of the patrimony of cultural institutions of all kinds.

But, how we arrived at the final editing of this handbook? In 2010, the Italian Ministry of Cultural Heritage, out of the desire to cooperate between archives, libraries and museums for sharing best practices, descriptive norms, instruments, and standards, set up at national level a working group of experts, chaired by ICCU, with the objective of drafting guidelines for online virtual exhibitions, This work, ended in the publication of *Mostre virtuali online: linee guida per la realizzazione (versione 1.0, settembre 2011*[2]*)*, which was proposed as the Italian contribution to the European project INDICATE (International Network for a Digital Cultural Heritage e-Infrastructure).

Starting from this first elaboration, the INDICATE working group on Virtual Exhibitions edited a first deliverable[3], with the objective of reviewing the current situation on virtual exhibitions and virtual performances processes, the state of the art of the technology used and the relation between cultural institutions and e-nfrastructures.

This first document included the results of a survey on virtual exhibitions where all partners were invited to participate as well as those collected during the thematic workshop on virtual exhibitions held in Amman (Jordan) last 11 December 2011[4].

Moreover, the INDICATE work in progress on virtual exhibitions and performances was presented several times in the framework of workshops held at European level (Barcelona, Sibiu, Florence, Stockholm).

[2] http://www.otebac.it/index.php?it/320/mostre-virtuali-online-linee-guida-per-la-realizzazione. This publication was downloaded more than 3500 times from the website of the Italian Technological Observatory for Cultural Heritage and Activities in 18 months.

[3] http://www.indicate-project.org/getFile.php?id=359.

[4] Proceedings: http://www.indicate-project.org/getFile.php?id=371.

Every time, during these workshops there was a big interest from the audience in the topics connected to virtual exhibitions and virtual performances and these workshops gave us the opportunity to collect other good practices in the field.

All these results stimulated the INDICATE working group dealing with virtual exhibitions to edit a handbook including practical tools and recommendations targeted to cultural institutions interested in creating virtual exhibitions and performances.

Therefore, this handbook includes the most relevant results described in the first deliverable, improved and enriched with recommendations, a practical kit and a list of references, which take also into consideration the results achieved by all INDICATE partners at national level and in the framework of other European and international projects.

We underline that the experience gained in other European projects was fundamental to edit this handbook, mainly:

- MINERVA[5] which produced several publications and tools connected with the quality of cultural web applications
- ATHENA[6] and LinkedHeritage[7], which, besides their main role to aggregate cultural content for Europeana, investigated the current standards in digitization in order to increase interoperability within the cultural heritage sectors;
- DC-NET[8], the main aim of which was to develop and to strengthen the coordination of the public research programs among the European countries in the sector of the digital cultural heritage.

[5] http://www.minervaeurope.org

[6] http://www.athenaeurope.org

[7] http://www.linkedheritage.org

[8] http://www.dc-net.org

In presenting the first version of this handbook – which should be considered a working draft to be enriched over time with the addition of new experiences and best practices that could provide inspiration to cultural institutions – we hope that in the near future many experts will contribute to the debate with their comments, suggestions, and proposals, also after the end of the INDICATE project.

*Rossella Caffo*
INDICATE Project Coordinator

# Introduction

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. The goal of this outputs 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 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 important strategic activities 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 the physical exhibition.

The technology of virtual exhibition should be carefully choosen to be useful and accessible for disabled visitors. Attention must be given when interpret an artefact for blind people, selecting

colors (contrast) for background. Different level of details for 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.

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, centered on the single user experience, working on the proximity to the cultural consumer.
- Educational aspects are important criteria to define content, instruments, and services.
- Whenever 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's 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.
- In design the exhibition it's advisable to use scalable system architectures, which make 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 transcoding, 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 for 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 pointing out the high collaboration potential between 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 organized by cultural institutions and e-Infrastructures providers in the near future to present each other experiences and best practices, that could stimulate cooperation actions.



Finally we list two initiatives which will benefit from the results of INDICATE in the field of virtual exhibitions:

- The recent constitution of a working group on virtual exhibitions in the framework of the Linked Heritage project, which will investigate how to improve the quality of metadata in virtual exhibitions projects.
- The Italian project MOVIO[9], an example of public-private partnership (18 months, funded by Fondazione Telecom Italia) which intends to realize a kit to build online virtual exhibitions. Through it, Italian cultural institutions will be able to highlight masterpieces of their collections, as well as less known or "not visible" works of art. The kit will consist of: an open source MMS for the creation of online virtual exhibitions; the equivalent version for mobiles (iPhone, Android for smartphones and iPad); the version of App for popular mobile platforms (iMovio); online tutorials and training in Italian and English language. This kit will put in practice and validate what declared also in the INDICATE guidelines.

[9] http://www.movio.beniculturali.it

# 1 Concepts and definitions

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 document.

## 1.1 Exposition, 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.

## 1.2 Online 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**, however in this document 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 include 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 information 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 case, 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, thay 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.



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**Material exhibitions vs. Virtual exhibitions**
**The point of view of museum curators**

Susan Hazan, Digital Media Curator, Israel Museum, Jerusalem
Shara Wassermann, Exhibition Director, Gallery of Temple University Art Gallery

Although the full sensorial and emotional impact of a "physical" exhibition can never be replaced by a web-based alternative, the added value of a virtual experience derives from:

- Accessibility of rich cultural content directly to your personal computer or the palm of your hand
- Freedom to navigate the content along your chosen path and at your own pace
- Ability to save, store and reuse content for your own goals
- Flexibility of cross-linking one virtual exhibition with another or with other sites through external links
- User agency - a virtual exhibition presents a golden opportunity for user-centered experience: a unique sense of ownership.

### 1.2.1 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.

### 1.2.2 Virtual museum

A virtual exhibition is not a “virtual museum”. A deep debate on the subject was carried on in “Archeologia e calcolatori”, suppl. 1, 2007.

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 – Ioannis Kanellos 2010. They divide virtual museums in the following carhegories:

- *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.

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

### 1.2.3 Digital object

One of the characteristics of virtual exhibitions is the use of digital items. **Digital items** (or **digital objects, digital documents**, **digital 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, images, 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.

**Databases** are organized collections of items. They are the archives that allow them to be stored in a functional fashion.
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 preservation 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 at national and regional level: `http://www.askaboutireland.ie` (Irish national aggregator), `http://carmentis.kmkg-mrah.be/eMuseumPlus` (Federal museum aggregator service, Belgium), `http://collections.culture.fr` (French national aggregator), `http://www.culturaitalia.it` (Italian national aggregator), `http://www.culturalia.ro` (Romanian national aggregator), `http://www.culturegrid.org.uk` (UK national aggregator), `http://www.kulturpool.at/display/kupo/Home` (Austrian national aggregator), `http://www.muziejai.lt/emuziejai/index_en.asp` (Lithuanian museum aggregator). The German and Greek national aggregators are under construction.

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

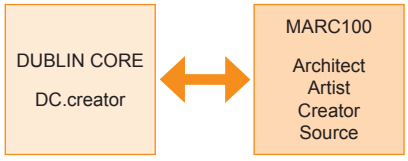
**Metadata,** associated with field labels, comprise information on the digital item, and are commonly broken down into:

- **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 preservation).

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

Metadata can be associated to any digital item or "abstract" resource: HTML documents, digital images, databases, 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.




**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

### 1.2.4 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**

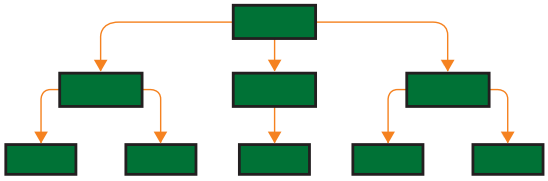
**linear model**, to which, at most, a **hierarchical or tree-like structure** can be superimposed. Text is thus read starting from the first page and ending on the last.

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

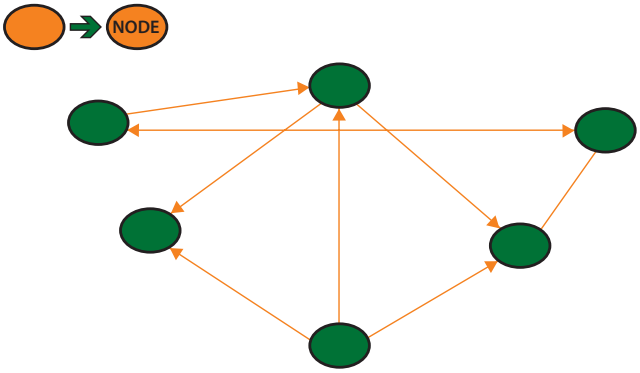
Hypertext allows to browse within the contents of the virtual exhibition.

Here, the information organization models are schematised:

**Hypertext: sequential linear model**

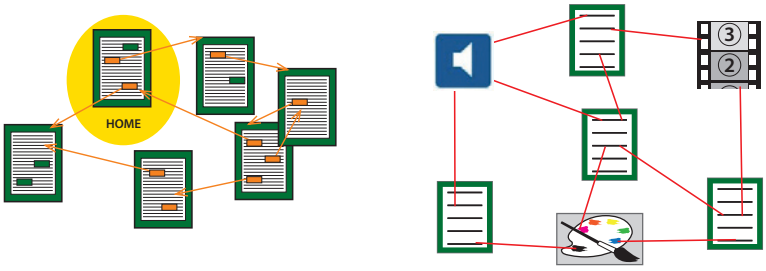


**Hypertext: hierarchical or tree-like structure**




**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** **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. 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

### 1.2.5 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.

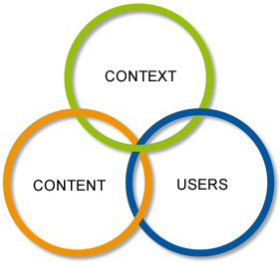
This structure, typical of virtual exhibitions, must be adapted to the website hosting the exhibition, unless the latter has its own autonomous website.

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 contexts – 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

### 1.2.6 Users

In this document, 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 interaction*, First edition (September 2008) below quoted. 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.

- **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 web application must be user-centred, "taking into account the needs of users, ensuring relevance and ease of use through responding to evaluation and feedback*"

* http://www.minervaeurope.org/publications/handbookwebusers.htm (see paragraph 2.4 Users and usage)

- **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 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, cultural institutions need to grant the coordination of internal and external information flows, 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 Ioannis Kanellos and Sister Danilia in 2009 for the implementattion of a thematic virtual museum, the Annunciation museum (`www.annunciation.gr`), which definitely, from our point of view, may be considered a virtual exibition. 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.

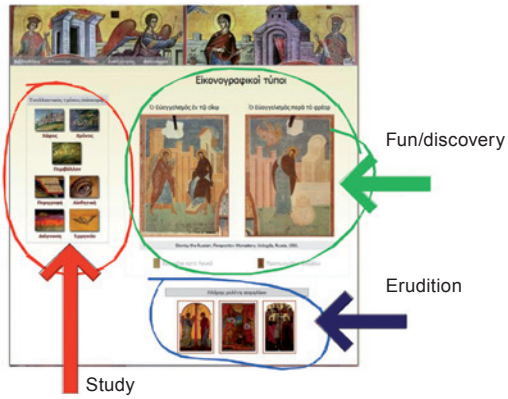
- **The visit "Fun/discovery"**: It is built on the profile of the art amateur. The interruption can take place at any time without affecting the overall intent. The entire collection is organized into sub-collections around a prototype. The visitor enters through the prototype and conducts a visit to 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



- **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)**



**References**

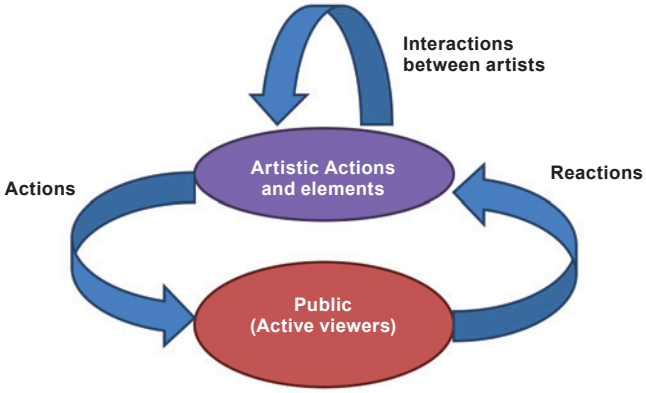
MINERVA. *Handbook on cultural web user interaction*, edited by MINERVA EC Working Group "Quality, Accessibility and Usability", First edition (September 2008), http://www.minervaeurope.org/publications/handbookwebusers.htm.

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 and the paper included in the proceedings of the Workshop on Virtual Exhibitions held in Amman last 11 December 2011, http://www.indicate-project.org/getFile.php?id=371.
We thank prof. Kanellos for having provided both images.

## 1.3 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**.

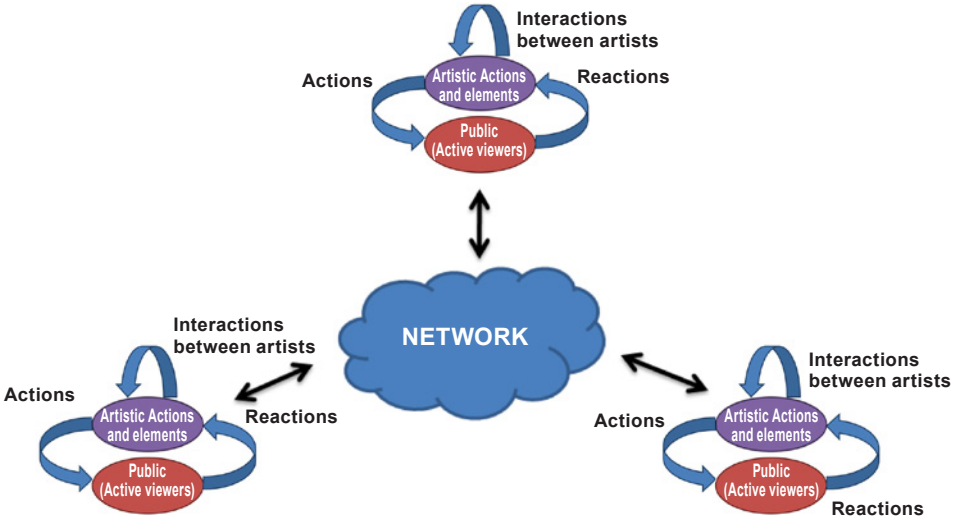
In the virtual performing world the key element is ***the interaction*** between the different actors involved in the show. In general terms, a performing art event can be shown as the diagram below:






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

The aim of 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 different ways:

- End to end (connecting physical spaces)
- Real to virtual world, connecting the real world with the 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-humane 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.

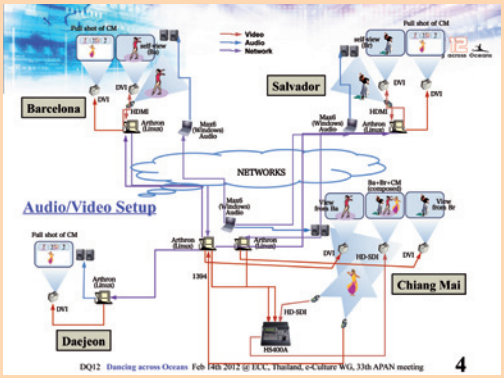
### Virtual performances: use case example

In order to better understand the virtual performances developments and the related e-Infrastructures, a virtual performance example is analysed:

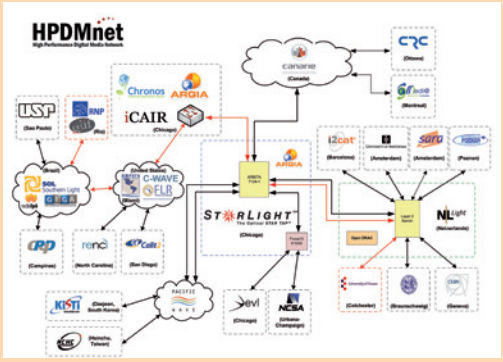
**Dancing across oceans (DQ'12)**
**Three continent networked music and dance performance**
*Feb 14th 2012 @ ECC, Thailand, e-Culture WG, 33th APAN meeting*


During the APAN (Asian Pacific Advanced Network) 2012 congress, there was a Live Music and Dance performance with interactive participation of people and different organizations in three different continents: Chiang Mai (Thailand), Barcelona (Spain), Salvador (Brazil) and Daejeon (Korea). The full shot of the main stage at Chiang Mai was streamed to KISTI (Korea) in real time.

**Performance Infrastructure**
As the performance includes live interaction of dancers and audience in the four venues (endpoints) – Chiang Mai, Barcelona, Salvador and Daejeon – the network infrastructure was setup to support live transmission of HD audio and video streams.



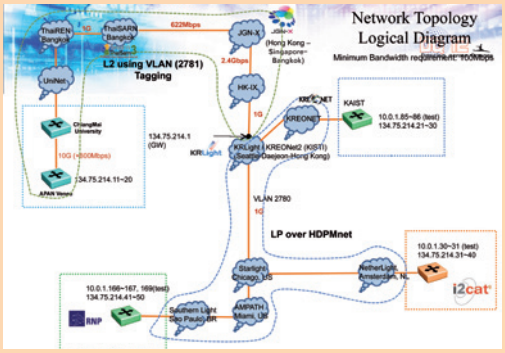

**HPDMnet**
The High Performance Digital Media Network (HPDMnet) is an example of a high-capacity network that allows connecting intercontinental networks and sites for media delivery [www.hpdmnet.net]. It represents an experimental network research initiative that is designing, developing and implementing the world's first international high performance service specifically created for high quality, large-scale digital media, including support for extremely high volume media streams.




**Monitoring**
All endpoints must have in their connections monitoring of their respective network performance and monitoring of the multimedia applications.

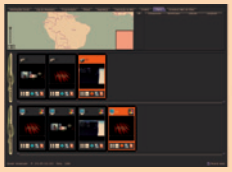
**Network Endpoints**

Barcelona: Konic / i2CAT
Chiang Mai: APAN main auditorium
Salvador: Ivani Lab, LAViD Lab, RNP PoP-BA, RNP PoP-RJ
Daejeon: KISTI

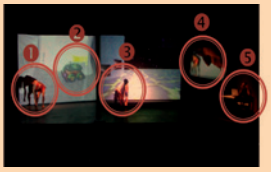



**Software**

Arthron was developed to assist the execution of artistic performances that make use of multimedia representations and real time sharing of real and virtual spaces. In this context, Arthron was used in the domain of research and development in Art and Technology, as well as in artistic presentations like Versus, In ToQue and e- Pormundos Afeto events. Arthron's main functionality is the simple and direct interface, designed for the manipulation of different sources and streams of media (audio and video) simultaneously. This way the user can remotely add, remove and configure the presentation format as well as schedule the streams of media in time and space during an event. Arthron is composed of six main components: Articulator, Encoder, Decoder, Reflector, VideoServer and MapManager. The Articulator is responsible for the remote management of the other components, concentrating a great part of the Arthron functionalities such as stream scheduling (manual or automatic, via the creations of different scenarios), network monitoring and measurement, remote configuration of other modules, access control, automatic generation of a web page for online publication of low definition videos, addition of several video effects, chat for communication between the components and much more. The Encoder is responsible for the capture and encoding (when necessary) of the media source, which can be external (DV or HDV camera, DVD, etc) or internal (a local file). The Decoder's main functionality is to decode and display the media stream in a specific device (monitor, projector, etc). The Reflector is responsible for the replication and redistribution of a media stream over the network. The VideoServer is able to transcode the media streams that will be published online, being able to transcode to the flv, ogg and h264 formats. The MapManager controls and displays the interactive map of the Arthron components. All streams can be generated in geographically distributed locations.



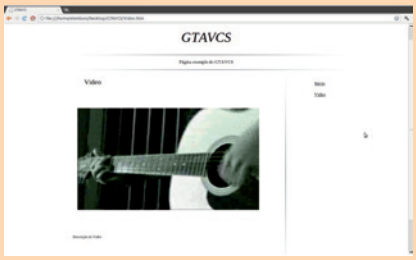
A: Arthron's Articulator main screen




B: Elements of the e-Pormundos Afeto event, on the stage of the Dragão do Mar theater

In B we can see a general overview of the objects in scene during the show. The dancer located inside the Dragão do Mar Theater, in Fortaleza, can be seen in (1). The central screen that receives the video stream of the dancer from Barcelona can be seen in (3). On the left screen (2) is shown the video stream generated by the Robot Galateia, from the Natal-Net laboratory. On the right screen (4) is the video sent to the Internet and several people could watch online, inside the GTMDA website. In (5) we can see the musician located in Fortaleza.

System module where the user can visualize the states (scenarios) and configure events




Automatically generated web page of the transmission of a specific Decoder

Images of the Versus show

**Remote Control for Music to synchronize audio and video from multi-sites**

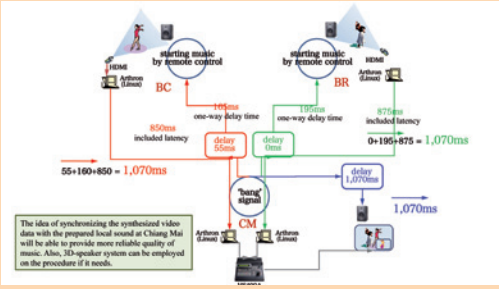
*Step 1: measuring of RTT using OSC (Open Sound Control)*
- Sending a 'bang' signal from CM to Ba/Br
- The arrived 'bang' signal returns to CM immediately
- Measuring the RTT between started 'bang' and returned 'bang' at CM

*Step 2: measuring of delay time including latency through Arthron from each site Ba/Br to CM*
- Shooting the Max6 window with a camera connected to Arthron at Ba/Br
- Sending a 'bang' signal from CM to Ba/Br, at the same time, started the video recording with a webcam connected to Max6 machine at CM
- When a 'bang' signal arrived at Ba/Br, the object in the Max6 window will blink in red

- The video recording at CM will continue until the red blinking on the video from Ba/Br is appeares
- Calculating video frames from the start to red blinking, and then multiply 33 (FPS: 30)
- The actual delay time is video delay time - (OSC RTT/2).

*Step 3: remote control of starting point of music at Ba/Br*

- Adjusting the delay time of each start signal sent to Ba/Br and of start signal for the local music which should be synchronized with receiving video from Ba and Br
- Finally, we can get synchronized audio and video all together between three sites.




**Conclusions**

Nowadays, the mutual exchange of global culture occurs in various ways and very often. One of the most efficient and effective ways of achieving audio-visual collaboration among people is by the use of computer networks, especially if long distances separate them.

Here, there are gestures from four geographically distant locations meeting virtually and they are suddenly transferred to another space. The tools of the digital age allow us to easily communicate with people on the other side of the world in new ways.

# virtual exhibitions

# 2 The production process of a virtual exhibition

The process of production of a virtual exhibition 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 exhibition 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.)

In order to carry out a complex initiative, one must first define the process leading up to it, which comprises a series of actions, each of which represents an activity to be implemented either by individuals or working groups in order to reach a common goal.



In the case of a virtual exhibition, this process includes several phases, which can be summarized as follows:

**Conception -->> Design -->> Creation -->> Testing and publication -->> Communication, and dissemination -->> Updating, maintenance, and preservation**

## 2.1 Conception

A virtual exhibition has a conception phase of varying durations.

### 2.1.1 Brainstorming

The conception phase begins with brainstorming, 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. Any brainstorming session for the conception of a virtual exhibition should be inspired by the essential **5 Ws** of journalism, plus one **H**.


**Who, What, When, Where, Why, and How?**

The application of this rule makes it easier to collect the ideas and organize the results of the brainstorming session in a concise and essential manner, and helps to ensure that important information is not overlooked.

The outcome of the brainstorming session will be the scaffolding around which the virtual exhibition will be built.

Let us try to apply this rule to the conception of a virtual exhibition:

**WHO:** the actors involved
- the target audience (broad audience, schools, niche audience, etc.)
- the curators
- the scientific committee (experts, curators, researchers…)
- the editorial secretariat
- the institutions (museums, archives, libraries, etc.)
- the professionals involved (editors, IT technicians, web designers, multimedia experts, etc.)
- intellectuals and artists (writers, painters, musicians, etc.)
- sponsors
- media partners
- ...

**WHAT:** the contents
- the topic
- the title
- the texts
- the digital resources to be used
- links with non-virtual exhibitions
- ...

**WHEN**: timeframe and deadlines.
- the inauguration date for the virtual exhibition
- the deadlines for the various activities
- links with non-virtual exhibitions
- ...

**WHERE:** the places
- which server
- where to promote the virtual exhibition
- where to stage related non-virtual exhibitions
- ...

**WHY**: the goals
- the reasons behind the decision to stage a virtual exhibitions, its main topics, and certain choices (e.g. a memorial, an anniversary, a non-virtual exhibition, etc.)
- the intended goals
- ...

**HOW:** the modalities
- how will the exhibition be staged from a conceptual point of view?
- with which approach?
- with which style?
- through which technology?
- how will it be promoted?



### 2.1.2 Thematic relations

During the conception phase, it should be kept in mind that the contents of a virtual exhibition [CNR 2007] 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**

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, http://soi.cnr.it/archcalc/images/VM.pdf

## 2.2 From planning to creation

During the planning/design phase, the ideas that emerged during the conception phase are fine-tuned, and their feasibility is assessed. All of 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 digitized
- 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.

### 2.2.1 The project team

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.

*follows* **Project team: activities and skills**

**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 are 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.

*follows* **Project team: activities and skills**

**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.

*follows* **Project team: activities and skills**

**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.

For complex projects, it may be useful to prepare a table that summarizes the professional skills involved:

**EXHIBITION XY – PROJECT TEAM TABLE**

| Activity | In-house staff | External suppliers |
|---|---|---|
| Scientific curator | | |
| Scientific committee | | |
| 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 | | |
| Media partnerships | | |
| Quality control | | |
| External consultants | | |

### 2.2.2 Selection of digital resources

On the basis of the issues identified during the conception phase, the sections of the virtual exhibition are fine-tuned by identifying and detailing – through archival, bibliographical, and web research along with benchmarking analyses – all the digital content that the project team would like to host in the virtual exhibition.

It is thus desirable to create a file in which all information on useful digital resources in each operational phase can be stored.

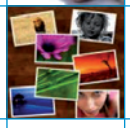
In particular, it will be necessary to note the following information for each resource:

- the section in which it is located
- the type of resource, including, if available, a thumbnail of the image
- a title or brief description
- the institution which owns it
- the state of digitization
- the digital file format
- the intellectual property rights (IPR) associated with it (including waivers to be requested; usage fees, etc.)
- relevant notes.

The state of digitization is a particularly important aspect, especially the following:

- whether the resource is yet to be digitized
- whether the resource is digitized and metadated
- whether the resource is digitized but not yet metadated
- whether the resource is digitized, but quality is too low for viewing
- whether the resource is digitized but with poor metadata.

The table below is to be used as a template for compiling the dossier containing the digital resources and content selected.

| XY EXHIBITION/ROUTE – SELECTION OF DIGITAL RESOURCES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sec.** | **Thumbnail** | **Type** | **Title/ Description** | **Institution** | **Digitiz. status** | **Format** | **IPR** | **Notes** |
| X |  | Text | | | | | | |
| X |  | Image | | | | | | |
| X |   | Image with OCR | | | | | | |
| X |  | Video | | | | | | |
| X |  | Audio | | | | | | |
| X |   | 3D | | | | | | |
| X |  | Database | | | | | | |
| X |  | Animation | | | | | | |
| X |   | Virtual application (e.g. game, etc.) | | | | | | |

### 2.2.3 Definition of the architecture: contents, information, and services

Once the target audience and topics are identified, the structure of the virtual exhibition must be defined by identifying the approach to illustrate the chosen topics and the level of detail with which they will be treated.

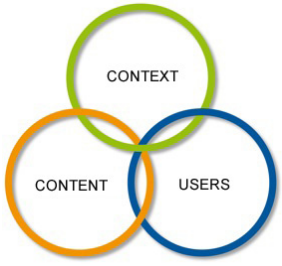
The virtual exhibition must have its own menu, which must be accessible from every one of its pages.

In case one chooses to open the exhibition with a cover, the latter constitutes the first impression visitors will have of the exhibition, and serves as a sort of welcome. Along with the navigation menu, visitors must always find the following:

- identification symbols of the sponsoring institution(s) (name and logo)
- the title of the exhibition, including its subheading
- the event the initiative is part of (e.g. celebration, centenary, etc.)
- a brief description, if warranted (two lines)
- a clearly visible link to the webpage that includes information on the non-virtual exhibition.



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**.




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

#### 2.2.3.1 Content area

The **content area** is the area in which the exhibition's topic is expanded upon. It is made up of several information units.

The individual **sections of the exhibition** comprise the various chronological or thematic segments into which the topic is divided. They are made up of one or more pages, each identifiable by its title. This part is the core of the virtual exhibition, and it contains content organized thanks to hypertextual and hypermedia structures, and expressed through a series of digital items (text, images, video, audio, 3D applications), with a homogeneous style and structure:

- brief descriptive texts
- closer examinations of particular topics
- image galleries

- interviews and narration
- video clips
- animation
- spoken audioclips
- music
- audio guide extracts
- documents (newspaper clippings, eyewitness accounts, manuscripts, etc.)
- maps
- 3D content
- synoptic tables
- captions for the digital objects
- ...

These sections can be linked to an **introduction page** that details the objectives, characteristics, and target audience of the exhibition.

**Apparatuses** provide the scientific references upon which the exhibition rests, and they can be a starting point to delve further into the topic at hand. They are generally targeted at a specialized audience, and include:

- indexes
- thematic bibliographies
- thematic website indexes
- filmographies
- chronologies
- sources
- glossaries (related to topics, places, people, etc.)
- lists of results obtained by accessing databases
- publications.



#### 2.2.3.2 Information area

The **information area** provides news on the virtual exhibition and, separately, on the non-virtual exhibition staged prior to or concurrently with the virtual one. Each element of this area, expressed in summary form, could constitute a separate page.

Information on the **virtual exhibition** should include:

- specifics on the technology used (need for plug-ins, limits on accessibility, existence of alternative versions, etc.)
- credits (authors and contributors, collaborating cultural institutions, sponsors, etc.)
- conditions of use regulating access to the virtual exhibition and the use/re-use of its contents (which do not necessarily coincide with those of the website hosting the exhibition)
- ...

Information on the **non-virtual exhibition** should include:

- the exhibition's location (including geographic coordinates, and information on public transport access)
- the exhibition's dates (including any extensions), opening hours, costs, and discounts
- available services (reservations, online ticketing, guided visits, multimedia visits, catalogues, disabled access, bookshop, cafeteria, coatroom, parking)
- related events (conferences, screenings, external events related to the exhibition, etc.)
- promotional material (brochures, fliers, posters, catalogues, documentary videos) and any other document related to the event (press reviews, interviews, etc.)
- credits (authors and contributors, collaborating cultural institutions, sponsors, etc.).

The section containing information and material on the non-virtual exhibition also constitutes a *de facto* online IT archive of what was produced during the event.

#### 2.2.3.3 Services area

The **services area** allows direct access to the web pages that provide services, which may include:

- education and edutainment services
- services requiring payment
- games
- e-commerce

**Edutainment**

The possibility of using virtual exhibitions and thematic routes 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.

**Games**
Especially in the case of museums that offer edutainment, virtual reality can help to 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.

**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 exhibitions or to portals hosting virtual exhibitions.

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 exhibitions, e-commerce projects may also include e-ticketing procedures.

**References**

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

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.



### 2.2.4 The technology to be used

The choice of technology to be used in staging a virtual exhibition is strictly dependent on the available resources.
The following should always be kept in mind:

- Quality is independent from technology: it is possible to create a quality product even using very simple technology solutions that guarantee the accessibility and usability of content should be preferred
- technologically innovative choices do not necessarily reflect accessibility and usability criteria
- it is better to choose open source and standard technologies, if available, rather than proprietary technologies
- it is better not to adopt innovative technologies without testing their efficacy, intuitiveness, usability, and accessibility
- high-tech solutions are not preferable in and of themselves, but only to the extent they are efficient in conveying content.

Currently, 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



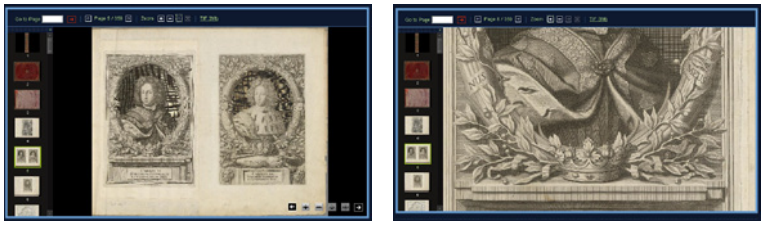
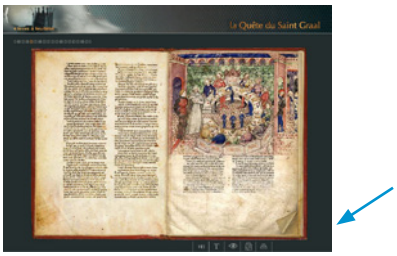


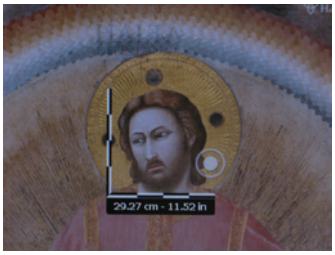
**Image magnifier**

- **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**
(courtesy Alfredo Corrao)

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

2.2.4.1 **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 will 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

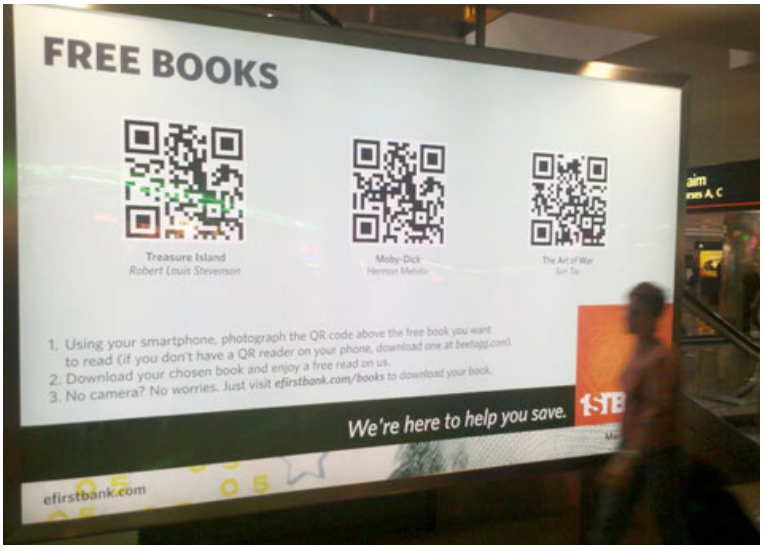
Below we discuss the most widely used devices and applications:

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 smartphones – 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
- **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.

2.2.4.2 **Augmented reality**

Augmented reality (AR) 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.

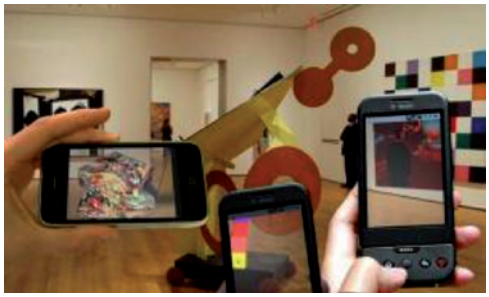
Augmented reality technology also makes it possible to **"read" the landscape**, by visualizing on the display screen of one's mobile device the name of the places in its field of view. In practical terms, the device uses information from its GPS, electronic compass, and accelerometer to calculate which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



**Augmented reality at MoMA**

**References**

Rafal Wojciechowski, Krzysztof Walczak, Martin White, Wojciech Cellary, Building Virtual and Augmented Reality Museum Exhibitions, *Building Virtual and Augmented Reality Museum Exhibitions,* 2004, http://www.tencompetence.upf.edu/trac/worldmap/raw-attachment/milestone/Marco%20Teorico/Building%20Virtual%20and%20Augmented%20Reality%20Museum%20Exhibitions.pdf

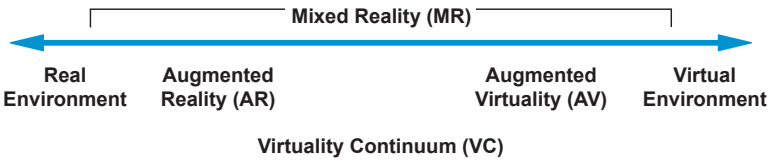
A system that allows museums to build and manage Virtual and Augmented Reality exhibitions based on 3D models of artifacts is presented. Dynamic content creation based on pre-designed visualization templates allows content designers to create virtual exhibitions very efficiently. Virtual Reality exhibitions 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.



### 2.2.4.3 Mixed Reality

According to Wikipedia, 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 virtual reality 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 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.




Source: Milgram P., Kishino F., "A Taxonomy of Mixed Reality Visual Display", IEICE Transactions on In-formation Systems E77-D (12): 1321-1329, 1994; http://web.cs.wpi.edu/~gogo/hive/papers/Milgram_IEICE_1994.pdf

The explosion of the augmented reality 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 Choudary - Charvillat [*et al.*] 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**

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

### 2.2.4.4 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.

We suggest to go indepth into these topics through these ouputs: the GIS guidelines, edited in the framework of the ATHENA project, which had the objective to prove basic information for the description of geographic locations, and the case study on GIS carried on by the INDICATE project which aimed to define the requirements and to investigate how geo-location services could be applied to discover cultural content for education, long-life learning, and creative industry, benefiting of e-infrastructures.

**References**

ATHENA. Digital cultural content: Guidelines for geographic information, edited by ATHENA WP7 Working Group "Development of plug-ins to be integrated within the European Digital Library", 2011. http://www.athenaeurope.org/getFile.php?id=787

INDICATE case study: Geocoded digital cultural content using e-Infrastructures. http://www.indicate-project.eu/index.php?en/97/case-studies

### 2.2.5 The budget

The budget is the key tool for the economic planning of events. It must be put together during the earliest phases of the project, in order to have a clear idea of the financial resources necessary for the activities planned. The budget is fine tuned as cost estimates become available. It is better to seek several cost estimates in order to verify whether they are congruent with the services offered. The budget must be put together by the exhibition's curator, in collaboration with the technical-scientific secretariat and the administrative director. Below is a table illustrating the budgeting process.

**XY EXHIBITION/INTINERARY– BUDGET**

| Before the request for cost estimates | | | | After the request for cost estimates | |
|---|---|---|---|---|---|
| **Expected date for committing expenses** | **Activity** | **Expected amount** | **Sponsor income** | **Supplier** | **Estimated cost (including VAT)** |
| dd/mm/yyyy<br>.....<br>..... | Ex. Digitization | € 00000,00 | XYZ | Supplier name | € 00000,00 |



### 2.2.6 Definition of operating phases and timeline

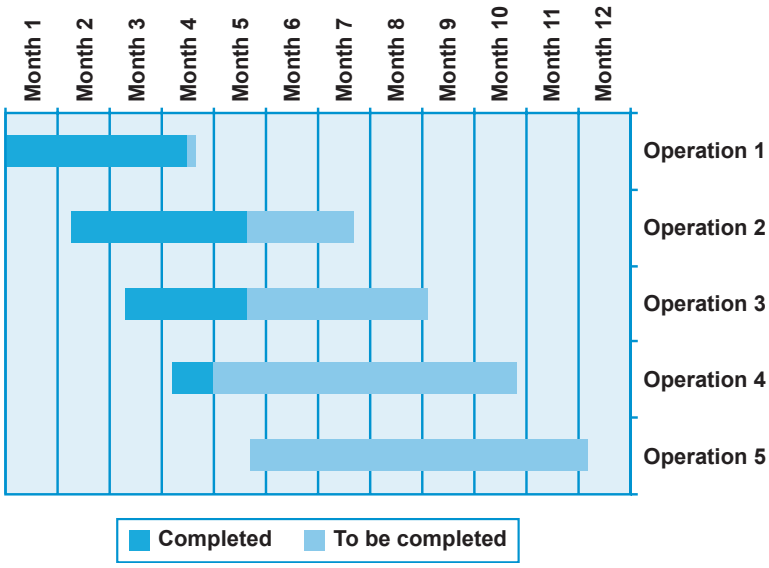
On the basis of the project in question, a list of activities to be carried out must be drafted along with the related workflow; i.e. the organization of procedures and timelines for achieving the goals that have been set.

The main activities to be included in the workflow include:

- Defining the exhibition's architecture
- Defining all copyright issues
- Creating and/or re-writing texts and multi-media resources
- Digitizing and metadating digital objects
- Translations
- Graphic design planning web design
- IT development
- Assembling the virtual exhibition
- Testing
- Publication

- Communication, promotion, and press office
- Maintenance.

In order to provide a visual depiction of the schedule and deadlines, a simple table can be used, or alternatively a Gantt chart, which will help visualize the project's state of advancement.



## 2.3 Testing, publication, communication, and dissemination

### 2.3.1 Testing and publication

Once the virtual exhibition has been put together, it must be put through a series of usability and accessibility tests, which ideally involve a panel of users.
Once the testing phase has been completed, publication can begin.

The folder containing the exhibition must be added to the website structure. Its location – section or page that will host the exhibition - will have been decided during the planning stage. The virtual exhibition's URL must indicate the resource in a unique, unambiguous manner. The overall size of the exhibition must take into account response times and the technology – hardware and internet connection - available to the average user; indeed, if response time is too long, demand drops rapidly.

**Rules on accessibility**

**Accessibility** denotes the feature of a web application according to which its information content, navigation modalities, and all its interactive elements are accessible to users independently of their disabilities, the technology they use to access the application, and the context in which they access the application.
W3C. WAI guidelines and techniques. http://www.w3.org/WAI/guid-tech.html



### 2.3.2 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.

#### 2.3.2.1 Traditional communication tools

Communication through traditional channels is **linear and one-way**. The promoter of the campaign prepares a message targeted at a previously identified audience, whose function is to receive the message.

Obviously, the online virtual exhibition must be advertised first and foremost on the website of the relevant institution, in the news section of the site and on dedicated webpages.


**The Guggenheim advertises its exhibitions with a link on its main page, in its news section, and with a link to a video**


**The webpage of the "Chaos and classicism" exhibition**

Other traditional communication instruments, to be distributed physically or telematically, include:

- press releases, newsletters, conferences, and interviews on various media channels in order to encourage the publication of information on the event in newspapers, magazines, radio and TV stations, generic or specialized web portals, blogs, etc.
- catalogues and other publications
- advertising material (brochures, digital or paper flyers, posters, postcards, CD-ROMs, merchandising).



### 2.3.2.2 Social media marketing

The advent of web 2.0 – a term coined by Tim O'Reilly in 2004 to define a more participatory web – has impacted the world of communications to the extent that social media marketing has become a discipline that uses social networks as if they were media channels. The promotional message is created interactively by interpreting user feedback.

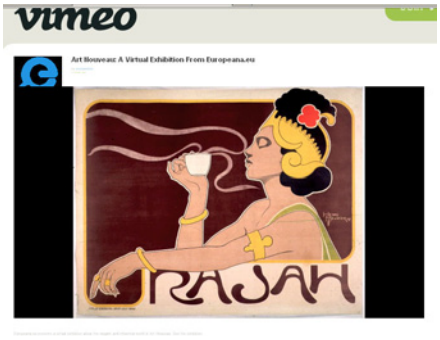
In this case, the event and/or online virtual exhibition will be promoted through:

- the creation of fan pages, events, public or private profiles on Facebook and other social networks
- creating web content and initiatives aiming to create a community (discussions, polls, contests, viral videos, communities)
- publishing videos on **video-sharing platforms** such as Youtube, Dailymotion or Vimeo.

The main activities available to the user include uploading and/or viewing videos. Those who upload a video can assign it to a specific category with the help of tags and add a caption with a description. Users can rate the video, add comments, share it with other users, link it to their own web page, add it to a playlist, etc.

For promotional purposes, it is best to upload brief videos (max. 1.5-2 minutes) in order to avoid boring and driving away the user. Additionally, it is best to categorize and assign tags that make it easier for remote users to find the relevant videos. As the marketing field has shown, **viral videos** are generally funny, interesting, or highly innovative videos that are eagerly shared through videoblogs, blogs, IM, email, etc.

An efficient viral video is generally filmed with low-resolution cameras and no tripod. The video maker's brand is generally only present on the final screen shot.

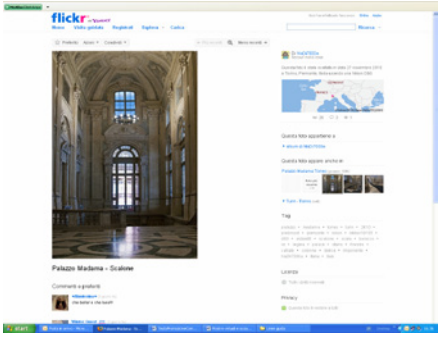



**Showcase for the online virtual exhibition "Art Nouveau" promoted by Europeana**


**Presentation of the multi-media exhibition dedicated to Fabrizio De André (2010)**



- the publication of images on photo-sharing platforms such as Flickr.




**Palazzo Madama has created its own groups: visitors can participate by adding photos of exhibitions**


**The Brooklyn Museum encourages visitors to take photos during their visits and to share them on the Flickr group.**

- the promotion of the exhibition through the Euromuse portal (`http://www.euromuse.net/`), a public access portal that provides detailed information on the main exhibitions in European museums and the MICHAEL collections portal `http://www.michaelculture.org`)
- etc.

Europeana, in the pages of the “Art Nouveau” virtual exhibition, makes it possible to download the embedding code for the banner, which can be incorporated into one’s own site, portal, or blog.


**Embedding code for the “Art Nouveau” exhibition banner**

### Finding one’s way among social media

Social media include: blogs, microblogs, podcasts, videocasts, forums, wiki, and web communities. In order to better understand them, they are grouped below by function.

- **Social News:** sites such as Digg, Sphinn, Newsvine, and BallHype provide news on various topics and allow viewers to rate and/or comment on the articles. The most voted articles are promoted to a more visible position
- **Sharing platforms:** sites such as Flickr, Snapfish, YouTube, and Jumpcut allow users to create, upload, and share videos or photos with other users. Visitors’ ratings allow specific content to have more or less visibility
- **Social networks:** sites such as Facebook, Linkedin, MySpace, and Twitter link users who share an interest or wish to discuss specific topics. Once they have signed up, users can keep up with the information posted by their “friends”, “followers”, etc.
- **Social bookmarking:** sites such as Delicious, Faves, StumbleUpon, BlogMarks, and Diigo make it possible to find and add to one’s bookmarks sites and information of particular interest. Bookmarks can be saved online so that they can be accessed from anywhere or shared with others.



#### References

MINERVA. Handbook on cultural web user interaction, edited by MINERVA EC Working Group “Quality, Accessibility and Usability”, 2008.

## 2.4 Updating, maintenance, and preservation

Digital preservation is the set of processes, activities and management of digital information over time to enture its long-time accessibility. Also virtual exhibitions should undergo these processes.

The difficulty in putting together and preserving a digital collection or exhibition thus lies in the fact that many different types of "objects" must all be preserved. The latter comprise several different inter-dependent components that must be available for them to be read (hardware, operating system, software …).

A few examples are listed below: the file format can be replaced by newer versions; a memory support can be replaced by newer versions or faster, easier to read new support types; the instrument that allows for memory supports to be read may be out of production, or the software used to create, manage, or access content may have been replaced by new, more powerful versions that require updated technology.

The spread of online storage systems and the use of open software and formats are a positive trend, and constitute best practices in terms of preservation policies, including in the institutional field. Digital storage ensures that future users will be able to identify, search for, process, interpret, and use documents in an environment characterized by ever-changing technologies under conditions that guarantee the documents' authenticity. This type of activity is also characterized by risk management and the request for continuous policies, instruments, and standards of representation.



Digital storage is becoming an important function that requires specific skills, such as those of digital curators.

We suggest to go indepth into this topic analysing the results of the INDICATE case study on digital preservation, which investigates how e-infrastructure enabled long term preservation can ease the transfer of the cultural heritage to future generations. The main objective of this study was to review the current situation of digital preservation process and policies in Europe, the state of the art of the technology used or in development, the relation between preservation institutions and e-Infrastructure providers and to describe which actions can be taken in a feasible way to initiate the coordination of a European eco-system of data repositories for the long term preservation of the digital cultural resources.

**References**

INDICATE case study on digital preservation. http://www.indicate-project.eu/index.php?en/97/case-studies

# 3 Tool kit

This chapter is highly pragmatic; it provides concise information for operating solutions, and translates the concepts expressed so far into practical recommendations and working tools.

The first three paragraphs regard technical aspects that are part of the planning phase.

The style of an exhibition is the outcome of the choices and means of expressions through which its contents are organized and communicated.

According to Kalfatovic 2002, whoever curates an exhibition 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.

The elements that help an exhibition become expressive and effective – both overall and in terms of its individual pages – are its graphics, and the style of its text, the right use of digital objects.

This tool kit does not specifically include recommendations for smartphones and tablets.

**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

## 3.1 Graphic design

Four aspects characterize the pages of a virtual exhibition:

- its **content**, which comprises the information to be communicated to the user. The greater the content, the greater the value that users confer upon the page
- its **structure**, both in terms of navigation structure (system of links that allow the user to reach the various sections of the virtual exhibition) and in terms of the **logical structure** of the page
- its **presentation**, meaning the various ways the structure is presented to users (graphs or visual and non-visual presentation for users using assistive technologies or alternative browsers)
- its **behaviour**, which causes the alteration of the structure and its presentation in response to actions generated by the user (by dragging or pushing a button on the mouse or keyboard).

Successful graphic design must keep all these aspects in mind, and focus especially on **presentation** while following a **logic** that can balance **visual sensations** and **graphic information**, guaranteeing the recognisability and identity of the sponsoring institution.

Web-based graphic design projects should be entrusted to a **web designer:** a good traditional graphic designer does not necessarily have experience with **web designing**.



Every web design solution must always comply with accessibility (a web application must be accessible to all users, independently of any disabilities and of the type of browser used) and **usability** standards (a site must be useful to users, and meet their needs in the best possible way).

Successful graphic design must attract users to explore content while maintaining aesthetic balance.

Visually, graphics must be effective and coherent. They must highlight the exhibition's most important elements and place content in a logical, predictable manner.

Usability experiments have shown that when users view a webpage, they are first attracted by a mass of shapes and colours, a few of whose elements emerge from the background. Later, they grasp specific information, starting with images (from the largest to the smallest) and then text, keeping in mind that in Western countries this process generally begins from left to right, and from top to bottom.

**GRAPHIC DESIGN: Brief recommendations**

- keep your target audience in mind
- avoid pages filled with only text: they are unattractive to the eye
- seek the right balance between text and audience, and remember that this balance is closely linked to the instinctive way our eyes move across a page
- try to insert the various elements along the visual itinerary according to their order of importance
- limit or avoid the use of purely decorative images
- use image, graphics, and animation only in support of the content you are trying to communicate
- even if you need to enter extensive content, let the page breathe! Empty space has its importance, too
- modular page design is preferable, since it guarantees homogeneity and flexibility in modifying content and/or inserting additional content
- do not fear that a coherent graphic design may appear boring or dull to users. Efficient design will allow them to navigate web pages and identify with certainty the content that most interests them
- you do not necessarily need to be original or creative, or to establish your own graphic style: always keep in mind that your goal is to achieve a pleasant and functional result with the tools at your disposal
- always analyze other people's solutions, and identify their strengths and weaknesses, because they might serve as sources of inspiration for your project
- maintain a constant dialogue with those in charge of planning information architecture
- once the layout has been defined, test it on potential users who are not aware of your project. This is the ultimate test of your idea's success
- stay humble and accept user suggestions. Do not ever forget that they are the ones who will have to use the online content.

In more detail:

- try to adopt an interface that uploads fast and is easy to modify
- optimize the use of images by making them as light as possible
- implement graphic solutions by applying cascading style sheets (CSS). This will make the page lighter and make future changes easier
- do not turn text into images, in order to make it easier to find using search engines.
- carefully assess your choice of colours, which aim to obtain contrast that will make content jump out while complying with accessibility criteria
- guarantee adaptability to any monitor, video resolution and graphics card
- do not ever forget accessibility requirements.

## 3.2 Text style

The efficacy and readability of texts, especially those published online, requires particular care that must always be kept in mind in order to avoid abandonment on the part of users.

**Text style: Brief recommendations**

- break down complex contents into several units (pages)
- adapt your writing style – colloquial vs. scientific – to your target audience (children, general audience, researchers...)
- have clear ideas on what you want to communicate
- treat the page as if it were a map providing precise indications: titles, subtitles, brief texts broken down into paragraphs, blank spaces, keywords, boldface...
- if possible, use a "cascading" structure (begin with essential information, followed by more detailed content, and ending with a brief summary)
- the start of the page is very important: it must be able to hook the reader
- unless the context requires it, try to avoid lengthy texts that break up the narrative's rhythm and may cause the page to scroll
- read the texts several times, and let some time pass between each reading. You will be able to cut unnecessary or redundant words each time
- if possible, use a colloquial writing style to keep the reader's interest high, and provide in-depth documentation for more detailed content
- avoid redundant adjectives and brackets
- re-read the text aloud to verify whether it works from a communicative point of view
- avoid sloppiness (typos, broken links, cut-and-paste)
- be aware that when writing at a computer, the text is not written after being thought out, but rather typed directly as it is being formulated, with the risk of imprecision or hurried revisions
- be precise and transparent (accurately indicate text authors, sources, etc.)
- add captions to digital objects
- prepare a concise style manual with the editorial norms you intend to adopt (capitalization, bibliographic references, caption format, etc.).

In more detail:

- use HTML syntax correctly to ensure the widest degree of accessibility
- if you are supplying additional information as PDF documents, use an accessible format.

## 3.3 Multi-media resources

In an exhibition's web page, multi-media resources play an essential role in ensuring concise, effective communications. Images, sound, and videos almost always comprise culturally significant contents in and of themselves, which add value and scientific credibility to the product.

### 3.3.1 Still Images

Technically, digital images are divided into "raster images" and "vector images":

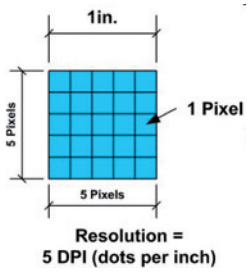
- **Raster images** (or bitmaps) use a grid of square image points known as pixels. Each raster image is made up of a fixed number of pixels, determined by the grid (resolution: pixels on the long side x pixels on the short side), which in turn determines their maximum size. Each pixel is assigned a 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.



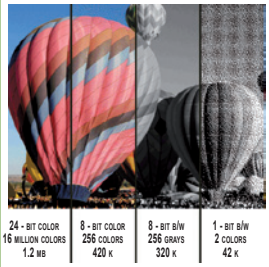
| | Raster images | Vector images |
|---|---|---|
| |  |  |
| Advantages | • They are well-suited to reproducing subtle shades of colour. The photos we take with our digital cameras are raster images<br>• They are easy to modify<br>• They can be read by many software types | • They are well-suited to reproducing images with few colours (i.e. logos, text, stylized images)<br>• They can be easily scaled, modified, and adapted to monitors, with no loss of resolution<br>• They can be modified with computer graphic programmes, which require certain specific skills<br>• They can be used for web animations, since they are fast to download<br>• 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<br>• 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** |  Resolution = 5 DPI (dots per inch) | 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.<br>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:<br>• the combination of real size (base per height) and resolution<br>• the level of compression<br>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 |

Source: *ATHENA. Digitisation: Standards Landscape for European Museums, Archives, Libraries*, 2009

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. |

Source: *ATHENA. Digitisation: Standards Landscape for European Museums, Archives, Libraries*, 2009

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.<br><br>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 !<br><br>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.<br><br>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).<br><br>The advantages of watermarking include:<br><br>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.<br><br>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.<br><br>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.<br><br>The disadvantages of watermarks include:<br><br>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. |

| | |
|---|---|
| *follows* **Digital watermarking** | **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).<br><br>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.<br><br>    <br>**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-my-pictures/`
- **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.

**Brief recommendations**

**Generic**

- Establish image use and re-use policies from the outset
- Always caption your images
- Specify the format and size of the images to be downloaded

**Technical**

- If you want to obtain good results, work with high-resolution files, and optimize them later on the basis of their intended use
- Create small files (in terms of Kbytes), so that images can be rapidly uploaded and downloaded
- Make available files whose size makes images readable
- Make available both detailed and wide-angle images, not just the former
- Comply with accessibility requirements, by inserting into each image published on the web the alternative text (ALT) describing the image, so that visually impaired users who use screen readers can interpret the image's content

- Keep in mind that web crawlers index the alternative text (ALT) of images, and therefore inserting it is also useful to appear in their results list
- If possible, associate information on images to XML files in order to be able to visualize metadata
- Give files names that reflect their content, in order to make them easier to find on the part of web crawlers

**Related to copyright**

- Verify the intellectual property rights associated to each image
- Keep in mind that economic rights related to the use of photographs remain in force for seventy years after the author's death (law 633/1941, art. 32 bis)
- For images depicting people, keep in mind that a person's portrait cannot generally be published without their consent or that of their heirs, unless the person is famous or there are specific reasons to publish their portrait
- Whenever you use image protection systems, make sure they do not make the images difficult to read

**References**

MINERVA. *Technical Guidelines for Digital Cultural Content Creation Programmes*: Version 2.0, 2008
Editors: Kate Fernie, Giuliana De Francesco and David Dawson.
http://www.minervaeurope.org/interoperability/technicalguidelines.htm

ATHENA, *Digitisation: standards landscape for european museums, archives, libraries*, 2009
http://www.athenaeurope.org/index.php?en/110/promotional-material/11/10-booklet-digitisation-standards-landscape-for-european-museums-archives-libraries



### 3.3.1.1 OCR: text conversion

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:

- acquisition of the digital image from the analog object
- definition of areas

- OCR scanning
- text recognition
- spell checking
- 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.).

Every system to convert digital images into text has its shortcomings, and it is unlikely that the converted text will be entirely free of spelling and punctuation errors: at the end of each OCR scan, it is essential to carefully re-read and check the entire document, comparing it with the original.

OCR programmes spell-check the text obtained from the original image, and on the basis of the languages available in their dictionaries (French, English, Italian, etc.) they suggest possible alternatives when faced with an illegible word. When the system does not offer an alternative word, the operator must type the correct one. The dictionaries of OCR programmes are capable of adopting the terms inserted by the operator: anytime the programme comes across the same image of the same term (which had not been recognized) on other pages of the document being processed, it will recognize it.



In case only low-resolution images are available, or images that reproduce pages that were poorly printed (faded, old, or ruined), the procedure can turn into a major nuisance for the operator: a low percentage of character recognition on the part of the system necessitates a careful visual check and a painstaking verification of spelling and punctuation.

**Format and size of text file**
A good copy of an original volume can be reproduced digitally in various formats: .pdf, .html, .doc, .rtf etc. For best results in OCR scanning, it is essential that the resolution of the original image be at least 300 dpi.

A text file obtained with OCR “weighs” a lot less than the original image from which it was obtained. For this reason, it is easier to use on the web – for example, as part of a virtual exhibition – by memorizing it in a single file. If the heavier image version of the same document is to be published online, it must be divided into dozens of files, thus allowing the work to be published in its original form, which is undoubtedly preferable in cases of particularly valuable editions, for example.

A file in text format supports the “Search words” function, which is very useful for studies, analyses, or simply surfing the document.
Below is a comparison of the same book in image format and in text format obtained with OCR.


BIBLIOTHÈQUE
DES "ANNALES INSTITUTORUM" - VOL. V

ANDREA DA MOSTO
Direttore dell'Archivio di Stato di Venezia

L'ARCHIVIO DI STATO
DI VENEZIA

INDICE GENERALE, STORICO, DESCRITTIVO
ED ANALITICO

CON IL CONCORSO DEI FUNZIONARI DELL'ARCHIVIO
PER AUTORIZZAZIONE SPECIALE
DEL MINISTERO DELL'INTERNO DEL REGNO D'ITALIA
AL "COLLEGIUM ANNALIUM INSTITUTORUM DE URBE ROMA"

TOMO I

ARCHIVI DELL'AMMINISTRAZIONE CENTRALE
DELLA REPUBBLICA VENETA
E ARCHIVI NOTARILI

**Example of original work obtained through a simple image scan**


BIBLIOTHÈQUE
DES "ANNALES INSTITUTORUM"-VOL. V

ANDREA DA MOSTO
DIRETTORE DELL'ARCHIVIO DI STATO DI VENEZIA

L'ARCHIVIO DI STATO
DI VENEZIA

INDICE GENERALE, STORICO, DESCRITTIVO
ED ANALITICO

CON IL CONCORSO DEI FUNZIONARI DELL'ARCHIVIO
PER AUTORIZZAZIONE SPECIALE
DEL MINISTERO DELL'INTERNO DEL REGNO D'ITALIA
AL "COLLEGIUM ANNALIUM INSTITUTORUM DE URBE ROMA"

TOMO I

ARCHIVI DELL'AMMINISTRAZIONE CENTRALE
DELLA REPUBBLICA VENETA
E ARCHIVI NOTARILI

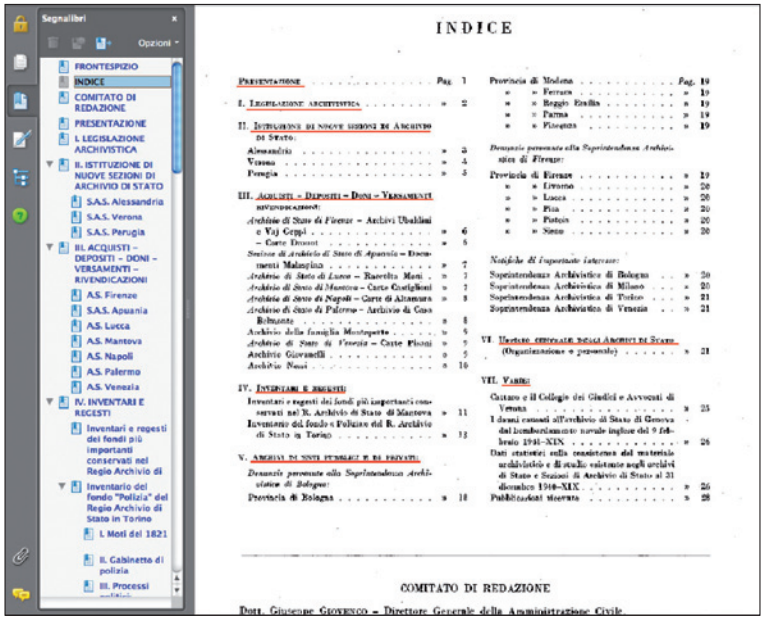
**Example of a copy of the original obtained with OCR (in this case, the entire 278 page book in text format is contained in a file of just 796 KB). The same book in image format had to be broken down into 136 files in order to be published on the web, as its total size was 55 MB**



For various reasons (goals, software used or available, resources, etc.) it is possible to make an OCR scan and save the text under the original image.

The advantage provided by the OCR format is that one can use the *Search word in text* function while maintaining the appearance of the original work. The disadvantage of this is the large file size. See for example the image below, in which the graphic interface is that of the original compressed image, while the actual text is saved underneath and is not visible.

Much like for other file types (for example, images), documents acquired with OCR in .pdf and .html formats can be accompanied by interactive elements (such as indexes or internal links) both to facilitate navigation of the text (intended as a volume or part thereof) and to provide additional information not included in the original analog edition (e.g. notes, comments, etc.). In the example below, we have a digital edition obtained with OCR: the text is saved under the original image. The edition is equipped with interactive elements such as links and indexes, both to facilitate navigation within the document and to provide additional information.






**Advantages arising from the use of OCR**
Using OCR to convert a document to .pdf makes it possible to attach metadata to the document using tags.

In order to perform this operation, one can add tags thanks to some of Acrobat's features. Acrobat's inference engine tries to infer the correct tags by analyzing the characteristics of the document's paragraphs. For simple documents, results are rather satisfactory, but it will almost always prove necessary to intervene on the PDF document thus obtained.

Additionally, there are open source crawlers that use statistical criteria to automatically tag a document scanned with OCR. OCR scans of books that are partially or entirely re-published in an online exhibition provide the undoubted advantage of being indexed, and thus searchable by search engines (e.g. Google), including the internal search engines of the website/portal that hosts the exhibition. For this reason, and unlike non-OCR book images, for which only the text captions added to images are searchable, the entire text of the volume will be searchable, with great advantages for that text's accessibility online.

### OCR: Brief recommendations

**Generic**

- Establish from the outset policies on the acquisition of texts in digital format, and evaluate its advantages and disadvantages compared to scanning the image of one or more parts of a volume, or text conversion through OCR software.
- Once an OCR scan has been completed, results must be double-checked by an operator through a careful re-reading of the document: the quality of the original text is directly proportional to the recognisability of characters on the part of OCR software.
- The .pdf and .html files obtained thanks to OCR scans can be supplied with interactive elements (e.g. indexes, internal links) to make them easier to read and to provide additional information missing from the original analog edition (notes, comments, etc.).

**Technical**

- In order to obtain a lighter file (in terms of Kbytes), which is easier to use on the web, it is preferable to scan the document with OCR software. The same work in image format is far heavier, but it does allow for the work to be reproduced in its original form (useful for rare editions).
- Associate relevant captions and tags to the content obtained through OCR, in order for it to be easily found by search engines.
- If possible, add metadata to OCR files in order to increase the available information on such files, and to make them indexable on the web.
- If you use OCR programmes to acquire text formats from images, always keep in mind that these are accessible resources.

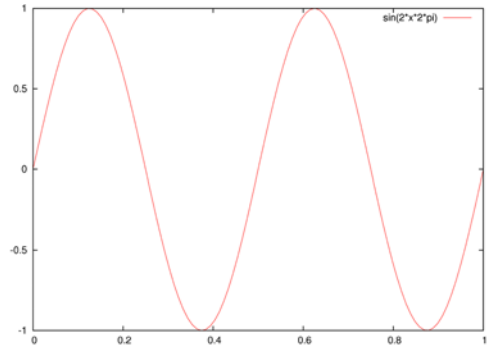
**Related to copyright**

- Always identify the intellectual property rights associated with the text you want to scan, in order to make it available online only after receiving formal authorization from the holders of these rights.



## 3.3.2 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<br>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<br>ISO/IEC 13818, Part 3: Audio<br>ISO/IEC 14496, Part 3: Audio<br>(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. |

Source: *ATHENA. Digitisation: Standards Landscape for European Museums, Archives, Libraries*, 2009

### SOUND: Brief recommendations

**General**
- Establish from the outset the use and re-use policy for audio files.
- Carefully evaluation the duration of the audio files you want to publish in order to maintain the user's interest.
- Specify the format and size of files to be downloaded.

**Technical**
- Avoid adding background unless strictly related to the content being viewed (for example, for an exhibition on Verdi, having one of his operas playing in the background is acceptable only if strictly related to the libretto of the opera being presented).
- Irrelevant background music may be annoying to the user and could interfere with assistance technologies.
- Give the user the opportunity to manually activate or deactivate the audio file.
- Comply with accessibility requirements by providing an alternative text.

**Related to copyright**
- Verify intellectual property rights associated with each audio file.

**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

### 3.3.3 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 |
|---|---|---|---|
| Author | Macromedia (New Adobe) | Microsoft Corporation | Apple Computer Inc. |
| Producer | Adobe Systems Incorporated | Microsoft Corporation | Apple Computer Inc. |
| Date | Since 2002 | (?) | Since 1991 |
| Identifier | Not available | Not available | Not available |
| Rights | Copyright Adobe Systems Incorporated | Copyright Microsoft Corporation | Copyright Apple Computer Inc. |
| Description | 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 nternet access, and is compatible with most of the systems used to publish videos online. | 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 intends to edit their own footage, it is best to grab it directly in MiniDV (AVI) format, which preserves the original quality and frames. | MOV is the Apple Quicktime format for Macintosh operating system, and is the equivalent of AVI for Windows. It supports many levels of compression and many advanced video functions (including high definition). |

| Title | 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** | ITU-T (International Telecommunication Union Telecommunication Standardization Sector) | Moving Picture Experts Group | Microsoft Corporation |
| **Producer** | International Organization for Standardization (ISO) | International Organization for Standardization (ISO) | Microsoft Corporation |
| **Date** | 2000 | 1999 (version 1)<br>2001 (version 2) | (?) |
| **Identifier** | ISO/IEC 13818:2000 | ISO/IEC 14496 | Not available |
| **Rights** | Open standard | Open Standard | Copyright Microsoft Corporation |
| **Description** | 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.<br>Ideal for video on the Web and Podcasting. | Microsoft format for multimedia projects, in high definition.<br>Very versatile and “open” for the variety of compression levels supported. |

Source: *ATHENA. Digitisation: Standards Landscape for European Museums, Archives, Libraries*, 2009

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)**<br>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)**<br>A wider format than the classic television screen, with proportions that mimic those of cinema screens. There are versions of varying widths. |
|  | **Letterbox**<br>Technique that makes it possible to view widescreen formats on regular 4:3 screens.<br>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**<br>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 type of support can be embedded into web pages: RealMedia (for example, RealVideo, RealAudio), QuickTime videos, Flash animation, etc.

**VIDEO: Brief recommendations**

**Generic**
- Establish from the outset policies regarding the use and re-use of video files.
- Carefully evaluate the duration of the video files you want to publish in order to maintain the user's interest.
- Specify the format and size of files to be downloaded, and include an estimated download time on the basis of the connection used.

**Technical**
- Give the user the opportunity to manually activate or deactivate the video file.
- Comply with accessibility requirements by providing an alternative text.

**Related to copyright**
- Verify intellectual property rights associated with each video file.
- In general, videos of less than 30 seconds duration are treated as citations and are exempt from usage fees if used for non-commercial purposes..
- Embedding can violate property rights. Always verify the terms of use associated with the resource to be embedded.



### 3.3.4 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.<br>• 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<br>• 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.<br>• Requires a high-quality video card and a fast processor for optimal use. |
| **Anaglyph images** | • Low cost<br>• Possibility of applying 3D technology even to a single archived image.<br>• They are still a novelty online, and if used correctly they can attract non-institutional visitors to the exhibition.<br>• Availability of free software that can rapidly create various types of anaglyph images. | • Use of glasses (with coloured lenses)<br>• Loss of colour fidelity (unsuitable for using images for scientific purposes). |
| **Panography** | • A "natural" view of places, as seen through the human eye.<br>• Perfect colour fidelity (if correctly photographed and processed).<br>• Possibility of inserting multi-media content of various types into every scene.<br>• Modularity of the "interactive tour" and consequent costs. | • "Ad hoc" production of images.<br>• 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.<br>• Requires a high-quality video card and a fast processor for optimal use.<br>• Environments that no longer exist cannot be reconstructed. |



3.3.4.1 **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.



### 3.3.4.2 Immersive photography

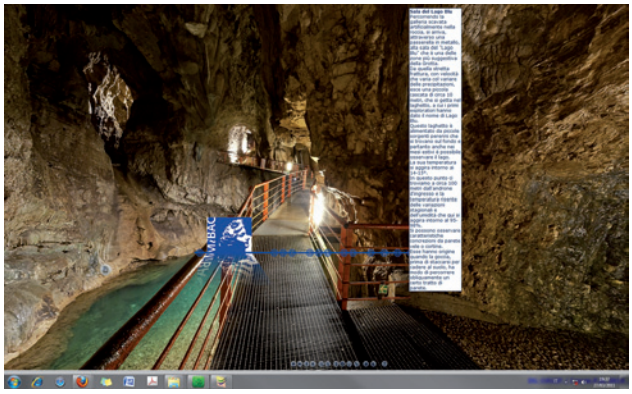
Panography, or "immersive photography", is the current synthesis between traditional static photography and video clips. It makes it possible to view the entire surrounding environment, which can be viewed without being subject to visual constrictions (only the point of view of the photographer) or functional 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.



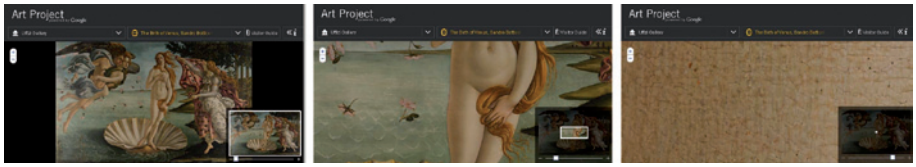
**Panography of the Caves of Pastena**
(courtesy of: Alfredo Corrao)

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.).

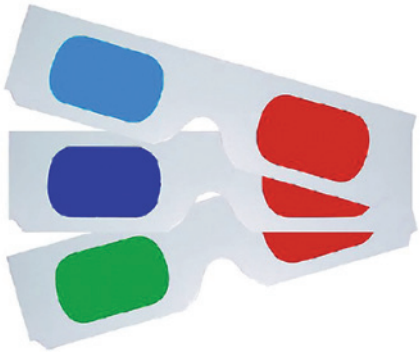
The processing of an immersive photograph begins with photographing the scene from the anterior nodal point of the camera/lens combination used, and the subsequent processing of the files thus obtained in a workflow that can include the use of various types of image processing software, including at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

### 3.3.4.3 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.

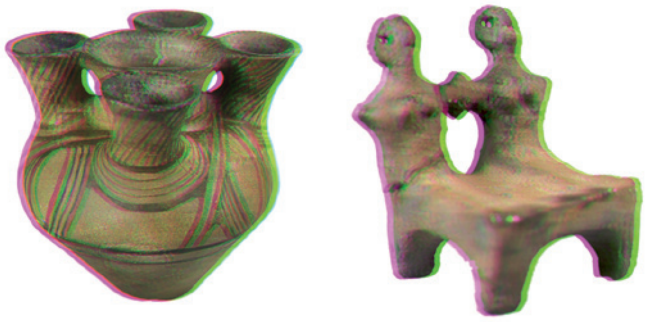


**Glasses for viewing anaglyph images**

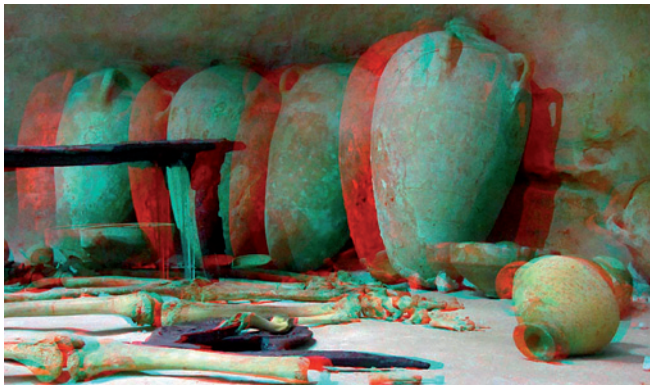
These glasses make it possible to see only one of the two images with each eye, the combination of which gives the impression of stereoscopic vision.

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.

**3D: Brief recommendations**

- If you apply the zoom function to images, keep resolution in mind to avoid unpleasantly grainy images.
- Choose software that does not require downloading proprietary plug-ins.
- Choose solutions that ensure maximum compatibility with existing browsers, operating systems, and hardware platforms.
- Accompany 3D objects and animations with a statement that refers to the difficulties regarding accessibility.

### 3.3.5 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 penetrated into military, health and gaming sectors. Psychologists have used them to treat anxiety problems through virtual exposition to specific situations, doctors use them 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 burst in 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 visualisation and interaction concepts. [9]

Progressively, cultural heritage institutions are becoming more interested in 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 expensive. 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.

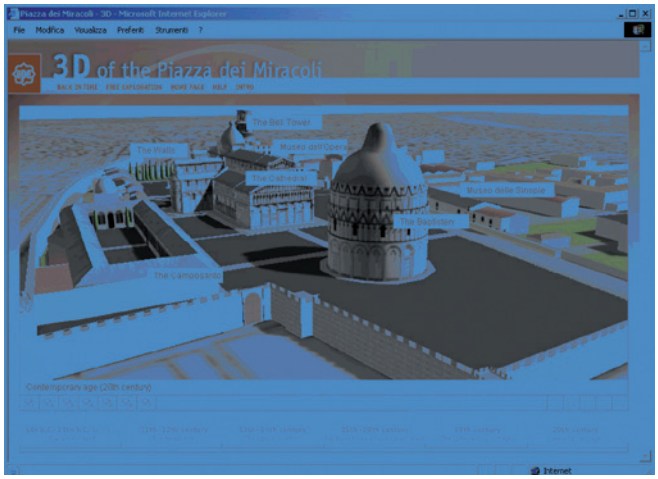
**Modelling**

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 [20], 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 to 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 capture 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.

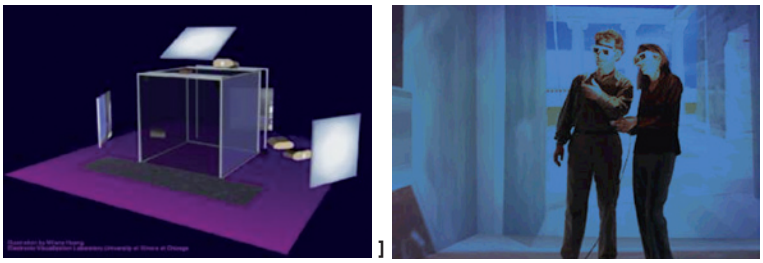
**Immersive interfaces**

*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]

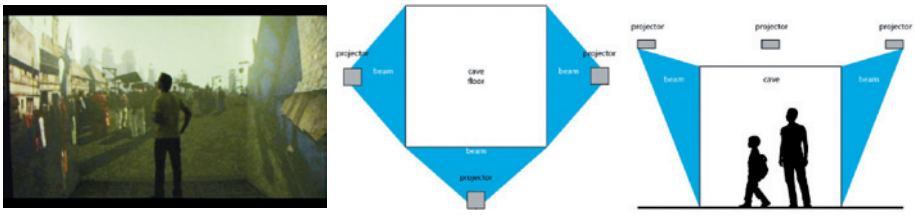
Immersion is the feeling of being in a virtual space, and Virtual Reality is the integration of lower-level technical areas that, combined, allow the user to be immersed in a virtual scenario and interact with it. There are multiple configurations in high performance immersive platforms, each of them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



We can distinguish between projection based systems, like CAVE, Immerse 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.

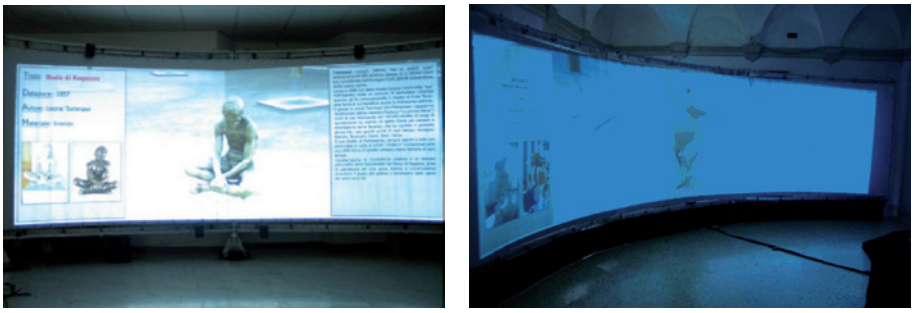


**Visitors immersed in the Kivotos System, presented in [3][4]**




**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]**

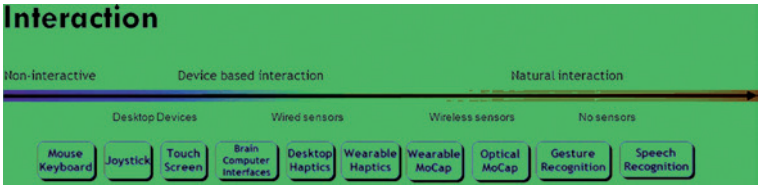
In [6] they introduce a single projection device with an museum guide application accessible from web and from the exhibition site where users at both sides can interact through a 3D model of the exhibition.

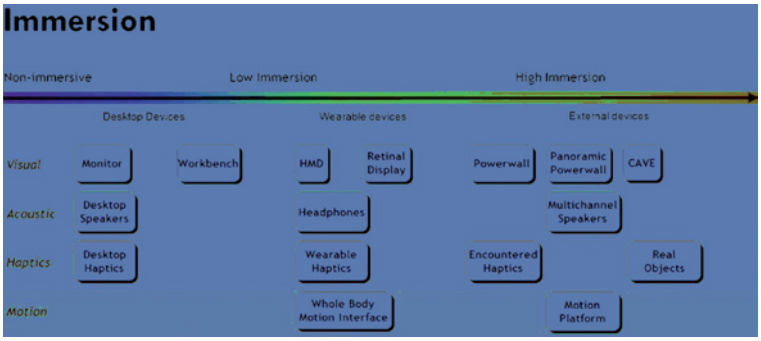
**User interacting and screenshots of the virtual worldsystem presented in [6].**

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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### 3.3.6 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**.

In Italy, for example, 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.

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.

## 3.4 e-infrastructures

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 advanced e-infrastructures capabilities.

### 3.4.1 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.

### 3.4.2 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.

### 3.4.3 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.

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# virtual performances

# 4 Technical aspects

## 4.1 Image

### 4.1.1 Video resolution

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

Most commonly used resolutions are shown in the next figure.

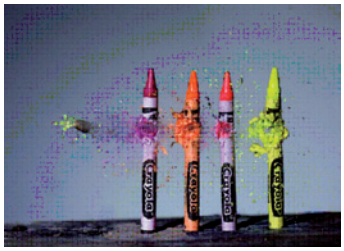



### 4.1.2 Colour coding

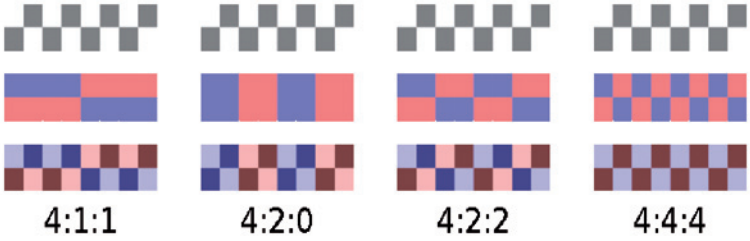
Colour coding will determine the number of bits per colour used in the digitisation of the image.

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 on human perception of colours.



However, due to transmission limitations (normally the 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.

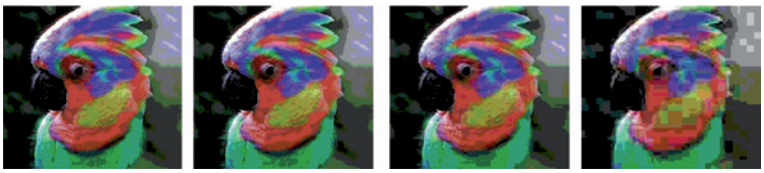



Most frequently used colour coding in distributed virtual performances will be Y'CbCr in a 4:2:2 or 4:2:0 reducing 1/3 and 3/4 respectively from the conventional RGB.



### 4.1.3 Video compression

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 compression 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.

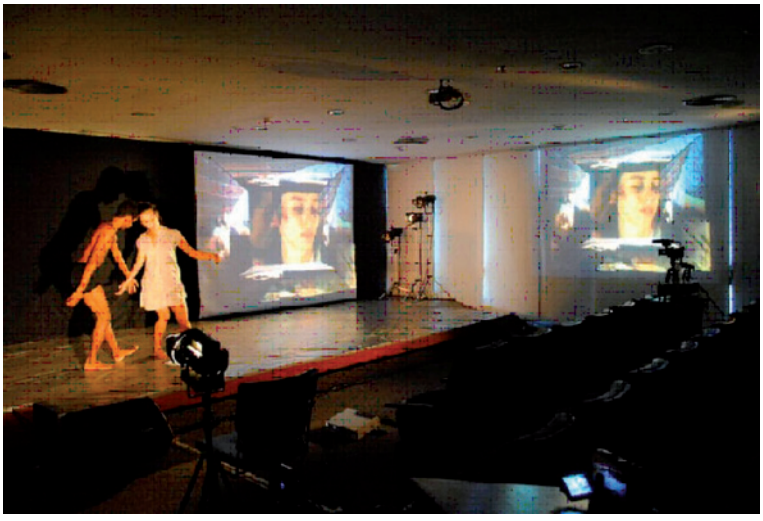
3. Low latency H.264 family:
   a. Medium quality
   b. Medium computing power required
   c. Up to 1/100 compression ratio.

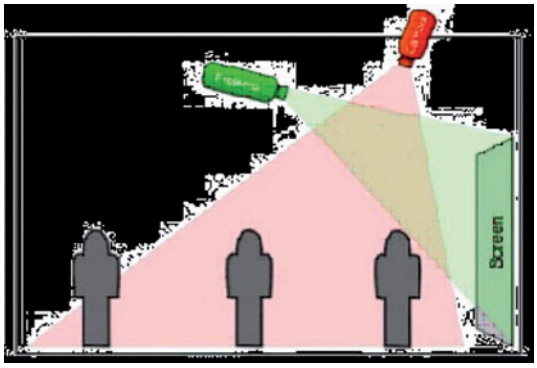
### 4.1.4 Projection

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 needs and possibilities should be taken carefully into account.






The first aspect 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 selecting the appropriate projector for a virtual performance is its power (in lumens). As shown in the figure, required lumens power will be based on screen size and the level of light required in the performance.



**SELECT THE RIGHT PROJECTOR**

**Low ambient light**
Little to no light enterin room

**Some ambient light**
Some additional light in romm. Slightly dimmed, window blinds leading some light.

**Bright ambient light**
Windows open during daylight hous that cannot be dimmed like in an open office settings. Bright enough for audience note laking.

| 4:3 Screen | | | | |
|---|---|---|---|---|
| **Screen Size/ Lumens** | 72'' | 100'' | 120'' | 150'' |
| 750 | | | | |
| 900 | | | | |
| 1100 | | | | |
| 1300 | | | | |
| 1500 | | | | |
| 1700 | | | | |
| 1900 | | | | |
| 2100 | | | | |
| 2300 | | | | |
| 2500 | | | | |
| 2700 | | | | |

## 4.2 Audio

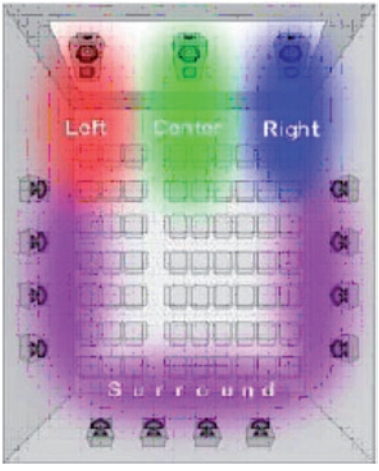
Subjective human tolerance to errors/artefacts in audio systems is quite lower than in video systems (ears are logarithmic “devices”). As in all events, in virtual performance events, audio quality always becomes a key element.

Also when working in distributed scenarios, the complexity of the audio configuration increases 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.

### 4.2.1 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.

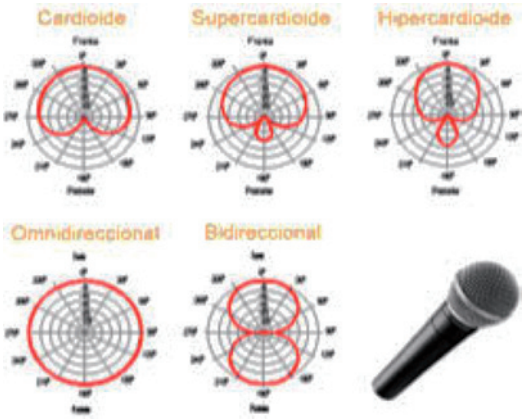





There are so many different microphones in the market, depending on:

- 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`)

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.



# 5 e-infrastructures and technologies

All techniques, approaches and designs are focused on the premise that the architecture should assure high-quality and, if needed, interactive communications. Interactivity requires to meet strict real time constraints. That means that the whole system should introduce delays below 150 ms (ITU-T Recommendation G.114). In order to achieve the interactivity constraint and quality requirements, all the technologies should be uncompressed to avoid processing delays and in some cases a strict real-time compressed data can be used to meet bandwidth restriction like in a commercial Internet scenario. Thus, ideally the operation chain from the capture in the sender side of the network to the visualization side in the receiver is based on raw video data, avoiding possible artefacts and delays from the coders.

In this section some of the most relevant infrastructures and technologies to enable virtual performances are listed.



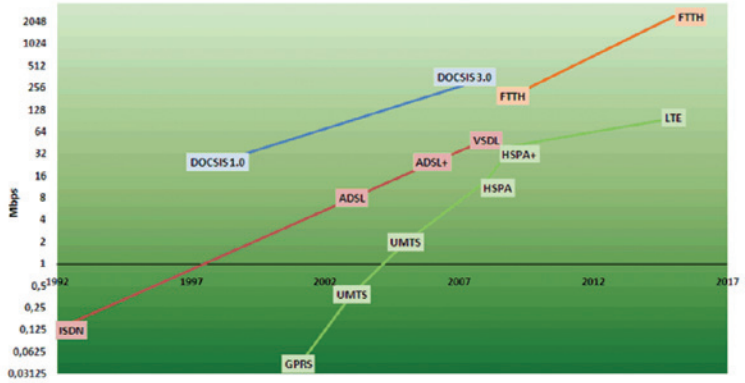
## 5.1 Network Infrastructure

The widely fluctuating demands of rich digital media applications have to be supported by the underlying network infrastructure. Currently, there exist many network technologies able to provide broadband Internet access to end users. Although the rapid evolution in the bandwidth capacity of these networks, it must be noticed that the current Internet network doesn't provide guaranteed QoS parameters. Thus, the loss effect due to Best Effort based delivery modes, delays and jitter need a special consideration when streaming events over the Internet take place. Even more when interactivity is desired. The alternative is to use controlled and dedicated networks apart from the current commercial Internet.

Some examples are given next for both, mobile and fixed networks:

- Mobile networks
  - LTE (Long Term Evolution)
  - WiMax
  - 3G
- Fixed networks
  - FTTH (Fiber To The Home)
  - xDSL (x Digital Subscriber Line)

It's interesting to notice, at the following figure, the evolution of them:




**Source: ICP-AMACOM**
**Evolution in a fixed and mobile access networks**

## 5.2 Adaptive and scalable multimedia technologies

Users get connected to the Internet through different devices (mobile, PCs, HD displays, etc.) and networks (3G/UMTS, ADSL, VDSL, etc.). Devices and networks can vary a lot in their features and conditions. Hence, each user has a specific context. This situation produces a very heterogeneous environment while there exists an increasing demand for customized services. In the case of growing multimedia communications, it is challenging to deal with such a heterogeneous environment to provide personalized and adapted contents. In addition, multimedia applications must face the dynamics inherent to users behaviours in an appropriate manner in order to overcome possible failures of these kinds of systems (e.g. churn effect). In this sense, it's recommended to use scalable and robust video coding techniques to deal with heterogeneity. Moreover, to take more advantage of these techniques, distributed approaches for media delivery should be considered for distributing contents on the network. Finally, context information must be used to make the adaptation process possible.



### 5.2.1 Coding: video coding

*H.264*

The H.264/AVC video coding standard has recently emerged from the cooperation of two experts groups: the Video Coding Experts Group (VCEG) from ITU, which has developed all the H.26x video-telephony coding standards and the Moving Picture Expert Group (MPEG) from ISO/IEC, which has built the MPEG video standards used in storage, broadcast or streaming applications.

*MPEG-2*
MPEG-2 is widely used as the format of digital television signals that are broadcasted by terrestrial (over-the-air), cable, and direct broadcast satellite TV systems. It also specifies the format of movies and other programs that are distributed on DVD and similar discs. TV stations, TV receivers, DVD players, and other equipment are often designed to this standard. MPEG-2 was the second of several standards developed by the Moving Pictures Expert Group (MPEG) and is an international standard (ISO/IEC 13818). Parts 1 and 2 of MPEG-2 were developed in a collaboration with ITU-T, and they have a respective catalog number in the ITU-T Recommendation Series.

Source video coding techniques such as **Multiple Description Coding (MDC)**, **Scalable Video Coding (SVC)** and **Multi-View Video Coding (MVC)** can be applied to improve the scalable and robust media distribution process. These techniques are well suited for situations where the quality and availability of connections vary over time. Using MDC or SVC in a, for instance, P2P streaming scenario, the demanding peer can choose the best peers candidate to make the transfer, and ask for different descriptors or layers in each case. As all information is travelling by using different routes, if one of the descriptions or layers suffers packet loss or delay, the receiver is still able to decode the video. Next, both techniques are briefly described.



*Multiple Description Coding (MDC)*
MDC [1] [2] [3] is a source coding technique that encodes a signal (in this case a content) into a number of N different sub-bitstreams (N≥2). Each bitstream is called “descriptor”. The descriptors, which are all independently decodable, are meant to be sent through different network paths in order to reach a destination. The receiver can make a reproduction of the media when any of the descriptors is received. The quality of the reproduced media is proportional to the number of received descriptors. The idea of MDC is to provide error resilience to media streams. Since an arbitrary subset of descriptors can be used to decode the original stream, network congestion or packet loss, which are common in best-effort networks such as the Internet, will not interrupt the playback continuity but will only cause a (temporary) loss of quality. The quality of a stream can be expected to be proportional to the data rate sustained by the receiver. Several MDC approaches can be found working in the pixel-domain or in the frequency domain. In addition, techniques can work with spatial or temporal information, even combining both and obtaining hybrid solutions ([4][5][6][7][8][9][10]).

*Scalable Video Coding (SVC)*
SVC [11] adapts the video information to the network constrains splitting the images into different hierarchical layers. These layers represent the quality of the image, so, from the base layer, each successive layer improves the image quality, getting the full picture quality with the total

amount of layers used. SVC is the name given to an extension of the H.264/MPEG-4 AVC video compression standard. H.264/MPEG-4 AVC was developed jointly by ITU-T and ISO/IEC JTC. These two groups created the Joint Video Team (JVT) to develop the H.264/MPEG-4 AVC standard. This system is compatible with MPEG-4 in its base layer.

*Multi-View Video Coding (MVC)*
MVC [12], one of the first standards towards formal 3D encoding, has recently attracted a lot of research. Compressing multi-view sequences independently is not efficient since the redundancy between the closer cameras is not exploited. MPEG and VCEG groups jointly created an ad-hoc group 3DAV [13], which received several contributions for Multi-View coding. A good review on the proposed algorithms can be found in [14]. As an output of this work, Multi-View Video Coding (MVC) is generated as an amendment to H.264/AVC, exploiting temporal and inter-view redundancy by interleaving camera views and coding in a hierarchical manner. The multi-view video codec based on H.264/AVC exploiting the correlation between cameras in a backward compatible way is proposed in [15]. Several prediction structures are proposed with the signalling in the bitstream. Codec is based on baseline profile and using only P pictures. It showed superior performance for dense cameras. First version of MVC extension of H.264/AVC was released in and can be used for some applications such as real time video communication.



### 5.2.2 Transmission

#### 5.2.2.1 Protocols

Regarding transmission protocols, **segmented HTTP-based delivery** is the preferred method of many vendors, e.g., Microsoft Silverlight Smooth Streaming, Adobe® HTTP Dynamic Streaming, and Apple HTTP Live Streaming (HLS). The Motion Picture Experts Group (MPEG) and 3rd Generation Partnership Project (3GPP) have also moved to support segmented files delivery with their Dynamic Adaptive Streaming over HTTP (DASH) initiatives.

Find below some of the most relevant protocols used nowadays:

*HTTP Live Streaming (HLS)*
HLS [16] delivers audio and video over HTTP from an ordinary web server for playback on phone, mobile device and desktop computers. HTTP Live Streaming Protocol supports both live broadcasts and pre-recorded content (video on demand). The HLS protocol sends a playlist of small segments that are made available in a variety of bitrates from one or more delivery servers. This allows the playback engine to switch on a segment-by-segment basis between different bitrates and content delivery networks (CDN). It helps to compensate some of the network variances and infrastructure failures that might occur during playback.
HLS is now widely used in some of the media streaming server, e.g.

Wowza, and it is already available as a video delivery vehicle on some of the major devices on the market, like the iPhone/iPad, Sony PlayStation®3, Roku, Android 3.0, and more.

*Fragmented MP4 (fMP4)* [17]
When it comes to adaptive bitrate streaming over HTTP, file format is very important. The fragmented MP4 (fMP4) file format is the basis of IIS Smooth Streaming, Adobe HTTP Dynamic Streaming, and two industry streaming standards, meanwhile the streaming solutions based on MPEG-2 Transport Streams (M2TS) are the basis of proprietary HTTP Live Streaming (HLS) format developed by Apple.
M2TS format has been used for almost two decades. It has been deployed in different broadcast delivery systems and physical media supporting formats (e.g DVD). However, little has changed. For instance M2TS still lacks an integrated solution for digital rights management (DRM). The M2TS derivative used by the proprietary Apple HTTP Live Streaming (HLS) protocol also lacks timed-text or closed-captioning features such as CEA 708 for ATSC TV or SMPTE Timed Text for fMP4 Common File Format.

The fMP4 file format was specifically designed to address the needs of modern streaming to computers, televisions and mobile devices. Therefore, fMP4 offers a number of key benefits over M2TS solutions, such as:

- Trickplay capabilities (e.g., fast-forward, pause, instant replay)
- Seamless stream adaptation to local conditions
- Reduced storage requirements
- Backwards compatibility with M2TS-based solutions
- Integrated digital rights management (DRM).



*Dynamic Adaptive Streaming over HTTP (MPEG-DASH)*
Popular services such as Netflix use MPEG-DASH-like solutions. In fact, Netflix uses a very similar solution to deliver fragmented MPEG-4 video via HTTP to a large number of streaming customers.
MPEG-DASH [18] is a developing ISO Standard (ISO/IEC 23009-1:2012, applicable to streaming services over the Internet). DASH is a standard for adaptive streaming over HTTP, similar to HLS and FMP4, that has the potential to replace existing proprietary technologies like Microsoft Smooth Streaming, Adobe Dynamic Streaming, and Apple HTTP Live Streaming (HLS). A unified standard would be interesting to content publishers, who could produce one set of files that play on all DASH-compatible devices. Recently, the official version 1.5 of the HbbTV specification [19] introduces support for HTTP adaptive streaming (based on MPEG-DASH), improving the perceived quality of video presentation on busy or slow Internet connections. It also enables content providers to protect DASH delivered content with potentially multiple DRM technologies based on the MPEG CENC specification.

*RTP*
The Real-time Transport Protocol is adapted to wireless transmission. RTP can carry any data with real time characteristics, such as interactive audio and video even if the protocol itself does not provides mechanisms to ensure timely delivery or Quality of Service guarantees. However, RTP does deliver the necessary data to the application to make sure it can put the received packets in the correct order and it can check whether packets have been lost or not.

*RTCP*
RTCP is often used with RTP, as RTP is used to transmit data and RTCP is used as a feedback channel on the QoS. RTCP does not transport data; it only sends control packets to participants in a streaming multimedia session.
Streaming media server can be remotely controlled by a client through RTSP. VCR-like commands are used to control the distant server like “play”, “pause” or “record”… However, RTP takes charge of data sending for the actual audio and video data.

*SDP*
Streaming media may be described by a Session Description Protocol in order to initialize parameters. Session description is a format conveying sufficient information to discover and participate in a multimedia session. Ports should be reserved in the IP multicast address to receive those pieces of information. Synchronization with the elementary streams may be helpful in order to firstly receive description prior to decoding or decrypting the transmitted streams.



### 5.2.3 Quality of Service and Experience

- Quality of Service (QoS) – defined as set of network indicators characterizing telecommunication services, constituting its quality and stating their usefulness to satisfy user expectations. QoS is focused on absolute indicators, specifying technical features of service
- Quality of Experience (QoE) – defined as level of user satisfaction of services provided by operator. The measurement of QoE level allows to (in subjective or objective way) determine “is a user satisfied with the service?”. QoE indicators are used to designate the minimum level of quality which can satisfy the user.

QoS metrics are based on network/packet analysis and are developed since 1994. QoS is technically a driven set of parameters such as packet loss, delay, etc. Such metrics make it possible to measure specific network conditions. As such QoS metrics can be used to detect problems in the network. Moreover, QoS metrics are used to specify the contract between network operators. Therefore, numerous network tools, like routers, are able to collect QoS metrics.

QoS specify the network conditions for particular stream or streams i.e. QoS describes the packet stream parameters. Therefore, it is not enough to control QoS parameters by certain QoS metrics implemented in network devices. Currently traffic shaping is commonly used in order to obtain packet stream fitting particular QoS limitations. It is obtained by using leaky bucket algorithms or different queuing systems.

Other tools supporting QoS and already used are different protocols. The best example are Differentiated Services (DiffServ) and Integrated Services (IntServ) protocols making it possible to support different QoS contracts for different traffic flows. Another widely used QoS supporting protocol is Multiprotocol Label Switching (MPLS). Finally, new wireless standards like 802.11e supports different traffic classes and therefore, makes it possible to get different QoS conditions for different traffic type.

Authors of many publications propose QoE models that support measurement of network performance with users satisfaction using services, but they do not meet demands and recommendations from ITU-T G.1000 series. The existing solutions dedicated to measure QoE level can be grouped into two main categories depending on the availability of the reference signal:

- black-box - based on analyzing system under test by comparing the received and reference multimedia signal,
- glass-box - in which results of measurements are various key performance indicators (KPI) of a service based on the observed intra-system (pocket) level parameters (e.g. jitter, delay).



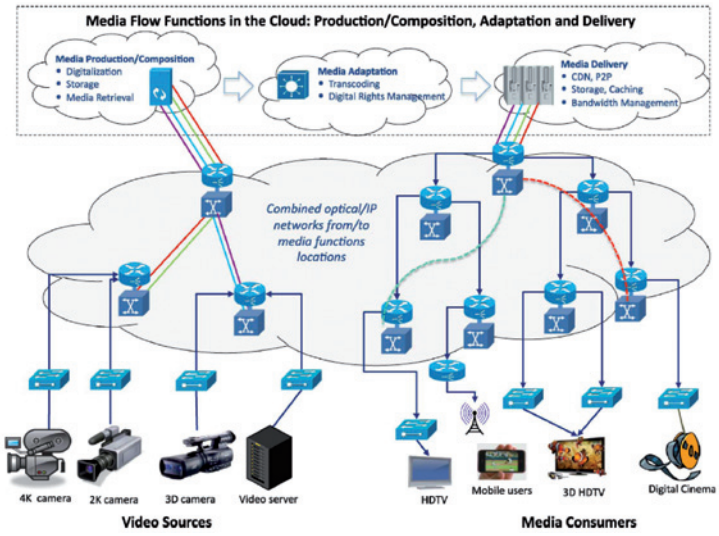
In turn, methods for QoE measurement belonging to the black-box group are divided into four subcategories:

- PESQ (Perceptual Evaluation of Speech Quality) - described in ITU-T P.862 standard based on psychoacoustic attributes of human hearing,
- PEAQ (Perceptual Evaluation of Audio Quality) - described in ITU-R BS.1387 standard based on psychoacoustic attributes of human hearing,
- PEVQ (Perceptual Evaluation of Video Quality) - based on psychovisual attributes of human sight (standardization procedure in progress),
- PEDQ (Perceptual Evaluation of Data-link Quality) - described in the ITU-T G.CHIRP standard.

### 5.2.4 Distribution schemes

Currently Internet media delivery offers unicast connections that can be established from one communicating point to another. However, when many points need to communicate, appears the bandwidth scalability problem, which is proportional to the number of communicating parties. To solve this, there exist multicast transmission technologies,

but they are not widely deployed into the current commercial Internet due to different connectivity devices (routers), manufacturers support and security issues. Obviously, in private, controlled and dedicated networks, where operators have full control over the infrastructures, multicast can be deployed. To solve this issue in the current Internet, several initiatives have arisen to provide this multicast capability to the Internet. They are known as Application Layer Multicast (e.g. P2P applications) or other Over The Top services (e.g. CDN).




**Source: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6151796**

*Content Delivery Network (CDN)*

Content Delivery Network (CDN) is a solution that has been successfully used in systems such as World Wide Web. CDNs offer fast and reliable services by distributing content to cache or edge servers located close to users. In this way, a CDN improves network performance by maximizing bandwidth and improving accessibility. Typically CDN includes content-delivery, request-routing, distribution and accounting infrastructure for a complete service.

Advantages of CDNs for rich multimedia accessible over broadband IP networks seem obvious. However, there are differences between a CDN used for traditional Web content and a CDN designed specifically for multimedia content. CDNs for Web content typically support only straightforward delivery of low-quality streams. The multimedia CDNs, on the other hand, aim at delivery of content with quality that can compete with traditional broadcast media, and support sophisticated services. The special consideration required for the delivery of digital video and audio content is due to the specific characteristics of this type of content. The nature of multimedia content affects a number

of design decisions such as CDN topology, number and locations of replica servers, content allocation and distribution. The multimedia features that are relevant in the context of a CDN can be roughly divided into two groups: 1) characteristics of multimedia content objects such as typical data volume and encoding techniques, and 2) delivery and content access modes. The former group includes multi-stream and multi-layer encoding. The latter group includes scalable and adaptive streaming techniques, and non-sequential content access modes. A consideration is given also to content demand patterns and its influence on CDN resource requirements.
A CDN can be a dedicated private network or a shared network. The operational model for each type is necessarily different since a shared network, i.e., CDN offered as a service, does not impose any start-up costs and allows more flexibility in resource provisioning.

*Peer-to-Peer (P2P)*
P2P networks let us share information without centralized components thanks to the cooperation of peers. These systems have well known advantages in terms of scalability, robustness or fault tolerance. Their properties must be considered for the design of the new platform to alleviate the load in the core CDN, thus, allowing end nodes to share popular contents more efficiently, or to optimize some distribution processes inside the platform.
However, if all users receive and serve data, the probability that one stream breaks is higher because of the replication rate of the streams. For this reason, source coding techniques (e.g. MDC and SVC) are suitable to be used in combination with P2P distribution techniques to face packet loss. The main problem would be the redundancy they introduce.



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## 5.3 Tools and services

This section lists some relevant tools and services provided by e-Infrastructures in the framework of virtual performances.

### 5.3.1 HD Streaming tools

There are many options to achieve HD Streaming for broadcasting purposes and SD high quality videoconferences. These sets of tools are open source based software 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:

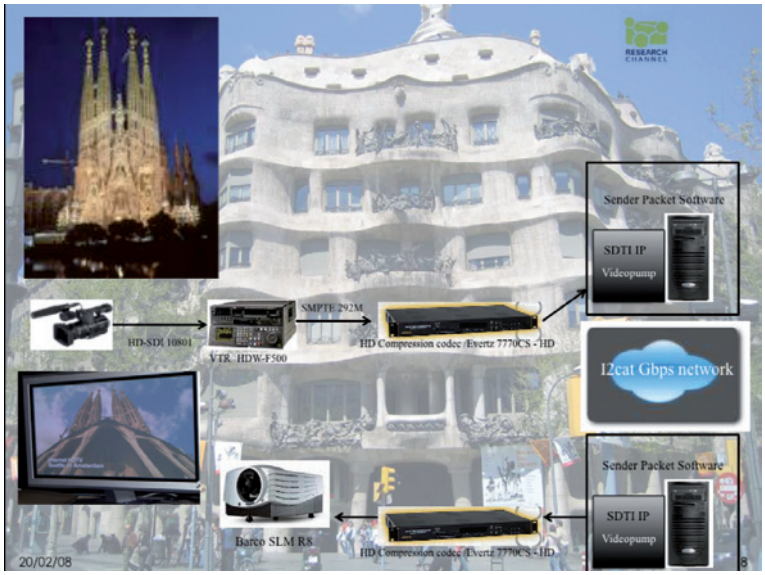
- Platform: Linux/Windows/Mac
- Audio: 48 kHz/16 bit uncompressed

- Video: Standard definition, DV25 compression, 720x576
- Standard: PAL/NTSC
- Bandwidth: 30 Mbps
- Capable of IN/OUT hardware interfaces (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 through 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**

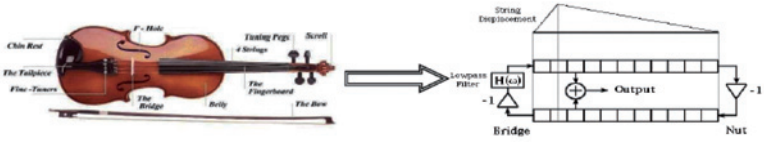


### 5.3.2 Physical modelling synthesis

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

The Physical Modelling 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 behaviour as a mechanical system.

Physical modelling 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 modelled can be found in instruments such as a violin, though the energy excitation in this case is provided by the slip-stick behaviour of the bow against the string, the width of the bow, the resonance and damping behaviour 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 modelling 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 modelling 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.

### 5.3.3 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 planets, volcanoes, earthquakes, a painting, a moving image, etc.).

## 5.4 Virtual performances. Basic requirements

Streaming performing arts between different remote locations is a challenging task as it introduces strict technological requirements that should be meet to offer the best possible experience to users. Artists need to carefully transmit to the audience all the details of their performances. Thus, high quality, low latency, reliable, efficient and robust services and infrastructures should be deployed to guarantee the success and enjoyment of spectators.

### 5.4.1 Network requirements



Typically, streaming applications can be classified according to their purpose and the requirements they introduce.

| Category | Bandwidth-sensitive | Delay-sensitive | Scale |
|---|---|---|---|
| File download | No | No | Large |
| On-demand streaming | Yes | Yes | Large |
| Audio/video conferencing | Yes / No | Yes | Small |
| Live broadcast | Yes | Yes | Large |

From the network perspective, dedicated high-speed and error-free infrastructures are typically needed for this kind of events. Often, Fibre Optic (FO) network connections are used. The use of these infrastructures is needed as high resolution and, consequently, high bandwidth, are commonly required. Notice that high-resolution streaming will allow appreciating the details of the performance displayed in big screens such as cinema screens, projections or tiled displays. In the near future, high-speed wireless and mobile network technologies are to be deployed. Some examples are LTE (Long Term Evolution) and WiMax. However, channel errors and interruptions will need a special treatment. Nevertheless, these technologies will allow mobile users to access to high-quality contents from their mobile and wireless devices anywhere and anytime, enabling the deployment of novel high-quality services.

In some countries, the massive deployment of this kind of infrastructures and Internet connections remains limited to dedicated and costly dedicated lines.

Regarding the technical realization of events retransmission, streaming software and hardware are required. Nowadays, there exist many tools that allow sending a big amount of data in real time from one place to another through the network and, even, between different locations in a collaborative manner. These elements are key and need to be optimized to meet the requirements of each particular event. What's more, if the event requires interactivity between the artists and the audience, then, delay becomes a critical parameter to be handled. If there is not enough bandwidth available to stream the event in a raw format (maximum quality), there are different compression techniques (including codecs) that can be used. However, a trade-off between delay, bandwidth and resolution should be found to accomplish with the desired final quality level (service requirements). In digital media applications, high quality refers to multiple measurable parameters, including frame rate, pixel resolution, a wide range of colours, and other quantifiable characteristics that provide a user experience far superior to what is possible with common broadcast technologies today. To determine this trade-off, the network needs to meet the service requirements. The next figure shows the relation between different resolutions used in HDTV streaming applications and the required bandwidth for uncompressed and compressed (using h264/MPEG-4 AVC codec) video transmissions for one stream.

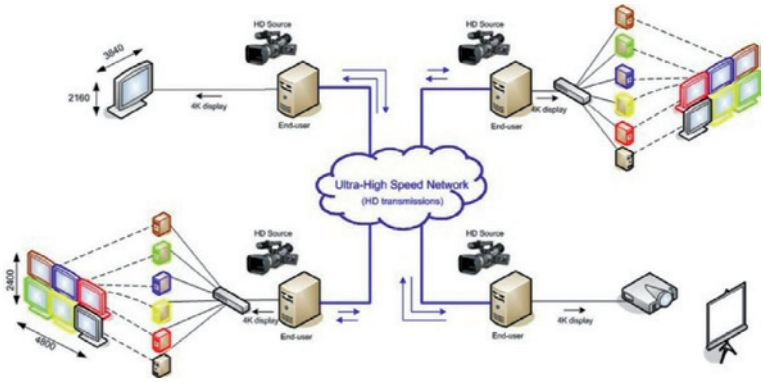


| Digital Media Service | | Frame Rate (Frames/s) | Resolution (HxV in pixels) | Color (bits/pixel) | Data Rate in Gb/s Single View Video | | Data Rate in Gb/s Multi-View Video (16 channels) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Uncompressed data rates (Gb/s) | Compressed data rates in Gb/s (20:1) | Uncompressed data rates (Gb/s) | Compressed data rates in Gb/s (20:1) |
| HDTV[1] | | 25 | 1920x1080 | 30 | 1.56 | 0.07778 | 24.89 | 1.24 |
| | | 50 | | | 3.11 | 0.15552 | 49.77 | 2.49 |
| 3D HDTV[2] (Stereo HDTV) | | 50 | 2x1920x1080 | 30 | 6.22 | 0.31104 | 99.52 | 4.98 |
| Digital Cinema/ HD remote visualization[3] | 2K | 24 | 2048x1080 | 36 | 1.91 | 0.09555 | 30.56 | 1.53 |
| | | 48 | | | 3.82 | 0.1911 | 61.12 | 3.06 |
| | 4K | 48 | 4096x2160 | 36 | 15.2 | 0.76441 | 244.61 | 12.23 |
| | 3D 4K | 48 | 2x4096x2160 | 36 | 30.58 | 1.53 | 489.22 | 24.46 |
| Ultra High Definition Video [4,5] (8K and beyond) | | 60 | 7680x4320 | 36 | 71.66 | 3.58 | 1.15Tb/s | 57.33 |
| | | 120 | | | 143.33 | 7.17 | 2.29Tb/s | 114.66 |

**Source: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6151796**

The next figure shows a possible testbed including the basic necessary elements involved in an event retransmission, including:

- Capture devices: cams
- Transmission channel: network
- Display devices: projectors, TV, TFT…

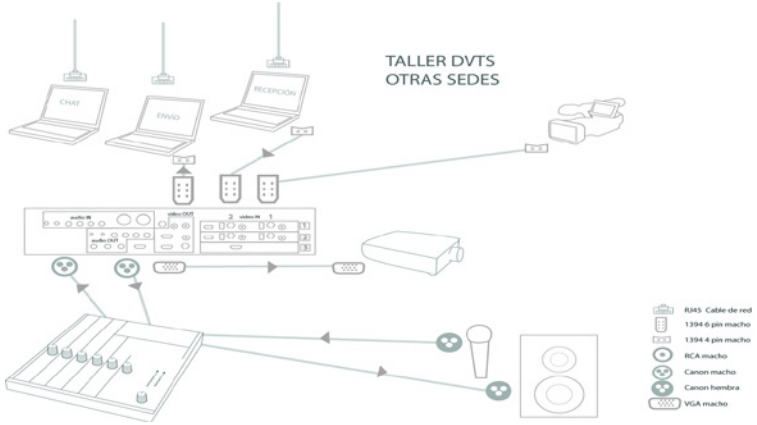



### 5.4.2 Equipment requirements

To develop a virtual performance between 2 locations the basic equipment will include:

- Audio-visual equipment:
  2 Cameras
  Audio Mixer
  Video Mixer
  Video Projector
  Microphone and Speakers
  A/V Capture Card

- Computers and Network:
  2 PCs (1 for Tx and 1 for Rx)
  Symmetric Connection at least 2 Mbps (SD Quality) or 6 Mbps (HD Quality) using h.264 codec
  According to the Available Bandwidth, the proper technology will be chosen




**Scenario**
Source: IGLOR Soluciones Audiovisuales Avanzadas SL

**The Cultural Ring. An example of e-infrastructure for Culture**

The *Anella Cultural* (Cultural Ring) was created jointly by the Catalan government (Generalitat de Catalunya), the Centre de Cultura Contemporània de Barcelona (CCCB), the i2CAT Foundation and the Xarxa Transversal network of municipal councils. It's aim was to develop a network of cultural facilities that will make intensive use of the opportunities afforded by the second-generation Internet to foster content exchange, coproduction of on-line events and research into new uses of the web in the production of culture. It seeks to streamline the dissemination of culture and offers to creators a tool for experimenting with new digital art applications. Anella Cultural is a ground-breaking endeavour in the field of Research, Development and Innovation since these techniques have never before been applied to cultural activities.

Since it's creation in 2006 the network of connected cultural centres has considerably increased:


**Anella Cultural. Evolution of connected cultural centres (2006-2012)**

Through the Ring, thanks to second generation broadband Internet, these cultural centres in Catalonia co-produce and share cultural projects and combine live and virtual events, with a view to making audiovisual communication and technology part of the channels through which culture is created and disseminated. In 2011, via simultaneous broadcasts in various locations, over 40,000 people had access to a range of activities including festivals, talks, live debates, and dialogues with artists, shows, concerts and opera.

The Cultural Ring represents an example of a starting point for the intensive use of the e-Infrastructures for culture. The available infrastructure already available let us think on new uses and approaches, integrating not only performing arts, but also Digital Cultural Heritage.

# 6 References

In this chapter, we shortly describe several examples of virtual exhibitions and virtual performances collected through the survey launched in the framework of the INDICATE project, during several INDICATE workshops and further analysis.

## 6.1 Virtual exhibitions

**Le phare de Cordouan (France)**

French project aiming at 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 large selection of documents, including archives, photographs, video sequences, sound recordings, 3d animations…. The project, managed by the French Ministry of Ecology and the Museum of Royan, is targeted to the general public, schools, university students, children, tourists. It includes a virtual exhibition in a physical environment, makes use of 3D polarizing stereoscopic glasses and tracking technology. It is realized 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.



**Lascaux (France)**

http://www.lascaux.culture.fr

The project, realised in 2008, is a three-dimensional digital version of the cave, allowing visitors to go from room to room of the cave. 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 videosequences 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 in English, French, Spanish, German and the sign language. The content is valorized through augmented reality, zooming, timeline and moving pictures.

**Museu de Badalona. A sensorial experience (Spain)**

http://www.museudebadalona.cat

The museum of Badalona manages an area of 3500 $m^2$ of roman town. In all this area the visitor can live the experience through all his senses, in order to relive the daily life in a roman city. Here, the museography provides not only information, also creates an atmosphere that involves the visitors and give them the necessary elements to understand the archeological site without previous knowledge. The visitor starts 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 the Roman Empire in the country and the construction and development of *Baetulo.* This virtual reality projection was created mixing a virtual reconstruction of the town in a 3D architecture and real characters. Also, the projection recreates part of the archaeological tour that the visitor does in the museum.



**Romanorum Vita (Spain)**

http://www.romanorumvita.com

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, a virtual visit of the enriched exhibition; the online catalogue; the blog *Romanorum Vita* (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. Coordinated by the Exhibitions Department of the Obra Social La Caixa, it is targeted to the general public, schools, university students, children, and tourists. Multilingual project: Spanish, Catalan, Basque, and Galician.

**The oldest wood wheel in the world (Slovenia)**

http://www.koliscar.si

Web portal, which is in working order since the beginning of October 2010. The main protagonist 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 exhibition is targeted to the general public, schools, children, tourists, families. It is connected to a permanent exhibition. 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).

**Anatolian Civilisations Virtual Museum (Turkey)**

The Turkish Anatolian Civilizations Museum is one of the most important and major museums in Turkey, built in the early stages of the Turkish Republic. In early 2000 a virtual museum project was developed. This project is targeted to the general public, researchers, schools, university students, children, tourists. It was realised by the Education Department, ICT Department and Exhibitions' Department, completely in-house. The project is not multilingual. Digital content is composed of texts, images and videos, valorised through slideshow, image magnifiers, pageflip, and panographies.



**Princeses from far lands.**
**Catalonia and Hungary in the Middle Ages (Spain)**

http://www.mhcat.cat/extension/mhc/design/mhc/princeses/index.html

This project offers an interactive multimedia experience of all the contents related to the exhibition that took place at Museu d'Història de Catalunya in 2009. Targeted to the general public, it was commissioned by the Museu d'Història de Catalunya and developed by a private company. The main language is Catalan, but there is partial translation in Spanish and English.

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

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

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 exhibition, but it includes richer content. Targeted to the general public, schools, university students, children families, it was realised by the Education Department and the ICT Department of the museum, partly in-house, partly in outsourcing. Most of

the content is either in Italian either in English.

**Progetto Corsini (Italy)**

http://www.grafica.beniculturali.it/progetto%20corsini/index.htm

The project, 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 volumes virtually reconstructed. The project was targeted to university students and researchers. All digital resources (text, images, videos) are provided in high resolution.

**The Virtual Museum of Iraq (Italy)**

www.virtualmuseumiraq.cnr.it

The Iraq Virtual Museum (IVM) is a multidisciplinary research project promoted by the Ministry for Foreign Affairs and under the scientific supervision of the Italian National Research Council (CNR). The project, shown online in 2009 after four years of activity, is designed to create a content, rich website, free to the general public – based on the archaeological collection of 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, not available yet. The IVM project exploits different new integrated digital technologies for virtual heritage, focusing on the use of photomodelling, 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 seven hours of navigation. It is targeted to the general public, researchers, schools, university students and tourists.



**Elsa's room (Italy)**

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

Digital version of the exhibition held at the 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. 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, and Spanish.

**Annunciation virtual thematic museum (France, Greece)**

http://www.annunciation.gr

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 complementary 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-centered museology. It is targeted to the general public, researchers, secondary schools, university students, tourists.



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

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

Among the collections of the Musée national de la Renaissance, there 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. Today, this masterpiece from the German Renaissance is unveiled in a new exhibit with an interactive multimedia interface. Thanks to 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. The project 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. Content is provided in French, English, and German.

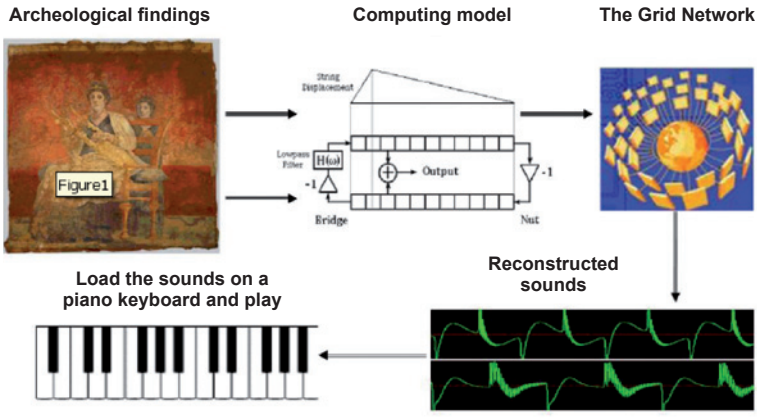
## 6.2 Virtual performances and cooperation projects

### 6.2.1 Virtual exhibitions using e-infrastructures

**The Astra project**

http://www.astraproject.org

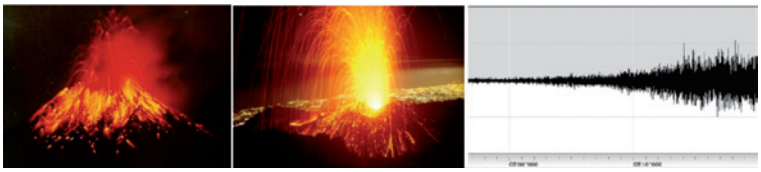
The ASTRA (*Ancient instrument Sound/Timbre Reconstruction Application*) project aims at reconstructing the sound or timbre of ancient instruments using archaeological data as fragments from excavations, written descriptions, pictures, etc. The technique used is the physical modelling synthesis, a complex 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 performances may be downloaded: http://www.astraproject.org/download.html

**Sonification of volcanic seismograms**

Currently, no definitive method to predict volcanic eruptions has either been discovered or implemented. 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 or even days before the event.



Converting seismic data into sound waves, through the sonification process, involves substantial computer processing. The melodisation of a data set allows to convert into aural signals almost any kind of information.

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



### 6.2.2 Education: music and drama

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

Viola lesson made by Maestro Luigi Alberto Bianchi, one of the greatest violists in the world, 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.

### 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**



### Music collaboration: LOLA project

http://www.conservatorio.trieste.it/artistica/ricerca/progetto-lola-low-latency

The Low Latency (LOLA) project 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.

**DancingQ 2006**

http://csperkins.org/research/ultragrid/

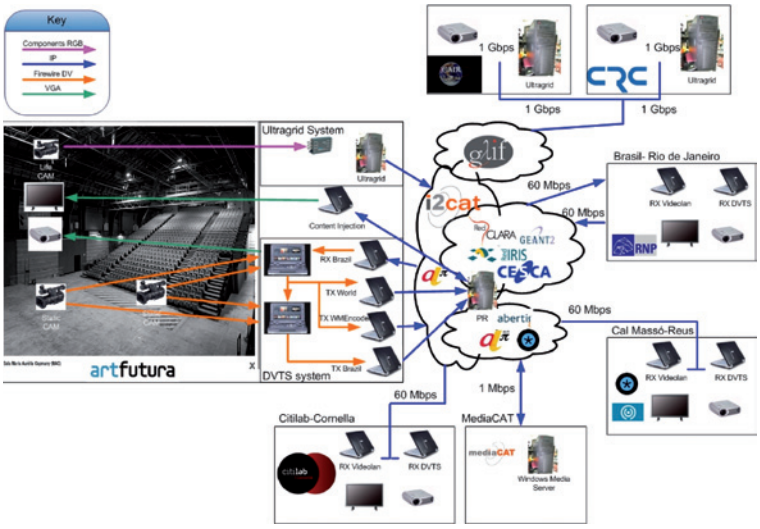
It was the first live transoceanic (Korea-Montreal-Barcelona) transmission of uncompressed HD-SDI (Digital Cinema format) over IP networks using a required bandwidth of around 1 Gbps only available in research networks. The system transmission was based on UltraGrid, a low latency high quality audio and video transmission over IP. During the performance a traditional Korean Dance was transmitted simultaneously to Canada and Spain.



**Art Futura 2007**

www.artfutura.org

During the Digital Cultural festival Art Futura in 2007, i2CAT participated in collaboration, between others with the Catalan Cultural Ring, CRC (Canada) RNP (Brazil), in a distributed cultural event where some events, speeches and performances where distributed along the globe by using heterogeneous technologies according to the individual capabilities of each collaborator. It was the first time that several technologies (Ultragrid, DVTS, Windows Media Server…) and research and commercial networks were combined in order to democratize the technology reaching as much users as possible.




**DIBA 2009**

In 2009, i2CAT in collaboration with Apuntolapospo, Ovide BS, the University Pompeu Fabra and the Gran Teatre del Liceu, performed 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 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.



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

http://citilab.eu/en/node/3973

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: 1) a series of speeches where every topic was deeply discussed in the speech sessions and global cultural round tables; 2) an artistic performance with a welcoming performance that not only show genuine Korean traditional music, but also a networked performance linked to Spain, which was a typical

instance of performing arts over future internet. The technical scene was designed to create a fully interactive scenario with different players that originated a Flamenco-Pansori fusion in Real Time.

**Emergences Festival (France)**

www.festival-emergences.info

This international festival dedicated to new artistic forms and new media was organized by Dédale and took place in Paris from 2002 to 2007. Collaborations were implemented with 2 other festivals organized at the same time, in Strasbourg (Ososphère) and in Aix-en-Provence (Arborescence). They put forward a simultaneous programme of networked performances and creations, of digital experiments and live retransmissions. They also set up a temporary radio created for the event, and which content was generated by the programming of the festivals. A permanent device was also implemented, creating connections and dialogue between the public of the three festivals.
Here are some examples of the networked projects shown during the Emergences festival:



**Se toucher toi, Grégory Chatonsky (France)**

http://incident.net/works/touch/#

*Se toucher toi* is a networked installation, produced by Le Fresnoy, Studio national des arts contemporains, and presented in Paris and Strasbourg. It is an installation using ADSL broadband and composed of three devices: a room, the picture of a landscape and a computer mouse.

By manipulating the mouse, the hands of a man and a woman touch each others. Then, both hands shy away from our power and move independently of our manual movement. It is because somewhere else, on the Internet or in another geographical space, a double of the installation works and another person manipulates the device. This installation makes the spectators-users become aware of their role in the interactivity by making tangible the hand which plays a role of mediation between two other hands.

**(((No music))), La Boîte Blanche and Carl Y (France)**

http://www.nomusic.org/

(((NOMUSIC))) started in June 2001. The platform offers two types of live. In its classical form, the participant plays alone at home for one hour. He can also play in dual. Dual is a live in which two geographical sites are linked via Internet and mixed together in stereo. (((NOMUSIC))) wishes to generate improbable duals and gatherings between two participants during one hour time in a web audio performance.

No storage is made, it is an instant access to a selective event. The mechanism of the programming is not automated; it is relayed manually for 24 hours without any interruption by laboiteblanche and Carl.Y., two real human routers who are at the service of continuous audio stream and who endure technical difficulties and give rapid formation on the technologies of streaming to all the participants.



**Passages, Joëlle Bitton (France)**

http://www.superficiel.org/joelle/research/pages/passages.htm

*Passages* is a public space installation that aims to connect intimately people in different cities. It offers passers-by a troubling sensory experience in which bodies overlap and which begins to form a relationship between strangers. This work was presented both in Paris and Strasbourg, linking spectators from the 2 cities.

**Selfworld / Apparent sensory perception (France)**
http://www.festival-emergences.info/2005/fr/home-24861.php

Paris, Strasbourg and Aix-en-Provence host a real time polymedia environment composed of hybrid technologies: physiologic captors, virtual reality, telepresence...
In Strasbourg, a performance staged by the collective art group Eternal Network is filmed in real time. The images are sent directly to Aix-en-Provence, where a spectator, equipped with captors on his body receives them. All his senses are stimulated by the performance in Strasbourg.
Thanks to the captors, his physiological reactions are recorded and sent to Paris where they will bring life to the Maison de la Villette's architecture. A device created by the Kitchen enables animating with sounds and visuals the front and four chapels of the building. The device is spread over the whole architectural space; it also includes spectators who significantly influence the progress of the event with their number and actions, thus becoming real partners of the event. The sounds in Paris are sent to Strasbourg, where they are mixed with the images of the performance.
The outcome of the performance originates from the overall data gathered from the three festivals; it results in a hybrid video portrait, available online.




**Metamembrana, Marcel.lí Antúnez Roca (Spain)**
http://www.marceliantunez.com/work/metamembrana/

Metamembrana is an interactive audiovisual installation, consisting of a large scale panoramic projection, showing 8 interactive stories, controlled by 4 interfaces. *Metamembrana* was produced by L'Anella Cultural, CCCB (Centre of Contemporary Culture Barcelona), the i2CAT Foundation, the cities of Olot, Reus, Granollers, Lleida and Barcelona, in collaboration with Dédale. When it opened, it was exhibited simultaneously through five exact replicas in each of these cities all linked by Internet.
The installation aims to create means whereby the spectator becomes part of the work. To achieve this, a large part of the content of *Metamembrana* arose through social interaction based on the exchange of ideas and materials between individuals and organisations in each of the participating cities.
The interfaces enable the users to browse through a hypertext made up of eight interactive micro-stories. These can be accessed through the panoramic landscape that functions as an index for the work. Five of these stories are interactive films and they arose from the social interaction.

The landscape also enables access to other interactive devices such as *Fembrana,* which is designed as an online interactive instrument enabling the different exhibition centres to be linked (when there are several), and it also enables spectators to interact in real time with Internet users.

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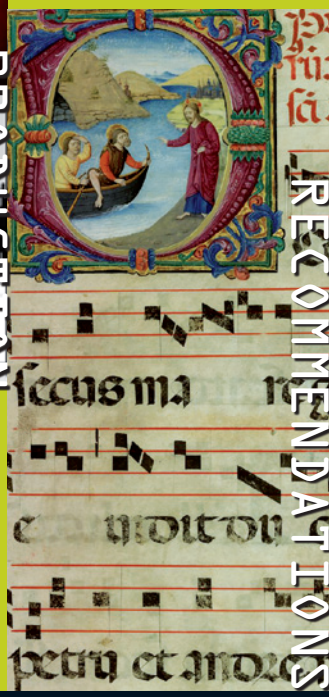


This handbook is targeted to cultural heritage professionals (curators, archaeologists, art historians, archivists, librarians, designers and web designers, information scientists, communication managers, etc.) working in the valorisation and dissemination of knowledge also through exhibitions and performances made available online.

It intends to provide a useful conceptual tool for the digital transition process regarding cultural heritage, which must be tackled with the right infrastructure and adequate conceptual, theoretical, organizational, and management tools, along with an awareness of the deep changes in prospects arising out of the chance to separate the governance of culture preservation from the strategies to promote cultural heritage, which strategies are often aimed at local tourism marketing and the exploration of new forms of cultural tourism.