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# Proceedings of the first ArCo Conference



## **Art Collections 2020**

Design and Museum Design,  
Digital Heritage, Historical Research,  
Posters

### **Editors:**

Francesco Valerio Collotti,  
Giorgio Verdiani,  
Alessandro Brodini

The volume: **Art Collections 2020,  
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## 1<sup>st</sup> ArCo – Art Collections

Cultural Heritage, Safety and Innovation

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Original dates: May 28<sup>th</sup>-30<sup>th</sup> 2020

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## PROCEEDINGS SUMMARY

<b>Design and Museum Design Session (ARCO 2020, DMD)</b> .....	Pag. 5
Uliva Velo, Shaping spaces for exhibitions .....	Pag. 7
Bianca Manzon Lupo, Architecture, museography and museology in dialogue: analyzing the Museum of Tomorrow .....	Pag. 19
Angela Benfante, Exhibition Architecture in Turin. Through the gaze of Pier Luigi Nervi .....	Pag. 31
Francesco Brogna, The Military Museum of the Polo di Mantenimento Pesante Nord di Piacenza .....	Pag. 43
Giada Cerri, Museography and Seismic Hazard: the design project of the Majolica Room, National Museum of Bargello, Florence .....	Pag. 49
Eliana Martinelli, Rebuilding the ruins. Mediterranean open-air museums .....	Pag. 61
Paolo Belardi, Vittorio Gusella, Riccardo Liberotti, Camilla Sorignani, The gipso TECA of the University of Perugia: conversion of a heritage building in a plaster cast gallery .....	Pag. 69
Leonardo Tizi, Dolores Ferrario, Maria Campanaro, Matteo Aricò, The impact of museum design on visit experience from an environmental psychology perspective .....	Pag. 85
Elena Lucini, Chiara Marchetti, Elizabeth Gesualdi, Michele Rambelli, Minimal interventions Leveraging on applied research to introduce small, yet radical, acts of change in the museum experience .....	Pag. 103
Armand Vokshi, Buncart Tirana: dialogue between the regimes in Albania .....	Pag. 107
<b>Digital Heritage Session (ARCO 2020, DH)</b> .....	Pag. 123
Silvia Marín Ortega, Aleix Barberà Giné, Three different digitization techniques for works of art: RTI, photogrammetry, and laser scan arm. Advantages and drawbacks in the practical case of a Romanesque lipsanoteca .....	Pag. 125
Alessandra Ferrighi, Teaching Tools and Methods for Doing History. The History of Architecture in the Digital Era .....	Pag. 139
Chiara Eva Catalano, Stefano Marziali, Michela Spagnuolo, Documenting the restoration process in 3D digital catalogues .....	Pag. 147
Emanuela Faresin, Luca Zamparo, Documentation and Digitalization of Ceramic Collections in Veneto: the MemO Project .....	Pag. 159
Giorgio Verdiani, Digital museums: meaning, use, phenomena and ideas for the virtual twins adventure .....	Pag. 171
Giovanni Pescarmona, Technology and religious architecture: a virtual reconstruction of the tramezzo at Santa Croce in Florence .....	Pag. 183



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Luca Pasqualotti, Contemporary Architecture rising from Tradition. San Francesco in Pitigliano .....	Pag. 197
Laura Carnevali, Michele Russo, CH representation between Monge's projections and Augmented Reality .....	Pag. 209
Novella Lecci, Documenting cultural heritage in rural areas for its understanding and for a development perspective: a map for the Orsini Park in Pitigliano .....	Pag. 221
Paola Puma, The archaeological survey for the conservation of memory, the first step of the Volterra in 3D Project .....	Pag. 231
Paolo Formaglini, Filippo Giansanti, Stéphane Giraudeau, Alessandro Peruzzi, From mega to tera: Data storage and its diffusion for large-scale photogrammetric surveys .....	Pag. 237
Ramesh B, Arun Menon, Koshy Varghese, Remote Rapid Visual Assessment (RRVA) in the Conservation of a Dilapidated Historic Temple .....	Pag. 249
<b>Historical Research Session (ARCO 2020, HR) .....</b>	<b>Pag. 263</b>
Alessandro Diana, Cristiano Giometti, Between art and Documents: Exhibitions in Florence between the Nineteenth and Twentieth Centuries .....	Pag. 265
Beatrice Mazzanti, Exhibiting the Garden: An Idea and its Phenomenology in Florence from the 1930s to the 1950s .....	Pag. 275
Emanuela Ferretti, Lorenzo Mingardi, Trait d'union with History. Leonardo Savioli's Staging of the Exhibitions Firenze ai tempi di Dante and La casa abitata (1965) .....	Pag. 287
Michela Bassanelli, Tracing a History of Etruscan Art Exhibitions .....	Pag. 299
Gertrud Olsson, The Turkish Modernist Osman Hamdi Bey and his View on Artefacts .....	Pag. 307
Lorenzo Ciccarelli, Renzo Piano, Dominique de Menil and the Artifice of Intimacy .....	Pag. 317
William Cortes Casarrubios, Renzo Piano and his Project for the Vedova Foundation in Venice .....	Pag. 327
Francesca Funis, The International Consultation for the New Exit on Via dei Castellani and the "Nuovi Uffizi" Project: a Missed Combination .....	Pag. 341
Nina Robbins, Museological Value Discussion Promotes Sustainable Heritage .....	Pag. 357
<b>Poster Session (ARCO 2020, PS) .....</b>	<b>Pag. 363</b>
Pelin Arslan, A Museum in between: Troy; Past, Present, Future .....	Pag. 365
Andrea Pasquali, Ylenia Ricci, The digitalisation of Cultural Heritage for the non-invasive study of Architecture ....	Pag. 379
Olimpia Galatolo, Physical Architectural Models Heritage and AR/VR Technologies: studies and perspectives ..	Pag. 389



Art Collections 2020, Digital Heritage (ARCO 2020, DH)

# Digital museums: meaning, use, phenomena and ideas for the virtual twins adventure

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## Abstract

In our time, the progressive digitalization of “everything” is moving the society to new behaviors and new paradigms in finding information, learning, visiting a museum, understanding artworks, and taking choices. The transformation is a part of the Industry 4.0 evolution and of the progressive advent of the Society 5.0, even if these definitions may appear a little rhetoric, it is impossible to ignore, negate or neglect the expansion of the digital layer all over the cultural environments, the built heritage and on any kind of collections from those made of simple items, to those grouping rare masterpieces. At the base of any process of digital communication, creation of catalogue, development of a virtual environment and so on, there is the creation of a digital version of the real. The progressive increment of the accuracy of the digitalization process, even if yet far from perfection, brought the formulation of a very practical definition, the one of the “digital twin”.

The digital twin is obviously the digital version of something real, existing, or just designed/imagined and next to be real in the following processes. This term seems to fit well any operation creating a digital copy of any manmade artefact, from the building to the artwork, creating the needed base for study, analysis, simulation, optimizing the level of details and the communication accordingly the aims of the project in which the digital twin production is included. In the museums, the recent development of very affordable ways to pass back from the digital twin to a physical copy has opened a series of possibilities that are worth of attention to any designer and cultural exhibition planner/manager, while they offer wide opportunities in presenting and communicating the collections as well as single items. In this contribution, a series of case studies, from the direct use of virtual digital models to the reproduction with scale variations of large statues and architectures will be explored in the intention of creating a taxonomy and some main guidelines in the use and development of the digital twins for cultural heritage and artwork collections.

In this process a specific attention will be due to the digitalization strategies, considering both the active solutions (i.e., the classic 3D laser scanner) to the passive ones (i.e., Photogrammetry), evaluating not only the accuracy and the massive data gathering, but the overall workflow and its compliance with professional and practical needs.

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## **1. Introduction**

Underlining how much the digital revolution has “flooded” the whole human society, changing behaviors, and integrating any process is almost a superfluous act, it is clear wherever anyone may take a look, and the depth of the transformation comes from an expansion growth in time. The age of development of many solutions talks by itself: first CAD interface and hardware + software in 1963 (Sutherland, 1980), first GIS system 1963 (Fazal, 2008), metaphor of the “desktop” interface 1970 (Baecker et al., 1995), first Mobile Phone 1973, first Personal Computer 1974. Starting from these early steps the evolution of technology at first walked, then it run. At the present state of these continuous digital innovations, museums have seen a great transformation in terms of content and the way of being understood and managed; the almost total diffusion of personal devices and the possibility of connecting to the global data network from almost anywhere, have been added to a large growth in variety and richness.

The recent pandemic event has pushed in the direction of moving online and enhancing the access to digital version of the museums. But this is just an occasional acceleration in an ongoing process. The digital evolution has led to a complex revision of the way of thinking about the museum, the permanent and temporary exhibitions. Significant effects took place regardless of whatever size and layout of the exhibition space, whatever the material on display, whatever the topics. From the specific museum to the larger one, the transition from static forms, marked by observation, to interactive forms is always present and visible. The scope of contents and how to present them has expanded enormously, the museum has become an exhibition and didactic machine, facing one of the most significant transformations since the birth of its concept.

The need to duplicate the museum has emerged, also by creating its digital double, possibly usable online, directly accessible from any computer device. The artworks, the masterpieces, the elements of attraction, have remained a central aspect, but the quality of the communication tools and the importance of the dissemination contents have become an extremely important and present element. The possibility of showing the visitor the intrinsic characteristics of work and the potential to represent non-visible elements have led to the development of specific and efficient communication solutions and have highlighted the importance of representation as a fundamental form of the transmission of concepts, theories, hypotheses, and anything else that can be associated with the reality of the place visited or the work observed. The representation, conducted through current digital media, therefore becomes an important communication tool: it allows the vision of what is not present, of the same work when it is far away, of the appearance of a place before its transformation, of a monument, work, city or single architecture, before its alteration or even destruction; it allows to represent works and architectures never realized, the fruit of the genius of artists and architects, but never materialized in their completeness.

The cases and combinations can be very numerous and multiple, but the centrality of the quality of the representation remains the element around which everything is articulated, not necessarily from an "artistic" point of view, but from that of the right balance between abstraction and concreteness, based on the extent of the level of imagination that is left to the visitor and based on the level of wanted communication completeness. However, it is a process for which the drafting of rules and the definition of procedures are still fully underway, and the cases of the solutions adopted, of course, can be very varied. The factor linked to innovation involves all the parties concerning about the planning of the museum or exhibition, poses large risks of rapid obsolescence and requires a solid knowledge of the relationship between potential and result on the part of who realizes the solution, but above all by those who commission and request it. This latter condition is not always present and potentially causes cost increases and possible missed opportunities. However, some basic examples can be identified for a minimal taxonomy of situations in which the digital contribution integrates and expands the museum's "real" exhibition function. These examples will be listed below, without claiming to be complete, but as a partial listing of application possibilities in which the factor of representation is very present in the definition of the result.

## **2. A new, more “expanded” concept of museum**

Since its definition as a type of building, the museum presents, from an architectural point of view, two main elements that distinguish it. The first is its external configuration, necessarily capable of underlining the entrance



and denoting the appearance and importance of the place based on its relevance, as well as its relationship with the general project to which it belongs. The second aspect of greater importance is the internal architectural space, based on the same project will, but aimed at exhibiting, guiding, suggesting, and exhibiting works and contents. The internal space can also abandon the scheme of the outside. It can create spaces, volumes and paths that divert the visitors' orientation and which, in a positive sense, isolate them from the real context of the place from which they entered.

The visitors pass from an urban area surrounding the museum to the space of the visit, an environment and context different from the usual one, displaced in time and place from surroundings.

The exterior architectural apparatus becomes a sort of filter, a passage space that is the envelope of fascinating content. These two architectural areas overlap and integrate the exhibition apparatus, both in the overall form and in the single exhibitions. An apparatus more and more integrated by digital solutions, by multimedia that act robust interchanges between the virtual and the physical world. The ability to express effective communication becomes a fundamental element in all the situations where digital integration becomes an important and predominant element. Just few digital screens are capable of expanding spaces influencing the perception of the visitors, the clutter of a monitor can give access to spaces and volumes of information that do not correspond to the real size of that place.

This condition is favorable to teaching and concentration, however, requires appropriated and articulated environments, they should be strictly linked to the exhibition logic that is mediated and composed with the "museum machine". The whole system is then completed by secondary but fundamental service and storage spaces, and those of plant engineering. These articulated spaces are most of the time out of sight and access for the visitors, but they pump all the functions needed by their users for practical and comfortable needs.

The structure of these service spaces may be newly designed or an integration and expansion of existing structures, like historic buildings born as exhibition spaces or adapted to this role starting from a certain point of their existences. The coordination of these plants to the general efficiency of the exhibition system is something new, that open interesting and yet quite unexplored opportunities to the design of museum, influencing the sensations in certain rooms or even the behaviors of the visitors. Obviously, such a system strongly needs a digital/informatic control of all the features and probably moves the next step in museum design in changing it into a real "machine".

But today the concept of museum mostly appears closely linked to its exhibition system, to its contents, sometimes very focused on single items or artworks. When setting up specific rooms or exhibitions is needed, the aspect of digital tools becomes a strategic element. This happens because this is the time of IT revolution, and the attention of the users is positively oriented in the use of digital tools, a condition that supports the creation of the illusion that a digital display system may perform the magic of altering space and time.

A screen can present thousands of images in the same space, an interactive object can increase attention towards a real one, so that the visitor will dedicate more time to it; a virtual reconstruction can bring the eyes and mind back to an age far in the past.

In all the cases of permanent exhibitions, a design of new digital integrations should never be too exclusive or decisive, the whole exhibition system should not depend only on the presence of a digital layer and it should never super-impose itself over the artworks or original items. Any technological solution chosen, will certainly see evolutions and transformations, with new alternatives, within few years; an exhibition that is too rigidly anchored to spaces dimensioned on specific fruition procedures could soon be outdated or even inadequate.

The solution of adopting access procedures to the IT part based on the use of each visitor's devices is certainly interesting; it has often been proposed in recent times for the development of display solutions, to cope against the risk of obsolescence of the IT equipment made available to the public and with some significant effect in trying to contain the costs of an exhibition.

Using their tablets or smartphones, the users may have an additional guide and additional learning options, receiving data directly on a device of their own. It is a very practical solution, well capable of exploiting personal devices, making them even more useful and appreciated by their user. But at the same time, relying excessively on solutions of this type may prove to be in the medium and long term not such a brilliant choice, unless planning the necessary updating of contents and procedures based on the instruments available among

users. This involves a planning of activities - and investment - extended over time and capable of progressively adapting the options present in the exhibition to the technological development.

At the same time, those who organize an exhibition based on personal devices must always keep in mind the potential "discriminating effect" caused by the system requirements: if these are all pushed towards the most recent models, a part of the public will not be able to participate, with the risk to produce potential disappointment and ineffectiveness of the experience, especially in medium-sized groups, such as tourists' groups and students' groups.

In parallel to this, if every exhibition or museum today may integrate and enrich itself thanks to the digital contribution, it is at the same time true that for many of these richly complex spaces it is possible to create highly versatile and valuable digital versions. In this sense, the cases can be traced back to two main cases: exhibitions and museums that base their online digital twin on a model that closely resembles the physical form of the real architecture or exhibition, and those who prefer to create a different duplicate, independent from the aspect of the places, an "alternative" solution that can be very varied and then concentrates on the highest level of realism on the reproduction of the collections or on a multimedia variation on the elements of the collections. Some solutions are today very interesting, both for those who design the digital twins of the exhibitions and for those who are interested in the set of knowledge preserved therein.

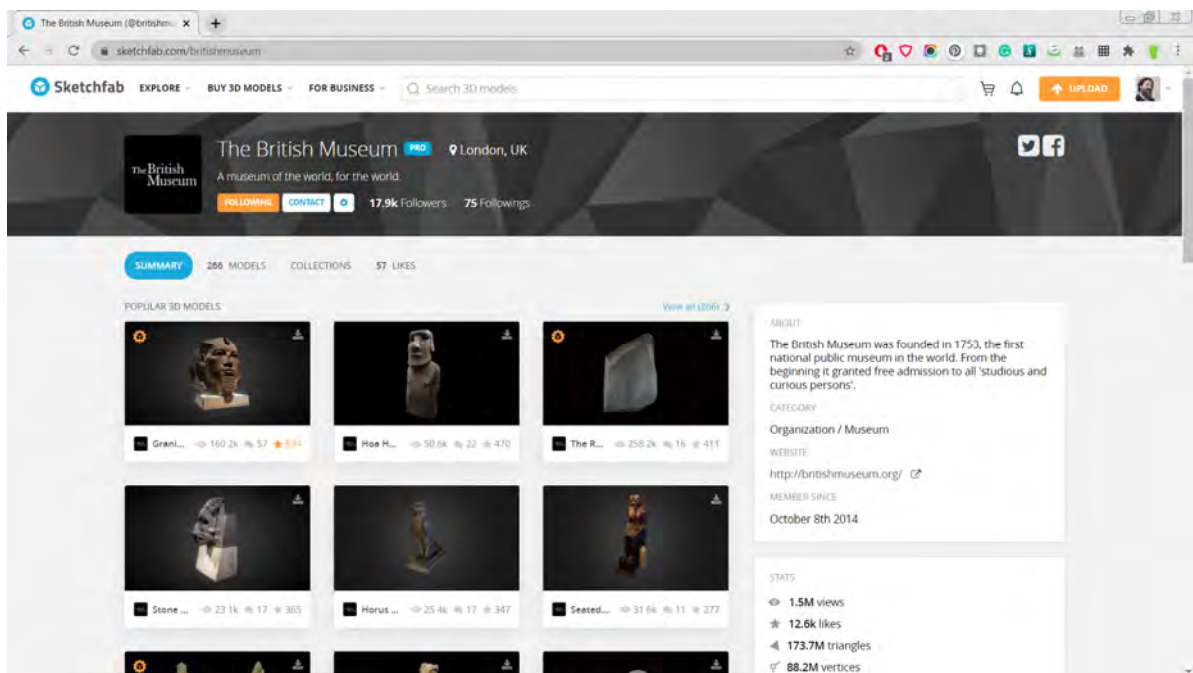


Fig. 1. The British Museum profile in the Sketchfab system, [www.sketchfab.com/britishmuseum](http://www.sketchfab.com/britishmuseum).

The development and diffusion of the Sketchfab platform ([www.sketchfab.com](http://www.sketchfab.com)) starting from 2011 and its initial opening to museums with safe and cost-free data sharing offers, has generously relaunched the presence of digital 3D models that can be consulted by remote visitors. An example above all, is the British Museum, which on Sketchfab has started an extensive migration of digital pieces from its collections.

Other Museums, like the Smithsonian (<https://3d.si.edu/>), have preferred to use similar but different solutions for sharing the digitalization of their collections, sometimes making most of the models freely available at full resolution.

The evolution of digital surveying, especially in the field of photogrammetry, has been certainly an accomplice of this process, which has brought rapid and highly effective tools available to operators from different disciplinary areas. As a result, exhibitions, collections, and entire museums have accelerated the digitalization of their collections.

Thinking about this scenario, it is possible to organize a minimal shortlist of the Museum in the present digital age according to the following:

- Traditional Museums
  - Basic website (mostly to present the contents)
  - Social media profile (mostly to promote the activities)
- Museums with basic multimedia presenting/teaching solutions
  - Short videos,
  - Projections
  - Classic interactive displays
  - Simple online catalog of the collections
- Museums with advanced multimedia presenting/teaching solutions
  - Virtual and/or Augmented realities solutions
  - Complex projections
  - Physical interactive models
  - APP for the visitor's device
  - Advanced online digital twin of the whole museum or of large parts of the collections
- Museum with a complete online digital twin (Architecture space+collections)
- Museum with a digital online version (not strictly conformed to the real architecture or contents)
- Online only Museums

The real solutions may move from one element of the list to the other with a variety of declinations, thus this subdivision may be easily checked in many Museums all around the world. They all share the same orientation towards enhancing communication and capacity of spreading information, making the contents they present more and more capable to deliver knowledge and comprehension about the place (Arslan, 2021).

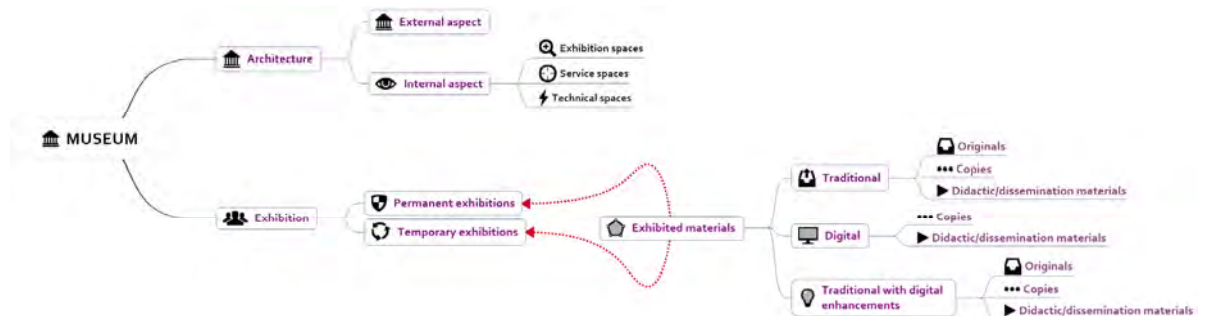


Fig. 2 . The museum and exhibitions in our time, an essential scheme of the architectural aspects and digital expansion of the exhibits.

### 3. Introverted and extroverted perspectives

The digital reconstruction of architecture or of urban parts is still a constructive operation and at the basis of its definition, there is the same logic operation that could create the foundations of any traditional, real reconstruction. Virtual reconstruction may perfectly work side by side to digital integration to the Museums, the creation of a 3D model on screen or in a physical maquette can be an excellent additional part to any exhibition, resolving uncertainties from the visitors and working as a perfect direct communication tool. However, there are substantial differences between every single reconstruction, to the extent that, as the number of available clues, required deductions, the determination of the result increases, while the request for abstraction from the user is reduced.

The will, often very strong and easily verifiable, of wanting to provide "certain" visualizations, significantly increases the demand for the solution of uncertainties by those who scientifically guide the reconstruction and this both in terms of references to other elements that still exist, and in terms of actual ideation, often necessarily forced by mere intuition and deductive process. The operation of "solving" and virtually recreating

what is missing therefore compares the idea derived from the clues recognized in existing buildings and projects over time, styles, and influences. For example, the apse of a church, present only in the archaeological trace and visible in its entirety only in a series of pictorial representations, even when these representations are idealized and/or "disrespectful" of the current rules of representation, can gradually be brought back to a "credible" entity through the comparison with existing buildings of the same period but also understanding how the perception of space has influenced the old representations.

The past process of drawing may differ from the rules of contemporary perspective, making more difficult to have accurate reference elements. Most of the time, starting from few drawings, those who carry out the reconstruction first develop a sort of "introverted perspective", they collect tangible and direct ideas, defining and then selecting the terms of reference, making use of their own visual and cultural heritage experience.

They are called to compare theories and textual and graphic suggestions, coming from pre-existing archives and studies, applying a metrological analysis to what is available and trying to extend a possible layout to the missing parts.

This step can take on a real aspect of reverse design, the one aimed to going back to the reasons of the original project, a retro-designing process starting from the traces and such as to restore the built heritage in a form that, if not properly identifying, at least will show a deep understanding of the past, or, at least, will present a happy intuition. This last step is not particularly original; numerous authors from the past two centuries have ventured into this kind of identification.

Often, they reached a "vision" more than a clear understanding of their predecessors, sometimes operating in order to "restore" and reconstruct the places, not in virtual forms, but often with the materials taken from the reality and working directly on the sites. But this process took place with a profoundly different attitude compared to the options available in the present time.

Even if, wishing to see it in a poetic way it looks possible to assert that time itself proves to be elusive on this topic, almost changing its duration according to the cultural transformation: the restorers of the nineteenth and early twentieth century operating on built and archaeological heritage seem able to operate a special passage, moving their intervention procedures to a position culturally close to their ancestors, they can mimic their choices and read and interpret processes in a way that is difficult to implement in the present, they seem closer in thoughts to the ancient authors, centuries and centuries away from them, than what operators today looks if compared to these past engineers, architects, archaeologists, distant, in time, only a few decades.

The available clues, according to their degree of reliability and according to the level of transformation with which the architectural space has reached the present time, define the obtained model, giving support and mediating intellectual speculation, defining a very complex interweaving of elements, from which the resulting proposal will come out in more than one single solution. But an excessive indeterminacy can never benefit the visitor of a museum, just few people visiting an exhibition collecting the various versions of a reconstruction may really appreciate the possible variables in the various cases.

If telling the story of this uncertainty can be an engaging narration, its communicative ability can support the reading and interest of any visitor, but if the uncertainty is only due to the loss of traces, or the tangle of clues, it is often preferable to present to the public only what is considered the best option between the range of possible ones. The in-depth analysis and the many variables may just remain available for scholars in proper contexts.

The multiplicity of possible solutions will have to be traced back to a preferential choice, something subject to further possible variations, but the chosen solution must be presented with the right level of comprehensibility to the observers, it must be capable of transmitting extended contents, like the design will and the meaning of the place in its ancient/original aspect.

The choices about the form of presentation becomes a fundamental moment. In example, a single representation, in axonometry or perspective, however detailed, will leave a lot to the imagination of the observers who will complete the hidden parts.

A map with all the level of accuracy, properly mapped, may be a good companion to every reconstruction exhibition; different colours will identify the various level of accuracy in the resulting model. At the same time extremely realistic and scenographic representation may sacrifice to spectacularity too much of the possible choices from the visitors. In other words, virtual reconstruction is a work of teaching by images and balancing the graphic message according to intentions. Until the graphic choice does not influence the honesty of the reconstruction.

Considering some case studies that apply these concepts may help to better describe the way this process works.



Fig. 3 . Preparation of the physical models of the Montecastrese fortifications and setting up of the Civic Museum of Camaiore.

### 3.1 A lost fortification nearby Camaiore, Tuscany, Italy

The operation carried out for the reconstruction of the Montecastrese fortification near Camaiore, destroyed in 1224 and presented in the form of a virtual reconstruction at the Civic Museum of Camaiore in 2016, fits into the previously described procedure.

The representation, based on a large view of the digital model of the reconstructed, is accompanied by two simplified touchable physical models of the present state and a hypothesis of the original state, a solution that, graphically and with a significant reduction in the level of detail, manages to transmit the transformation from a fortress to an agricultural area with terraces, trying to communicate the strong and dominant aspects of the ridge in its medieval state.

In this way the models suggest a clear reading of the relationship between the landscape part and the fortifications, supported by explanatory drawings, videos about the exploration of the area with an aerial camera and leaving, various copies of architectural fragments and leaving the rest to intuition.

### 3.2 The destroyed citadel in Arezzo

In front of the previous this is a more complex case, most of all because the complete destruction to the basements of a whole citadel. The ancient Cathedral of San Donato al Colle del Pionta in Arezzo was destroyed with all its settlement in 1561.

The investigation here has required completeness of details and the resolution of all the architectural spaces, supported by various data gathering methods, included visiting other real context with well-preserved and potentially similar architectures, so to capture every possible evidence for the reconstruction. Only minimal traces of the whole citadel remain.

A medieval Cathedral of extreme reconstruction difficulty, for which interpolating between data from the digital survey of the area, multidisciplinary analysis, study of the available iconographic repertoire and identification of comparable elements, it was possible to develop between 2014 and 2016 a first reconstruction that can be completely visited with immersive visualization (based on an Oculus Rift system)<sup>1</sup>.

The whole set of reconstructions and digital contents connected to the research was used in the exhibition "Sacre Macerie, Arezzo torna al Pionta" (Holy ruins, Arezzo goes back to the Pionta Hillcock) which took

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<sup>1</sup> The cultural association *Academo*, "R. Pellegrini" ([www.arezzerperlastoria.it](http://www.arezzerperlastoria.it)) has promoted the research and supported all the phases of the intervention project for the Colle del Pionta. The research unit for the Department of Architecture, University of Florence is composed of G. Verdiani (Coordinator), F. Tioli (topographical survey), A. Pasquali, A. Mancuso, M. Pucci, I. Giannini, G. Chiti, A. Frascari. Data processing: G. Verdiani, M. Pucci, A. Mancuso, I. Giannini, G. Chiti, C. Gira. Geological survey and materials analysis coordinated by dr. S. di Grazia. In collaboration with Dr. S. Vilucchi of the Archaeological Superintendence of Tuscany and prof. A. I. Volpe.

place in Arezzo in December 2017-January 2018, a selection of digital materials assembled in a video was later hosted at the National Archaeological Museum “Gaio Cilnio Mecenate” in Arezzo.



Fig. 4 . Virtual reconstruction of the Cathedral of San Donato on the Pionta hill, Arezzo (C Gira, 2016).

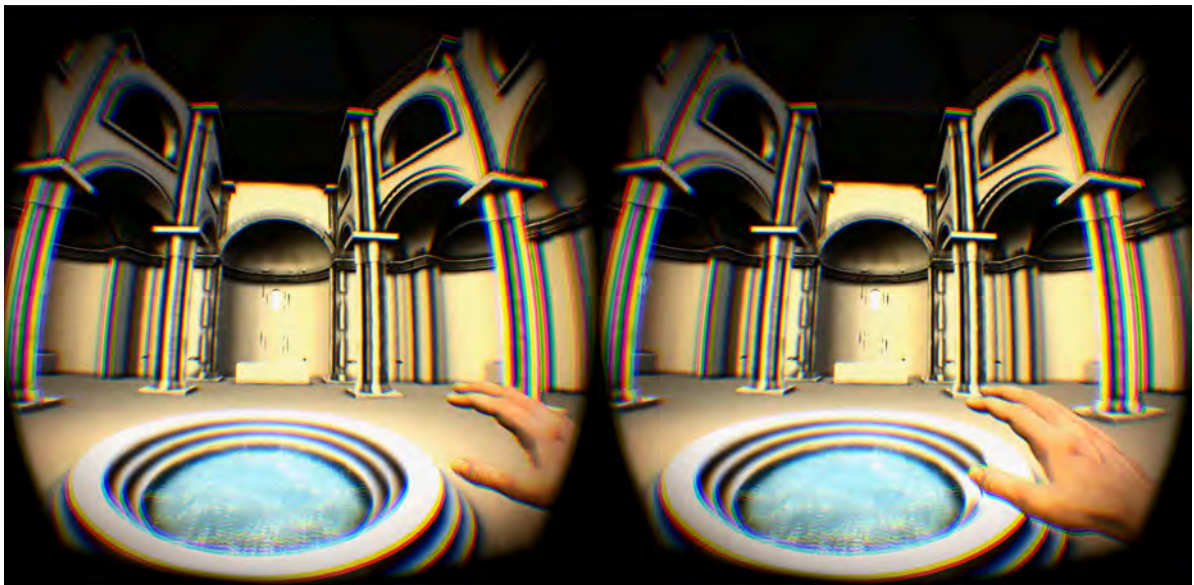


Fig. 5 . Visualization through Oculus Rift SDK2 with Leap Motion of the virtual model of the Cathedral of San Donato at the Pionta hill, Arezzo, internal view (C Gira, 2016).

The relationship between digital reconstructions and exhibition spaces highlights a fundamental characteristic of the set-up and presentation based on virtual spaces, which is the need to present, above all, the quality of contents that should be always a priority factor. The preparation of the operators who perform the virtual reconstruction, therefore, becomes fundamental, both from the point of view of the technical and cultural aspects necessary to define the appearance of the lost place and from the understanding of the technological solutions

available to visualize the result, with a multimedia direction able to understand the didactic act as well as the will and the pleasure of creating surprise in the observer. This requires a type of training of its multidisciplinary nature, which must coordinate very different aspects, rarely (and not necessarily) available in a single figure, but possible and desirable in the coordination of projects of this type. The result of this process will, in any case, be directed towards the users, will bring out the results of the individual operator or research group towards a more or less wide audience, will place the result in an "extroverted perspective" aimed at the observer and intended to convey a summary of what is understood, and which has reached sufficient completeness to be defined and presented. A condition which, however, it would be erroneous to consider always as fixed and stable. The model produced, even if represented according to only one of the methods listed above, encounters an important test bench in the same virtual implementation phase, sets up a comparison with the real "realization" of the hypothesized model and, placing it in a public context exposure, may receive interesting ideas and be able to introduce further alternatives and variables.

#### **4. Some reflections on the context**

The virtual reconstruction of a place requires an appropriate context; this is most often well defined by the designer of the installation but must always be consistent and facilitate understanding of the proposal. Conditions change, even radically, according to the tools used: the use of a static image, a video, an immersive space, or an interactive element requires different spaces and moments of perception. A physical model, a representation of the reconstruction, will have its footprint and the people who stop to observe it will take a space and further space must be reserved for the passage of visitors not interested in this stop. A large, illustrated panel will be best viewed from a specific distance, but at the same time, the design of that space must contain and mitigate the presence of other visitors, who must not be able to become an obstacle to the visit of others. Similarly, it will happen for a monitor that presents a video, and herewith even more important, given the potential risk of missing a passage of interest.

The presence of solutions animated by sounds and music must always be positioned and calibrated concerning the general layout of the exhibition, avoiding confusing, distracting, and interfering with other sectors of the above. Sounds and music can draw a visitor to a room, but if the sounds are too permanent for the entire space of the visit, this could easily be unwelcome. The production of appropriate multimedia, however, opens up an extremely complex front. The spectacularity of graphics and animations often does not derive strictly from the Cultural Heritage themes, but from cinematic and videogame contexts that have redefined many concepts of antiquity in a "pop" version. The general visitor -not a scholar- perhaps does not seek the spectacularity of a film as an end in itself, but often he is certainly not disappointed by it, and a lively, dynamic sequence, which shows reconstructions of a past time supported by music, something with the "Cut" of an epic film, inevitably favours the taking of the theme. Even if in indirect form, a remarkable ability to catch the public attention of a place, an archaeological site, a castle, or a set of particular finds, now a day, may pass from this order of products and with an increased ability in attracting the attention.

Obviously, the hope is that this variation in communication may help in obtaining more resources for scientific activity and not only conveying them in building more and more spectacular shows. However, it is preferable that this product is developed with consistency and positive commitment, so that all the present elements are correctly represented and well balanced, not the victim of excessive scenic effects. While avoiding excessive spectacularity can produce more reasoned products, at the same time the attempt to attribute an excessive "scientific nature" to the virtual reconstruction process may produce equally limiting effects. The number of variables, the level of approximation and the complexity of the choices to be made during reconstruction are very often of such magnitude and articulation that talking about repeatable and verifiable processes is risky; it can be understood as a process to be developed according to clear rules, but the level of personalization for each specific case makes the empirical factor important. On the other hand, those processes of interpretation and structuring of repeatable rules for reconstructions and those which are still under development (London Charter 2009, Sevilla Principles 2011). Last but not least, it is important to remind the importance that any reconstruction should have a support drawing where all the parts are classified by their level of accuracy, a subdivision that may help, especially other scholars, to understand the complex of choices and the degree of reliability of each part presented.

These are procedures mainly based on the attribution of different colour levels based on the level of abstraction

exercised and still being defined according to a single standard. These mapping criteria will allow, if adopted, to increase the readability of the reconstructive process, facilitating the transition between different studies and allowing a gradual growth of certain models (Apollonio, 2016).

## **5. Designed hypotheses and realized hypotheses**

Any architectural reconstruction always starts with clues, which can be of various entities: sometimes they can be certain documentary evidence, such as the presence of ruins, drawings and representations, photographs, archive documents, written descriptions. Sometimes the digital reconstruction takes place with one or more reconstructions made previously behind it. This whole set of traces, however evident and complete, may still require deductions aimed at reconstructing missing parts. In other cases, the traces are minimal, only the concept or a few historical traces of the building are present, the ruin is missing, detailed descriptions are lacking, the location of the building is missing. In other cases, the very idea of the building may also be missing, there are only some parts of it, perhaps even dismembered, but no further traces other than a few architectural elements. Still, the building may never have existed or, better still, have only been designed, so there are only a few drawings of it, sometimes even a single representation. These situations do not necessarily require very ancient contexts to materialize. Situations of war, seismic events and other disasters, inappropriate use and neglect, the dispossession after abandonment, the evolution of the city that requires space and new structures, have led in the past and will continue to lead to the disappearance of architectural structures for which, later, virtual reconstruction may be of interest. This image of the present should remain a clear vision for every operator who faces the themes of the hypothetical reconstruction of transformed or abandoned places. Our present is populated with abandoned and disused buildings, unfinished structures, and construction sites. This is likely a permanent human condition, not a phenomenon of our time. It may have increased due to the greater size of cities and urbanized areas, but the coexistence of structures in use with abandoned areas and areas under construction is necessarily a possible coexistence in all periods. The large archaeological sites, the vast areas populated by ruins of various types, do not necessarily indicate a single phase in which the entire area visible today as a ruin was vital and active; on the contrary, the image of the ruins can convey the impression of a system that despite having developed over a multiplicity of years has been completely used in the same period. The vast rocky areas can be a very clear example of this concept, the incredible number of churches and settlements, such as those present in Cappadocia, Turkey, can suggest a very large and exceptionally devout population, but at the same time, there are no demonstrations of the coexistence of such large populations or simultaneous use of entire settlements. It is credible to imagine that with the progressive expansion of the settlements, the parts subject to degradation were simply abandoned, or "downgraded" to ancillary uses, in favour of the new ones (G. Verdiani 2013). But the image that is received is nevertheless that of the vast settlement, the story received on the spot tends to lead to astonishment, not necessarily to reasoning. Those who carry out the reconstruction process must read and listen but must keep their logic and interpretative capacity attentive: the most widespread belief can often contain both concrete factors and potential deceptive elements.

Wanting to give a logical structure to the virtual reconstruction process, considering an architecture or a site of which visible traces remain, this can be developed, not in order of importance, but in a logical and operational order, as follows: 1) collection of information about the specific theme; 2) any survey of the state of affairs when this type of documentation is not already available or not sufficiently detailed/reliable; 3) definition of a set of graphic drawings useful for the development of the reconstructive proposals: 2D drawings and 3D model for surfaces; 4) analysis and in-depth study of the historical context, of the construction phases, of the comparable elements, of the units of measurement of the time to which reference is made, of all the specific and unique elements of reference for the study carried out; 5) development of a reconstructed model starting from the 2D and 3D bases, developing the proposal from the first or second ones according to the procedure recognized as necessary for the specific case; 6) phase of comparison and analysis with other skills, testing the result, any corrections and variations in the reconstruction choices; 7) definition of the final model, single or multiple result of the previous process; 8) definition of the form of presentation to the public of the reconstructed product, improvement of the model based on exhibition needs; 9) development of secondary analytical and presentation models useful for fixing the process and sharing it with other scholars; 10) disclosure and dissemination of all the research products.

In the case, on the other hand, of architecture or urban part that is completely lost or never built, the process



remains the same, but with the replacement of point two with a significantly different approach which will be: the study of the area of presumed or ascertained construction of the work and collection of all the material useful to allow the definition of a plausible basis for the reconstruction. Wanting to give an example of a case where the "collection of materials" takes on a specific aspect, consider the now "historical" intervention (as it was developed over ten years ago, a very long time for digital media) implemented for the Buddhas of Bamiyan, in Afghanistan, disastrously destroyed in 2001 by the Taliban. For this lost monument, the reconstruction was carried out by photogrammetry starting from the set of documentary and tourist photos available globally. An appreciable digital solution to recover, at least in part, a criminal social and cultural disaster (Grün et al., 2004).

Both for the intervention in a context of pre-existences and fragments, and in the case of the non-existence of visible traces, for point five the procedure, as already mentioned, is very varied and dependent on the object itself and can often require a real process of "retro-design" or "reverse design". This particular approach asks the reconstructor for a clear understanding of the architectural language, of the technical issues, but above all of how the architects of that specific time thought about the project. A very complex work in which the use of contemporary digital tools is essential, but where an elastic and intelligent way of thinking about architecture will be the basis of any significant achievement. It will be necessary to reach a meaningful abstraction to capture the thoughts and logic of a bygone era, but a creative approach and any lucky insights will only help. In the interpretation of the missing architecture, all the certain and concrete references will be fundamental, not subject to variation concerning their evidence, while, for everything that must necessarily be left to the imagination, the identification of design schemes, practical choices, the relationship with the ancient natural territory, the construction techniques of the time, will lead to configure the operational scenario as a kind of journey to rediscover the past. This process may require a well-organized group of skills, but at the same time, it will also need a strong ability to eliminate all influences to rethink the reason for the project from scratch, identifying from scratch the problems and ideas that have moved the design choices.

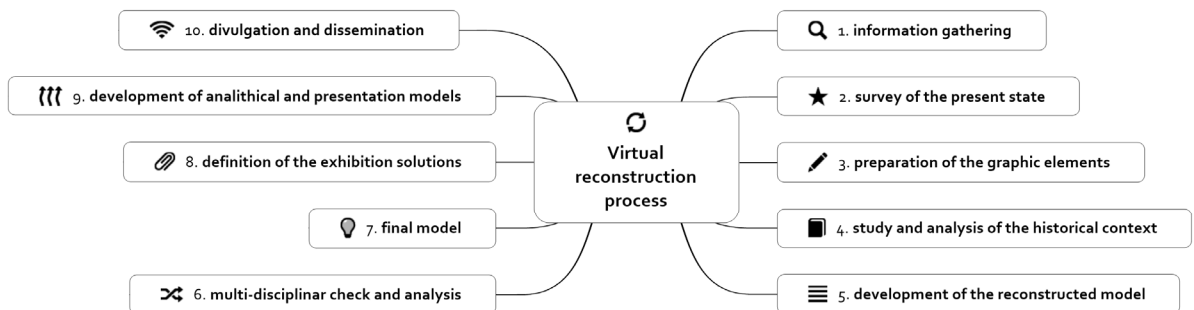


Fig. 6 . An efficient process hypothesis for virtual reconstruction procedures.

Once the reconstruction is complete when the model that concentrates all the theories and reasoning developed will be completed, we will proceed to the definition of the solution in which it is to be presented, defining the most suitable solution for the exhibition project. In the more complex case among those already illustrated, namely that of presentation through an interactive digital model, two quite different cases will arise based, first of all, on the real dimension of what must be presented.

First case: small and medium-sized objects, "manageable" objects (such as pottery, tools, accessories, weapons, etc.) or even only "inspectable" under the virtual condition and free from physical problems of the digital model (such as vehicles, statues, statuary groups, small architectures, constructive elements, etc.); for this category of elements, the model consultation procedure will inevitably refer to the classic interaction operations, namely linear movement, rotation, a variation of the point of view (Habakuk Israel, 2016), possibly supplemented by additional solutions, such as, just to give some essential examples, the variation of the lighting, the variation of the applied texture, the consultation of descriptive cards of the specific characteristics of parts of the object, etc. (Guidi et al., 2015).

For objects of architectural scale, the interactivity may be based, in addition to previous operations, also on processes that allow credible access and visit the architectural space, with the consequent need to define the rules of interaction between architectural elements and visitors. Consequently, you will choose the degree of freedom

you want to give to the visitor in the virtual space, or if you want to offer him an experience that simulates the real (mainly: movement bound to the ground with a human-sized point of view, the impossibility of passing through the objects) or if you want to make the visit surreal (possibility of flying, falling from high points, passing through obstacles). The elements of the interaction can be very varied. Since this is a first-person visit, the possibility of interaction with elements capable of interacting such as movable, interrogable objects, virtual actors, events subject to variation depending on the visitor's behaviour will be limited in complexity and articulation only by the choices and the will of the programming. The opening of models of this type towards a system of "serious games" (adopting a very widespread term in the context of interactive computer graphics for cultural heritage) is very immediate and once again mainly depends on the will and possibilities of those who coordinate the multimedia presentation project (Hale and Stanney, 2014).

## 6. Conclusions

Our age is characterized by the digital revolution and this involves and transforms procedures, methods and forms of communication and understanding, how much the way of representing what is not there has changed can be seen watching movies and video games or multimedia applications. Any cultural heritage operator or common visitors find themselves moving in an expanded context of great complexity, where the technological preponderance imposes rules that are not always easy to grasp by all the operators of a multidisciplinary group, but for which, often, the boundaries and the real possibilities of use can still be something to discover. Although obvious, this broad and rich context highlights a fundamental need that at times still seems at risk of neglect, namely that of coherence and content, of the realization of reasoned and coherent projects that allow effective adoption. and a real and profitable benefit in the adoption of the multimedia presentation project for Cultural Heritage, a scenario in which digital reconstruction inevitably plays an important and strategic role.

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