Sandro Parrinello

edited by

Digital & Documentation

Databases and Models for the enhancement of Heritage

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The volume consists of a collection of contributions from the seminar "Digital & Documentation: Databases and Models for the enhancement of Heritage", realized at the University of Pavia on the day of June 26th, 2018. The event, organized by the experimental laboratory of research and didactics DAda Lab. of DICAr - Department of Civil Engineering and Architecture of University of Pavia, promotes the themes of digital modeling and virtual environments applied to the documentation of architectural scenarios and the implementation of museum complexes through communication programs of immersive fruition.
The event has provide the contribution of external experts and lecturers in the field of digital documentation for Cultural Heritage. The scientific responsible for the organization of the event is Prof. Sandro Parrinello, University of Pavia.

This publication is made with the contribution of DICAr, Department of Civil Engineering and Architecture of University of Pavia, through the joint research of the experimental laboratories DAda Lab - Drawing Architecture Document Action and PLAY - Photography and 3D Laser for virtual Architecture LaboratorY.

University of Pavia

DICAr - Departmen of Civil Engineering and Architecture

DAda Lab - Drawing and Architecture DocumentAction

PLAY - Photography and 3D Laser for virtual Architecture laboratorY

The event "Digital & Documentation" has seen the participation of professors, researchers and scholars from University of Pavia, Nanyang Technological University of Singapore, University of Rome "La Sapienza", University of Catania, Politecnico di Torino, University of Florence, University of Palermo, University of Chieti-Pescara "G. d'Annunzio".

University of Pavia

Nanyang Technological University of Singapore

University of Rome "La Sapienza"

University of Catania

Politecnico di Torino

University of Florence

University of Palermo

University of Chieti-Pescara "G. d'Annunzio"

The event is promoted by the Order of Engineers of the Province of Pavia and by the Order of Architects, Planners, Landscape Architects and Conservators of the Province of Pavia.

Order of Engineers of the Province of Pavia

Ordine degli Architetti, Pianificatori, Paesaggisti e Conservatori della Provincia di Pavia

Order of Architects, Planners, Landscape Architects and Conservators of the Province of Pavia

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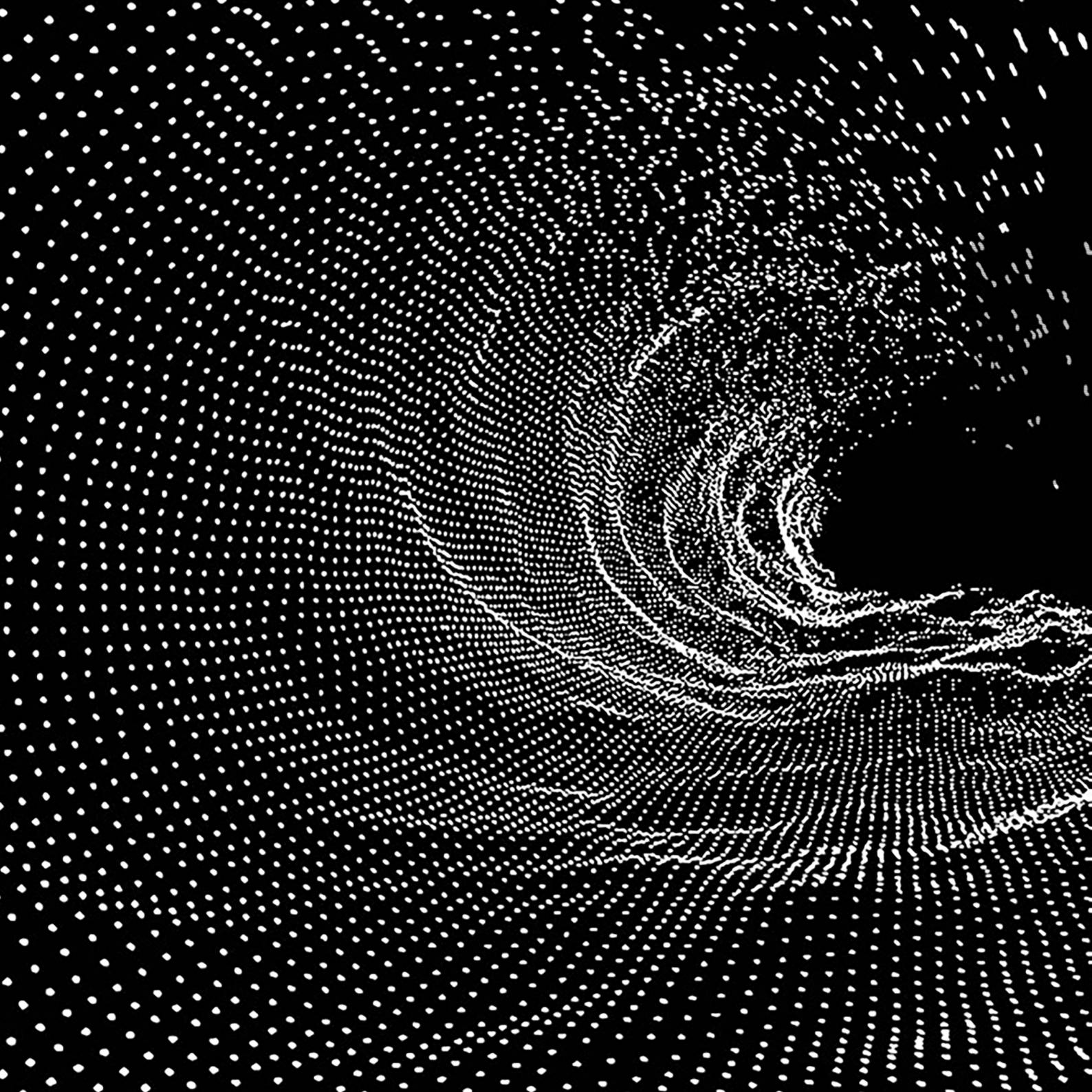
M.A.T.C.H. P.O.I.N.T. THE ENHANCEMENT OF MUSEUM SYSTEMS

Presentation



Digital Models as Medium for Heritage

Alessandro Reali

The theme of "modelling", in the course of the history of research, has always concerned the attempt to transform in "reality" a "virtually" conceived vision, consolidating mechanical or mathematical prototypes capable to establish a scientific foundation explaining the more complex physical and mechanical phenomena of nature. Engineering, understood in all its different and complex forms of study and experimentation, has inevitably found the use of mathematical and mechanical formulations and the application of complex languages, even if universal, maintained mainly in the sphere of written formulation. Today this communicative need finds new possibilities of expression in the digital sphere.

The recurring theme of "documentation" is understood as the appropriation of the historical and cultural heritage, with particular reference to the architectural field, and therefore of its own identity. Thus, it has highlighted how theoretical reflections and deeper analysis on tangible and intangible heritage are able to explain, through drawings and models, the cultural substrate necessary to describe the target contexts, regardless of the science that governs them. The contemporary technological development of this era is affecting not only the techniques and applications of documentary processes, but it leads also to a general process of rethinking the deeper meaning of knowledge and its multiple deriving variations, dealing with systems for the development, management and enhancement of heritage. New representation systems produce new expectations related to digital communication, changing the objectives and constantly renewing the demand in analytical terms of cognitive requirements, also in response to needs more linked to the computational nature of interaction within the models themselves, now capable of providing quantitative as well as qualitative answers.

This phenomenon is directing the professional and academic world to update on practices and elaborations of new outputs, obtaining multi-data products and complex archives of information that can simultaneously respond to multiple purposes.

The increasingly complex management of dynamic flows of data, that produce digital archives, linked to the use of increasingly high-performance technologies, is directing academic research towards the development of documentation and modelling systems that, associated to models themselves, include also calculation codes in order to plan activities and interconnectivity between physical-mechanical models.

Information acquired in current documentation activities on heritage is often overstated with respect to research objectives and, in some cases, not sufficient to fully represent some of the intangible aspects linked to the cultural value of historical heritage. Therefore, there is a strong need to organize the structure of knowledge in order that the available technologies can select the necessary data to define a cognitive framework

of information. Thus, in the form of images and digital models, it develops augmented and implementable tools, generating direct and synthetic information necessary to produce knowledge. In this way, an informative and interactive database, constituted by the union of models and metadata, becomes the instrument for the preservation of historical memory of Cultural Heritage, for architectural complexes, museum systems or intangible assets.

The model, whose numerical component determines and characterizes every aspect of its reliability, can become a tool for the management of the asset in terms of planning interventions in the short, medium and long term, and also for its enhancement.

The conference day in which the first "Digital & Documentation" event took place, promoted by DAda LAB and PLAY laboratories of DICAr, Department of Civil Engineering and Architecture of University of Pavia, included the alternation of guest speakers who dealt with the topic of the digital transposition of cultural assets from multiple points of interest. The central topic of the conference was the paradigm of 3D modelling for Cultural Heritage at the different representative scales, investigating how these models, or digital duplicates of environments, structures, contexts or details, could be declined on different transformation processes to define adaptive readings for heritage analysis.

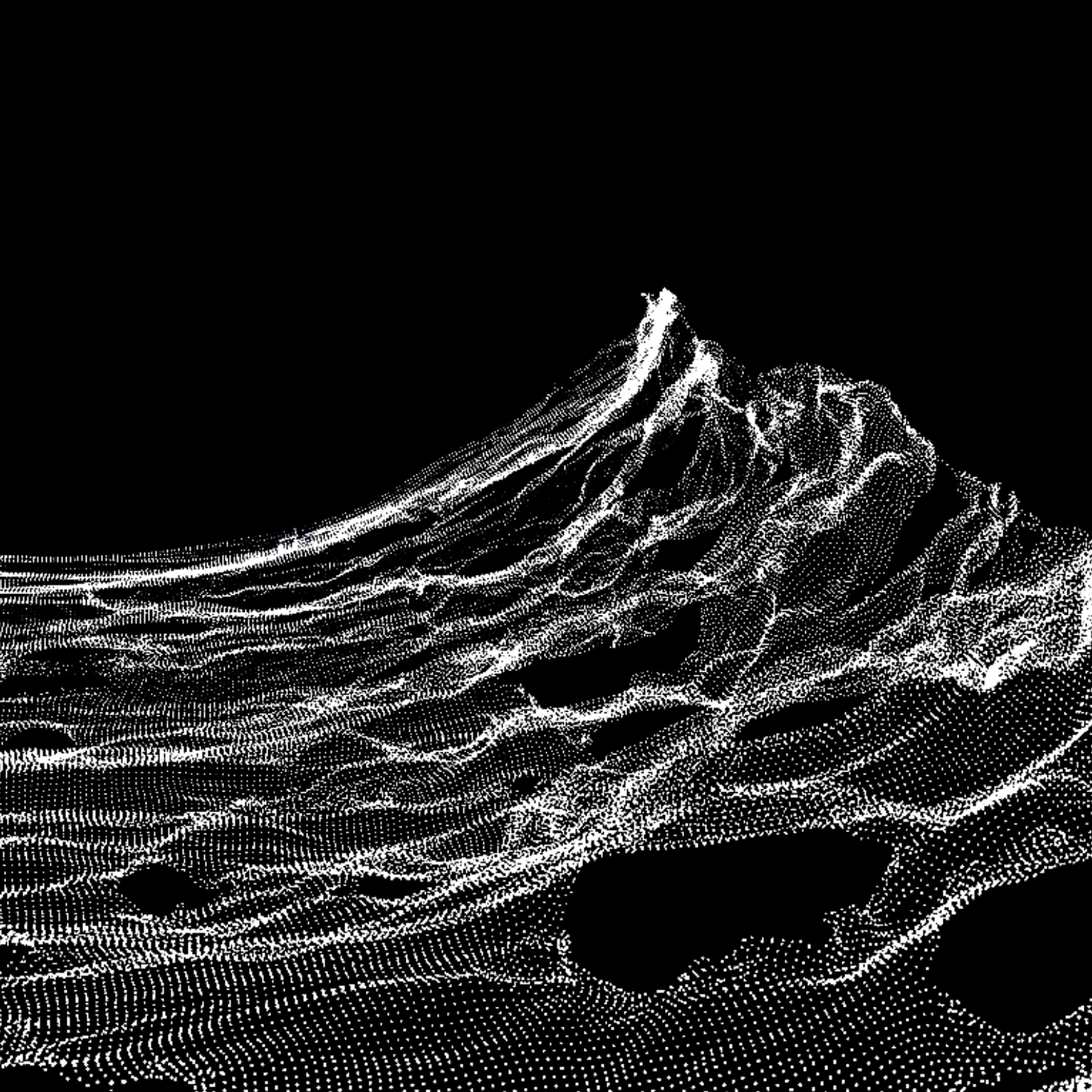
The presented digital and computerized models highlight some proposals to create systems of interaction between users and heritage, in the various forms of the architectural-engineering paradigm. Configured as wide extensions of human intelligence, these models seem to constitute a deepening of characteristics and values of architectural heritage. Thus, they define reading systems of existing objects and implementation systems of information, capable of showing activities directly related to heritage, which therefore assumes the dual identity of real and digital.

The conference day, which offered multiple points of reflection on the subject of digital documentation, was characterized by the participation of professors and researchers in the field of drawing and representation, coming from prestigious national and international universities, and it allowed to face transversal reports on the practices that concern the production of methodologies related to heritage documentation. Theoretical reflections and practical aspects have been added to didactic and research experiences, linked to methodologies and operating procedures applied directly on site; thus, they become able of producing new representations of our Cultural Heritage, in a sort of updated excursion of what, in the academic field, is currently developed in the research for the digital documentation of architecture and Cultural Heritage.

As proved by the various interventions proposed during the event, degree courses and departmental laboratories,

where these activities mainly take place, allow researchers and students to significantly increase their sensitivity and expressive possibilities in the field of documentation of the historical-architectural heritage. In this way, research and experimentation renew the commitment and their centrality in orienting the future designer to a careful reading of physical reality in the digital form, to build the bases of a correct dialogue between project and existing historical-cultural context.

As Director of the Department of Civil Engineering and Architecture of University of Pavia, I can only be satisfied by the results of this interesting conference day, and more generally by the excellent activities that are continuously developed on these topics with great passion and engagement within our Department.



PREFACE

Digital and real: parallel processes of documentation and project

Nowadays, the deepening of the documentation of architectural heritage inevitably implies a reflection on the value that digital communication has assumed in the practice of "drawing" and of the architectural "project". The importance of "documentation" and the selection of a communicative language for the dissemination of our historical heritage, in order to preserve its memory over time, is reflected in many areas of "design", whether it deals with the construction of a building, or the construction of a logical-procedural thought.

A letter wrote in 1470 attests how Leon Battista Alberti provides Ludovico Gonzaga with the motivations that would have led him to transform the Gothic church of Sant'Andrea in Mantua, according to an "ancient" designed project. Thus, it marks the beginning of a binomial between the document, intended as a narrative tool of values and symbols of the past, and the architectural project, intended as transposition of an idea into a physical, material space. Nowadays, the operation of digital documentation is finalized to the production of images that look for a mimesis of the investigated object both in a semi-total and narrative way. The latter, inspired by the shapes of the real, develops to describe and communicate present aspects through a communicative language that goes beyond the visible phenomenon. While Alberti was inspired by an ideal model to communicate, through words, a designed idea, the current society, starting from the real object, is used to transpose through images an idea of architecture that is beyond time, physical and material space.

In this dualism between image and text, understood as vehicles of a particular thought and recount of architecture, communication becomes part itself of the architectural project and, at the same time, it is transformed in a tool for the preservation of its memory. Thus, the architectural space is abstracted from its context, becoming something else, outside time and physical space: in other words, a "virtual" space is born.

The configuration of new architectures in "virtual" forms makes possible to extend the life of historical buildings and to create new spaces, as "timeless" spaces, accessible and available in a further digital time, that is infinite and without dimension. In this sense the virtual image, or the "virtual" in its overall definition, describes architecture and Heritage in their unlimited space, even if not yet existing and therefore not describable. Thus, the new digital configuration of Heritage, shared and globally perceived by a community of individuals that enjoy it, is shaping a new reality of our historical-cultural memory; a transformation of the way in which ideas can be composed, on the basis of experience, to become Disegno.

Progressively, the technological revolution and the diffusion of information initiated with the digital era have transferred the sphere of Drawing and Representation towards an almost totally immaterial communication system. Through digital images, unreleased scenarios

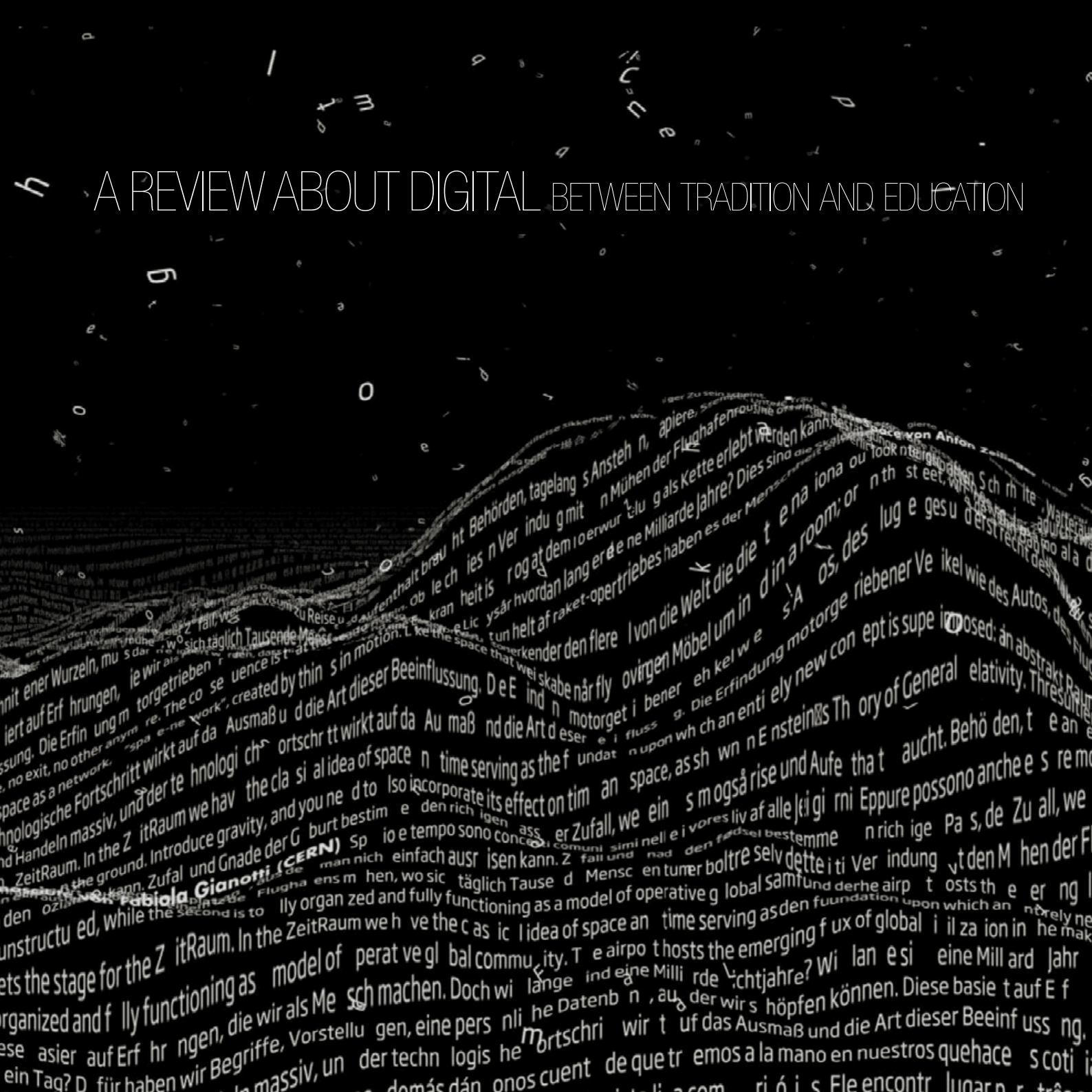
have been prefigured, being part of an idealized future or of a glorious past, witnessing landscapes in continuous transformation. Thus, image is given the task of re-proposing the characteristics of a determined context by implementing its contents and meanings in its virtual dimension, often modifying the concept of reality itself in favour of a greater emotional involvement from the user.
To the many utopian images associated with the "real", the research in the field of drawing and representation is increasingly projecting itself towards the development of new expressive systems, able not only to describe the complexities of contemporary spaces, but also to actively involve the viewer in learning and disseminating the collected information. Within this field of technological experimentation and communication development, which includes contemporary cinematography, serious games and educational entertainment, museum spaces and contained art-works collections have also found their place in recent years, in favour of the promotion of a cultural experience system increasingly projected towards sharing and global enjoyment.
In these new digital spaces, therefore, a parallelism is generated, between real-material and virtual-digital, where human experience wants to configure itself again giving rise to new project scenarios. The implementation of meanings in the virtual context of digital expression grants a second life to the dimension of places, whose laws are defined by a new grammatical reformation of the communicative language given by computer science.
In this cultural transformation, documentation processes are updated to finalize the entire process of data management through a natural graphic decomposition of the analysed set and its transposition into an information system.
This is not a transformation only developed few years ago and now consolidated, but it is a methodological evolution still in progress, as usual, because it is closely connected with the evolution of digital tools for the virtualization of image and the constant production of new meanings. This implementation also implies a simplification of the complexity of real space, so that the process of construction of image replicates, completely, the act of drawing, and the elaborated products become instruments from which to derive simplified and critically interpreted information about the specific described object.
The research activities illustrated in this first volume "Digital & Documentation", relating to a scientific field that ranges from Drawing to Design in architecture highlighting its symbiosis of virtual-real, are part of scientific experiments in which numerous professors and researchers participate at national and international level. The different experiences of digitalisation, of interaction between users and three-dimensional drawings or representations proposed in the volume, show the development of a joint multidisciplinary action within the different researches, with a mix of communication codes necessary to build a lexical polyphony able to realize new learning logics, both in the virtual and real field. "Digital" experience and enjoyment, thus, means

the interconnection of data, and the actualization of actions and design analysis and knowledge that, even at an unconscious level, qualify the learning. Even if the research is moving towards more effective ways in which the technologies of heritage documentation can guarantee the reliability of the obtained databases, the presented researches witness the interest in practices of management and interaction with these databases, till to increase a dynamic transposition of the contained spaces and objects. The Digital is transformed from "target" to "mean" of documentation, becoming an investigation tool for virtual scenarios, retracing the historical memory of artefacts, analysing flows and designing new spaces of the future. The digital reconstruction of a monument, analyzed and measured, means to build a digital "double" on which to experiment the infinite possibilities of management; a model where time becomes a modifiable variable and in which it is possible to review the past, reconstructing the different stages of development and the units that have characterized the growth of the complex, to compare its present and to plan its both digital and real futures, as parallelly possible.

S. Parrinello


ZeitRaum
Ars Electronica Futurelab

A REVIEW ABOUT DIGITAL BETWEEN TRADITION AND EDUCATION



Sandro Parrinello

University of Pavia

Associate Professor of University of Pavia, European Research Ph.D. in Representation and Survey Sciences.
Since 2012, he is Visiting Professor at Perm National Research Polytechnic University (Russia) and in 2015 he receives an honorary degree from the State Academy of Civil Engineering and Architecture of Odessa (Ukraine). Since 2005, he is an expert of UNESCO; in 2011 he was appointed Expert and Voting member in ICOFORT as contact person for Italy.
He is director of DAda Lab. - Drawing Architecture Document Action Laboratory of University of Pavia, and director of Joint LS3D Landscape Survey & Design laboratory of University of Florence and University of Pavia.

01 PRESERVING MEMORY THROUGH IMAGE

LANDSCAPES AND DIGITAL DATABASES FOR DOCUMENTATION

Abstract

The creation of digital media that represent historical architecture, cities, places and environments that actually exist, is nowadays an increasingly widespread practice. In this sense the disciplines of Representation and Architectural Survey, of Drawing, are configured to qualify appropriate paths for the development of reliable models from which to conduct simulations and experiments for the analysis of heritage. The gap between technical documents and informative products is increasingly reducing thanks to the peculiarity of the information systems to be configured not only as a vehicle of orientation for databases, but also as models that, through their image and their virtual usability, collect and qualify information and metadata defining, in addition to experimental representative prototypes, also cognitive structures.
In the digital space of virtual simulations, time vanishes and the image of heritage is re-configured, outlining a new reality, a second life for the represented context, reserving from environmental risks and conveying more information addressed to a multiplicity of utilities, which come into contact with such systems and models. The "digital twin" of the "real" represents an opportunity for the preservation of memory but also an enhancement tool from which the image of heritage is increasingly dependent.

La creazione di supporti digitali che rappresentano architetture storiche, città, luoghi e ambientazioni realmente esistenti, è oggigiorno una pratica sempre più diffusa. In questo senso le discipline della Rappresentazione e del Rilievo Architettonico, del Disegno, si configurano come le deputate a qualificare percorsi appropriati per lo sviluppo di modelli affidabili dai quali poter condurre simulazioni e sperimentazioni per l'analisi del patrimonio. Il divario tra elaborati tecnici e prodotti divulgativi è sempre più sottile grazie alla peculiarità dei sistemi informativi di configurarsi non solo come veicolo di orientamento per banche dati, ma anche come modelli che, attraverso la loro immagine e la loro fruibilità virtuale, raccolgono e qualificano informazioni e metadati definendo, oltre a prototipi rappresentativi sperimentali, anche strutture cognitive.
Nello spazio digitale delle simulazioni virtuali il tempo si annulla e l'immagine del patrimonio si ri-configura, delineando una nuova realtà, una seconda vita per il contesto rappresentato, ponendosi relativamente al sicuro da rischi ambientali e veicolando informazioni più indirizzate ad una molteplicità di utenze, che vengono a contatto con tali sistemi e modelli. Il "doppio digitale" del "reale" rappresenta un'opportunità per la preservazione della memoria ma anche uno strumento di valorizzazione dal quale l'immagine del patrimonio ne risulta sempre più dipendente.

Databases from digital architectural survey: quality and development systems

Heandling with databases for architectural documentation is not just about determining the structure of a large data system on a surrounding context. It concerns, more specifically, with a new cognitive filter, through which it is possible to read and interpret the architecture of things and space. In the search for expressive languages applicable to Built Heritage, the graphic product emerges as an expressive vehicle for digital data, predisposed to update the binomial of "sign and significance" in the byte dimension. Even though, a few years ago, databases were considered a "support" of the architectural drawings and they occupied towering bookshelves in the offices of public administration, today the same drawings, considered as a critical base for the understanding of the context's structure, have changed their image becoming databases, thus "containers" of containers.

Technological progress and the arrival of the digital Era have moved, in the area of Cultural Heritage, all forms of documentation systems towards the realization of digital platforms. These units collect descriptive devices useful for the development of new methodological protocols, appliable for the comparison of heterogeneous information. Similarly, the science of architectural survey in all its different forms, from archaeological to urban survey, has been oriented towards the development of methodologies able to produce digital environments in the form of *point clouds*, as databases of spatial coordinates and vectors. The result of this transposition of data, from spatial "sign" to "code", results in the transformation of all the processed digital graphics in a database, which needs to be further processed and organized in order to be managed for its maintenance.

The possibility to extend the architectural dimension in the digital space, recreating three-dimensional shapes that could be enjoyed as real spaces, is the research basis of video *games* and virtual simulations since the early '80s. Thus, what is happening today is the discovery of a new virtualization process, with the opportunity to transfer the correctness of metric and geometric data into the digital space, increasing the construction of digital archives on architectural heritage in the aim of preserving its memory.

Digital space, dimensionally finished[1], becomes discrete through the point cloud conformation, where every single piece of the surface loses its value if decontextualized, but it becomes increasingly valuable in the context of the entire cloud for the description of the specific dimensional space, environment and mutual relations of its elements. In particular, these point clouds are constituted by dynamic formats, in which the spatiality is repurposed in its three dimensions: thus, the opportunity offered by orbitation empowers the interaction with the virtual space, It allows a constantly changing management of the point of view and a direct interaction with the space, the object or the individual element, improving therefore the knowledge of the digital-real space itself.

As part of the graphic post-production and modelling process that transforms the drawing into a spectacular computing scene, the action of critical re-elaboration reaches its maximum programmatic expression with the awareness of an interaction between databases, both methodological and instrumental. The measurement database, obtained by a practical action on the site, is based on an automatic acquisition and census of points by laser scanner instrumentation or photogrammetric procedures, and it is regarded as the new starting point for renewed actions of interpretation till to develop the drawing. This critical interpretation process of data acquires itself, again, the sense of a real database when it works in terms of interactions within the virtual-digital system.

The optimization procedure of digital models and the export of databases in different formats, which allow the post-production of data, finalizes the result of their elaboration process. Thus, it revolutionizes the relationship with artworks, places and heritage, increasing also a different trust in digital technology, that must be justified at least through the

definition of standardized methodological protocols and certifications, to ensure its validity.
It is important to consider that, potentially, the interactions between different databases are strongly constrained to the ability of programmers, in their management and intervention in problems regarding the nature of files and their connections. In this perspective, the ability to create effective relationships between information systems and representative tools for Cultural Heritage undoubtedly impacts on the ability of a certain community to be "reflective", to better interpret and understand itself and, shaping updated basis, also its own future.
In particular, digital databases for cultural assets are the necessary means to structure models able to reproduce the complexity of reality, since they can provide tools for virtual simulation and connection among environments and contexts, even when they are all quite different. In the same way, contemporary digital databases are characterized by the necessity to interact with the numerous areas of documentation, description, control and simulation of the real system.
In the recent years, the increase of databases regarding cultural assets has marked the creation of numerous libraries and archiving systems, destined to disappear because of the fast evolution of the state-of-art of technologies. A crucial starting point for a significant related reflection is on the architectural research, where databases have to assume complex forms, supporting a three-dimensional nature, and to interact with different kinds of data and information, including representation systems of space. As a result, the main critical issues are both: linguistic/cultural, where the graphical structure not only involves the lexical communication but also defines the forms for the representation models, i.e. the

Fig. 1 - On the left, one of the greatest interactions between social and information-communication: the "post-mortem" exhibition of Michael Jackson, in 2014, performed at the Billboard Music Awards in an hologram form. On the right, the transposition in 2016 of Uffizi Museum of Florence in Tokyo: real-size paintings, interactive screens and a small 4k 'theater' were reproduced to create a more realistic experience inside the virtual museum.

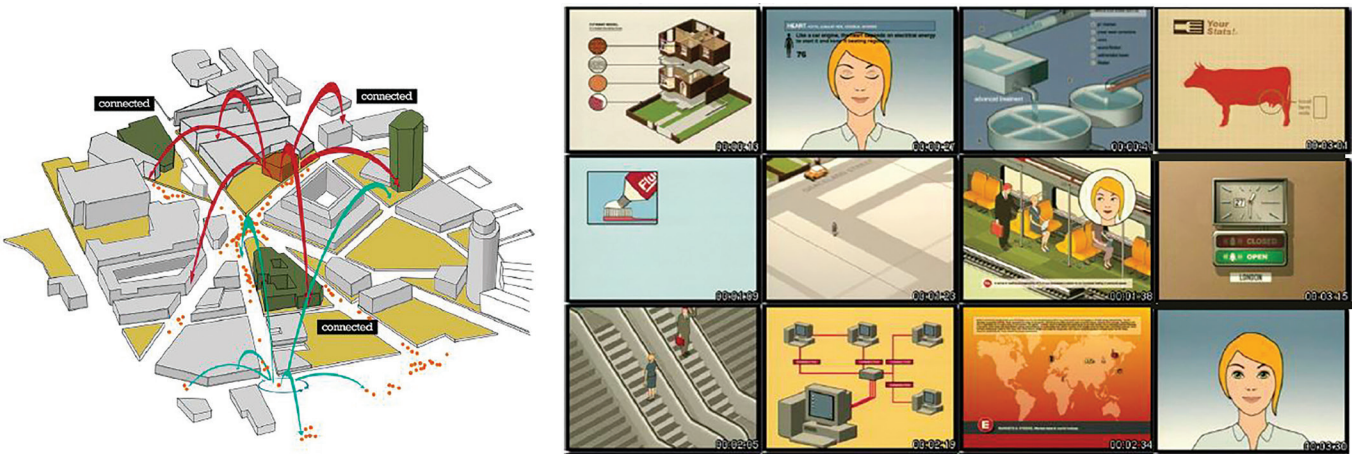


Fig. 2 - Some images from the video "Remind Me" of the Norwegian group Röyksopp (2002), that allude to an interconnected landscape, including buildings, streams of people and communication systems between them. Each element of the city is part of a constructive process managed in a digital database.

cognitive structures relating to both the real and the virtual systems of databases; technological, where IT technology, web-graphic, drawing and different engineering solutions for communication shall find a proper way to interact, in order to unify languages of digital nature.

Real-time communication, use and interaction

The issue of the different natures of digital data has to be considered, mainly deriving from metric and photographic acquisition processes and than elaborated in the form of three-dimensional systems with high information content. Thus, it is necessary to point out the representative nature of the resulting models, validating a methodological path to lead them as essential communication and management systems of the specific surveyed object.

The visual appearance of *reality-based* models, with their corresponding texture, is often sufficient to satisfy a first demonstration purpose about the ability of some software to generate three-dimensional models of very high reliable perception to the target object. However, the interactivity offered by current navigation systems is able to amplify the visual communication offered by 3D models, investing in their *reality-based* potential[2] as for *Structure from Motion* products with shapes that imitate human vision and gestures[3].

The spread of new open source media and the new "fluidity" in conceiving contemporary places and architectures, no longer as part of an historical process but as "information" belonging to the digital sphere, is added to the theme of interactivity, of the concept of "being" here and there, out of space and time and always interconnected with the world, that has led to an epochal revolution in the field of information technology and graphic representation[4].

Cyberspace and virtual reality, where the new three-dimensional representation systems of environments are inserted, allow to configure spaces, places and objects where

the various aspects of representation coexist, from the sign to the digital data, from text to sound. Thus, the configured virtual reality can associate multiple communication purposes: from a simple visit to the surveyed and virtualized architectural asset, to its hypothetical reconstruction, redesign, reconfiguration.
The post-production of the digital model in a virtual environment requires a lot of attention, control and management of data by the operator, in particular according to the nature of the model within the cyberspace. Reality-based modelling uses numerical models, consisting of polygons and vertices, which approximate the shape of each architectural element, from a corresponding discrete 3D database with a certain number of polygons chosen according to the purpose of the database. In order to be easily shared on web and by users, the corresponding virtual models and places require careful planning to be easily recognizable and codable. Thus, real time systems, receptors of these digital products, offer different levels of interaction between users and virtually modelled environments, from the lower (as QuickTime VR systems) to the higher interaction, as the latest generation Games, capable of sharing spaces and settings between multiple users.
The transformation from a two-dimensional to a three-dimensional system, organized on various levels of investigation, is link to the possibility of each element, surface or single polygon of the model to be selected and interrogated.

Fig. 3 - SimCity is a management video game developed by Maxis and published by EA Games since 1989. The objective of the game is to create a new city starting from nothing or from an already existing city. To improve the quality of life of sim-citizens, it is necessary to deal with the construction of police stations, fire stations, power stations and other services that allow the city to survive, all complicated by a series of environmental disasters that hit the city. The view of the game in the early versions of the program is from above, replaced in the following by an isometric and perspective view.

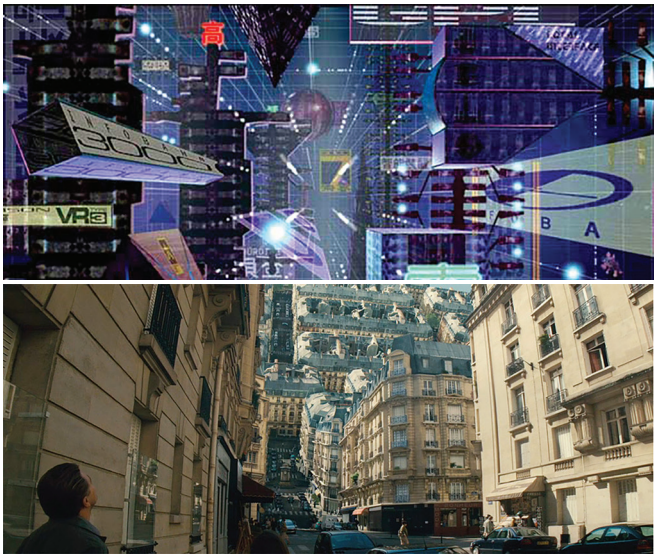


Fig. 4 - The digital space that looks like a city in the movie "Johnny Mnemonic" (R. Longo, 1995) and the multi-dimensional virtual reality of "Inception" (C. Nolan, 2010). Immersive systems that use databases produce more and more facilities similar to the real space, in which to overcome the three dimensions and to extend space toward infinity.

Thus, it becomes part of a methodology capable of extending the use of the digital image and reality-based modelling not only in the field of management but also in that of virtual real time representation.
The dynamics of the "movement", in fact, play an essential role in the contemporary communication system and above all in the digital age: the simulated object can rotate with respect to the observer or be static while the observer goes around it, in a total decision-making autonomy. Furthermore, the scene can be enlarged or reduced and topologically transformed, so as to greatly amplify the perceptive capacities of users. The experience of total immersion in three-dimensional spaces (Virtual Reality) allows to deceive the senses of the viewer, offering more capacities that in reality, involving him in a digital space with the possibility of its manipulation. Thus, the described space must be composed of polygonal models optimized to simplify the file management, associating textures of excellent quality to perceptually increase the geometric detail[5]. Thus, virtual reality assumes the function of configuring itself as the most effective system of representation of space, allowing the user to analyse, manage and interact directly with the globality of information in the database.
Parallel to the options of fruition, the management procedure of semantic division of elements of the virtual scene constitutes an indispensable organizational structure for the storing process of data, starting from the mental act of drawing to integrate and transform the corresponding digital system, in where each element can be part or can constitute an autonomous database, exhaustive and predisposed for the user.

A digital landscape for the human dimension

The potentials offered by the panorama of virtual interactive fruition must not deceive on an excessive confidence in the capacity of tools and software. The development of a documentation project through digital technologies continues to require a project activity that is completely similar to the same of survey. It is necessary to assess the objectives of the survey, to understand the most appropriate tools for providing data that are joint to the expected results, in terms of numerical values that qualify specific phenomena, and as most appropriate methodologies to realize these measurements, following a process of discretization on the shape of target objects for survey and documentation.
The definition of a structure that qualifies the surrounding landscape is included in this activity of analogical computation. The delineation of a given element implies the consideration of its existence within a wide system, not only from a dimensional or contextual point of view, but from a more general cultural context. It is not a coincidence that survey activities partly coincide with a process of study of documentary sources and analysis, previously defining that same phenomenon. From this first survey, guidelines are determined to define

Fig. 5 - On the left, Ivan Sutherland's machine, made in 1968 as the first virtual reality system with a viewer, inspiring the field of cinema and whose development led to the creation of VR glasses offered by Google company. At the center, the interaction and movement of the body in Sensorama machine, the first to allow the use of immersive virtual space, which inspired '80s video games up to the dynamic interactions of Nintendo Wii. On the right, immersive systems in the film world: from Tron (1982, by S. Lisberger); Tagliaerbe (1992 by B. Leonard); to reach the most recent Matrix (1999, by L. and A. Wachowski) and The Cell (2000, by T. Singh).

the contours of the documentation target, and the necessary information is acquired for a direct comparison with the real system, considering their correspondence in the present. Thus, the applied documentation product will enrich digital archives, documentary systems and information systems, implementing another puzzle of the devices' panorama for the description of that cultural context called "landscape". Landscape itself is the act of representing the landscape. There is no landscape without a landscape imaginary. The landscape can express itself in many terms, including those statistics, but it cannot be expressed only in the quantitative dimension, it must include qualitative aspects that reside in the character, in the temporality and in the constant relationship of its connection to man. Classified as a project in its own definition for the expression of relationship between man and environment, the landscape is semantised and involved of multiple meanings.

The knowledge of a landscape implies the necessity to define a common territory of representation of a specific cultural identity, and therefore it refaines the aim to gather and connect symbols and forms to define criteria of correspondence to a determined context. Thus, the ability to represent these aspects and characteristics imply the possibility of defining communication systems through which these cultures express or have expressed themselves. The result of this connection between man and context is experienced in different civilizations and in their models of shaped languages and self-representations. Perhaps, the highest expression of this relationship, considering the material culture and the implementing and gathering of meanings from the context, has to be found in architecture, which responds to the necessity to inhabit a territory and which describes, through decoration, also symbolically, the relationship that connects a civilization to a place.

Through digital technologies and research activities aimed at the construction of three-dimensional databases, landscape and its architectures reappear in the digital space, materialized in a structure that interconnects them. The digital space

Fig. 6 - The methods of interaction between users and digital databases in the entertainment area. Some of the most well-known video games, such as Hit Man or Assassin's Creed have partly taken up the fantastic scenery of cyberpunk landscape, adapting it to market needs.

thus qualifies itself as a territory of connection, of remote use according to specific codes of access that concern the programming and qualification of virtual "environments".
In these databases, which today greatly affect life and communication in the real dimension, a "second life" takes shape, not only about people and their interconnection through the re-modulation of languages, but also concerning the landscape that changes appearance and concretizes, precisely because of new connections, in the possibility of finding new representations that feed the relationship between man, civilization and territory.

In the digital space, time is also compressed and remodelled according to new qualities. The connections that have characterized the development of historical landscapes are expressed and, at the same time, renewed, offering themselves new opportunities.
Virtual realities or digital worlds are now considered, not only from the technical and practical aspect of support to conservation activities, as real opportunities or second opportunities for the survival of heritage (second life). Thus, the preservation of a digital heritage that documents its own life and activities remarks a considerable importance, and these databases, especially the risks of real heritage, may constitute themselves as assets to be protected in their function of preserving memory, shape, dimensions, physical aspect and intrinsic problems of the object in a form that is closer to the real one. Their role is thus not only joint to memory, but it concerns the virtual duplication of monument and heritage that, detached from the physical features and risks of the real place, can be kept in another safer place as the *cloud*, the digital database.
In recent years, the application of digital technologies and 3D modelling practices have reconfigured interpretative models and they have introduced new terms for assessing their quality, not just the aesthetic nature of places. The developing space is not the only one to be virtually represented, but also the methodological experience is realized through simulations and modelling, to learn the appropriate relation to real systems. Digital attitudes of simulation have over time renewed the mechanisms of these tools, and today interpretative logic and practices of intervention are replaced by an extremely detailed digital documentation system, with all the complications that support this procedure.
The confidence in digital technology, in the quality of source data to confirm the conditions that characterize the state of places, has motivated numerous studies and research activities. This paths of research, from the more philosophical aspects of interpretation of the graphic sign, focused on the specific operational practices to translate the information of real environments into signs.

Cognitive models and virtual platforms, interaction with data

"*People live and interact into the space, and each shared action has a value, a sense, an interaction based on the context in which it happens, the community to which it relates, to the local or global dimension in which it manifests*"[6].

The influence of physical places on the individual, as its inhabitant, shows how useful it is to consider the space as a dynamic phenomenon, within a reciprocal conditioning of limits of action and expression between the "context" and the "individual" subject. Virtualization of physical space has led to a radical revolution in *user-space-time* relationship: the interaction between the subject and the type of information takes place in the cyberspace and, "*bringing the gestures of the individual and the actions of the community to find fulfillment beyond real spaces*"[7], operators are forced to rethink the methods of approach to information content and their nature, necessarily re-shaped according to a new digital configuration. Cognitive models for information acquisition, processed and re-proposed within contemporary digital databases, assume a fundamental role in the management of information content and the interaction with users. They provide with a continuous action of feedback, with a far and closer approach between the real system and the parallel one that virtually simulates and amplifies contents. The virtual space is able to establish new canons of information and experience, configuring itself as a container of multicultural and interconnected information thanks to an increasingly participated form of knowledge construction. The "containers" of knowledge are configured as innovative spaces, interactive platforms in which intangible relations converge between users and virtual worlds responding to the perceived space, implemented by the ability to go beyond the laws of physics to facilitate every possible simulation of the real in terms of use of digital space.

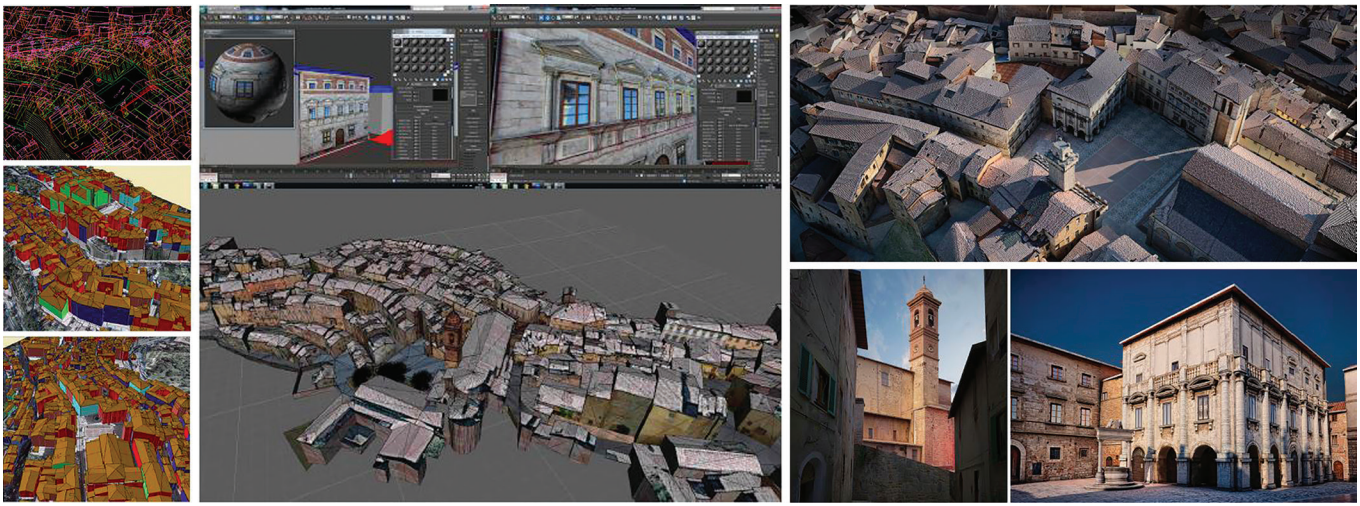


Fig. 7 - Some views of NURBS modelling and texturing of the 3D model of Montepulciano historical city center (SI), developed on the interactive platform of Unity 3D. The possibilities offered by navigation are characterized by the use of a visual interface and an interactive multimedia framework, which is revealed as a real emotional environment.

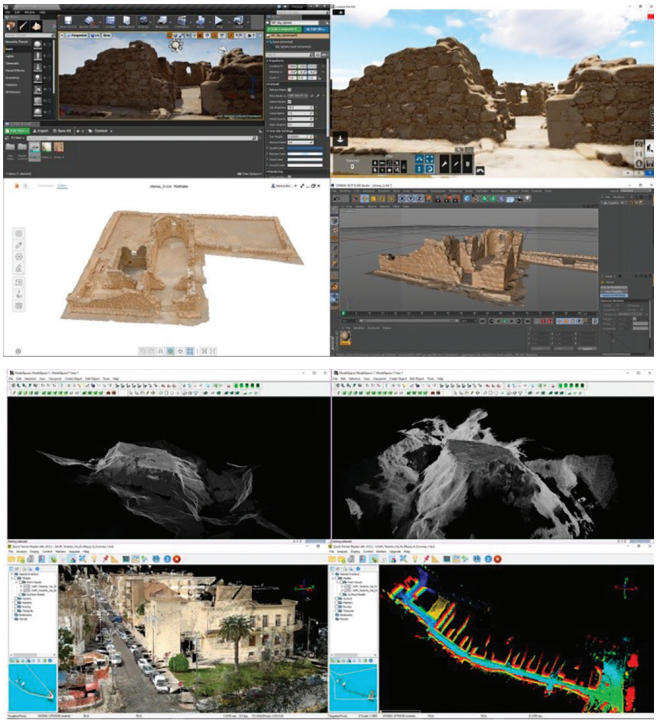


Fig. 8 - Different interaction with 3D databases: from the SfM modeling of the buildings ruins of Masada plateau (Israel), till the point cloud database acquired with laser scanner instruments of architectural and urban contexts of Taranto historical center (Italy).

In order to offer a system of interaction between user and container as intuitive, stimulating and productive as possible for the community, the interface between database and operator has to assume a specific representative language. When the platform joins the ludic character to the function of high information content system, it becomes a didactic and dissemination tool, within which more or less complex spaces are able to assume the value of navigable virtual museums. *Serious games*, as "*games that do not have entertainment and fun as their primary purpose*"[8], have been developed for mainly didactic and knowledge purposes, and they continue to be applied also in the architectural heritage documentation. When they deal with issues relating to the survey of architecture and its representation, it is necessary to consider the advantages and disadvantages related to the real-virtual relationship: creating reliable 3D models and high-level simulations involves using the best available software and hardware. It is therefore essential, with a view in optimizing production times and costs, to clarify the objectives that have to be achieved within the creation of a virtual platform.

The experience of immersion in three-dimensional models, designed to be used on World Wide Web (such as Virtual Reality Modelling Language system, VMRL) allows the sphere of representation to go beyond the sensorial limits of the viewer. This offers new opportunities to interface with space, and to allow the development of an independent configuration of time, approach and modalities of interaction with the digital environment. Virtual models and the attached information become part of a museum system that, in the case of wide architectural or archaeological complexes, are configured as real open-air museums, where the visitor is accompanied to become himself part of the visit-story. This is in contrast with the traditional use of real space, in which information is made explicit by the contents themselves, through various kinds of media.

The type of "mixed" museum combines the traditional system of visiting a museum space with the possibility of amplifying its information content through augmented reality, increasing the visitor's sense of fulfilment through the emotional involvement offered by a different narrative approach. Contemporary public desire to feel itself as protagonist of the "performance" and this type of approach to the visit certainly increases the interest for knowledge, understanding and respect of Cultural Heritage.

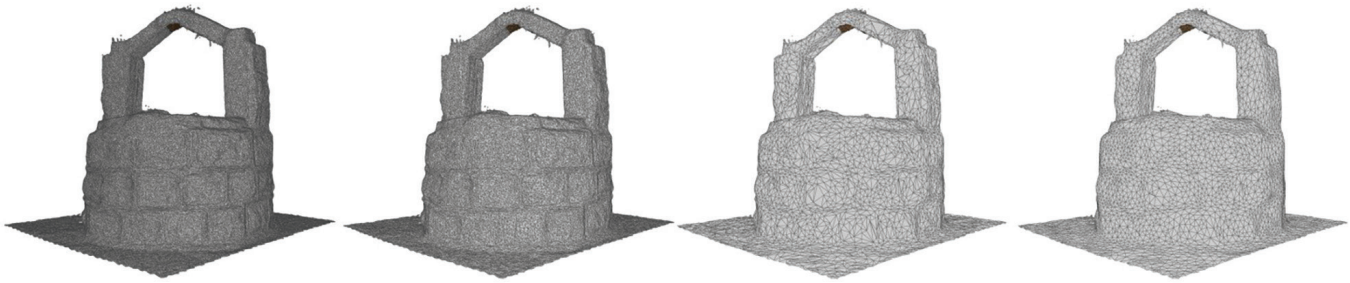
The hybridization between representative systems of drawing and photography seems today to contribute to the representation of complexity, by combining metric-dimensional and quantitative information with qualities of aesthetic character. Therefore, photographic image and reality-based modelling

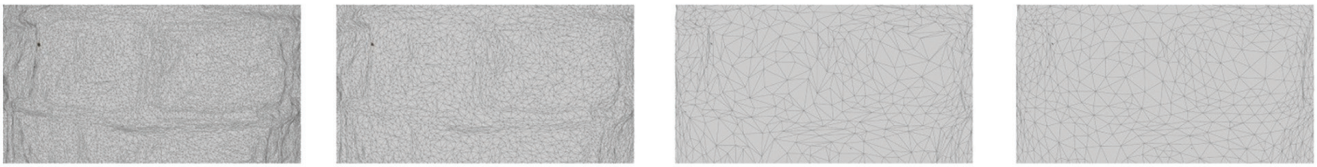
become central not only for documentary purposes, but above all as systems for a more complete and truthful representation of three-dimensional spaces for real-time fruition.
In this interaction, the procedure of semantic organization of the 3D model centralizes, through the drawing, the critical interpretation of the virtual scene, and it allows to generate an organizational structure useful both for data storage and for its visualization on Web systems. Cognitive models make it possible to find a specific correspondence between the model, the represented object and the fruition system precisely in the graphic explanation, or drawing, that constructs and instructs the virtual space defining the graphic structure of the scenario.

Drawing and construction of virtual scenarios, application examples

The use of databases, produced by digital survey processes, changes the constructive choices of drawings in relation to the different archaeological, architectural or urban scales of the reference system. The definition of methodologies for the structuring of interactive databases on Cultural Heritage can be summarized in relation to different purposes, concerning the development of models for the creation of augmented reality or for the realization of virtual realities referable to *serious games*.
In immersive systems, the methods of interaction with the virtual space (static, semi-static or dynamic) must be programmed, while for augmented reality it is important to consider that a filter, the real space, will always be identified between the user and the drawn space, and the virtual information system will constantly compare with it. The augmented reality defines the overlapping of fictitious layers, modifiable and implementable,

Fig. 9 - Virtual scenarios applied on the 3D model of Montepulciano, in Piazza Grande. Different illumination of the virtual scene has been simulated to change the perception of the place.





HIGH POLY MESH | FIRST DECIMATION | LOW POLY MESH | UNIFORM LOW POLY MESH

Wireframe | Solid | X-ray | Texture

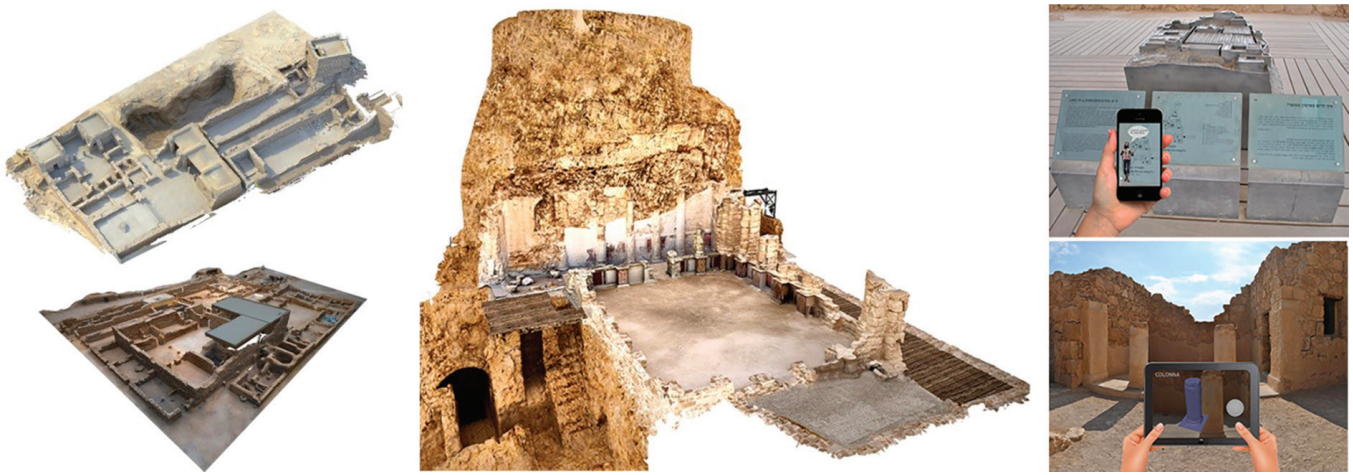


Fig. 10 - In the previous page: management and optimization of polygons process in different architectural 3D models, obtained by SfM methodologies. In this page, some optimized 3D models of Masada plateau (Israel), used as interactive "containers". Next, some augmented reality simulations. A descriptive content of explanation of the "query" object was associated to a "sensitive" display panel. The column is georeferenced and the information contents can be displayed on specific device (smartphone or tablet).

on real elements, and it allows the hypothesis of different narrative paths in relation to the different types of users. The visitor, identified according to specific targets of the graphic project, can enjoy the contents chosen for its specific target interacting with sensitive elements through portable devices, such as smartphones and tablets. More specifically, the aim is facilitating the relationship with descriptive information contents, such as photographic documentation or three-dimensional models.

The overlapping of layers allows to create a data and information system of diffusion, where an hypothetical "tourist" encounters different information for the same object instead of technical contents dedicated to an "expert" visitor. Through the use of "virtual", it is possible to build any type of scenario, infinitely modifiable and updatable, in order to release to the public a wide database that is difficult to communicate with other methods of visit.

This sector includes the different possible interactions between the virtual model and its real prototyping. The traditional museum visit can be combined with a tactile experience, taking advantage of the current technologies that allow to print 3D objects, faithfully reproducing artefacts and making them completely accessible. 3D models of paintings, architectures and landscapes make heritage accessible also to blind and disabled people, and the same models can become the access keys, located along exhibition routes, to connect the experience of the visit to the virtual systems of augmented reality. Considering virtual reality, the development of a museum system virtually visited and implemented with information content, in order to enhance the symbolic and cultural strength of a place, requires the design and drawing of the "container museum" as well as the specific "contents".

In general, the 3D model, built using NURBS or *mesh* modelling techniques, will be connected to a database containing different

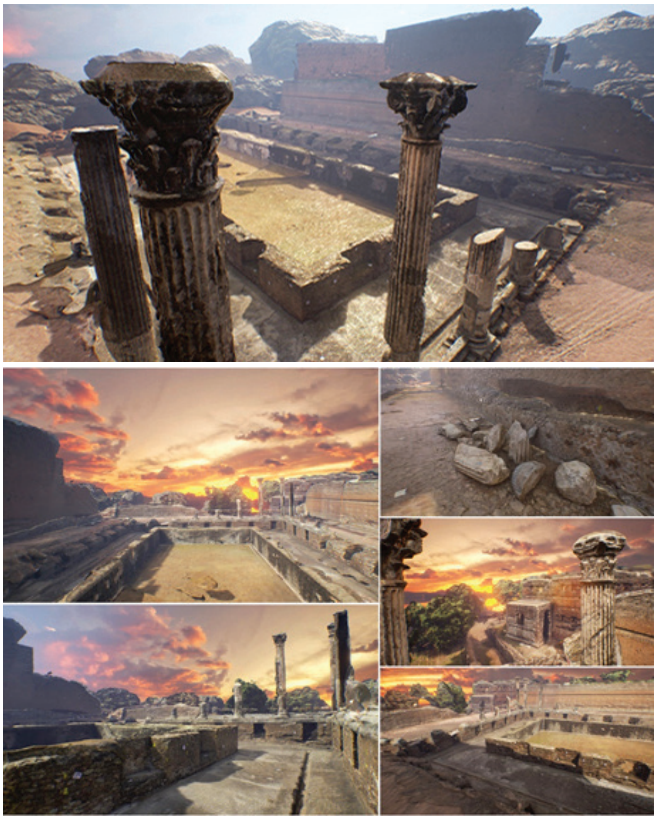


Fig. 11 - Portion of the building of Peschiera in Villa Adriana (Tivoli). Some views of the 3D model made with SfM methodology, composed entirely of mesh surfaces and imported in Unreal Engine 4 software.

natures of information type. A widespread example is the use of Unity3D platform where, in addition to the main asset of the model, it is necessary to provide a controller associated with an *avatar*, or a virtual character that allows the user to explore space using keyboard commands or through the mouse. The software allows to insert graphic elements and buttons that facilitate navigation and make it interactive to respond with the informative and educational purpose for the *serious game*. It is possible to insert information of various nature, of historical and architectural character or content in the form of quiz for educational purposes, assuming that a correct answer may correspond to the access to a next environment, and therefore the continuation of the visit, while in case of wrong answer the user will find an explanation on the subject information. The user, thanks to this kind of virtual structure, is directly involved and integrated in the development of the narration, and it is possible at the same time to learn information and concepts, as in an expected process for any type of museum visit.
Contents and media planned on the web platform are of various kinds: text files, illustrative videos, photographs and audio files, aimed at the different aspects of the place that becomes virtual. The user can navigate and move in space, questioning the points of interest and the attractions to which the various contents have been linked. With this digitized configuration, museums and cities generate virtual platforms for sharing information and enhancing cultural heritage, not only for the benefit of administrations, but for the represented territory and the entire community: through the simple interface of the website, the digital model allows users of any target to an intuitive navigation, thus favouring the interest and participation in the construction of virtual worlds, as "disseminators" of culture.

Real-virtual-real: the information cycle

The "virtual", understood as the new configuration where the size of "urban area" and "architectural space" are contextualized, "*is one of the main foods of the contemporary cultural creativity*"[9]. The virtual space is the place where what is hard to imagine that could happen, instead, happens, and the drawing must not necessarily be subject to the constraints imposed by the physical space. Thus, in addition to the growing use of digital technologies and dedicated software, the sperimentation of new forms of representation inevitably occurs within virtual possibilities. In addition, the fluidity of narration offered by digital systems allows to

increase the value of "database" and storage systems of the acquired information, leading to a virtuous circle where reality and its digitized representation of the object become one of the other enhancement tools. This process triggers interest and attention to the forms of management and representation related to digital databases. The action of synthesis, through which models have been extracted from the field of metric survey and transferred into the sphere of VMRL, implies a structured methodological process that sees once again the drawing as the medium through which it is possible to move from a complex acquired configuration of space to a discrete environment made of dots, lines and surfaces, that become sensitive in the interactive space.
The variety of configuration for a 3D digital system (video games, 3D models prints, websites, augmented reality applications), allows a different approach to the representation, re-evaluating limits, purpose and expressive potential. Virtual representative systems allow to develop an educational path that is more involved and aware of the environment, and that is able to increase the interaction between user and information. The biggest challenge in the development of a procedural process, for the realization of efficient virtual platforms, is to find a key of interpretation, also a drawing, first mental and then representative, to understand and build the relationships of the perceived space. In this sense, the possible representations are not separated from the traditional representation, moving from the symbolic context (more abstract) and becoming full of meaning which requires a greater integration by the user. This transfer can also move to representative models, that translate the real image in a virtual world, looking for an easy visual emotion into the reliability to reality. The lessons learned from these years persuades to believe that in any case signs and images can qualify structures that still, in their various virtual forms, produce more and more emotions, more autonomous shapes and may communicate to a more experienced users, towards a future which, in its infinite facets, is already in a virtual form.

Notes

[1] The term "*dimensionally finished space*" means a virtual control space, dimensionally known, measured and digitally delivered according to ordered mindsets that define the border and limits of the context. The virtual amplifies, at the same time, the possibilities of use and interaction, constantly shifting and modifying the edges and physical limits, making the digital space infinite.

[2] One of the main aspects that has characterized the evolution of digital models of the last decade is represented by the research on investigation procedures and so-called *reality-based* three-dimensional modelling of the architectural heritage, with the great opportunity of highly effective and intuitive means of visual communication and valid interface for database systems. Cf. Manferdini and Remondino 2012, pp. 103-124.

[3] This refers to the many *reality-based* models developed through SfM process and reverse engineering. Photograph, which has reassessed the boundary between art and reality, and the drawing both aspire to become instruments related to obtaining a unified image that transmits the most amount of variables and values that characterize the physical landscape Cf. Cianci 2008, p. 22.

[4] The dynamics of movement and the ability to extend the sharing by the individual user to the entire community, are the innovative aspects of interactive databases. At the same time, the scene can be enlarged or reduced and transformed topologically, greatly amplifying the perception of the visitor capacity. Cf. Maldonado 2005, p. 68-69.

[5] For a more in-depth treatise on moderation for virtual fruition and experimentation on a case study, cf. Basso 2016, p. 151.

[6] Cit. Ciastellardi 2009, p. 7.

[7] Cit. Ciastellardi 2009, p. 8.

[8] Cit. Michael and Chen 2006, p. 17.

[9] Cit. Unali 2014, p. 18.

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02 KNOWLEDGE, REPRESENTATION, PROJECT
BETWEEN DIDACTIC AND RESEARCH

Abstract

The concept of centrality in the project stage, within the wider building process, is often reiterated in the debate on both educational and research issues and their mutual interactions that are relevant to the subject of architecture and construction. This affirmation, which can certainly be shared, makes it necessary to update and accurately increasing the definition of the progress and evolution of the means available for acquiring, organizing and communicating knowledge and its project projection.
The disciplinary and operational boundaries between knowledge, representation and project are in fact the subject of a progressive reduction and an overall transformation into a sort of cognitive *continuum* which, for example whithin the avaible technologies, extends further beyond the boundary of simple project design to fully include the executive and managerial phases of the intervention itself, and that in other ways intersects specific models and paradigms to visual and multimedia communication when compared with the themes of remote use, augmented reality and in general of virtual reality.
In a sort of continuous heterogenesis of goals, the semantic objectives of survey constitute, for example, the operational tools and the premises of the project, just as its purposes, interpreted in a dynamic key through the temporal dimension, can be translated into instruments of control of the executive and management phase.

Sovente viene ribadito nel dibattito relativo alle questioni sia di didattica che di ricerca, e alle loro mutue interazioni pertinenti il tema dell'architettura e dell'edilizia, il concetto di centralità nel momento progettuale all'interno del più ampio processo edilizio. Tale affermazione, certamente condivisibile, rende necessario un percorso di aggiornamento e di sempre più accurata definizione al progredire e all'evolvere dei mezzi disponibili per l'acquisizione, l'organizzazione e la comunicazione della conoscenza, e della sua proiezione progettuale.
I confini sia disciplinari che operativi tra conoscenza, rappresentazione e progetto sono infatti oggetto di un progressivo assottigliamento e di una complessiva trasformazione in una sorta di *continuum* cognitivo che, ad esempio con le tecnologie già oggi disponibili, si estende ben oltre il confine della semplice previsione progettuale per includere pienamente le fasi esecutive e gestionali dell'intervento stesso e che per altri versi interseca modelli e paradigmi propri della comunicazione visuale e multimediale laddove si confronta con i temi della fruizione remota, della realtà aumentata e in generale della realtà virtuale.
In una sorta di continua eterogenesi dei fini, gli obiettivi semantici del rilievo costituiscono ad esempio gli strumenti operativi e le premesse del progetto, così come gli obiettivi di quest'ultimo, interpretati in chiave dinamica attraverso la dimensione temporale, possono essere tradotti in strumenti di controllo della fase esecutiva e gestionale.

The fox knows many things.
Only one, but big, the hedgehog knows.

Archiloco

The concept of "knowledge" is characterized by both a theoretical dimension, connected to the historical-architectural investigation of the building, and a technical point of view, dealing with diagnostics, till the determination of the state of conservation of the built complex and the quantification of its residual levels of performance.
The topic of "interpretation" of the acquired knowledge, also, focuses on a second field of investigation, which simultaneously regards the epistemological dimension of the monument as a text and its hermeneutical stratification. In terms of operational practice, this concerns the determination of the relationships between an analytical-diagnostic moment and the decision-making phase of the design process. It generally takes on the meaning of "*coming back from a sign to its meaning*". The purpose of this hermeneutic operation is, for example according to Schleiermacher, "*understanding the speech as well and then better than the author himself*"[1].
It is interesting to note a singular assonance between Schleiermacher's theses and the thoughts summarized by E. Viollet-le-Duc in his *Dictionnaire*. In fact, Viollet argues that the architect who faces a restoration project must have "*understood all the parts of its structure as if the works was been directed by himself*"[2], since "*restoring a building is not preserving it, repairing it or build it again, it concerns restoring it in a state of completeness that may never have existed in nature*". This position must naturally be framed into the historical context in which it was formulated, and it is related to justify a deep and radical autonomy of intervention on the building itself. However, it is relevant, in the context of this analysis, the centrality that is assigned to the theory of the "partioned knowledge" as a necessary precondition for the design action.
The creative, and intrinsically design-oriented, dimension of knowledge is strongly assessed by Heidegger[3], according to whom knowledge is an active projection, either "project" or "interpretation", of something as a reference to other, different and further meanings, and then it is also recovered by Gadamer[4].
It is interesting to note that Gadamer, while clarifies the theoretical foundations of his research, of "*the knowledge and the right interpretation of the understood object*", applies the use of examples and references drawn from the world of arts and architecture.
It is a fact that a historical building can be considered at the same time as a text, as a message written in a specific code, and as such an object it is studied for its (semiotic) interpretation and more generally for its (semantic) meaning. However, in almost always, it consists in a text characterized by multiple rewrites, shortcomings, additions and integrations, which more properly transform it in a palimpsest, or "*a manuscript where the primitive writing has been scraped and replaced with another (often arranged transversally with respect to the first)*".
It emerges that the monument is understood as a complex stratification of different "texts", belonging to different historical periods and overwritten by partial or radical interventions. Its intimate nature raises subtle questions on the real nature of the comprehension, even before its interpretation and the subsequent planning strategy. Also, it should not be forgotten that (at least, by Gadamer) every action of understanding derives a cognitive spiral that brings a production (or rather an increase) of knowledge itself.
In fact, some central questions immediately arise:

- Which of the multiple layers avaiable in the historical building, each with its own meaning, has to be focus of a proper cognitive effort, and according to which hierarchical order?
- Should a priority of meaning (if this priority has to be defined) be recognized for its greater adherence

to the original aim of the monument, or maybe to the representative value of that fragment, regardless of its temporal location?

- Or, again, are all layers, included the most recent ones, equally witnessing an original and specific historical phase of the building, and so are they equally addressable of cognitive efforts?

Each of these questions refers to consolidated positions in the disciplinary history of restoration and conservation and hardly allows a uniquely determined answer, except for some ideologically oriented assumptions, nor we will discuss them in detail here.

It is interesting to underline that Gadamer does not exclude himself, although indeed very briefly, from formulating in the wider context of a much more articulated philosophical construction, a statement on having a bent for the rebuilding through the restoration process of an otherwise lost aspect, arguing that "*the building brought back to its primitive condition is no longer what it was, it becomes a destination for tourists*".

The statement is interesting not only for its explicit opposition to the design strategy of the "restoration as reconstruction", which is today largely minority, but it emerges for the more sophisticated underlining of the value of truth as a part of an irreversible historical flow, which makes necessarily "voted to failure" any hermeneutical operation (therefore cognitive and creative) that sees "*the understanding as the restoration of origin*".

Instead, it is possible to state, along with Paolo Torsello, that the first aim of the conservation project is to "*protect a possibility of understanding*"[5]. Thus, it follows the need to develop a design approach oriented to the conservation of each fragment of text, such as to not alter in any way the chain of facts that led to the current configuration of the object. Beyond any possible ideological fundamentalism, the question arises again on the graduation of the intervention, or on the determination of intervention strategies as much as possible coherent with the results of the cognitive process developed on the object. The most relevant moments that define this cognitive path are those that make happen a kind of dialogue between the monument and the architect.

It is interesting to note that already in 1929, Annoni had focused its attention to the "*direct query of the monument*"[6], as a central topic for any intervention strategy.

It is clear how this dialectical comparison with the historical building is both the expression and the request for a detailed analytical approach to the object, not only seen in the perspective of an architectural critique, but concretely approached as a physical object, carryng both historical-cultural and technical-material meanings. For the first time, by means of a truly innovative perspective towards the cultural and operational context of the time, the request for a direct comparison with the material dimension of the building is claimed. The double semantic value of the historical building is thus emphasized, as a repository of not only linguistic and formal meanings (of "signs" precisely), variously attributable to eminently historical-artistic and historical-architectural, but also material and constructive issues. In conclusion, according to Annoni "*only if one penetrates the unexpected meanders of the ancient constructions, and let the bricks and stones, the beams and the paintings, the organisms and the forms explain their unchanged word, only in this way the monument reveals his reason*".

It is precisely this attempt to acquire a multidisciplinary knowledge on the subject of investigation, not limited to the analysis of its specific material or morphological connotations but extended to the quantitative understanding of its performance specifications, applied to all its "meanders", even those " sometimes unexpected", that is today related to the more general term of "documentation". This includes, among others, the operations of integrated survey of the building and of instrumental tests conduceted on site or in laboratory.

The technical dimension of this amount of operations and interventions by sure provides evidence of the

relevance of technical and technological innovation in the conservation project. It is interesting to underline that the topic of technological innovation in the knowledge process, aimed at the restoration, was already considered relevant by Viollet, with particular reference to the existing documentation and mapping technologies. As Viollet states, "*Photography seems to have come precisely to help this great work of restoration of ancient buildings. In fact, until the architects had at their disposal only means of drawing, even the most exact, it was very difficult for them not to make any mistake and not to neglect certain but however apparent traces. Photography has naturally led architects to be more conscious in their respect for the smallest details of the ancient building, to become better aware of its structure*".

It is therefore not a matter of innovations related to construction techniques (still largely substantially anchored to traditional historical constructive knowledge), but it rather concerns those intrinsically experimental and technologically pioneering researches in image acquisition. Those are the years of the spread and improvement of photographic shooting techniques, seen by Viollet in their extraordinary documentary potential, radically different from the capabilities of traditional manual representation techniques.

As known, the term "survey" means at the same time both the "investigation" operation and the subsequent "graphic rendering" of collected data. This is not a mere operational distinction, since it is clear that this double semantic value brings relevant consequences both in theoretical and analytical terms, as well as practical and operational tasks.

This coordinated set of operations for measurement and restitution, which has an intrinsic representative objectivity, is a necessary tool for critical knowledge (historical, material and technological) of the artefact itself.

The intrinsic contradiction between the opportunity to secure a scientifically neutral reading of the surveyed object and the equally essential need to apply an effective selection among the whole amount of information to be communicate, therefore, is immediately clear. The final aim of the process is to manage the integrated acquisition of knowledge and the determination of intervention strategies. "What" to detect, "how" to detect it, and finally "how" to recompose the object of the surveys, defines the central questions in any conscious project of intervention on the existing heritage.

It is assumed that "*the architectural survey is an operation aimed at the knowledge of the building in its whole, detecting all the values, from the dimensional to the constructive ones, from the formal to the cultural values*"[7]. Thus, its intimate connection with intervention choices cannot be ignored in the preliminary phase. In fact, as Cesare Feiffer notes, "*the survey for the conservation project is a critical operation of selection of discrete points, but also a collection of metric values which are then processed and subjected to diagnosis, so the connection with object, but especially with the project, must always be kept in mind*"[8].

From the semantic bivalence of the term "survey", therefore, it derives the "*apparently insoluble dilemma*" emphasized by Mario Docci on how "*the survey is not only a passive element of knowledge, but an active element critically operating*". It is precisely here that the link between a careful survey and a conscious project has to be set, since from the outset of survey preliminary operations, and then progressively in the entire diagnostic cycle, the designer establishes an authentic dialogue with the building, aimed at deepen and understand the set of meanings, since "*it is during the process of survey that the building opens itself to the understanding of the surveyor*".

The same diagnostic process as a whole can be seen as a deepening on the most intimate scale of the building of a single path of critical knowledge, whose outcomes will then move directly into the choices of intervention. On the other hand, it is obvious that the survey of the building is intimately connected to the development of diagnostic operations, providing the basic representative substrate on which embedding the subsequent investigations.

In survey operations, not only the formal (or metric)

aspects of the building should be investigated, but also the technical-constructive implications of its architectural structures, integrating all the material and degradation outcomes that can be directly acquired, and which could be then further refined and implemented in the development of diagnostic tests. In the same way each structural instability in the investigated wall masonries should be indicated, taking the major attention in determining both the spatial developments of cracks' frames and the main and secondary lesions, as well as their interactions with the technological and constructive features of the structure.

In this context, a culturally qualified survey operation, as well as to be technologically advanced, includes different reading skills and sensibilities, integrating complementary disciplines. The assumption that the cognitive value of the survey belongs to the boundary of the representation is a highly limiting or reductive position, although sophisticated as regards the graphic aspects or accurate from the metric point of view, but unfortunately blind and silent under the technological, material and construction profile.

Once the test campaign has been completed and the objective analytical data of individual surveys have been acquired, the central issue focues on the evaluation (or interpretation) of tests' results and on the formalization of the design responses that can follow from them.

It is necessary guarantee a coordinated integration of results provided by specialized technicians coming from very different disciplines, as well as the cross-evaluation of results in the individual analytical determinations and in relation to the historical, material and constructive reading that has developed in the various phases of investigation of the building.

The quality of obtained instrumental results is intended not only in a literal sense, as objective quality of experimentations, but also as a more general adequacy and relevance of the adopted techniques and of the case study areas of analyses. Thus, this quality is defined within the design process as a complex interpretative basis and, therefore, as a cognitive support - necessary but not enough - for the determination of the response strategies of the project.

The whole amount of this articulated set of information, coming from the instrumental results of the diagnostic phase, certainly is "necessary" not only according to regulatory requirements, but rather as primary need for understanding, as essential prerequisite for a conscious design action. At the same time, however, that same wide cognitive base defects the character of "sufficiency" with respect to the same design purpose.

The relevance and complexity of the documentation process of an historical compound is nowadays widely accepted, at least as a general statement. However, the risk of indulging in the consolatory and fallacious myth of some biunivocal and objective deducibility of planning strategies, from the diagnostic results, should not be missed.

The question of the transfer of integrated results of survey into specific procedural and operational options, to be defined at the planning stage and to be implemented on site, represents the final transition from diagnosis to prognosis, and therefore to the definition of the therapies to be adopted.

In the absence of an established methodological and The survey tools available to the designer for investigations, analysis and experimental verifications on site or in laboratory, in the absence of an established methodological and operational knowledge, can lose much of their design utility. In fact, large set of information are often acquired, through human, technological and economic efforts, according to specific scientifically valid methods, but they lack a culturally unified approach, and in any case, they are poorly coordinated for the purpose of an overall reading of the building's peculiarities. When this happens, the fragile and essential link between obtaining analytical data and critical interpretation of the data itself may be broken, in order to achieve functional indications for the coherent development of the project. The execution of highly specialized tests must not complete its reasons and meaning in an almost necessary acquisition of performance data of the building, but it has to be configured as an authentic planning tool, organically integrated in a methodology of approach to the project both multidisciplinary oriented and internally unitary.

The project is then configured as one of the possible answers to the "questions" coming from the building itself, chosen by the designer because of his personal sensitivity, at that moment and in that place.
As stated by Gadamer, "*architectural objects do not stand firm on the edge of the river of history, but they are drawn by it. Even when a period of particular historical sensitivity proposes to restore ancient architectural structures, it cannot however claim to turn the wheels of history backwards; what is given is only to operate a new, better mediation between past and present.*"
This "mediation", this "fusion of horizons", immersed in an unstoppable and irreversible historical dimension, seems to be able to configure a possible approach to the theme of conservation, between reasons of history and reasons for the project. Therefore, it develops between the dimension proper to memory, swinging through the present and the past, and then, symmetrical, to the project, constitutively addressed to the future.
The awareness of an "historical perspective" of the architectural project (and therefore of the conservation project) is deeply connected with its "scientific value", and it witnesses its belonging to the horizon of both human and natural sciences.
Memory awareness may be recognized as a cornerstone and support of the project and at the same time one of the thresholds of this dual nature, with its amount of contradictions and creative inputs. As a creative and cultural effort, the conservation project is based on historical continuity, which represents a value, and a guarantee of a continuous process although developing a non-linear path. Meanwhile the project, as field of application of cultural models embodied with nature and its laws, faces an interpretative tradition (assumed from the natural sciences world) which finds in forgetfulness, instead of memory, its founding value[9]. The worth and necessity of forgetfulness, intended as the overcoming of all knowledge by new and more suitable acquisitions, represents one of the pillars of every modern scientific construction.
Even in the field of restoration and conservation theories, the "cognitive copernicanism" theorized by Resher[10] could progressively be extended, according that it is not possible to establish positions over time as cognitively privileged. This is, of course, a relativistic approach that would seem to weaken (by placing them in a non-privileged historical perspective) the interpretative paradigms and largely established theoretical systems. Already Viollet however (in some ways surprisingly) warned that "*in this matter the absolute principles can lead to the absurd*".
In conclusion, if we believe that "*the security provided by the use of scientific methods is not enough to guarantee the truth*"[11], it seems possible to recognize the famous "fox" of Archilochus[12] in the character of the designer, custodian of many knowledge none of them nevertheless "great", perhaps because that "great" knowledge may be recognized in the "truth" described by Gadamer, as "*discipline of querying and seeking*".
The truth therefore doesn't lives in the answers to our questions, but in asking questions; not in the project (intended as a formal act) but in the act of designing, as an everlasting curious and future-oriented glance.

Notes

[1] Cit. Schleiermacher 1959, p. 87.
[2] Cit. Crippa 2020, p. 261.
[3] Cf. Heidegger 1953.
[4] Cf. Gadamer 1983.
[5] Cf. Torsello 1997.
[6] Cf. Annoni 1929.
[7] Cf. Docci 1987.
[8] Cf. Feiffer 1997.
[9] Cf. Rossi 1981.
[10] Cf. Resher 1990.
[11] Cf. Gadamer 1983.
[12] Cf. Berlin 1998, p.69.

VIRTUAL SPACE AS A MEAN OF DESIGN EXPRESSION

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Subject of special study, which crosses all his research, is the definition and representation of an integrated and dynamic model that consists by heterogeneous information. The most recent essays focus on issues of interactive virtual representation, rendering, digital and physical modelling. He teaches at the Faculty of Architecture of University of Rome "La Sapienza", in the degree courses in architecture and industrial design.

03 DIGITAL MODELS
DISSEMINATION AND DIVULGATION

Abstract

One of the primary objectives of the research is "dissemination", the precious activity that allows "third" researchers to create new knowledge starting from our results. It is not easy to pursue it and we often find it weakened and confused within broader processes of communication that also include the activity of "divulgation".
The present contribution reflects on the role and difficulties of dissemination in research areas that base their knowledge and their actions among different scientific methodologies. A fertile and slippery terrain, where scientific processes based on quantitative data, collected with repeatable experimental measurements, and on qualitative data and interpretative hypotheses are compared.
The architecture sciences and among them the "*Disegno*", which is an integral part of them, frequently operate between these two methodological approaches.
The descriptive geometry is an evident case of this apparent dichotomy of the *Disegno*, because it originates from the exact sciences to manifest and express itself with the evanescent communicative complexity characteristic of the human sciences. Similarly, we can mention the architectural survey, which begins from the documentary sources using the philological and qualitative methods of historical research and then integrates them with the quantitative and repeatable data deriving from the instrumental acquisitions.
A correct and full dissemination activity, if pursued with tenacity, as well as helping the research, can become a supplementary verification tool to support the methodological approach adopted
The dissemination, finally, is effective if it expresses in detail the research methodology used and if it makes easily and freely accessible the experimental data adopted and produced.

Uno degli obiettivi primari della ricerca è la "disseminazione", la preziosa attività che consente a ricercatori "terzi" di creare nuova conoscenza sui nostri risultati. Non è facile perseguirla e facilmente si trova indebolita e confusa all'interno di processi più ampi di comunicazione che vedono presente anche l'attività di "divulgazione". Il presente contributo riflette sul ruolo e sulle difficoltà della disseminazione in ambiti di ricerca che fondano il loro sapere e le loro azioni a cavallo fra diverse metodologie scientifiche. Un terreno fertile quanto scivoloso, ove si confrontano processi scientifici basati da un lato su dati quantitativi, raccolti con misure sperimentali ripetibili, e dall'altro su dati qualitativi ed ipotesi interpretative. Le scienze dell'Architettura, e fra queste il "*Disegno*" che ne è parte integrante, operano frequentemente a cavallo fra questi due approcci metodologici. È un caso evidente di questa apparente dicotomia del *Disegno* la geometria descrittiva, che trae origine dalle scienze esatte per manifestarsi ed esprimersi con l'evanescente complessità comunicativa caratteristica delle scienze umane. Analogamente, possiamo citare il rilievo architettonico, che attinge alle fonti documentali con i metodi filologici e qualitativi della ricerca storica per poi integrali con i dati quantitativi e ripetibili caratteristici delle acquisizioni strumentali.
Una corretta e piena attività di disseminazione, se perseguita con tenacia, oltre che giovare alla ricerca, può diventare strumento di verifica suppletivo a supporto del percorso metodologico adottato.
La disseminazione, infine, è efficacie se esprime nel dettaglio la metodologia di ricerca utilizzata e se rende facilmente e liberamente accessibili i dati sperimentali adottati e prodotti.

Introduction

The word "*Disegno*"[1], in its broadest and polysemic meaning, is today associated in the scientific field to a set of activities that concern the knowledge and communication of both the real and the imaginary. We draw to communicate our thoughts to others, but we also draw above all to communicate to ourselves what we see and what we imagine. Through the "reflective" *Disegno*, our thought is projected to the outside, as representative mental model of our knowledge, so to be materialized, observed, verified and developed. A described activity that is normally recursive, and within we gradually improve our knowledge.
From a semantic point of view, the word "*Disegno*" describes both the action and the product of the action[2]. The *Disegno*, as an action, is expressed through instruments, and from their variety it follows the variety of the product. It is not possible to try even for a moment to enumerate and confine these instruments, even remanding to the heritage of tradition: every act of externalizing thought expressed in a representation (whether single or participatory) is part of that cognitive and communicative process that is proper of *Disegno*.
Among the numerous application and experimental fields of *Disegno*, the research in the field of Architecture is certainly one of the most fertile and significant. In this field, the activities of *Disegno* concern the knowledge of the existing, the definition of the imaginary and the representation of the project in each phases: from its conception to its construction.

Models of "Disegno"

Disegno is the mental model used to organize our thinking; graphic models used to represent it synthetically, by means of traditional techniques, are *Disegni*; digital models are *Disegni* too, both natural and integrated, static and dynamic, and through them the complex form is simulated and represented; *Disegni*, again, are the physical models realized in scale, either directly with manual skills, or indirectly through automatic prototyping techniques; and it is still a *Disegno* (it could be asserted) also the final product: the constructed building[3].
An assumption, the latter, which originates from two obvious considerations: on the one hand the transformation of the construction site, the increasing introduction of robotic processing and the consequent analogy of the built architecture to every other representation produced directly by digital models. On the other hand, the diffusion of responsive and adaptive architectural components that characterize buildings with dynamic behavioural qualities and, in fact, that shift the focus of the project from a single representation of the built model to a representation in

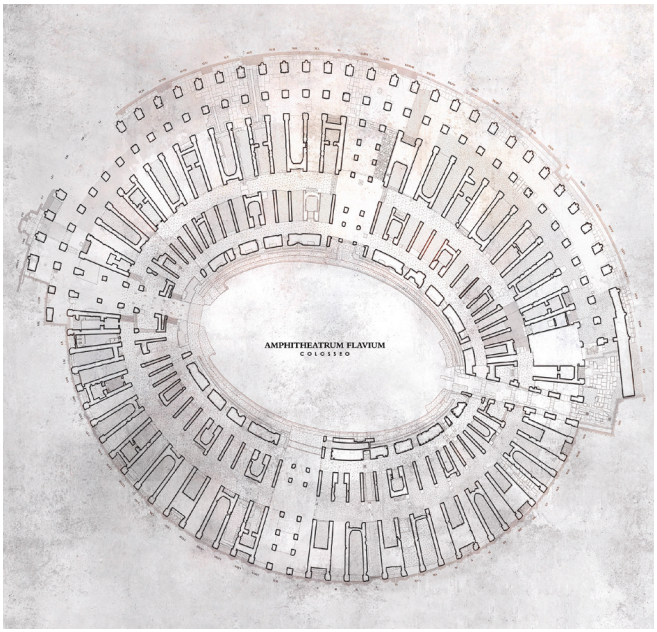


Fig. 1 - Iconography of the Colosseum. Reinterpretation and representation of survey data of the year 2000 by Cristian Farinella and Lorena Greco. 2018.

continuous evolution, produced by real-time processing of both digital and physical dynamic models[4].
The *Disegno* is therefore manifested through models, but also the *Disegno* is fed by models, both acquired from external processes, and generated and transformed by the *Disegno* itself[5].

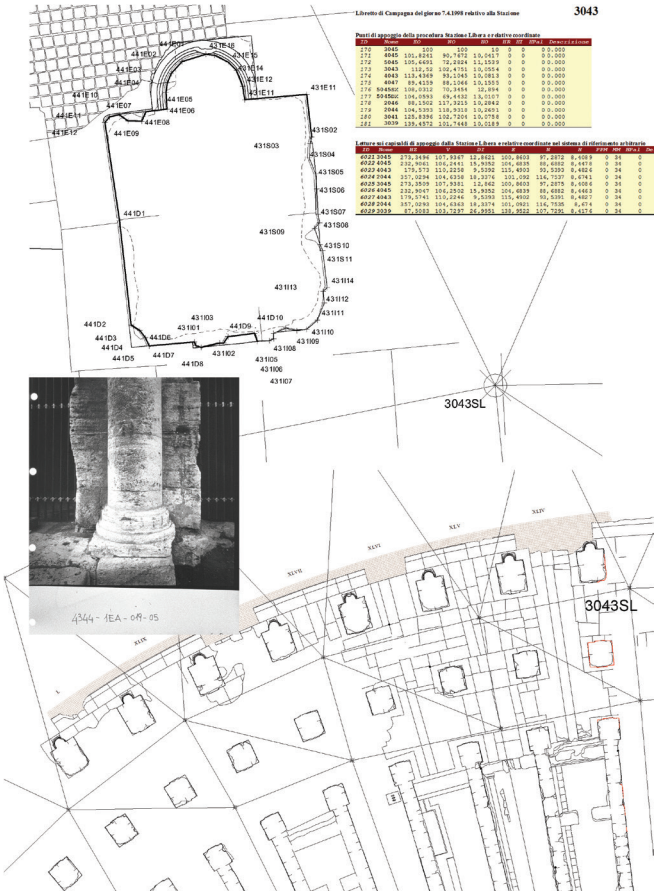


Fig. 2 – Iconography of the Colosseum: data from the survey book; graphic restitution; photography with highlighted the measured topographic points.

Qualities and transformations of the model

Each model is a discrete and partial aggregate of qualitative information belonging to the object to which the model refers. A graphic model of an architecture, for example, could express and highlight, in a synthetic and selective form, some perceptive aspects related to the use of the artifact; a digital model of the same architecture, acquired with laser scanning, would instead express the three-dimensional metric quality; photographic or colour sensors for punctual acquisition would instead provide information on the chromatic quality of the examined object.
Each model, as addressed, can contribute to the definition of the *Disegno* and it can be transformed by the *Disegno* itself. Transformations are basically of two types: projection[6] and integration. In the projection the model is transformed from one coding system to another; in the integration several digital models are related to allow elaborations and queries of more complex information aggregates. The integration increases the informative complexity of the model, while the query extracts selective information from the model; processing generates new information and therefore new models. Digital models, due to their ability to be easily integrated, processed and queried, play a fundamental role within these processes. However, the ability to integrate the digital environment does not exclude from the process the world defined as "analogical". The possibility of acquiring information from the real world (input) is now a widespread knowledge, through the wide panorama of available sensors; the possibility of reproducing digital data to the outside (output) is also known, using the equally wide scenario of digitally controlled actuators[7]. Less widespread is the awareness that this process can be developed in continuity. The difference between "*una tantum*" and "*continuum*" approaches is substantial since in the first case it is faced with an acquisition, while in the second case it deals with

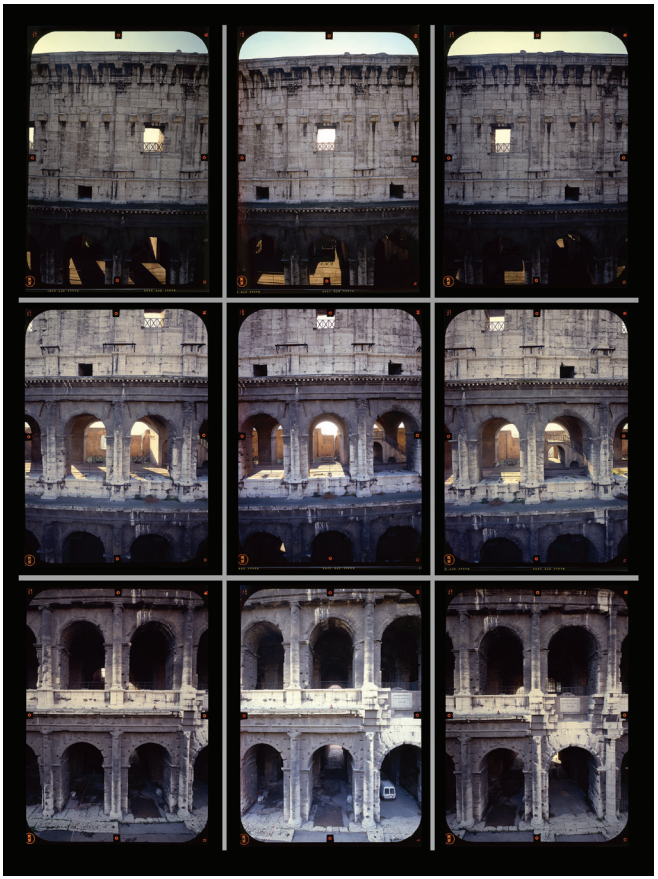


Fig. 3 - Sequence of 9 plates acquired with analogue metric cameras in correspondence of each fornix, proceeding vertically along the left order, the center of the fornix and the right order.

Fig. 4 - Photography of the monographs of the topographic points, from which it is possible to deduce the exact measured position.

monitoring. Only in the second case, the subject can be considered fully participating in the integrated model: in the first case, in fact, only a single and specific temporal image is integrated. What it is expressed in relation to the continuity of data input appears in a different form but it is conceptually similar in the data output process. In this case, it is used the term "production" when the output develops "*una tantum*", and the term "representation" when it occurs continuously.

In an ideal scenario, the model from integrated survey contains and relates, in a distributed and shared digital environment, the set of information referring to the object, semantically structured, both digital and digitalized, both static and dynamic. In the context of continuous monitoring, the same surveyed building constitutes an analogical information as part of the integrated model. Thus, the ideal integrated model of survey must allow the stratification of data in a temporal sense, accepting

acquisitions of heterogeneous information occurred in different periods, even significantly distant.
Knowledge or quantification of the reliability of the data is therefore a necessary prerequisite for the integration to be effective[8] and successfully aimed at subsequent dissemination processes.

Dissemination and communication

The terms dissemination and scientific communication indicate two profoundly different communication objectives, that have to be considered by the researcher with full awareness.
The term "disseminate", which figuratively refers to the process of spreading seeds over large areas for the growing of new plants and fruits, is intended here to indicate parallel processes of communication, where the transmission of knowledge allows the construction of a same new one. Thus, it is necessary that objective data, therefore experimentally reproducible, pass from one researcher to another, so that the second subject can build new experimentation on data compared to the first, integrating and developing knowledge. Quality, completeness, interoperability and information stability are the main critical points of this communication.
The term "divulge", on the other hand, semantically highlights, as recipient, a vast and heterogeneous public. The objective in this case is the general spread of knowledge, which is necessarily pursued in a form that is accessible to everyone, synthetic and simplified.
The information contents, from which the dissemination originates, are naturally also the primary sources of information for divulgation. However, the variety of possible actions, deriving from the heterogeneity of potential recipients and from the scalability of the contents, suggests the design of development methods both dedicated and secondary to research. Differently, as dissemination is aimed at communicative recipients and objectives (first of all the parallel processes with the aim of creating new knowledge), it is easier to generalize and integrate it into the primary research methodology, even strengthening it.
Dissemination must build its foundations, in the exposition of the applied scientific method and in the availability of the data subjected to the experimentation. On both these aspects the debate is wide, complex and perhaps not univocally resolvable. In particular, the methodological gap between "hard sciences" and those improperly called "soft" sciences is already known. "Exact" sciences and natural sciences are included among the first: in both the scientific method is considered applied in the "Galilean" sense, with

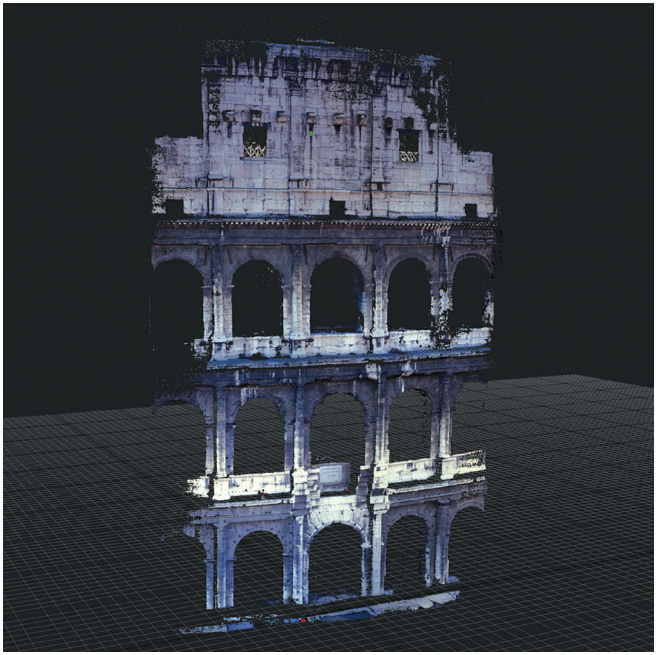


Fig. 5 - Restitution of the three-dimensional surface of the elevation of a Colosseum fornix, performed from an Image Based Modelling procedure applied to the analog photogrammetric acquisitions acquired in 2000.


10 - Colonna Traiana (47, 1/3 - 3, 2)


3 - Castel Sant'Angelo (40,0;26,3)


7- Rotonda del Pantheon (42,0;13,1)


8 - Colonna Antonina (45,2/3;14,2)


22 - Terme di Diocleziano (4,3;21,2)


20 - Basilica di Santa Maria Maggiore (8,0;22,0)


12 - Torre delle Milizie (4,2;5,0)


26 - Chiesa di San Onofrio sul colle (36, 1 ½ - 31, 2)


33 - Chiesa di San Pietro in Vincoli (9,3;12,1)


35 - Chiesa di Santa Maria in Aracoeli (0, 0 - 0, 1)


17 - Chiesa di Santa Croce in Gerusalemme (13,0;39,2)


29 - Chiesa di Santa Maria in Trastevere (32, ½ - 20, 0)


16 - Basilica di San Giovanni in Laterano (14,2;28,2)


24 - Chiesa di San Pietro in Montorio (32, 1 - 24, 1)

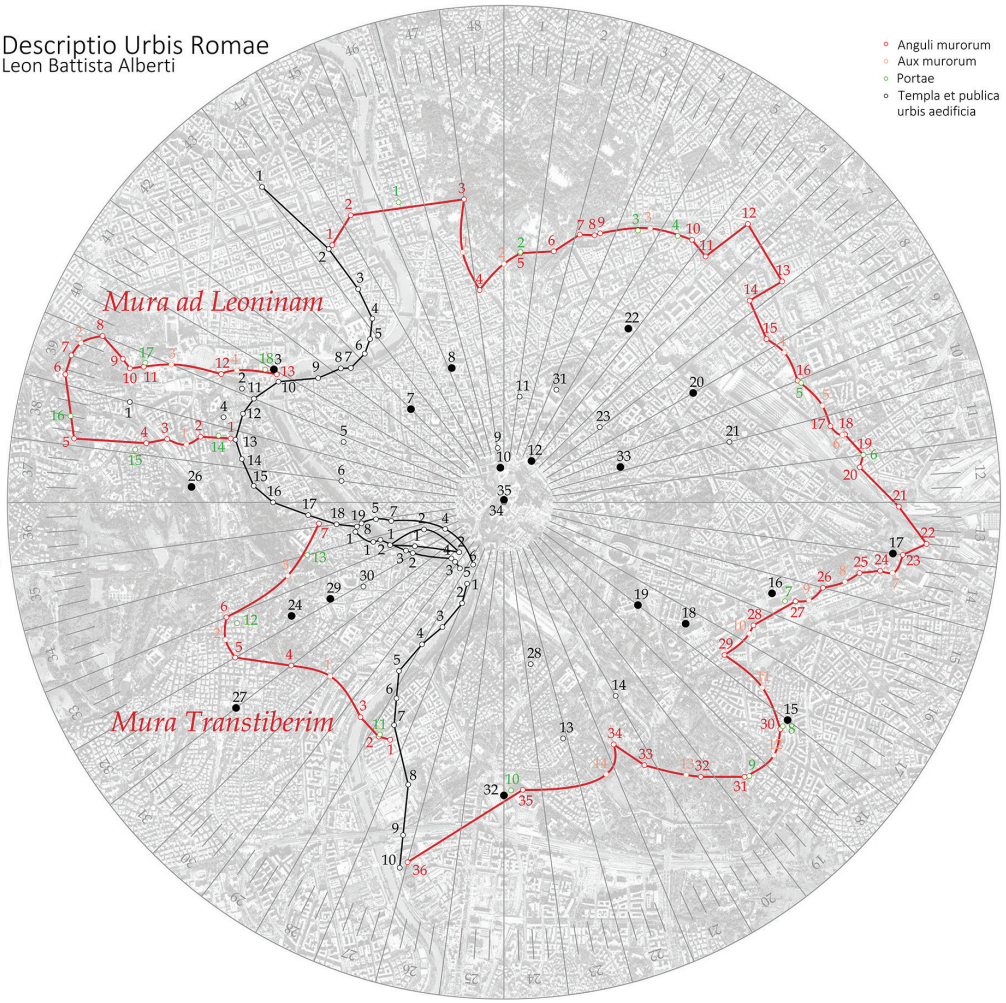

19 - Chiesa dei Santi Giovanni e Paolo (17,0;17,0)

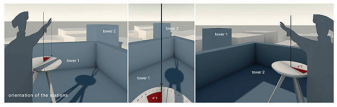

27 - Chiesa di San Pancrazio (31, 0 - 34, 0)

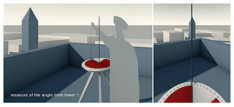

18 - Chiesa di Santo Stefano Rotondo (16,2;22,0)

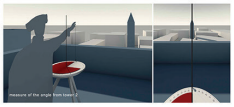

32 - Piramide di Caio Cestio (24, 0 - 29, 2)


15 - Chiesa di San Giovanni a Porta Latina (17,0;36,0)









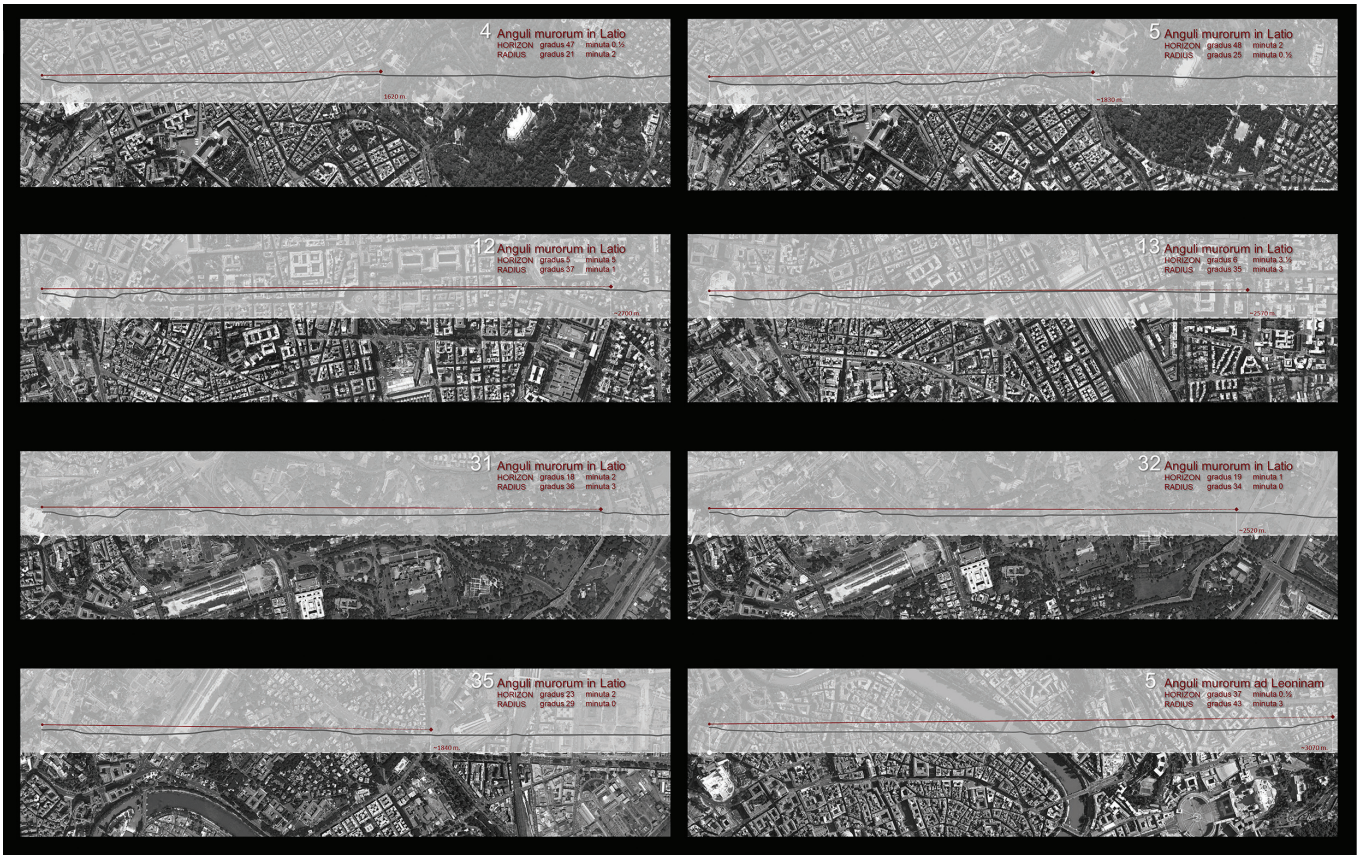


Fig. 6 - Descriptio Urbis Romae di Leon Battista Alberti: critical selection of the surveyed buildings, today persistent; virtual reconstruction of the survey procedure.

Fig. 7 - Descriptio Urbis Romae di Leon Battista Alberti: verification of the visibility of the measured points, through the identification of sections of the territory elaborated along the lines of collimation.

the predominance of quantitative data, collected with repeatable experimental measurements. Instead, human sciences belong to the second one, where qualitative data and interpretative hypotheses prevail.

The sciences of Architecture and among these the *Disegno*, which is an integral part of them, frequently operate between the two methodological approaches. One of the most evident cases of this apparent dichotomy, in the case of *Disegno*, is undoubtedly the Descriptive Geometry, understood in the most current sense of the term[9], which originates from the exact sciences to manifest and express itself within the evanescent complexity of communication characteristic of the human sciences. Nevertheless, it is the case of the Architectural Survey, which derives from the documentary sources within philological and qualitative methods of historical research, integrating them with the quantitative data and repeatable characteristics of the instrumental acquisitions.

This extraordinary complexity, which arises from the necessity to find a balance between experimentally repeatable data, definable as objective data, and interpretative analysis data, considered as subjective, is configured as a uncertain issue for researchers in the field of *Disegno*: dissemination, in fact, should distinguish in the communication, without the possibility of misunderstanding, the path based on objective and repeatable data and (if present) the choices and considerations of interpretative nature. Not least, all experimental purchase data should be easily accessible.

Experimentations

In consideration of these wide objectives and with the desire to experiment their full application, the research team has decided to pay particular attention to the requirements of dissemination, assisted by a group of colleagues[10], from different research activities already shared in the recent past. New researches have been specifically oriented to satisfy these aims and also other objectives, already concluded, have been revisited with a renewed critical view. Since the first steps of experimentation, the complexity and heterogeneity necessary for a rigorous dissemination process has emerged, together with an added value of research inspired by the renewed attention, since it introduces supplementary activities that are configured as additional tools for methodological verification.

The first experimentation, focused on the dissemination objective, has born from a departmental requirement, aimed at updating, integrating and developing the analogical data acquired at different times on the Colosseum. Particular object of experimentation was the survey carried out in the new millennium[11], whose results had been shared to the scientific community only in a synthetic form, by traditional printed publications[12]. Through time, however, it became clear that a product of increasing value, closely linked to that operation, consists in the archive of collected data itself: a rigorous and well documented acquisition[13], partially digital and analogical, which "photographs" the state of the monument in that particular chronological period. Most of the archive consists of native digital data, such as topographic measures performed with total station; other data are analogical but they can be digitized in high-precision models, such as the sequence of 9 metric photographic plates, performed at each of the detected arches; others are only analogical and they can be digitized to perform a simple documentation, such as photographs and schematic drawings related to the monographs of points of the horizontal section, created to represent the iconography of the Colosseum. In this rich dataset, it is possible to retrace the survey in time through a synchronic way, to further elaborate contents and develop them diachronically. It is possible, for example, to repeat a measurement made in past and to compare it with the current situation; but it is also possible to generate a new three-dimensional model of the surface of the façade of arches, elaborating the analogical photogrammetric plates acquired in the past, during the survey, with actual technologies.

Contaminated by the experience of reinterpretation of the Colosseum data, a greater consideration has been turned towards the analysis of the past, trying to identify a survey on which to implement, in a similar way, synchronic and diachronic experiments. Our attention has been focused on the undocumented survey that Leon Battista Alberti must have necessarily developed for the definition of the *Descriptio Urbis Romae*. The aim is of hypothesizing a plausible survey, in accordance with the basis data of the *Descriptio*, and of expressing it in a methodological mode as to be equally experienced today. Thus, it requires a double operation inspired by the methodological criteria of dissemination: the first, diachronic, is oriented to describe the method of selective analytical investigation. Observing the singularities of results produced by Alberti, it proceeds to identify some key objectives, which suggest interesting

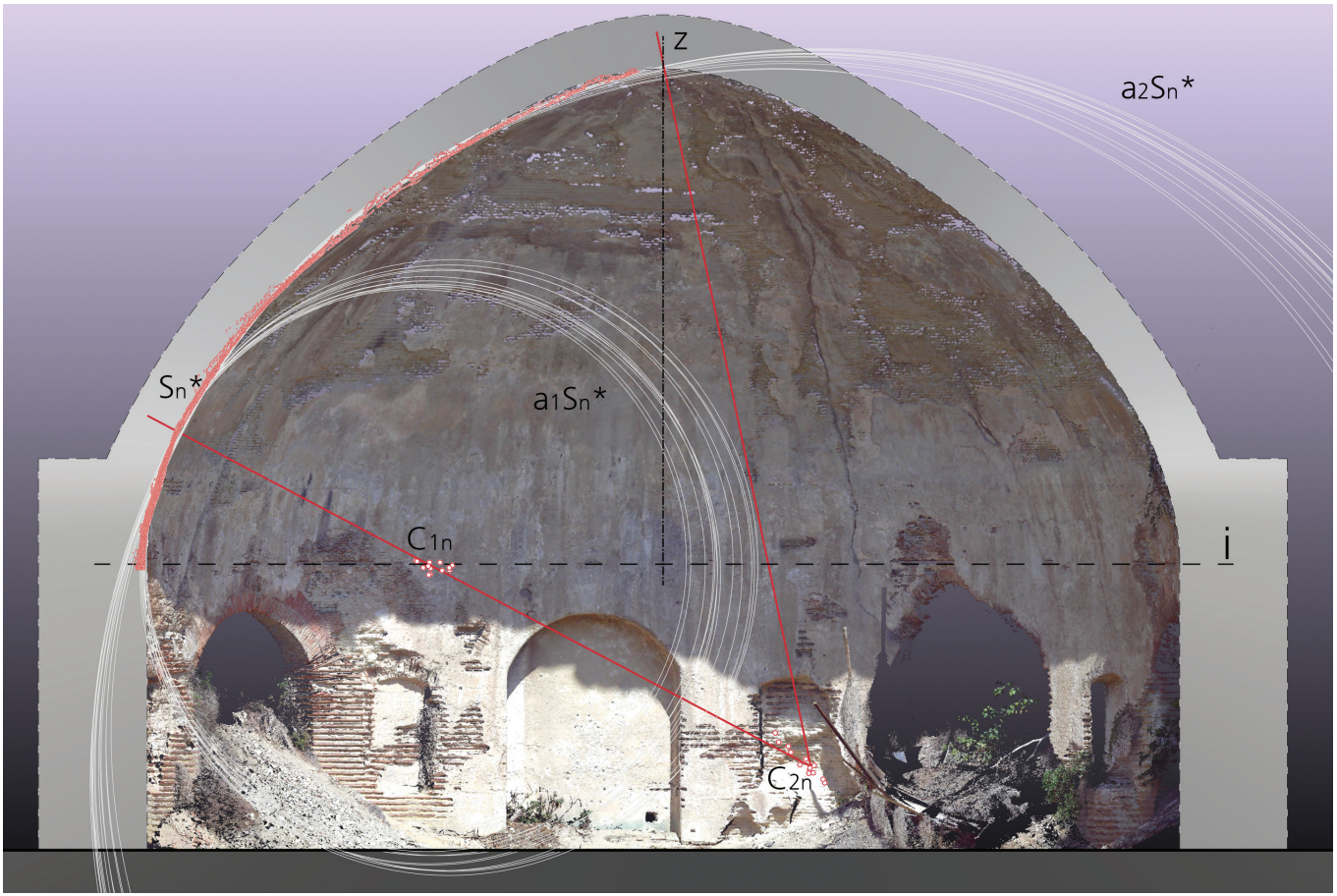


Fig. 8 - Temple of Diana in Baia, section of the vault. Graphic resulting from the processing of the best-fit algorithm, with reference to the circumference, applied to the radial sections of the vault. The results appear to be significant for the lower arc, as they highlight clustered centers arranged on the imposed plane, while they appear singular in distribution and position for the upper arc.

solutions for the interpretation of the relevant methodology used by Alberti. The second, synchronic, is aimed at repeating the survey of Alberti within the instruments and the operational and urban reality of that historical time[14]. The two operations define to each other's as verification tools.

The third sample experimentation concerns a recent survey, dedicated to the geometric-formal investigation of the vault intrados of the Temple of Diana in Baia[15]. After performing an acquisition campaign, by laser scanning, of highly defined three-dimensional point clouds, the data was analyzed

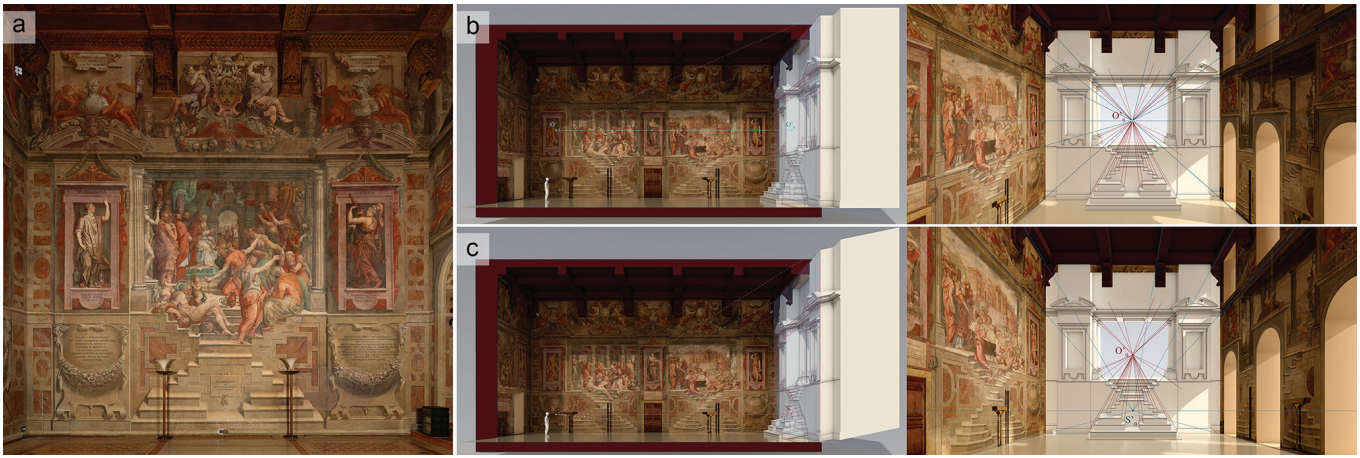


Fig. 9 - Leonardo Baglioni, Marco Fasolo. Interpretations related to the projective transformations of the architectural perspective model painted in 1546 by Giorgio Vasari at the Palazzo della Cancelleria in Rome (a - Sala dei Cento Giorni, west wall) with respect to the placement of the observer (b) and the spectator (c).

and checked to identify the geometric shape. From a methodological point of view, the analysis has been developed along a path of certain objective evidence, and it has stopped when it reached only probable and subjective evidences. Considering the repeatability of the morphological analysis by other researchers, a program of data verification has been described, where each step is solidly founded and where, once again, the same result always returns uniquely. Instead, the analysis deliberately stopped, without setting forward more probable hypotheses, when the result, although consistent, did not appear unequivocally constant. The procedural rigor has particularly involved the generating curve corresponding to the vertical section. Previous research has estimated the curve to be polycentric, consisting of two arcs of circumference. The analysis has confirmed the presence and nature of one of the two curves, although defining it in a slightly different way. The same process could not be possible for the second curve, whose existence, however logically probable, was not sufficiently certified by the results, that appeared differently interpretable and therefore not repeatable.

The fourth and final experimentation has addressed the issue of the definition of a methodology for the study of Architectural Perspectives[16], a field of research that unquestionably has generated from both scientific and humanistic knowledge. The key activities that characterize the research methodology on Architectural Perspectives are: collection and analysis of documentation; the acquisition of the artifact; its interpretation and finally the valorisation pursued through dissemination and disclosure activities.

In this context, the goal of dissemination requires specific attentions, configured as additional tools for methodological verification. Through the cognitive approach, for example, it will be natural to classify and ponder the quality of the

documentary information, structuring data in a relational dependency graph, to highlight their crucial nodes where simple interpretative hypotheses have taken the place of inductive or deductive ones. The philological analysis of the documentary apparatus must also consider, where possible, the experimental repeatability. Even in the acquisition phase, the dissemination objective can significantly influence the survey project, activating processes of procedural nature aimed at the acquisition, verification and testing of qualitatively enriched, more defined and versatile models. Finally, the interpretative phase of architectural perspectives can benefit from the dissemination objective, anticipating the sharing of experimental purchased data and allowing different researchers to stratify and compare various interpretative hypotheses, thus proceeding towards shared convergent solutions.

Free access to data

Dissemination, as already mentioned, is really effective if the research methodology is exhaustively exposed, and the used data are entirely available. Only on the occurrence of this condition, "third" researchers can (for the benefit of humanity) easily test and improve the gradually acquired knowledge. The growing affirmation of Open Access and the mandatory nature of research publications financed with European funds are auspicious signs, but the road is still far. Procedural rigor often does not find space for an exhaustive description within scientific publications; experimental data are rarely available and often bound by third-party organizations that possess the studied property. The interoperability and reliability of data are areas still to be perfected. An ethical and scientific research issue till to be developed and engaged.

Notes

[1] The Italian's word "Disegno" assumes a particular and complex meaning that is impossible to summarize with one of the currently used terms (design, drawing, sketch, representation), so, as suggested by Francesco Cervellini, I will use it without translating it.

[2] Cf. Cervellini 2013.

[3] Cf. Migliari 2004; Valenti 2004.

[4] Cf. Valenti 2004.

[5] Cf. Migliari 2004.

[6] The term "projection" is used here in conceptual terms as an "externalization" projection towards the outside of the model or its elaboration.

[7] "Actuator" means any device capable of converting energy into an action in the real environment.

[8] Cf. Bianchini, Nicastro 2018.

[9] Cf. Migliari 2009.

[10] A special thank to my colleagues Marco Fasolo, Laura Carlevaris, Leonardo Baglioni, Marta Salvatore and Jessica Romor, with whom I have longly discussed on the subject of dissemination and who gave their help in some of the experiments.

[11] The task of survey of the Colosseum, starting with the planimetry of high levels and the north hemicycle elevation, was formally entrusted by the Archaeological Superintendency to University of Rome "La Sapienza" on July 6th, 1998. The scientific responsibles designated by the parties, for the management of the research contract, were for the University Prof. Riccardo Migliari and for the Superintendency Arch. Giangiacomo Martines. The survey was part of a general study plan for the restoration and enhancement of the monument, entrusted to the Roman Universities and various Departments collected in the areas of competence. The "Survey" area, which included the Department of Representation and Survey and the Department of Hydraulics, Transport and Roads was coordinated by prof. Mario Docci.

[12] Cf. AA.VV. 1999.

[13] Cf. Migliari, Valenti 2012.

[14] Cf. Valenti, Romor 2008; Valenti, Romor 2016.

[15] Cf. Sinopoli, Valenti et al. 2018.

[16] Cf. Valenti 2014; Valenti 2016.

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His research deals with the project and its manifestation through the ephemeral balance between technique, form and construction.
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04 METAPHYSICS OF VIRTUAL
THE REDUCTION OF THE TRUTH IN THE VISUAL NARRATIVE PHENOMENA

Abstract

Already from the era of Aristotle's Greeks, the question of the reproduction of reality through the technique and the method represented the attempt to reposition, within the measurable, an activity that is, on the contrary, widely located in the depths of the space characterized by the absence of measures, proper to art and thus of its aim as an autonomous and subjective interpretation of the surrounding world.
The duplication of reality is one of the main fields of interaction between art and science, from Brunelleschi's experiments of Camera Obscura to the contemporary cybernetic condition of the virtual, where the limit of realism of virtual space seems to have far exceeded the contextual objectivity of the real space.
The question in the process of abstract thinking, that precisely today has reached the limits of technological perfection, present and increasingly widespread, is related to the relationship between the value of the automatic design process and that of the final product, in a relocation context of its own essence within a new configuration in space-time.
The search for a new lexical metaphysics, aimed at the compensation of the technological element, now seems an obligatory choice in the field of digital design, of its infinite reproduction and of the proper condition of alternative, duplicated or not, to reality.

Già dal tempo dei greci di Aristotele la questione della riproduzione della realtà attraverso la tecnica e il metodo rappresentava il tentativo di riposizionare all'interno del misurabile un'attività al contrario ampiamente sita nei meandri dello spazio senza misure, proprio dell'arte e quindi del suo proporsi come interpretazione autonoma e soggettiva del mondo circostante.
La duplicazione della realtà è uno dei principali campi di interazione tra arte e scienza, dagli esperimenti brunelleschiani della Camera Oscura alla odierna condizione cibernetica del virtuale, dove pare che il limite del realismo dello spazio virtuale abbia ormai di gran lunga superato l'oggettività contestuale dello spazio reale.
Il quesito insito nel processo relativo al pensiero astratto e proprio oggi, raggiunti i limiti di perfezione tecnologica, presente e sempre più diffuso, è relativo alla relazione tra la valenza del processo progettuale di tipo automatico e il valore del prodotto finale, in un ambito di ricollocamento della propria essenza all'interno di una nuova configurazione nel piano dello spazio-tempo.
La ricerca di una nuova metafisica lessicale, finalizzata alla compensazione dell'elemento tecnologico, sembra ormai una scelta obbligata nel campo del progetto digitale, della sua infinita riproduzione e della condizione propria di alternativa, duplicata o meno, del reale.

In the ancient sanctuary of Dodona, in Epirus, older than Delphi, priests lying under the secular oaks observed how the leaves fell surronded by the wind, and while considering how they hovered and then leaned on the ground, they drew predictions regulating for hundreds of years the life of archaic Greeks[1].

One time, at the beginning, there were forests, mountain slopes and meadows, Nature and its own geometric rules that inspired the evocative desire of man. Architecture and its image could only presuppose to define a reproduction of a contextuality of the humanity sense in a perfect relationship and balance with Nature.

From the first stereotomic constructions, as reproduction of caves inhabited by first humans, to Doric temples, where the colonnades consolidate a lithification of wooded sanctuaries in mountains of archaic Hellas, the process of transfer from the natural reality to the physical one was constant and of unchanged origin, compared to what, nowadays, is considered architecture in some way.

The slow but constant expansion of human civilization, and its necessity to tranfer an increasingly distant and controlled Nature within its vital nucleus, has brought to the first representations in an artistic vision, therefore interpretative, of physical contextual features in the field of analogy. As evidence of these first passages from one field to another, nothing remained of Greek paintings, certainly extraordinary, while much survived of the Roman ones, as direct descendance. The surprising attempts of Roman painting, in the field of spatial reproduction of natural and architectural systems, includes real landscapes, where there is always a perfect mediation between natural-biological structures and artefacts of human activity. These are among the first elaborate realities aimed at building a metaphysical, unreal landscape, based on the interpretative reproduction of an evident reality. It is sufficient to think about the extraordinary *fresco* of the Nymphaeum of Villa Livia in Prima Porta[2], where Roman painting, also reaching a completely contemporary technical maturity in the 1st Century, is able to exploit a three-dimensional conception of space, not only with the evident use of perspective but above all through the use of continuous perimeter walls, thus providing an illusion of space that surrounds the observer. The space supposed to be the garden, outside the Nymphaeum and the Villa, is reproduced in an environment

Fig. 1 - Forest.

Fig. 2 - Greek temple.

dedicated to *otium*, sheltered from the summer heat, in the shadow of a hypogeum architectural space, protective and isolated. Therefore, a proposition of a version of reality, almost certainly real outside the Nymphaeum, but transferred itself to the walls of the room in a manifestation of a version of *reality*, certainly *present* and not *possible*[3], transferred in a *virtual* representation.

The 14th and 15th centuries rediscovery of Roman painting and its virtual spaces changed, after many centuries, the visual expression of the world and, in particular, its tradition of represention. Brunelleschi's experiments, Masaccio's Trinity[4], the incessant work of Piero della Francesca, represent the consolidation of a journey that began almost before, perhaps already with Ambrogio Lorenzetti[5]. The restoration of a three-dimensional pictorial sensibility has modified the way of conceiving architectural forms from every point of view. The architecture of Renaissance is an architecture conceived three-dimensionally, contentual, representative, organized by volumes and interconnecting overlapped and subtracted masses.

Artistic representation of the virtual world and "architecture of the real" began to merge, constantly chasing in the creation of brush-elaborated forms by artists, often

Fig. 3 - "Casa di Livia", view and particular.

architects, who used painting, not limiting, to verify, propose and judge expressive possibilities, continuously renewed and accessible in their essential lines in a sort of archaic encoded database. From Masaccio in Florence, to Alberti in Mantua[6], till the modern, when the poetic of

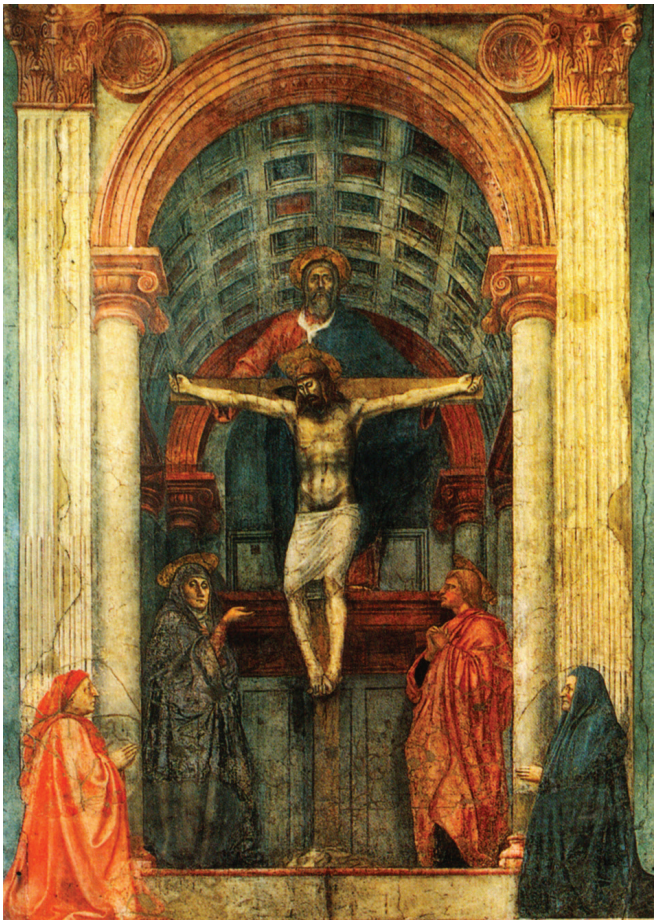


Fig. 4 - Masaccio, "Trinity".

Fig. 5 - Alberti, Sant'Andrea.

Rossi in the Cemetery of San Cataldo also draws its origins from an autobiographical sentimental affinity towards the painting of Mario Sironi[7]. Perhaps, this is the last example, late and almost anachronistic, of a direct relationship between figurative arts and architecture. The experience of modernism, of rationalism, has already shifted the attention, since the '20s, to new forms of art, dynamic and able to modify the content quotient of the single object.

Cinema, entered on the architectural scene with the famous *Metropolis*, and subsequently with the scripts by Moholy-Nagy for *Everytown* in *Things to Come*, invades the imagination of modernist architects, presenting itself as the only art able to effectively and affordably represent the broader intellectual system supporting the human

condition, that from utopian has shortly become dystopic.
Blade Runner, *Gattaca* and *Matrix* are only the most recent insertions of cinema in the imaginary of architecture. On the one hand, the use of existing architectures, as real decontextualized symbolic buildings, and on the other the realization in the field of virtual of only imagined projects, have confused the knowledge of what is or not real. Virtual and real merge definitively into a single information flow aimed at the constitution of a further world, unphysical, devoid of the usual rules relating to space and time. It is the beginning of the normalization of a simplified access to information, to the possible, indirect but however involved and determined new expression of metaphysics.
In 1993, Michael Heim published the book "*Metaphysics of virtual reality*" and that fundamental book is already significant and lapidary in the part of the premise:
"*Efficiency in contemporary business world requires email, digital documents and global connectivity. Our awareness of virtuality slips away when we lose the tactility of the postal envelope, which is the presupposition of "electronic mail"; in the moment in which it is forgotten the kinaesthetic exercise as presupposition of "manual writing"; and in the moment in which it is lost the dedicated presence that is the presupposition of the "telepresence". Since everyday life normalizes virtuality, the search for equilibrium stimulates to retrace again those studies that had advanced the signs of the nascent virtuality before its effective normalization. A careful critique of the real "virtual reality", as it was initially conceived, can help to awaken the conscience and to give a start towards that balance necessary for those who daily live in virtuality.*"[8]
What is this new Metaphysics: the overcoming of knowledge on a sensitive basis, the codification of a knowledge that can also relate to the *possible*, the anticipation of cyberspace.
In 1957, Heidegger already pointed out the change in the relationship of man with time[9]: its perception, in fact, seems modified by the imposition of a technological context, where information is now the basis of the quality of human life. The literature itself has sublimated its own prerogatives

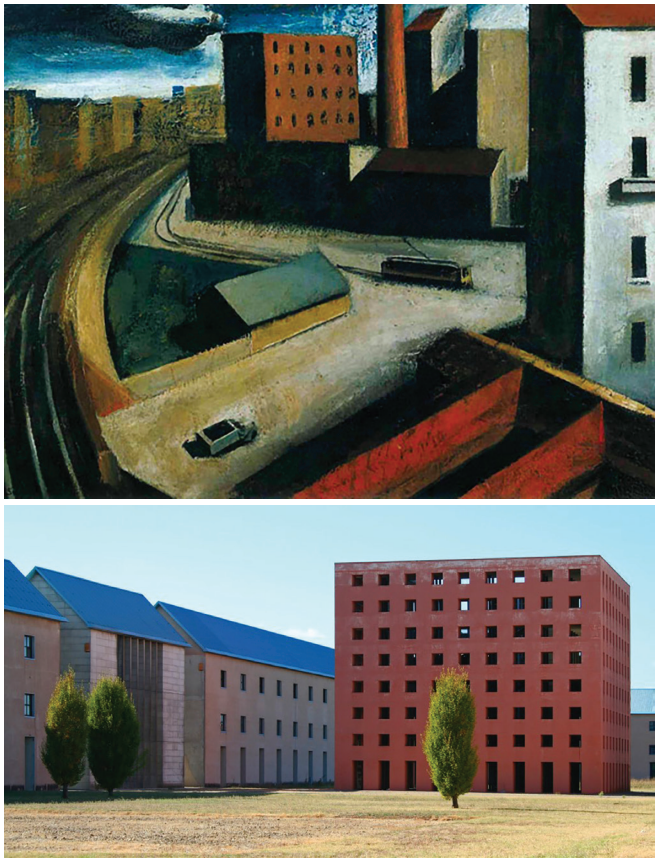


Fig. 6 - Above: Sironi, "Periferie". Over: San Cataldo, Aldo Rossi, Ossario.

of written and immutable letters by inserting the so-called hypertexts, capable of transcending this immutability disclosing as portals on the infinite territory of the internet.
Digitized writing, as well as architectural design, thus becomes pure information, and this goes beyond its univocal meaning, allowing to the interpretative contribution of others, that can modify its original content till changing its intellectual origin by destroying its meaning, the true sense

of things[10]. Thus, the passage from doctrine to content notion is immediate and almost automatic, a prelude to the so-called *infomania*[11]. Boolean logic dominates in a new Universe purified from Aristotelian syllogisms and centred on the virtuality of symbols and data, that constitute a reality digitally reduced in an a-rhythmic succession of 0 and 1.
Bitcoin and contemporary *datacracy*[12] are its present immanent example: the shifting of virtual money and the displacement of political or civil consensus, probably already virtual, now happens in very short times and on the routes supported by the numbers 0 and 1.
Thus, as already expressed by Marshall McLuhan and Walter Benjamin[13], the tendency to forget the origin of the process and the obvious superficiality in the knowledge about the appropriateness of available tools for representation, is modifying the thought concerning architecture, not only from the side of its conceiving but also and above all from the side of its understanding, its seeing, its interpretation.
The quantity of information in a continuous flow, now beyond the problems of overexposure, has made what

Fig. 7 - In the previous page: Blade Runner and Blade Runner 2049. © Warner Brothers Entertainment, Inc.

Fig. 8 - In this page, above: Matrix, Architect. Over: Lone Man, Blade Runner 2049. © Warner Brothers Entertainment, Inc.

Fig. 9 - Chinese "Abitare".

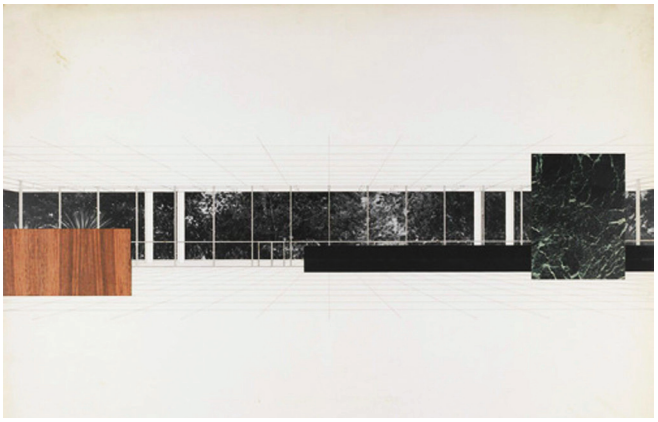


Fig. 10 - Mies, Collage. © 2019 Artists Rights Society (ARS), New York / VG Bild-Kunst, Bonn.

was prerogative of long meditated knowledge, within the Albertian *divisare*, as a cultural shelf sub-product, even for *discount*, intended no longer to actively suggest new solutions to critical conditions but rather to favour market factors linked to the *charme* and *appeal* to which the new *Homo Consumens*[14] is subjected.

Through the virtual, in its digital condition, architecture loses its function, its condition of utility. Also, it is already purified of the other Vitruvian categories of beauty (adequacy) since it does not respond to a program of coherence and solidity, since it does not respond to the laws of physics. It is ready to transmigrate definitively into the field of its pure representation as the scene of an environment with changed meanings.

Thus, also the man, deprived of his own contextuality, of his physical relationship with memory, objects and things, is framed and oriented in an unconditional technological praxis. He tends to realize the theories already foreseen a century ago by Aldous Huxley[15] and by many others after him: the dystopia of a new configuration of civilization, shaped by a technical-scientific utopia, where the manipulation of the individual and his control tend to be the goal. A "*last man*", as claimed by Nietzsche[16] and later by Fukuyama in

Fig. 11 - Lynette Jackson, Collage. © 2018 Lynette Jackson

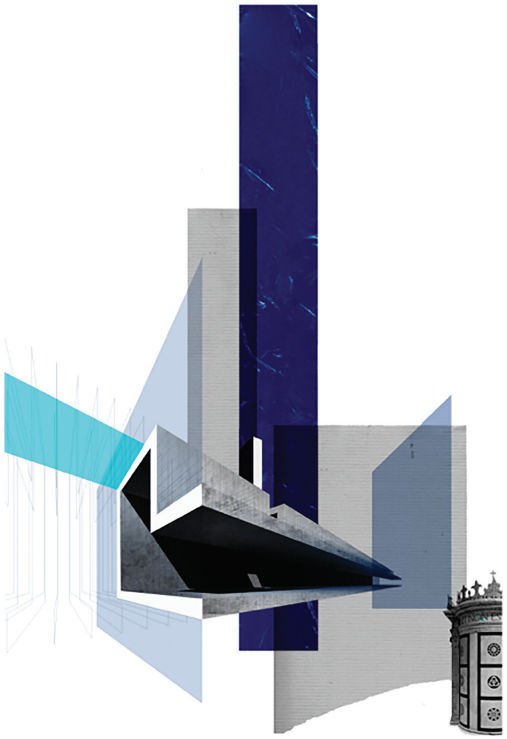


Fig. 12. MP, Casa Sacello, Collage.

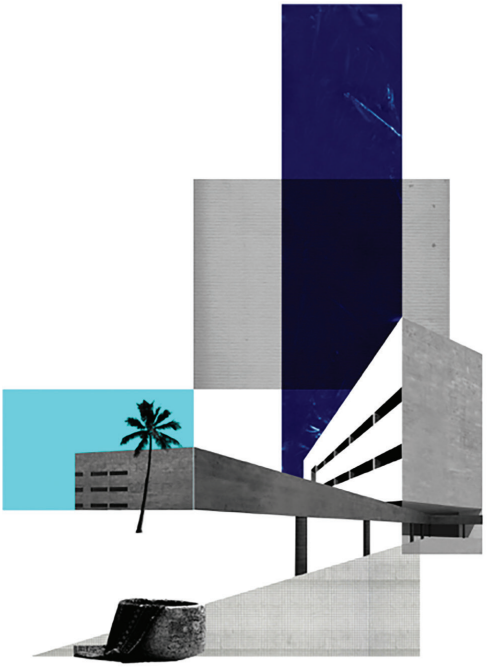


Fig. 13. MP, Palestina, Collage.

a society where "*...one does not become neither rich or poor; both things are too strenuous. Who still wants to govern? Who will obey? Both things too annoying. No shepherd no flock! Everyone wants the same things, everyone is the same: those who feel differently go by themselves to the asylum.*"[17]
Ultimately, a farm-grown man.
Therefore, the question inherent the process of abstract thinking, reaching today the limits of technological perfection, is focused on the relationship between the value of the automatic design process and the value of the final product, in a context of relocating their own essence to a new configuration in the space-time sphere.
The search for a new lexical metaphysics, aimed at the compensation of the technological element, seems a forced choice in the field of digital design, of its infinite reproduction and of the proper condition as alternative, duplicated or

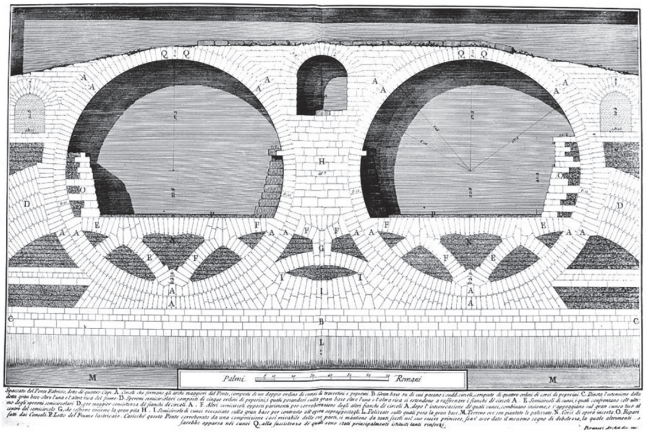


Fig. 14. Ponte Fabricio, Piranesi.

Fig. 15. Friedrich "reloaded".

not, of the real. Consequently, in architectural research it is necessary to re-orientate the digital representation of the project with respect to the purpose for which it is produced, bringing the project back to the center. Since it is not possible to understand *a priori* the complexity of the delta river of communication to and for architecture, within the so-called *digital project*, the use of digital tools will be rigidly framed as expressed for example by Purini already at the beginning of this century[18].

The bringing of virtual back into a condition of metaphysics of the *possible*, is an action that has to be implemented, not within the resistance to a process, but in the perspective of a joint cultural dialogue, mending the original link between

art and architecture, between space and his project, between representation of the real possible and its construction, at least until man will need a *home* and will be subjected to gravity.
The value of the relationship between technique and technology represents the epochal center on which *occidental thought* can construct a new humanistic idea; a radical thought, an intellectual journey capable of delineating what is still substantial in the developing of architecture. Thus, our civilization will need much more than new philosophers, rather than more powerful *render farms*.
In order to really prevent Nietzsche's prophecies, which are already acting, we should first of all reorganize the now destabilized balance between the humanistic "why" and technological "how", restoring the theory of architecture that has been slowly subtracted. Only theory and its apparatuses, as they have always done devoid of doctrinal contents, can help the habit, or the practice, like "*the rib that makes possible the construction of the arch: once completed its mission, it disappears and does not fall in the perception we have of the finished work, but we know that it was an obligatory and unavoidable passage, a necessary element to erect what we now see and admire.*"[19]
A difficult but exciting process, an attempt to look back to the infinite of *virtual* and *digital*, as instrumental techniques and not technologies, necessary expressive tools and not essential purposes.

Notes

[1] Cit. Homer, Odyssey XIV, 327-330, "*They said that Odysseus had gone to Dodona to hear, from the oak of tall canopy, the voice of Zeus, how he could return to the fertile land of Ithaca...*"

[2] The Villa of Livia in Prima Porta has belong to Livia Drusilla, wife of the Emperor Augustus. The residence is mentioned by Suetonius, Cassio Dione and Pliny. It is located at the 9th mile of Via Flaminia on a hill overlooking the Tiber in correspondance of Prima Porta.

[3] Virtual, possible, real, present, from Aristotle to Levy, passing through Bergson and Deleuze, the framing of these conditions is the basis for the current philosophy of digital language. As summary of the more contemporary approach to the relationship between these conditions, Gilles Deleuze: "*the real resembles the possible, while the current responds to the virtual.*"

[4] Masaccio, Trinity, Santa Maria Novella, Florence, 1427.

[5] By Ambrogio Lorenzetti, between the whole works, "*Presentation to the Temple*", Galleria Nazionale Uffizi, 1342 and "*Annunciation*", Pinacoteca Nazionale Siena, 1344.

[6] In the front of Sant'Andrea Church, Alberti reproposes the typology of the triumphal arch with just one fornix, just as in the Trinity of Masaccio the barrel vault with very similar lacunars suggests a relationship between the sacrifice of Christ and his triumph over death.

[7] Mario Sironi, *Periferia*, Collection Carlo Foà, Milan, 1922.

[8] Cit, Heim 2014, p. 10.

[9] Cf. Heidegger 2005.

[10] If the hypertexts in the digital writing, that constitute the access to the hyperspace of the network, have de-constituted the authorial contribution to Letters, we can assert that the effects of B.I.M. (Building Information Modelling) in the architectural project already form a panorama made of an architecture devoid of (real) authors.

[11] Infomania: concept exemplified in an essay by the same title by Michael Heim and subsequently reported in the book already cited.

[12] Cf. De Kerkhove 2001. For Derrick De Kerkhove the principle of datacracy, governance through the use of the network, is already underway, the cyberspace is the new place of political confrontation and management of human territories.

[13] Cf. Benjamin 2000.

[14] Cf. Bauman 2007.

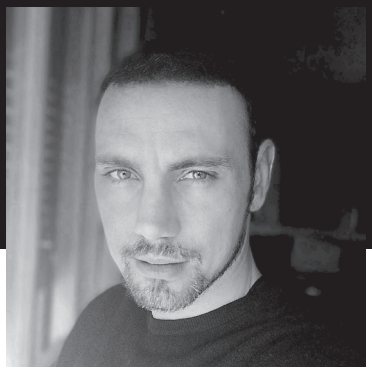
[15] Cf. Huxley 2000.

[16] The *Letztemensch*, anticipated and expressed by Friedrich Nietzsche. Cf. Nietzsche 1976.

[17] Cit. Fukuyama 2003, p. 319

[18] Cf. Purini 2003.

[19] Cit. Martí Arís 2007, p. 13.



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Among the experiences: Palladio Geodatabase; Expo2015 participation, with the 3D graphic competition "CameDesign_Future Home" winner of special mention; Fuorisalone 2015, interactive App development for Enel Energia and Mercedes Benz; movies and video clips for Enchanted Architect production and NuviRecords; participations in the Fantafestival of Rome.
From 2019 he is research fellow at Free University of Bozen as part of "VAR. HEE" project, for the development and testing of serious game using immersive virtual peripherals.

05 SERIUS GAME AND 3D MODELLING
FOR THE IMMERSIVE EXPERIENCES DEVELOPMENT IN DIGITAL TALE

Abstract

The current phenomenon of adhesion and progressive diffusion of the new immersive criteria offered by the active use of HMD devices, with regard to editing methodologies and design development in sectors with multiple purposes, now allows a better empathic link between the virtual visitor and digital spaces, effectively overcoming any other system of interaction with simulated environments. Thanks to the fluid learning curve of the software and to a progressive improvement of the level of emotional narration, the VR experience is easily adopted in the most varied fields, specifically aimed at describing, and telling, something that essentially cannot exist, or no longer exists, simulating experiences that are recorded in memory as real and can be repeated in the future.
The Serius game is thus the easiest way to exploit the potential of virtual platforms, in order to capture the attention, in a natural way, of users characterized by multicultural levels and social variables. This information system interfaces through playful dynamics, using software and methodologies that are not specific to digital architectural design but are rather similar to the development pipelines for next generation videogames. Immersion, Presence and Interactivity are the peculiarities that synthetically define the particular functionality of virtual devices, identifying the progress of the Third Digital Revolution, in which we passed from 2D vector representation to a three-dimensional reconfiguration manipulable on desktop, arriving at the current interactive scenarios, perceptively very similar to the real ones, thanks to the progress of rendering algorithms for the rendering of light phenomena and for the reproduction of IPR (Interactive Photorealistic Rendering) shaders with physically correct behavior.

L'attuale fenomeno di adesione e progressiva diffusione dei nuovi criteri immersivi offerti dall'uso attivo dei devices HMD, riguardo alle metodologie di *editing* e sviluppo progettuale in settori dalle molteplici finalità, permette oggi un miglior legame empatico tra il visitatore virtuale e gli spazi digitali, superando di fatto qualsiasi altro sistema di interazione con gli ambienti simulati. Grazie alla fluida curva di apprendimento dei software e ad un progressivo miglioramento del livello di narrazione emotiva, l'esperienza VR viene facilmente adottata negli ambiti più svariati, nello specifico finalizzati a descrivere, e raccontare, qualcosa che in sostanza non può esistere, o non esiste più, simulando esperienze che vengono registrate nella memoria come reali e possono essere ripetute nel futuro.
Il *Serius game* risulta così la modalità più semplice per sfruttare il potenziale delle piattaforme virtuali, per catturare l'attenzione, in maniera naturale, di un'utenza caratterizzata da livelli multiculturali e variabili sociali. Tale sistema informativo si interfaccia mediante dinamiche ludiche, impiegando software e metodologie non specifiche del disegno architettonico digitale ma assimilabili alle pipeline di sviluppo per *videogame next generation*. Immersione, Presenza ed Interattività sono le peculiarità che definiscono sinteticamente la particolare funzionalità degli apparati virtuali, identificando i progressi della Terza Rivoluzione Digitale, in cui si è passati dalla rappresentazione vettoriale 2D ad una riconfigurazione tridimensionale manipolabile su desktop, arrivando agli attuali scenari interattivi, percettivamente molto simili a quelli reali, grazie ai progressi degli algoritmi di *rendering* per la resa dei fenomeni luminosi e per la riproduzione degli *shader* IPR (Interactive Photorealistic Rendering) dal comportamento fisicamente corretto.

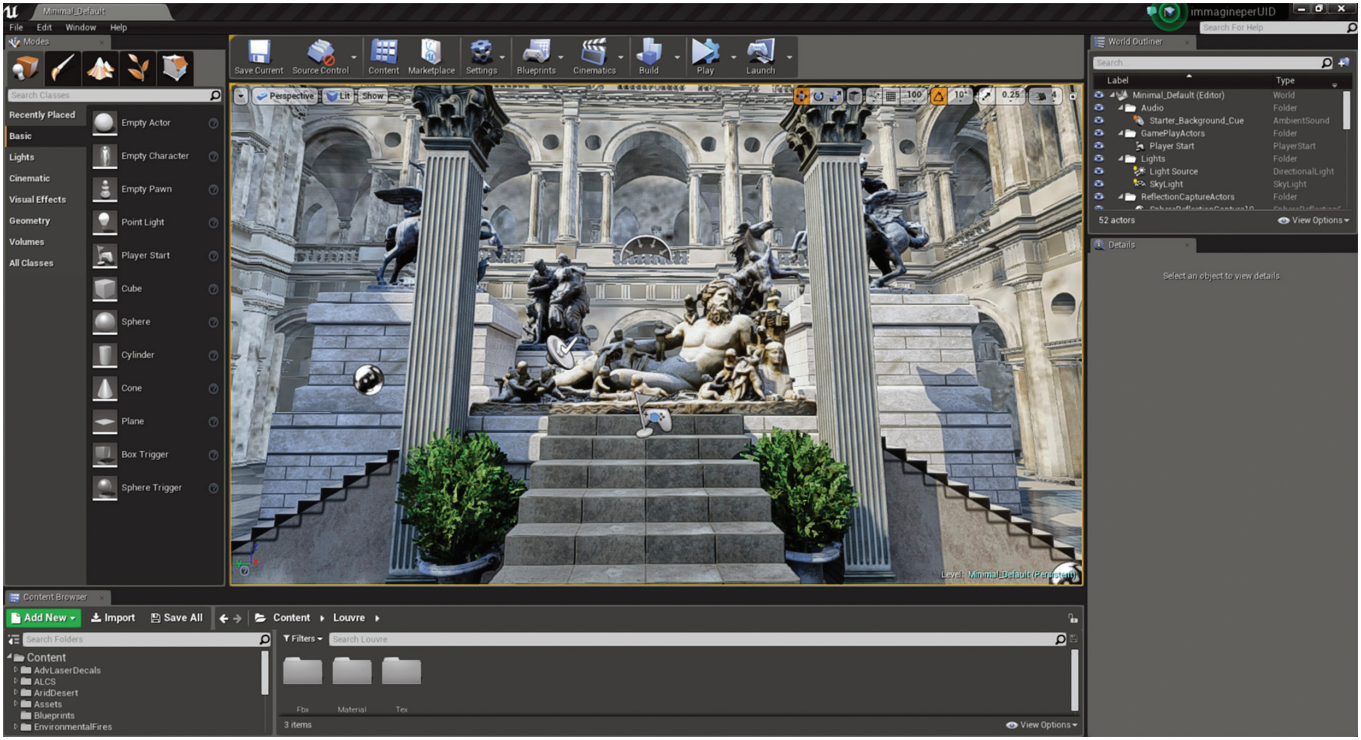
Serious game technology shares with the evolution of entertainment games the same development path and the same progress over time linked to the progress of software and hardware. Recent improvements in computer games, such as RTR (Real Time Rendering), the use of virtual platforms to support virtual and augmented reality and developments closely linked to the management of artificial intelligence to support the technical processes based on the identification of non-player characters and avatars, are just some of the aspects identifying the State of the Art related to the Serius Game. The popularity of video games, especially as a means and instrument of approaching more complex issues by younger users, makes them the ideal means for educational purposes, following a trend that sees the development of increasingly complex video games, increased both by pedagogical elements and by play components. The term Serious game therefore describes a relatively new concept, games for entertainment that are not limited to the goal of providing fun, but that allow a collaborative use of three-dimensional spaces usable for educational purposes in a number of application areas. Modern gaming technologies based on simulation, visualization and interactivity, offer the possibility to virtually reconfigure scenarios related to works of art and historical environments no longer existing through a digital reconfiguration that is based on in-depth scientific data, and on archaeological and architectural skills that actually put in communication the non-expert player with professionalism specialized in teaching, making the Cultural Heritage much more accessible in the understanding of its complex dynamics. Serious games can take very different forms of applications, ranging from tools that can be configured on mobile platforms such as smartphones and tablets, to complex applications on consoles, personal computers with advanced VR tools, more complex *mashup* applications, for example relating to combinations of apps between social software, or in the form of complex games not necessarily linked to the sector in question. According to an alternative school of thought, Serious games are information tools in which the play and the educational components are developed in a balance in which there is the willingness to create an effective and pleasant educational experience, regardless of the type of technology used, the technological support used, the type of audience to which it is addressed, and the genre developed. Over the years, the dynamics of the Serious game acquire increasingly blurred contours, not only in relation to the distinctiveness between Serious games and video games for entertainment, but also with regard to their actual influence in various sectors and media communication: in engineering, medical, educational, museum, but also in the use of the teaching of certain behaviors within companies or in relation to the exercise of some phases of work in industry. The dissemination of this new information tool acquires relatively different connotations and characteristics according to its actual use, preserving the fundamental aim of developing skills and competences to be applied in the real world through exercise in a simulated and protected environment. And so it is good to distinguish various media that have the peculiarities of the Serious game and that are used exponentially in different sectors: E_ learning, MOOCS, GAMIFICATION, PURE SERIOUS GAMES (declined with respect to the various application areas).

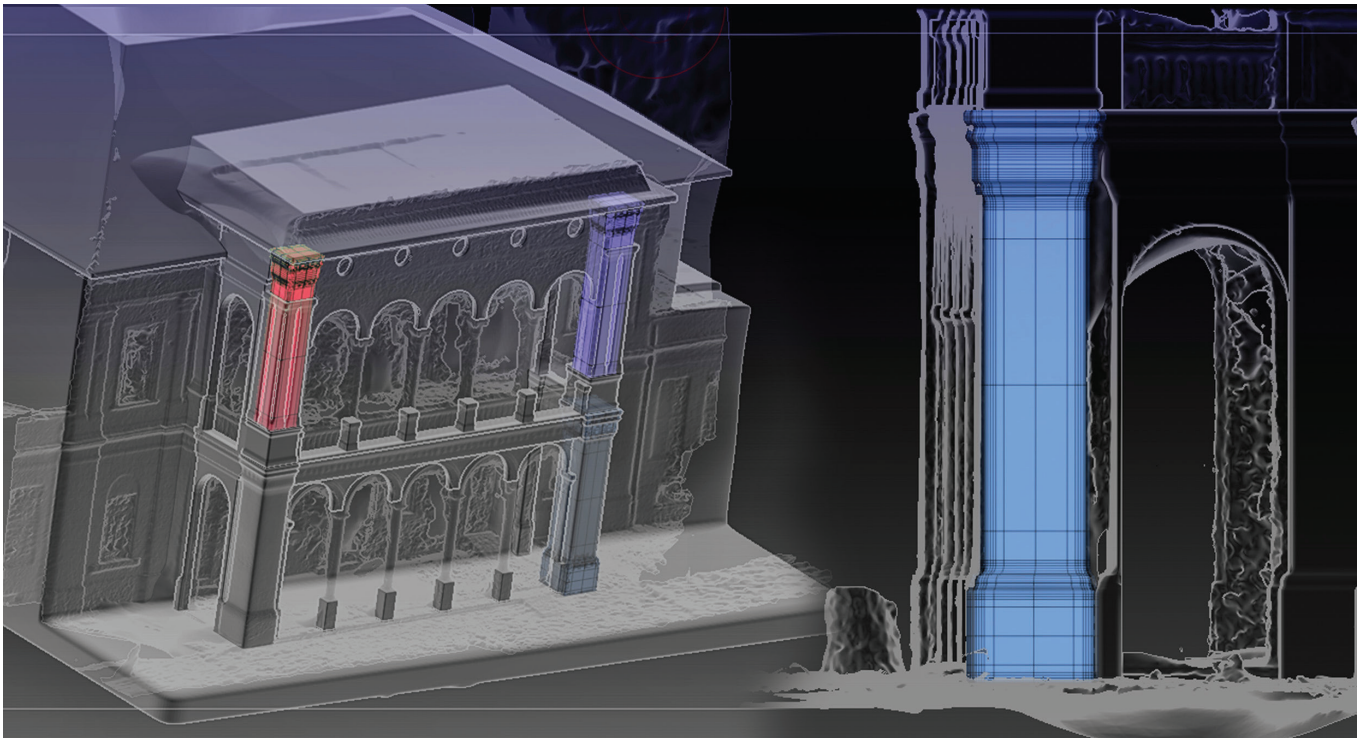
E-learning is among these the most generic term to define an alternative approach to traditional learning through advanced technological instruments. It can vary from simple learning through video interactive telematic lessons, to the use of complex digital tools and multimedia programs that allow an improvement of the general usability through learning aimed at simplification, customization and versatility of the level of difficulty according to the user. An advanced e-learning formula is MOOCS (Massive Open Online Courses). This particular type of Serious game identifies in practice those courses that take place online, designed for distance learning and a very wide audience, able to reach global coverage. This particular tool now makes use of the most popular social networks, such as

Twitter and Facebook, and specific software such as Skype, which, thanks to new super-fast internet fiber systems, can manage very large amounts of real-time data streaming that facilitate a user of millions of people. The first MOOC, which probably dates back to 2008, during the online conference "Connectivism and Connective Knowledge", in which the professors George Siemens and Stephen Downes were able to reach thousands of users at the same time freely making available to them the teaching material related to the course. GAMIFICATION has a much wider meaning and today it can

Fig. 1 - Darfur is Dying, serius game.

Fig. 2 - Oculus Rift on Editing Unreal Engine4 platform_Louvre museum inspiration ambient. (by A. Basso)





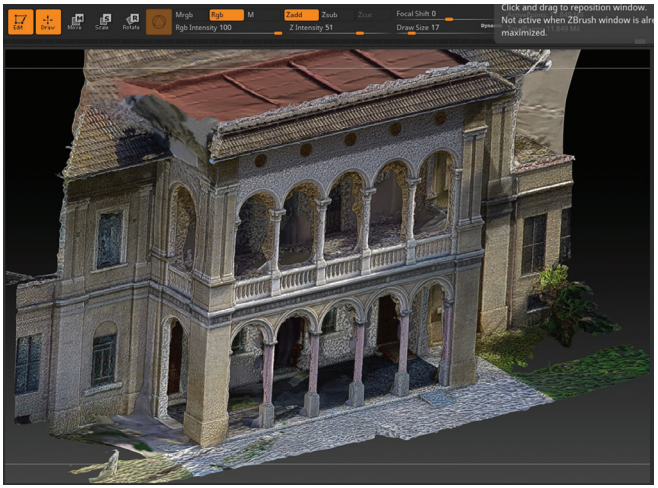


Fig. 4 - Retopology semantic suddivision in zbrush for virtual platform optimization. (by A. Basso)

Fig. 5 - Aurum reconfiguration by photogrammetry (zbrush retopology). (by A. Basso)

be considered often involved in the management dynamics of multinationals such as IKEA, Amazon, in the marketing and organizational management of the most important architecture firms, but also in the management of personnel employed by medium to large commercial activities. It consists in the use of elements taken from games and from the videogame component related to Game Design techniques inside contexts outside videogames, in order to increase participation and involvement but above all productivity.

The dynamics of game fiction related to mechanics based on competition and the achievement of objectives, such as the addition of progress bars, of points that certify the progress of users, closely affect the psychological behavior of players_ workers, as is the case in the game in a more contained way. The main criticism derives from the fact that it is a question of using dynamics belonging to a virtual dimension in a real dimension, and in more work situations, in which factors such as stress and physical fatigue are involved.

Such use of gamification exponentially is often not healthy for those involved in such dynamics. Dissimilar are the developments that define the pure Serious game, or entertainment video game that aims to transmit input and information within a protected work space, simulated three-dimensionally. Unlike GAMIFICATION, where we certainly find mechanics derived from video games but within real experiences that are clearly not simulations, a Serious game is a real game but designed with a specific purpose, different from mere entertainment, where all the elements typical of normal games, first of all a real gameplay, acquire different purposes that can still be the most varied and disparate, going from teaching to solving behavioral problems such as phobias (for example, Snow World is a VR-compatible Serius Game used in medicine to generate in patients with burn damage a suggestion induced by sensations of coolness) or teaching industry to assemble components before approaching a real assembly line. The most promising Serious games are those specialized in the cultural field and in the promotion of Heritage in support of museum education. In the last period the technological implementations of the visual graphic quality, of the artificial intelligence and of the interfaces, have, at a technological level, equated the Serious game to the commercial entertainment videogame, thanks also to a drastic lowering of the production costs and to the diffusion of new hardware, such as the Gpu and the VR equipment, and new software, such as Unreal Engine and Unity. Serious games thus become exponentially more sophisticated and perform better than in the past. Real-time graphics thus reach near-photorealism and virtual game worlds usually become populated by a considerable amount of high-quality content, generating an appeal equivalent to the experience that can come from watching a good movie. In this regard, Zyda, a researcher who was among the first to deal with the subject in depth, argues that the implicit pedagogical aspects of a Serious game should always be secondary to the playful, graphic and spectacular aspect, which means that a game devoted to the enhancement of Heritage should specifically retain its component of game play regardless of its pedagogical content (Zyda, 2005). The central characteristic of the Serious game, in order to influence memory, resides in its capacity of perceptive identification and simulation of reality. It is scientifically proven that the experiences made directly are recorded more easily by the brain in the hemisphere of memory, exploiting the celebral inputs specifically aimed at action: this leads to the involvement of the player in dynamics of the specific experience of simulation, virtual reality and augmented reality, in which the player's action allows more easily to record in memory the operations made virtually, acquiring even complex notions and activating unconscious mental processes related to storage, for example of a particular architectural aspect or an event occurred in the reconfigured scenario.

From 2005 on, many experiments and prototypes of Serious games for the enhancement of Cultural Heritage have taken place, such as that of Roma Reborn and Ancient Pompeii, which have allowed for the first time the development of a new type of involvement of aspects related to the areas of communication, visual expression of information, mechanisms of collaboration avatar player with virtual avatar, interactivity and playful entertainment. The Rome Reborn project has been, for about twenty years, one of the most complete projects of digitization and interactive reconfiguration related to historical urban scenarios. The main objectives of the project were the creation of an HD version of Roma 320 AC, a model with lower resolution for the creation of a "mashup" application with "Google Earth" (http://earth.google.com/

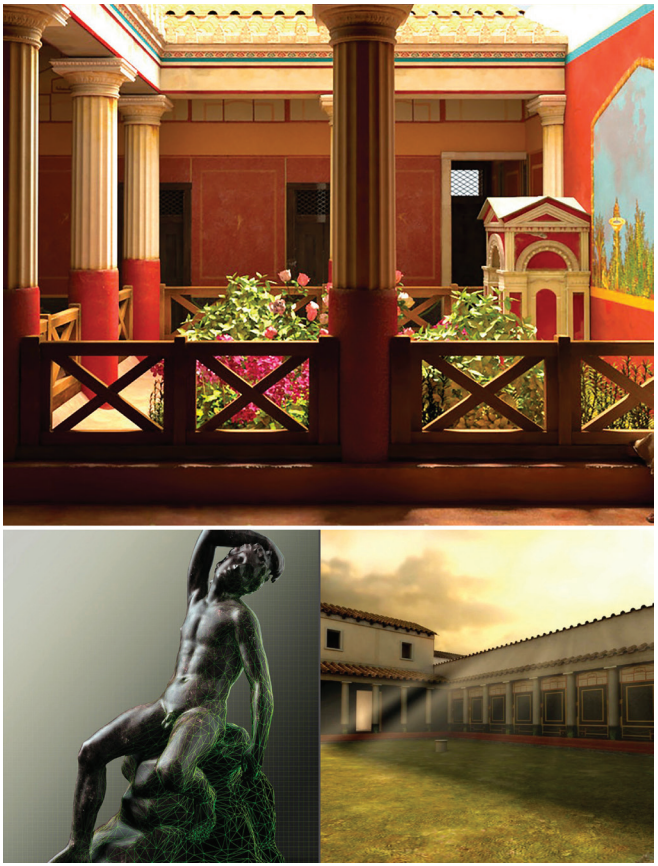


Fig. 6 - Ercolano Virtual Museum, Indoor-outdoor Domus VR tour.

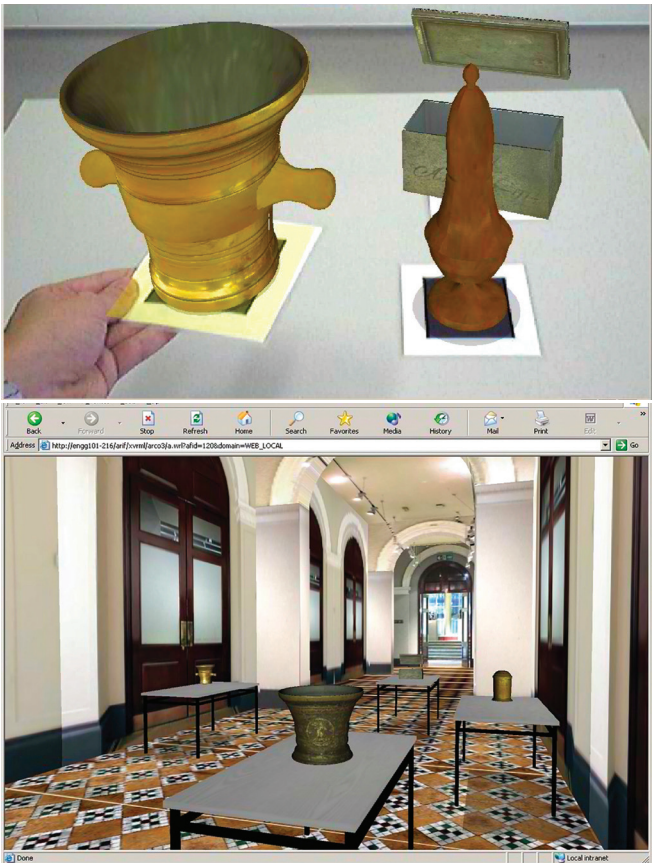


Fig. 7 - Arco project for VR and AR interactivity Museum.

roma/), and finally, a collaborative mode of the model to be used with VR applications aimed mainly at university education.

In order to study the effectiveness of the Roma Reborn project as a Serius game aimed at learning, exploring, re-enacting and researching the cultural and architectural aspects of Ancient Rome, the application then evolved into "Roma Nova", marketed at the time and used in various its components in the development of other VR and AR applications. In particular, the project aimed to test the suitability of the use of this technology to support archaeological exploration, with particular attention to the historical, cultural and social aspects of life in Rome, such as political, religious and artistic expressions. https://youtu.be/JIj9i8sJ9tE

To achieve these objectives, the project has integrated over time four virtual technologies, at the time at the forefront,

and the use of a detailed three-dimensional model including textures and volumetric effects, management of liquid shaders, simulation of crowds and animations of vegetation. These technologies include several external plug-ins and proprietary rendering engines, used in the run-up to the advent of new next generation systems such as Unreal Engine, such as "the Quest3D visualisation engine" (Godbersen, 2008). Instinct(maker) Artificial Life Engine (Toulouse University) or ATOM Spoken Dialogue System (http://www.agilingua.com) The use of the artificial life engine Instinct also allowed consistent animations of the crowd based on a sort of AI of the population of Rome that regulated the behavior of the characters according to the time of day and the social level assigned. The same system was later perfected in the famous commercial fantasy videogame Skyrim Elder Scrolls V, 2011.

The virtual avatars, with their different behaviors, showed the player the different aspects of life in Rome, such as living conditions, political intrigues and military conquests. The algorithm of management of the dialogue of ATilingua of Agilingua allowed to determine how the system would react to some questions of the player: ask questions, make suggestions and/or confirm an answer. The project also proved to be an excellent resource for testing archaeologists' past and current hypotheses regarding architecture, population behaviour, social interactions, topography and urban development planning, using virtual Rome as a test bed for better digital reconfiguration hypotheses.

Commercial games, considered a sort of hybrid between serius game and entertainment, belonging to the "documentary/strategic" genre, are mainly based on the

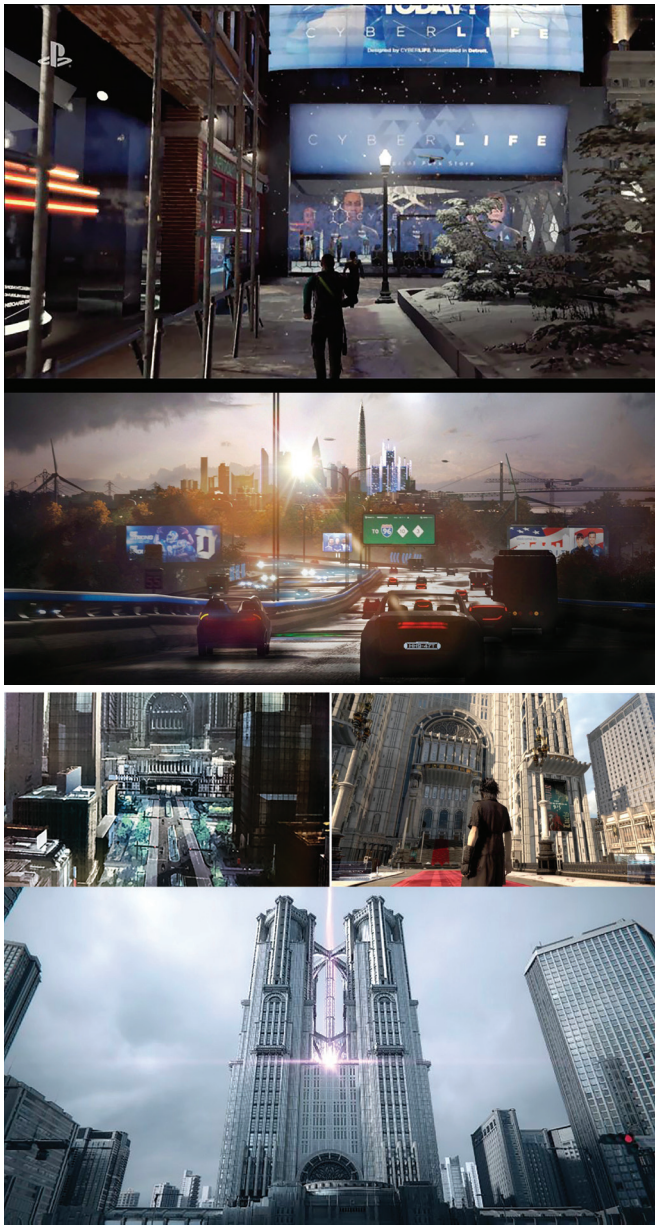


Fig. 8 - DETROIT Became Human (2018), reconfiguration of actual city for future hypotetic representation in a commercial videogame.

Fig. 9 - Final Fantasy 15 (2017)-Ferris inspiration for level architectural design.

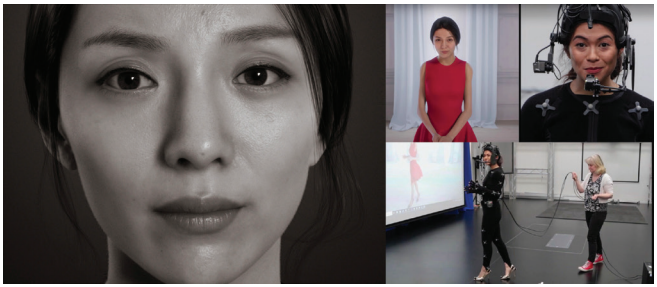
Fig. 10 - History Line 1914-1918.

Fig. 11 - Assassin's creed by Ubisoft, 3D reconstruction of Florence and Paris within some episodes of the series.

description of real historical events (often wars and battles), in which the human player can participate. They are games created mainly for fun, but their historical accuracy allows them to be used in educational contexts.
A first representative of this type was History Line: 1914-1918 https://youtu.be/r1M1uy-pU_E, by Blue Byte dating back to 1992, a turn-based strategy game describing the events of the First World War. The series that since 2009 has revolutionized the genre is that of "Assassin's Creed" by UBISOFT https://youtu.be/f_iwFCqFIGw, arrived through various editions to describe for about 10 years (from 2007 to 2018) different historical periods with an unprecedented graphic quality and realism, reconfiguring scenarios such as Renaissance Rome and Florence, Paris during the French Revolution, London of the Industrial Revolution, ancient Egypt and post-colonial America. With a development team of hundreds of digital artists, scholars of Architecture and specialized historians, the development of the game has given the opportunity to bring together actors from different fields of relevance with the same goal of reconstructing virtual scenarios corresponding as closely as possible to reality. The development of a digital technology and a virtual infrastructure to support the creation of 3D assets, dynamic systems and interactive animations related to Serious games, commercial games, simulations and reconfigurations for purely academic purposes, very often depends on the development budget available. In recent times, large companies in the commercial gaming sector have used multi-million dollar budgets, which can be used in comparison for film productions, mostly dedicated to the creation of resources such as three-dimensional models and animations and partly used in advertising campaigns and marketing presentations of animated intros, often developed for advertising purposes using the same material as video

Fig. 12 - Shadow of the Colossus by Sony (2006-2018 remake). The virtual reconstructions of architecture are inspired by Piranesi and the Romantic painters. Winner of numerous artistic prizes, it was the videogame that allowed the recognition of videogames.

games but with pre-calculated rendering techniques. Some of these costs can be reduced through the use of modelling procedural techniques aimed at creating digital terrain, elements that can be repeated by cloning or instancing, such as vegetation or urban assets components, optimized animations obtained from Mocap suits that can be adapted and reconfigured several times in the same scenario, asset billboards with almost zero polygonal density, etc. Thanks to the technological evolution of the digital infrastructures supporting the Serious game, the prohibitive budget of the first experimentations seems to have been much reduced, also thanks to the use of last generation gpu, much less expensive than in the past. The new Nvidia Turing technology, following the already excellent Pascal architecture of the Nvidia graphics cards, like the new RTX2080 Ti, allows in fact to obtain photorealistic effects, a more credible management of shadows and reflections, real-time Path tracing, smoother animations at a higher frame rate. With regards to software evolutions, free programs that were actually real game engines, such as the Torque Engine, favored by independent



developers and in the past successfully used in applications for cultural heritage, have been progressively replaced by powerful and complete Renderer and Compositor Real Time, as Unity 2018, Otoy Brigade and Unreal Engine 4.2x, free for academic research, which are now a key resource to produce high quality Serious games with very low budgets. The technological infrastructure suitable for a Serious game is the same as that used in a commercial videogame, subject in recent years to particular advances in terms of photorealistic quality and ease of execution:

- Graphic rendering progresses for the visual simulation component, procedural shaders, IPR (Interactive Photorealistic Rendering) materials, automation for territorial and naturalistic modelling.

- Progress in the management of interfaces and their graphic design, which defines a better interaction and comprehensibility of the videogame for the playing user (especially if they are not habitual players)

- Technical progress based on the behavioural identification of non-player characters and avatars: these are the evolutions related to AI, or artificial intelligence, and to the management of virtual crowds.

- Better interconnection between software by means of bridge plug-ins or new digital formats such as Alembic (functional for preserving metadata related to animations and the generation of fur and hair). This now allows for a smoother pipeline to transfer assets to your preferred virtual editing platform.

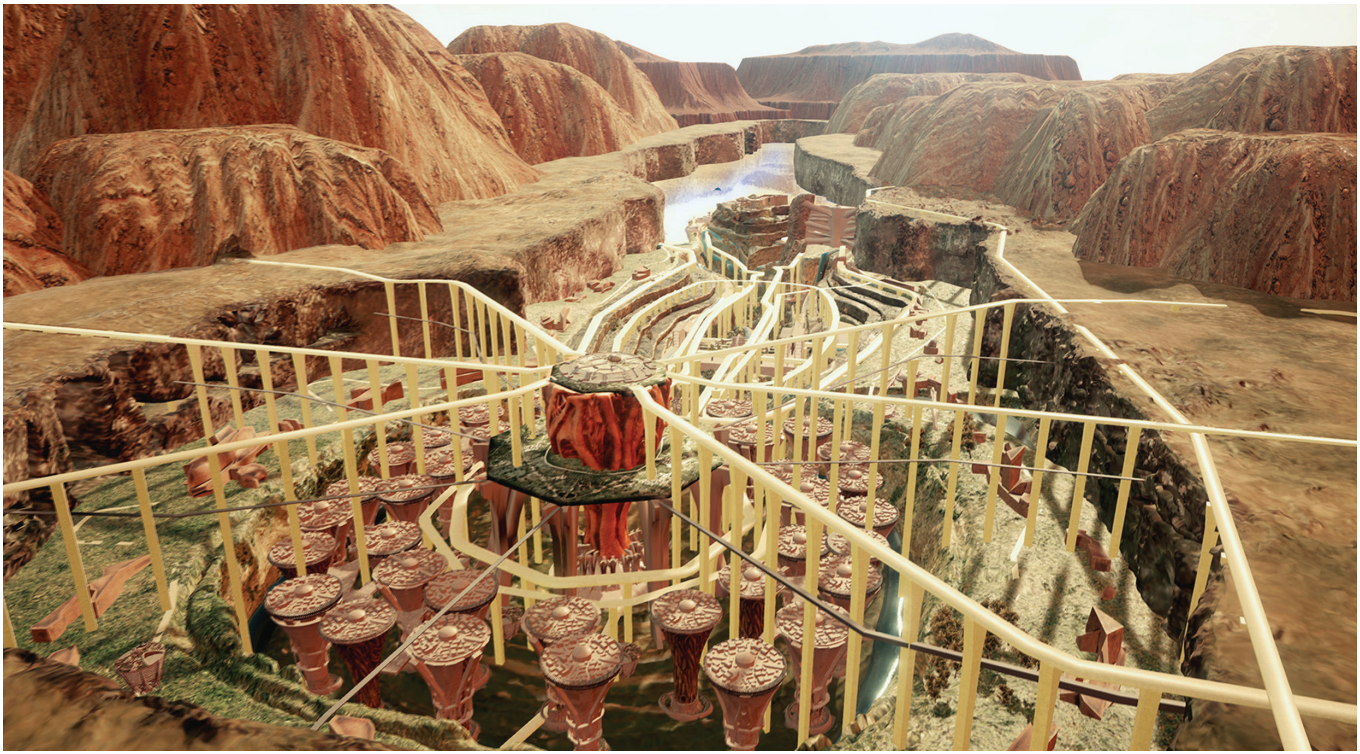
- Almost automatic integration with VR or MR (mixing reality) instruments such as headets such as OculusRift, HTC VIVE and HoloLens.

Fig. 13 - Project Siren (2018). Experimental MOCAP test in real time thanks to Unreal Engine together with the new advanced GPUs.

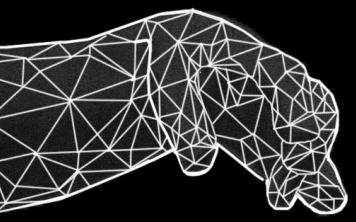
Fig. 14 - Laurie Anderson virtual experiment.

Fig. 15 - In the following page: Digital Reconfiguration of Mesa city-Soleri. (by A. Basso)

Moreover, the executive workflow seems to be progressively simplified to obtain 3D digital assets from photogrammetry auto-modelling, using photomodelling software now generally used such as Photoscan and Pix4d, thanks to the improvements of the programs involved, increasingly simple to use, more interconnected and complete, in order to achieve excellent results in the most diverse operations, such as UV edit, digital painting, the automatic development of Deph-maps (Bump, Normal and Displacement), Rigging etc..
In conclusion, the growing success of videogames, fueled among other factors by the great realism achieved, has left room for more effective types of teaching and new areas of application related to VR, AR and MR. These innovative approaches use current technology, as well as new digital techno-cultures, from simulated reality to artificial intelligence, identifying a closer interaction between man and machine. Together, these evolutions generate new research ideas that, in relation to the growing levels of confidence, usability and interactivity of technology, investigate the actual benefits but also the critical aspects of these new media, related to the immaturity of the instruments and inadequacy to the contemporary modus vivendi, and combined with an effective lack of long-term collective experimentation related to the 'intensive use of these tools or the possible risk of loss of interest for the real heritage that must instead be enhanced.



M.A.T.C.H. P.O.I.N.T. THE ENHANCEMENT OF MUSEUM SYSTEMS



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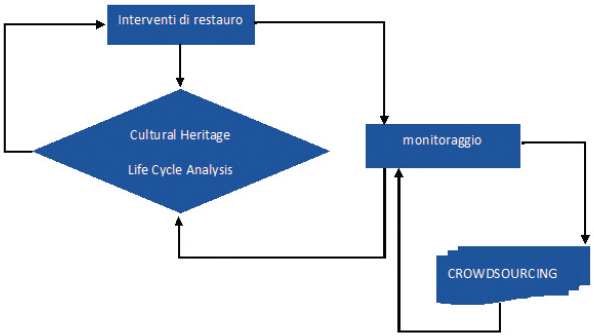
She is Marie Curie supervisor. She won the title of "Matteo Dellepiane Best Paper Award" at ISPRS/CIPA Workshop 3D-ARCH 2019.

06 CROWD SOURCING AND LOW COST STRATEGIES
OF SURVEY FOR DOCUMENTATION AND ANALYSIS OF MUSEUM COLLECTIONS

Abstract

In these last years, there has been an increasing use of the Structure from Motion (SfM) techniques applied to Cultural Heritage. The accessibility of SfM software can be especially advantageous to users in non-technical fields or to those with limited resources. Thanks to SfM using, everyone can make with a digital camera a 3D model applied to an object of both Cultural Heritage, and physically Environment, and work arts, etc. One very interesting and useful application can be envisioned into museum collection digitalization.
In the last years, a social experiment has been conducted involving young generation to live a social museum using their own camera to take pictures and videos. Students of university of Catania and Palermo were involved into a national event #digitalinvasion (2015-2016 editions) offering their personal contribution: they realized 3D models of the museums collection through the SfM techniques. In particular at the National Archaeological Museum Salinas in Palermo, it has been conducted an organized survey to recognize the most important part of the archaeological collection. It was a success: in both #digitalinvasion National Event 2015 and 2016 the young students of Engineering classes carried out, with Photoscan Agisoft, more than one hundred 3D models some of which realized by phone camera and some other by reflex camera and some other with compact camera too. The director of the museum has been very impressed from these results and now we are going to collaborate at a National project to use the young generation crowdsourcing to realize a semi-automated monitoring system at Salinas Archaeological Museum.

In questi ultimi anni, c'è stato un uso crescente delle tecniche Structure from Motion (SfM) applicate ai Beni Culturali. L'accessibilità del software SfM può essere particolarmente vantaggiosa per gli utenti nei campi non tecnici o per quelli con risorse limitate. Grazie all'uso delle tecniche SfM, chiunque può realizzare con una fotocamera digitale un modello 3D applicato a un oggetto sia che questo appartenga al mondo dei Beni Culturali, che dell'Ambiente o arti del lavoro, ecc. In particolare, un'utile applicazione può essere individuata nella digitalizzazione delle collezioni museali.
Negli ultimi anni è stato condotto un esperimento sociale che coinvolge le giovani generazioni a vivere un museo utilizzando la propria fotocamera per scattare foto e video. Gli studenti delle università di Catania e Palermo sono stati coinvolti in un evento nazionale #digitalinvasion (edizioni 2015-2016) offrendo il loro contributo personale: hanno realizzato modelli 3D della collezione museale attraverso le tecniche SfM. In particolare, al Museo Archeologico Nazionale Salinas di Palermo, è stata condotta una campagna di rilievo 3D, grazie alla quale sono stati acquisiti e modellati i pezzi più importanti della collezione archeologica. È stato un successo: nelle entrambe occasioni delle #digitalinvasion National Event 2015 e 2016 i giovani studenti delle classi di ingegneria hanno realizzato, con Photoscan Agisoft, più di cento modelli 3D, alcuni dei quali realizzati dalla fotocamera del telefono e altri dalla reflex e altri con macchina fotografica compatta anche. Il direttore del museo, molto colpito da questi risultati, attualmente collabora alla realizzazione di un progetto nazionale per utilizzare il crowdsourcing di giovani generazioni per realizzare un sistema di monitoraggio semi-automatico presso il Museo Archeologico di Salinas.



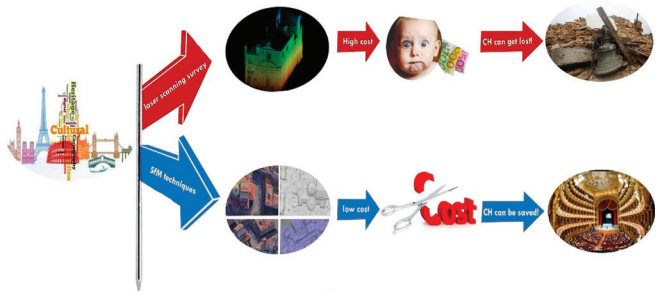


Fig. 1 - Life cycle of architectural heritage linked to planned monitoring.

Fig. 2 - Example for crowdsourcing project steps.

Fig. 3 - High and low cost monitoring.

Introduction

The potential applications of photogrammetric techniques are now well noted not only for industry insiders but also for all professional figures related to 3D structures from architects to surgeons from engineers to biomedical technicians from designers to astronomers and so on.

Due to the wide range of potential applications research in the field of photogrammetry is concentrated on strategies to support synergy between different sectors.

In our country, with such a vast cultural heritage featuring examples from various historical periods and being known worldwide for the richness of our historical buildings and artifacts, it is of particular importance to undertake conservation efforts in order to transmit these historical artifacts to future generations. Effective conservation requires that we perform maintenance at regular intervals and intervene, when necessary, to prevent damage to artefacts, this in turn allows us to find important answers regarding the cost of, and the frequency with which we conduct monitoring operations; conducting life cycle analysis of the asset itself. The curator of a good architectural or archaeological Museum should consider a monitoring plan which covers the entire life of an asset to ensure it's preservation.

Therefore the monitoring phase plays an important role in determining the life of an artefact.

However, the costs associated with intervention strategies are not inconsiderable and this, especially when concerning public administrations such as regional governments municipalities and publicly owned museums can pose an insurmountable challenge.

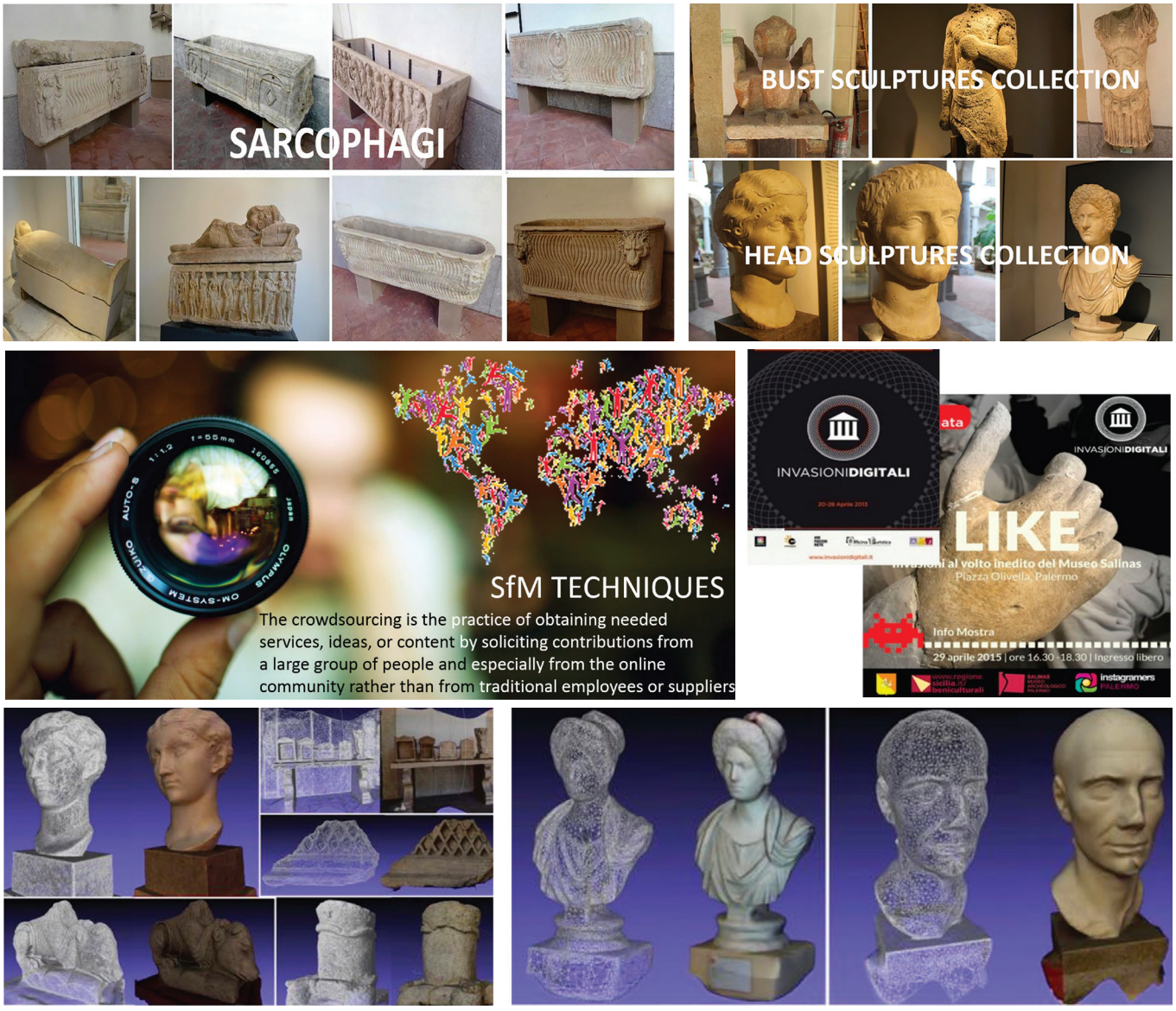


Fig. 4 - From the top: typological groupings of art works; monitoring solution: crowdsourcing project; digital invasions at Salinas museum in Palermo; some of the models made in 2015.

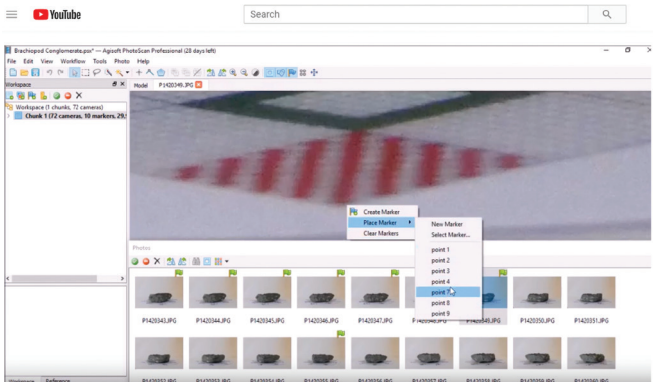
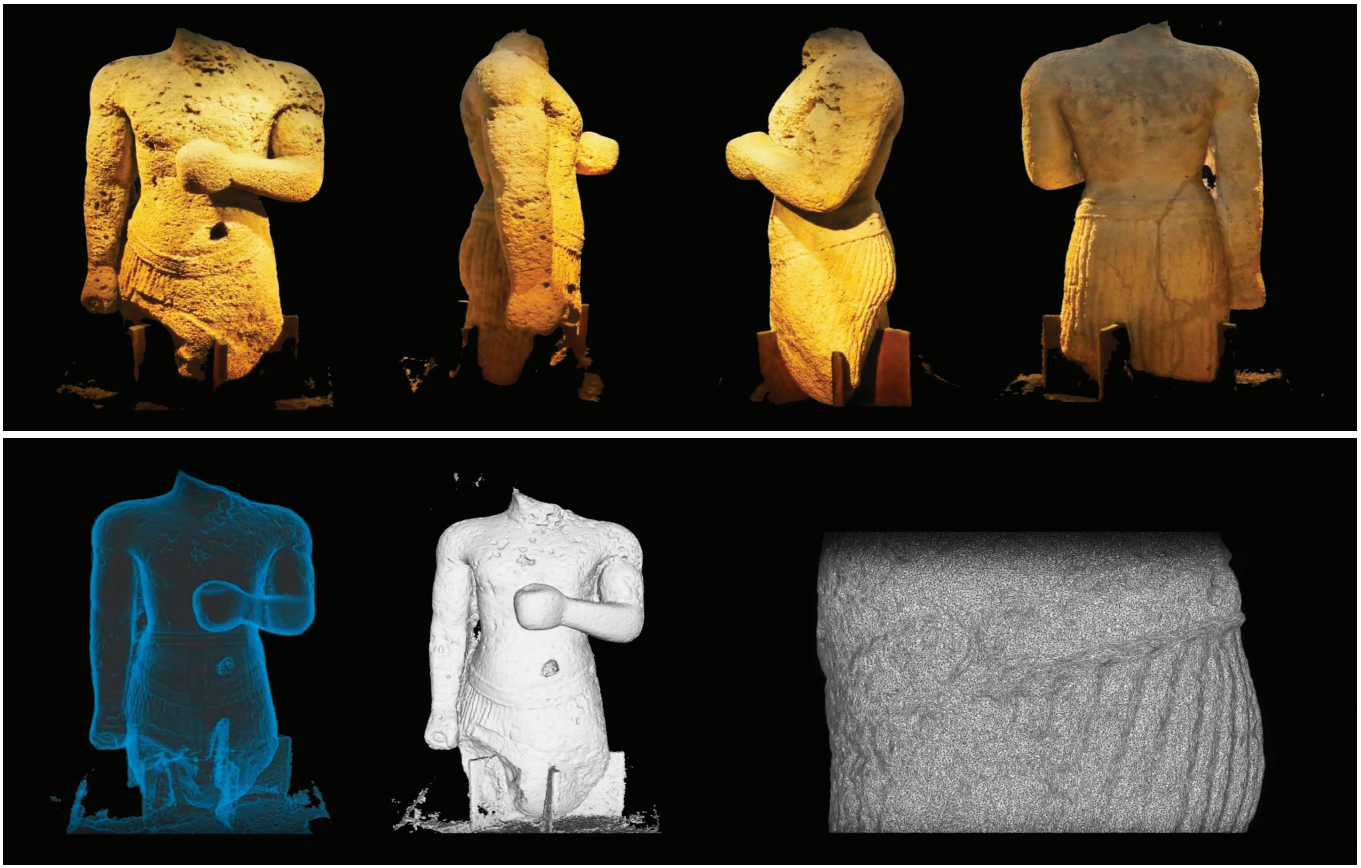


Fig. 5 - Tutorial on photogrammetric techniques.

Fig. 6 - In this page and in the following pages: 3D Models.

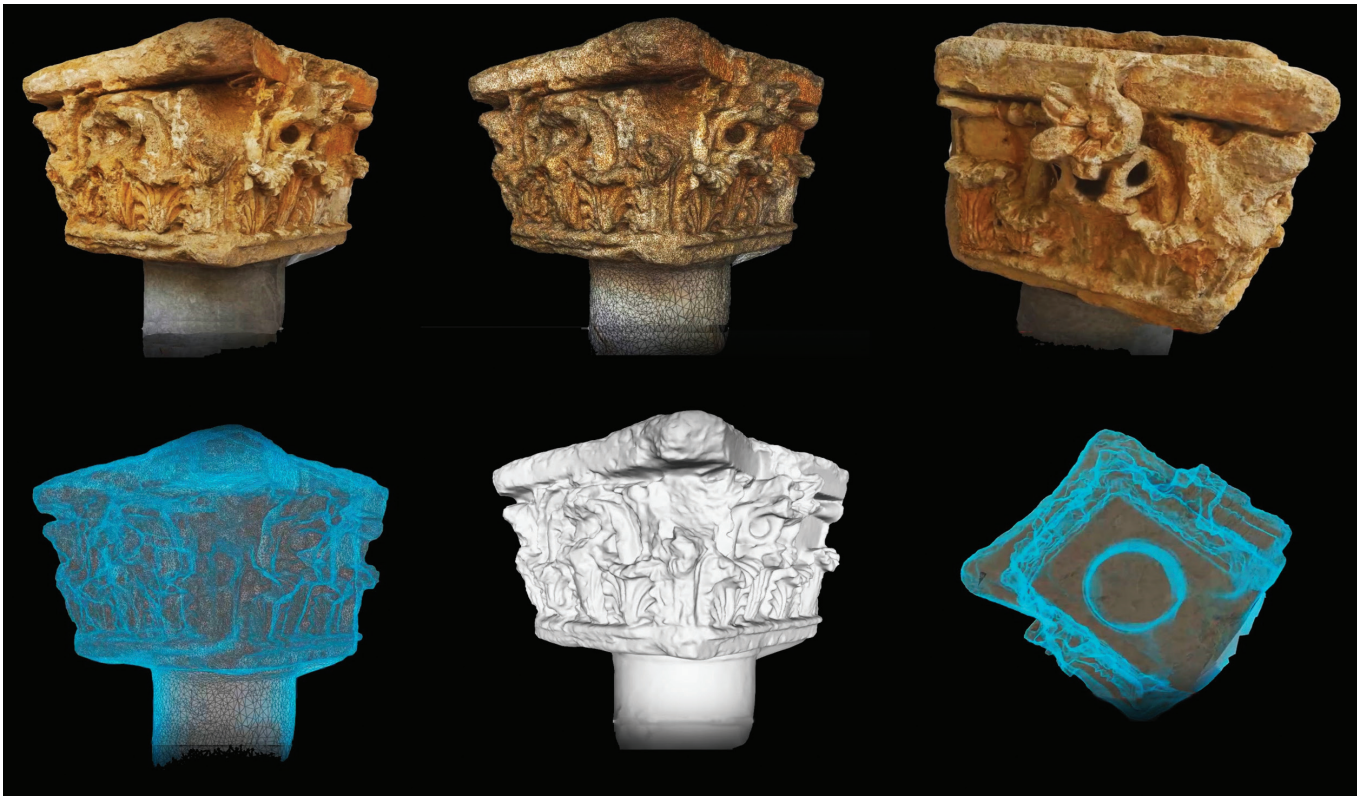
The principal objective of this research is to locate a workflow that allows us to develop an accurate 3D monitoring strategy with the lowest possible operating costs. Photogrammetry is the answer to this requirement, however, in the case of a museum in which there are numerous works of art, each of which have different needs and requirements, even the application of photogrammetric techniques may not be able to be applied immediately. If we were able to involve visitors to the museum in the application of photogrammetry, creating a synergy where visitors would help to preserve the artefacts through the use of crowdsourcing. Visitors to the museum would become both viewers and authors, and, if we could educate them on the correct application of techniques, they could become a precious source of information, elongating the life of artefacts in the museum.



Methodology: crowdsourcing and low-cost 3D serving techniques

Crowdsourcing is a collaborative model in which people or organisations obtain goods or services thanks to the participation, generally voluntary, of a group of people outside of the original group or company. Today, crowdsourcing models have been embraced by a vast variety of projects in different fields and they are made public through web-based dissemination. Initially crowdsourcing was based on the work of volunteers and enthusiasts who dedicated their free time to creating content and resolving problems. The open source community was the first to benefit from this.

The online encyclopaedia Wikipedia is a prime example of voluntary crowdsourcing. Today crowdsourcing has become a source of income, particularly for companies who develop projects that make use of this new organisational model. There



are some negative aspects of crowdsourcing both from an ethical and a financial point of view, principally concerns that companies will profit from voluntary work. On the country for public agencies that deal with the management of collective heritage artefacts, crowdsourcing has only positive aspects.
A museum is a prime example of the latter, in fact art museums must manage a vast amount of our cultural heritage in their collections and monitoring operations are phenomenally important to guarantee that the artefact itself is preserved in a good condition. However, monitoring operations are extremely costly and museums' administrations often have no choice but to allow an artefact to deteriorate as they are not capable of intervening due to the absence of appropriate funding.
The experimental survey discussed in this paper was conducted in a public museum in order to verify the feasibility of a crowdsourcing project to collect information on artefact that can be used to monitor their current state and determine if maintenance must be conducted. Low-cost 3D acquisition techniques (sfm) have been conducted both by experienced researchers and have been made available to museum visitors

in order to truly verify the real feasibility of this project.
A national initiative was developed in which participated museums opened their doors to visitors for one week and allowed them to use cameras for shapshots and movies, many first year students of civil engineering who were taking design classes were involved in this project to give themselves experience with photogrammetry. In this way students who have been previously trained on photogrammetry techniques have had the opportunity to obtain a dataset of real works of art from which they can extract 3D models.

Some students obtained these data sets using their cell phone cameras, others used high quality SLR cameras, and others still used different methods according to their personal availability. 1 museum that took part in this initiative was "il museo archeologico regionale Salinas di Palermo".
The administration of this museum has collaborated enthusiastically and favourably with the university of Palermo and thanks to this partnership is been possible to develop 3D data set of almost the entire museum collection.

Results: 3D models

In order to develop effective and thorough 3D models of the museum collection it was important to create a thorough plan in order to avoid having too many datasets of one model while other models had none.
Firstly a review of each work of art contained in the archives was carried out, then, after an on-site check, those are the facts which were not suited to photogrammetric techniques, or those from which the development of a 3d model would not have been possible: those which were not reachable as they were too high, those inside reflective cases, those which were too large, and those which were too close together etc.
Additionally old ones which were restored in 2011 and I kept in the museums warehouses were also not analysed.
The collection was then divided by type: sarcophagi, busts, heads, and great works.
In recent years the planning operations have been in refined making it possible to obtain increasingly reliable and precise models both from the visual and metric point of view.
A video tutorial on photogrammetric techniques was created and shared on YouTube. It should be noted that this is an amateur video which acts only as a test for a future official project video.
The criteria adopted for the tutorial were designed to ensure ease of learning by everyone without a lot of prior preparation or instruction, as if the user were an actual visitor of the

museum or any socio-cultural attraction they would likely only have the ability to take some photographs.
To this end the students participating were grouped into heterogeneous groups in order to simulate the heterogeneity of visitors in the real world.
Each group was then assigned between 2 and 3 works of art to survey in an equal amount of time, in order to calculate the average time per visitor.
The models which will be developed over the next two years are as follows.

Discussion and conclusion

The results obtained have achieved the set objectives and confirmed the reliability of the experimental procedure. We can therefore move forward with the project to collaborate with the museum for the development of a crowdsourcing model.
The implementation of a model of this type requires not only and adaptation and expansion of knowledge for the staff of the museum but also functional changes within the museum through the creation of a space in which the user can learn procedures to obtain a reliable data set via video tutorials, but also where visitors need a load datasets in order to create a model at home. This project also includes promotions for users who produce very beautiful or reliable models; such as free admission to the museum, free participation in various events, and free 3D printing of your model etc.
The number of tasks still to be accomplished and the measures which will have to be undertaken are innumerable but once a model is put into operation it will be possible to disseminate it's benefits and the technological know-how to other museums.

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07 THE DIGITIZATION OF MUSEUM COLLECTIONS
FOR THE RESEARCH, MANAGEMENT AND ENHANCEMENT OF CULTURAL HERITAGE

Abstract

The research project takes part of the pilot initiative "Create a network around your research idea", funded within the framework of the collaboration between Politecnico di Torino and Compagnia di San Paolo. The initiative promotes the research projects proposed by researchers of the Politecnico di Torino in collaboration with universities, companies and other entities of the socio-economic system located in Italy and in any other State Member of EU.
The research draws inspiration from BIM (Building Information Modeling) methodologies - more conventionally applied in the field of Construction Industry - to build a workflow capable of virtually reproducing 3D objects, integrating geometric and semantic information. The case studies are some small objects belonging to the collections of the Egyptian Museum of Turin and pursuing three different levels of knowledge: from the scientific research to the data management system up to the settlement of virtual platforms for dissemination.
The research project B.A.C.K. TO T.H.E. F.U.T.U.RE. - *BIM Acquisition as Cultural Key TO Transfer Heritage of ancient Egypt For many Uses To many Users Replayed* - tries to set up a new methodology in which the Information Modeling tools are used in an unconventional way, to build 3D models and linked databases of small objects, in particular belonging to museum collections and not publicly accessible. Inspired by Ministerial Decree n. 113/2018, entitled "Adoption of uniform minimum levels of quality for museums and places of culture of public belonging and activation of the National Museum System", we have reinterpreted the improvement objectives described in the document and associated them to the three defined macro areas, through the use of interoperable digital technologies.

Il progetto partecipa all'iniziativa pilota "Metti in Rete la tua idea di Ricerca", finanziata nell'ambito della collaborazione tra Politecnico di Torino e Compagnia di San Paolo, per promuovere i progetti di ricerca proposti dai ricercatori del Politecnico di Torino in collaborazione con università, aziende e altri enti del sistema socio-economico italiano e di qualsiasi altro Stato membro dell'Unione Europea.
La ricerca prende ispirazione dalle metodologie del BIM (Building Information Modeling), più convenzionalmente applicate all'industria delle costruzioni - per costruire un flusso di lavoro in grado di riprodurre virtualmente oggetti 3D, integrando elementi geometrici e informazioni semantiche. I casi di studio sono alcuni piccoli oggetti appartenenti alle collezioni del Museo Egizio di Torino, perseguendo tre diversi livelli di conoscenza: dalla ricerca scientifica al sistema di gestione dei dati fino al sistema di gestione dei dati. insediamento di piattaforme virtuali per la diffusione.
Il progetto di ricerca B.A.C.K. TO T.H.E. F.U.T.U.RE. - *BIM Acquisition as Cultural Key TO Transfer Heritage of ancient Egypt For many Uses To many Users Replayed* - cerca di impostare una nuova metodologia in cui gli strumenti di Information Modeling sono utilizzati in modo non convenzionale, per costruire modelli 3D e database collegati a piccoli oggetti, in particolare appartenenti a collezioni museali e non accessibili al pubblico.
Con specifico riferimento al Decreto Ministeriale n. 113/2018, dal titolo "Adozione dei Livelli Minimi Uniformi di Qualità per i Musei e i Luoghi della Cultura di Appartenenza Pubblica e Attivazione del Sistema Museale Nazionale", si è tentato di reinterpretare gli obiettivi di miglioramento descritti nel documento e associati alle tre macro aree definite, attraverso l'utilizzo di tecnologie digitali interoperabili.

Introduction

Many museums have huge collections as well as huge depots and storerooms where they store a remarkable number of historical artefacts. However, this wealth of objects could also represent a problem, from the management point of view, and a correct preservation as well as the widespread communication of museum collections are of utmost importance. The quantity and heterogeneity of small objects are very difficult to be managed, because they may be of too specific interest or their state of preservation is poor. The limited space available to exhibit collections means that many objects are stored without any real possibility of using them as an active part of the collection for their contribute to a general knowledge.

On the other hand, in recent years, museums have no longer been used just as "containers" of works, but are now used as places where knowledge is built, communicated, and shared in a complex system of relationships between subjects (institutions, curators, scholars, the public, visitors, the community, etc.), heritage (material, immaterial, collections, the territory, the landscape, etc.), and digital technologies (interaction, immersion, virtual and augmented reality, etc.). This change of view approach to museums is also acknowledged in Italian laws, in which museums are now conceived as "goods for use" available to the community[1]. New kinds of museums are being designed to promote knowledge for the public and the scientific community[2].

Within this scenario, each act made to conserve the heritage is naturally an act of communication, derived from a new "inclusive" vision of cultural goods, even in a museum, by pointing out a redesigned role and the subsequent responsibility towards the community. According to this, although the preeminent task of museums in the past was to conserve and increase the heritage of the collections, museums are now called upon to interpret a process of "democratization", not only of promoting participation, but also of collaborating in emancipating the public, where knowledge in the past was reserved for a chosen few, in general composed of specialists. Starting from the state of the art of representing knowledge through a digital model, this project is aimed at finalizing for the management, monitoring and fruition of museum objects. The main purpose of the proposed research is to build up a methodology that will be able to virtually reproduce 3D objects by integrating geometric and semantic information that will allow museum collections to be effectively used for management procedure; at the same time, those digital products can be valorized for a variety of possible visitors. In other words, the research will focus on the optimization of 3D recording techniques (metric surveys and modelling) and 3D data integration by offering a user-friendly way of sharing complex information at different levels of information. The purpose of the research in particular is to make use of the (Building) Information Modeling methodology for unconventional purposes, applying it to different kinds of small objects.

State of the art

The relationship between cultural heritage, digital technologies and visual models involves an increasingly wide area of research, which is oriented towards the renewal of archives and museums for the preservation and promotion of culture. In this respect, very recent research activities are the result of the progressive strengthening of digital technologies, but above all, they are determined by the requirements of a new audience, which is increasingly "digital" and thus requires museums to update their means of communication[3].

As far as the use of BIM applied in the Cultural Heritage field is concerned, no specific approach has been fully explored, because of some criticalities. A total absence of archeological element libraries, as well as the stiffness of the 3D modeling of unconventional shapes are the major criticalities that have partially been faced by the Scientific Community. However, we are firmly convinced that H-(Historic)BIM applications

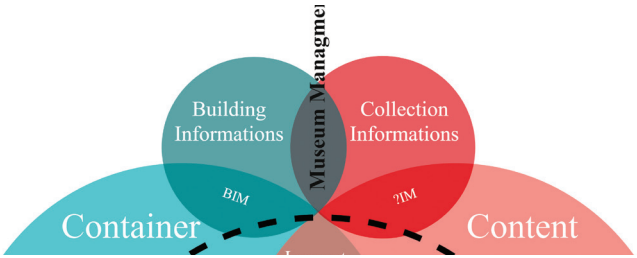


Fig. 1 - Relationship between the elements that are part of the museum experience.

could also be explored in terms of accuracy, infographic representation and above all data enrichment[4]. By the way, with regard to the use of BIM in the context of cultural heritage with reference to small objects, no prior experience exists on the subject due to some structural problems, mainly due to the rigidity involved in the 3D modelling of unconventional forms.
More generally, the digitization of collections, whether 2D or 3D, represents the first step for establishing a project perspective aimed at the digitization of museum heritage. In recent years, some research has been conducted on the digital survey and modelling of models and maquettes preserved in museums[5] as well as the enrichment of data concerning these models[6].
The research projects related to these themes are considerably broader in their scope: the European project MINERVA (2002/2005) was already aimed at facilitating the creation of a common vision through several actions and programmes to improve the accessibility and usability of cultural heritage on the Internet. Subsequently, the MICHAEL and MICHAELplus (2004–2008) projects created a network of national databases that allow access to Cultural Heritage through the adoption of digital resources of cultural and scientific interest. In 2008, with the birth of Europeana, the idea of a European digital library was affirmed. This acted as a collector for contributions already digitised by European institutions. Over the years, guidelines and standards have been produced European Data Model (EDM) documentation to facilitate data collection and segregation. Additionally, several European projects have worked towards the digitization and 3D documentation of historical artefacts (3D-COFORM). Among these, CARARE (2010–2013) and 3D Icons (2012–2015) were designed to support various cultural institutions interested in providing digital cultural content (archaeology and cultural heritage) through Europeana. At the same time, some digital infrastructures for archaeological research were financed for the management and integration of archaeological data at the European level, (i.e. ARIADNE, 2013–2015). Finally, the last calls (2018–2020) within European policies address the management of digital resources and advanced digitization, also aimed at the narration of objects, then projected towards the communication of cultural heritage. Several approaches have been tested in order to enable interaction between 3D environments and users, based on annotation systems. Platforms have been developed for document sharing and management, methods and techniques for multi-level annotation, metadata and vocabularies for the declaration of interpretative instances. As a starting point, the annotation system is based on ontologies, using a shared environment, thanks to the possibility to annotate different aspects of a text overlaps with metadata models and ontologies used for annotation, and related values vocabularies, but also with techniques for producing annotations[7]. The International Committee for Documentation (CIDOC) of the International Council of Museums (ICOM) developed a Conceptual Reference Model (CRM) that represents the outcome of more than a decade of work in standards development[8]: this was the reference ontology chosen in the framework for the ARIADNE project, according to the first aim related to the implementation of interoperability across archaeological data at the European level.
The communication aspect and the dissemination of initiatives aimed at the digitization of museums and museum heritage has led to the development of other projects: V-MUST (2011–2015) has created a network of excellence on virtual museums, providing information on the state of the

art and future developments. The focus on communication and enhancement of cultural heritage is also evident in the GRAVITATE project (digital platform for the re-unification, re-association, and re-assembly of heritage artefacts) and INCEPTION project (aimed at creating an innovative process for the 3D modelling of cultural heritage through an inclusive approach for 3D reconstruction of time-dynamic artefacts). These projects are also sustained by support and coordination actions, such as Virtual Multimodal Museum (Vi-MM) that support the main organisations working in the virtual museums to promote the development of high-quality policies to aid decision-making processes.

Regarding to the more technical issues of digitization, 3D metric survey techniques are today able to generate dense and accurate point clouds that can be used in the 3D modeling phase, which is influenced to a great extent by the knowledge of the breaklines that define the discontinuity of the shapes of an object (such as the Temple maquettes chosen as case studies and other small archeological finds). Breaklines can be manually surveyed but this approach is time consuming; automatic breakline surveys were tested in the past, but no many efforts were made and only a few results have been published till now. The existing solutions usually try to overcome this problem by increasing the density of the point clouds and reducing the blurring effect of automatic modelling tools. This solution requires high computation capacities and a huge amount of storage memory. Therefore one of the goals of the research refers to the opportunity to define the best acquisition methodology that ensures the possibility of obtaining accurate 3D models (and retopologized, according to a mesh simplification) in such a way as to be easily shared with other platforms and ready for web fruition.

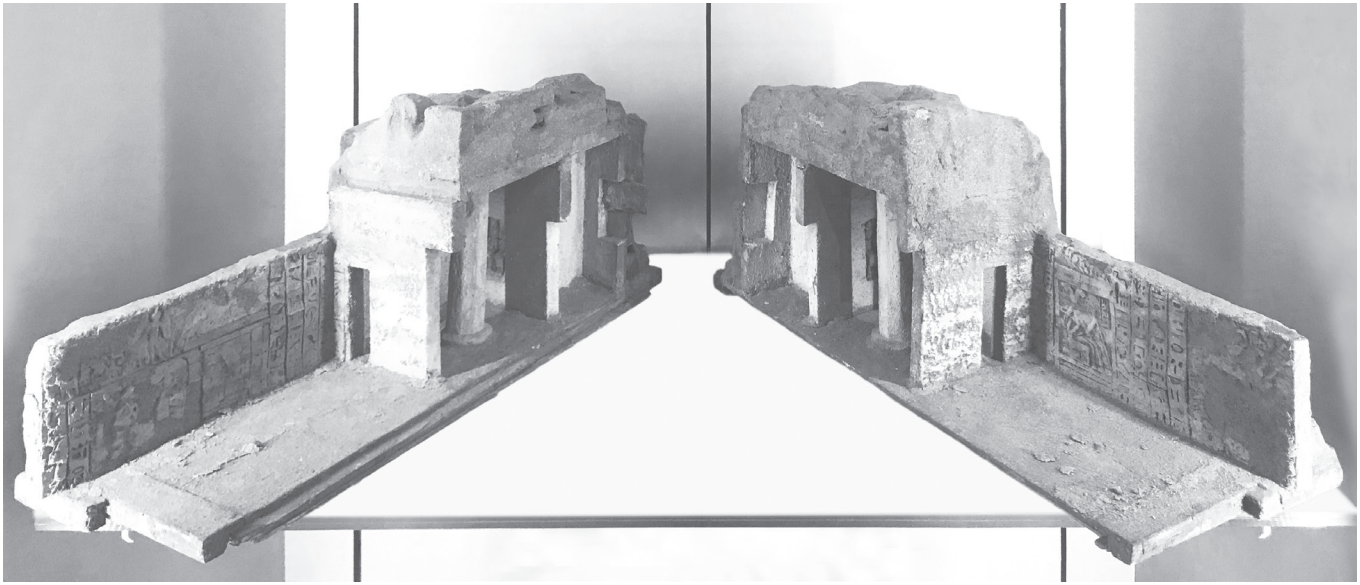


Fig. 2 - Physical model of the Roman temple of South Tafa divided into two halves, about 1820.

Description of the case studies

Museo Egizio has several physical models (maquettes) of Nubian temples from the geographical region between Abu Simbel and the Aswan dam; these refer to different historical periods. The museum contains 11 physical reproductions of Nubian temples, (Debod, Tafa North and South, Beit el-Wali, Kalabsha, Dendur, Gerf Hussein, Dakka, Derr, Abu Simbel, and Gebel Adda), initially located between Abu-Simbel and the Aswan Dam, which, after the flooding of the Nile, were dismantled and reassembled in safer sites. The models, dating back to the early 1800s, are generally composed of two halves (that, if opened, allow us to observe the interior; the authorship of the models is attributed to French sculptor Jean-Jacques Rifaud (1786–1852) due to observed similarities with some of his drawings from the time[9]. Most of these maquettes are conserved in specific storerooms inaccessible to the public.

Rifaud's models probably came to Livorno from Nubia between 1819 and 1823 and was subsequently transported to Turin where they became a part of the Egyptian museum's collection. The Egyptian museum, with its wooden models, offers several case studies to study the experimental procedures. Furthermore, these models represent complex elements, because they form miniature architecture models and not merely only small objects. The first wooden model that would be worked on is the representation of the minor temple of Abu Simbel (Nefertari's temple); it is composed of assembled wooden elements covered with a mixture of sand and wax. Its size is approximately 80 x 60 x 35 cm[10].

Fig. 3 - Half of the physical model of the Roman temple of South Tafa divided into two halves, about 1820.

Fig. 4 - Physical model of the Ptoleimaic-Roman temple of Thoth in Dakka divided into two halves, about 1820.

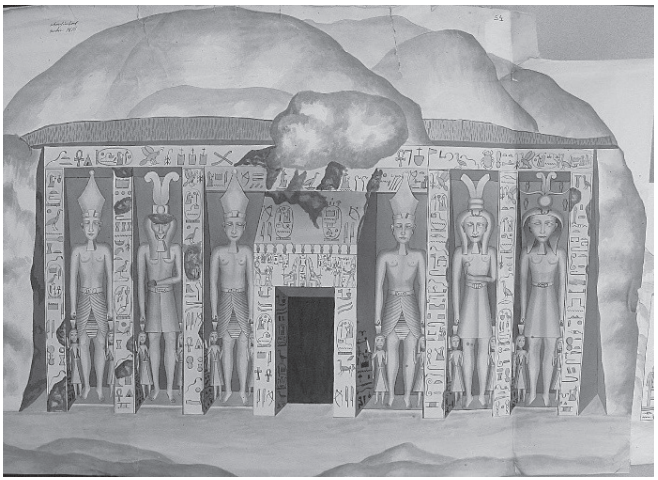
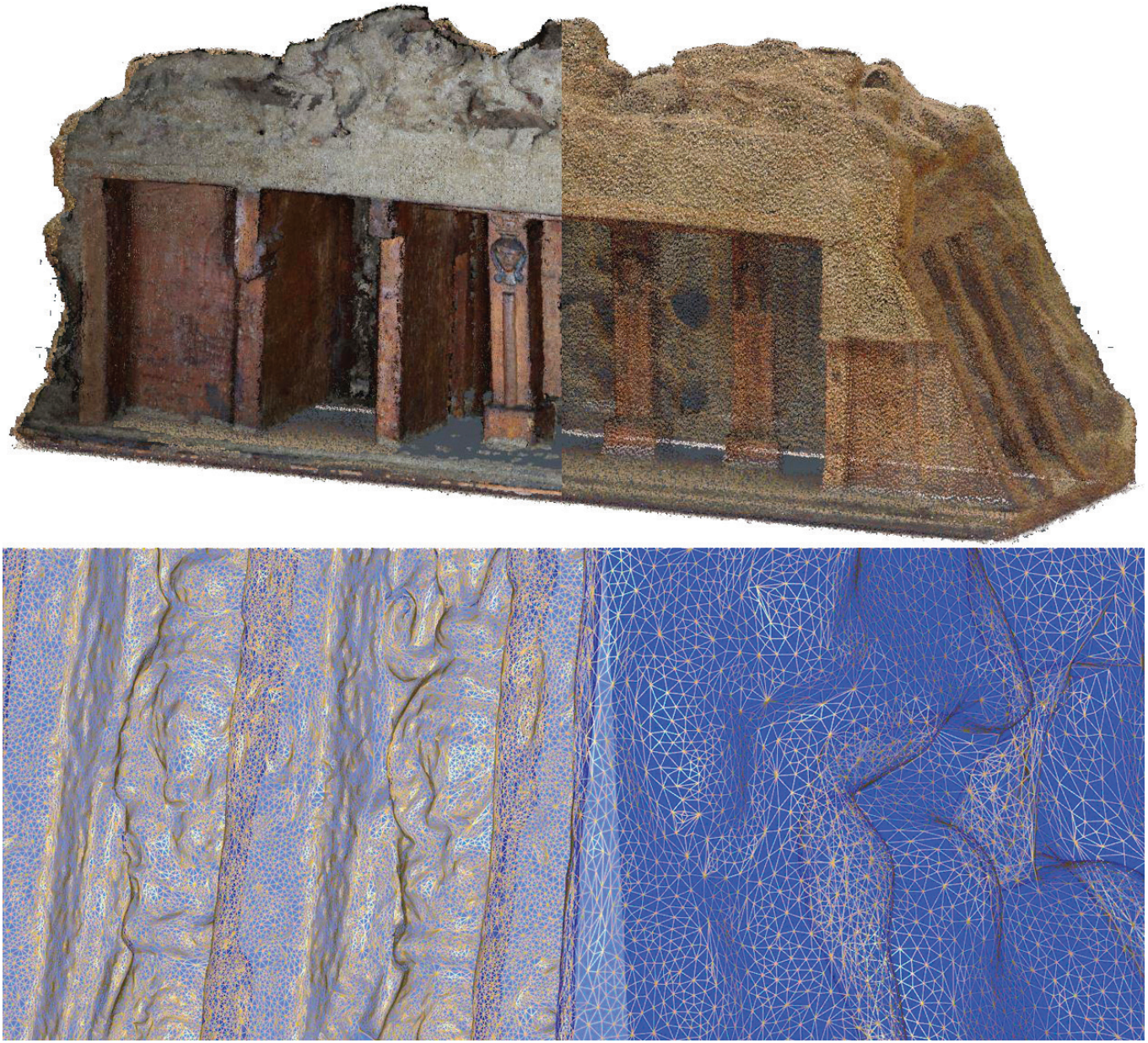


Fig. 5 - Drawing of the facade of the minor temple of Abu-Simbel. Author: Jean-Jacques Rifaud.



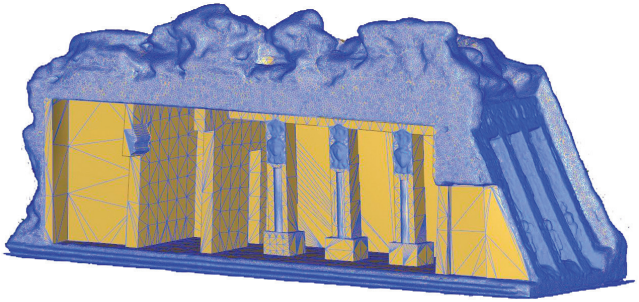


Fig. 6 - In the previous page. Top left, point cloud from photogrammetry; top right, point cloud from LiDAR. Below, some details of the model topology once the surface has been created.

Fig. 7 - In this page. The final model is the result of a weighted union between different clouds. The internal parts have been reconstructed assuming geometric surfaces that better approximate the surveyed shape.

Research activities

The research activities carried out in the first year consist of several phases:
- Documentary research and metric survey of the collections.
- Analysis, digitization and retopology of the acquired models.
- Semantic enrichment of metrically detected models.
- Critical analysis on methods and tools that can be used in the prefiguration of a web portal for increased and facilitated communication of the characteristics of museum objects.

The above lists the main steps validated on the first case studies examined, the temple of Nefertari in Abu Simbel and the temple of Taffa Sud.
Considering the aim of the research project, in the first phase of survey and digitization of the museum artefact, a metric survey accuracy of 2 mm was considered acceptable. Therefore, it was possible to take into consideration some detection techniques, generally excluded in the field of higher accuracy. For each sub-model, three different types of acquisition were applied:

- terrestrial laser scanning (TLS) with a flight time scanner (Faro Focus3D X 330).
- portable laser scanner (Faro Freestyle3D).
- photogrammetric survey using a DSLR camera (Canon EOS 5DS R) fitted with a Canon lens (fixed focal length 24 mm and manual focus).

The acquisition systems listed above provided point clouds with different characteristics; these differ in terms of density, resolution and presence of gaps (shadow areas not described by the clouds). The final dataset was then generated by the balanced integration of the three previously acquired datasets.
The analysis of the morphological complexity of the model led to some topological choices in the mesh modelling phase, describing the whole model by means of three different types of polyhedral surfaces. A type (1) formed by a few polyhedra for the representation of the internal flat parts; a type (2) denser in faces for the description of the internal and external sculptural parts; a last type of mesh surface (3) for the less accurate description of the irregular external part that simulates the rocky mass.
In parallel to the acquisition phase, the research on new methods and tools for the semantic enrichment of 3D models was carried out. For the information stratification, the Visual Programming Language (VPL) was experimented with the software Grasshopper. The first activities were carried out by linking the acquired 3D model to a spreadsheet, exploring the possibility of linking some general information to the model, obtained from the inventories made available by the Egyptian Museum.
The model was then enriched with the first data collected and appropriately converted for web visualization through the use of dedicated plug-ins in VPL environment.

Achieved results

The main results obtained from the beginning of the research project are shown below:
Definition of the procedure for the acquisition and digitalization of the museum object: on the basis of the tests carried out on

Fig. 8 - 3D model textured visualization of the Temple of Nefertari in Abu Simbel.

the first artefacts, a procedure was defined for the acquisition and digitization of the museum object, which involves the integration of three detection techniques for the definition of a dataset whose output is shown in the 3D object: an excellent compromise was reached between the measurement speed and the subsequent creation of accurately geometric models, correctly re-tested (low number of triangles on large flat surfaces, greater segmentation in more irregular areas) and ready to be semantically enriched with useful information for the management of the property and for possible use by visitors. This optimised procedure will be systematically used for the remaining finds that are the subject of the research.

Definition of data enrichment procedure using VPL technology:, the use of the 3D model in the field of communication has been tested through the use of VPL technology that allows both the semantic enrichment of the object and its visualization on an implementable web portal. The information enrichment of the 3D object must have a multidisciplinary character and must coexist within one or more databases dedicated to the individual disciplines and/or management areas concerned.

The first year of activity led to the identification of technologies and procedures that had not been explained in the project proposal, in particular the use of VPL technology for data enrichment of the digital model directly related to an Information Modeling environment. Another important and innovative issue is represented by the identification of the formal ontology to be adopted in the development of the research, to organize the data of the digital model. This allows to work on different types of data to be integrated into the digital model, including:

- Historical-artistic data related to the wooden model: information related to the wooden model and its value as an object belonging to a collection and its historical events (origin, dating, materials, uses, purposes, ...).
- Historical-artistic data of the represented object:

information about the architecture represented by the wooden model, from which it is possible to access information of a graphic, textual, numerical nature that tells the story of the represented temple (historical images, views of travelers, previous surveys, the procedures of UNESCO campaigns for the recovery of temples, new locations, etc. ...)

- Data concerning the management and maintenance of the object as part of a collection: information on the object management (the model) is generally contained in paper schedules stored in the museum archive. The digitization of the works and the consequent opportunity to enrich these virtual models with technical and specialized information allows the redesigning of the usual procedures for filling in the forms, making the cataloguing process more efficient.

In fact, the growing activity of digitization and sharing of museum collections makes it necessary to organize databases based on an appropriate computer ontology, i.e. a series of conceptual distinctions - impossible without the development of a semantics and a lexicon provided to computers by (human) programmers - that are transversal and interoperable.

For this reason, the next development of research will focus on the definition of an ontology based on the CIDOC-CRM (CIDOC Conceptual Reference Model) standard for the documentation of cultural heritage in museums collections.

Potential impacts and future developments

The methodological approach described above will make it possible to obtain:

- a rational use and classification of data concerning museum collections;
- possibility of a greater exchange and sharing of data with other museums;
- integration of different archives;
- long-term preservation of the data.

The complete novelty of the study in progress is to be found in the development of a prototype system that virtually reproduces objects and collections (content) in relation to its museum (container) allowing users to operate on the system of relationships content/container of the exhibition space. This issue is thought to support virtuous procedures of automated control of environmental requirements contained in the object schedules and in the building schedules, most commonly used in museums.

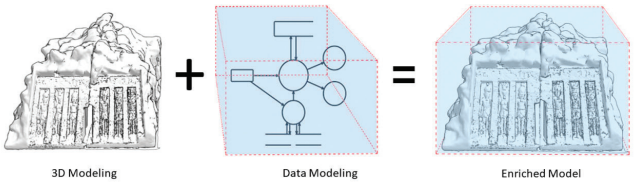


Fig. 9 - The procedure involves both the modelling of the shape mainly through topological control and the data modelling linked to the object through the setting up of a digital database.

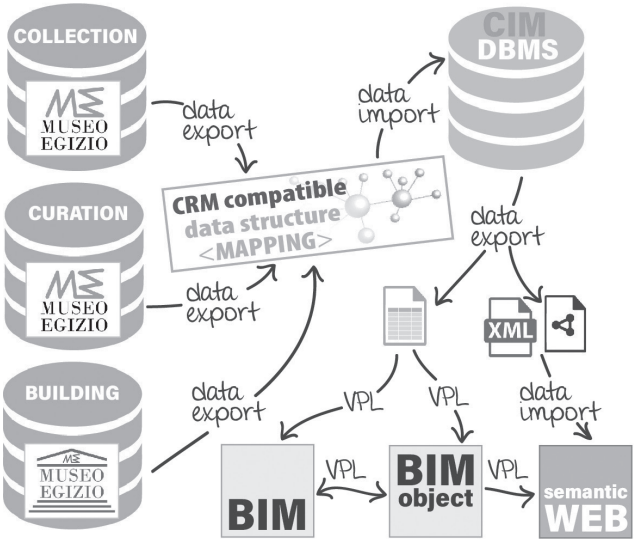


Fig. 10 - Collection Information Modeling (CIM) data management system and possible outcomes.

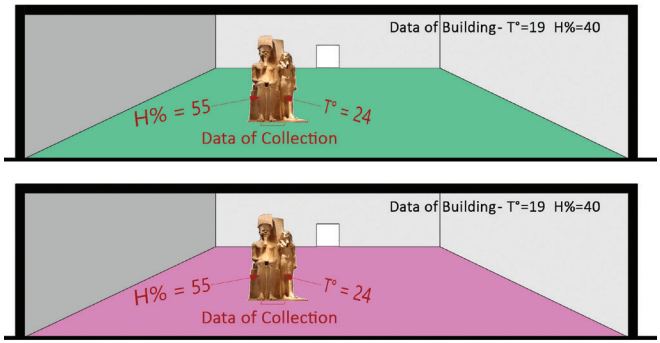


Fig. 11 - Direct dialogue between object and building information. Above, the object information relates positively to the building parameters: this means that the object can be located in that room; below, the object information relates negatively to the building parameters, so the object can not be located in that room.

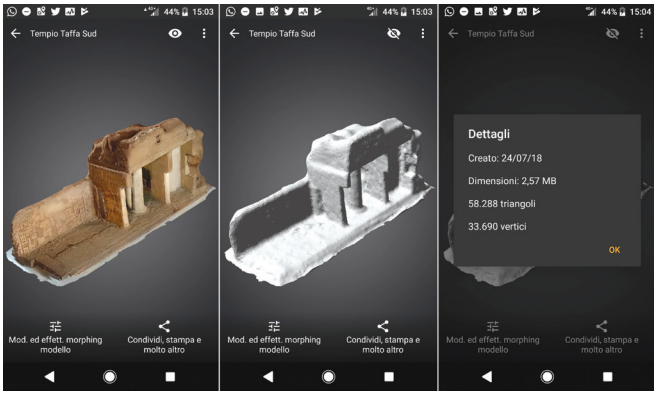


Fig. 12 - Visualization of a part of the Temple of Taffa Sud acquired with low cost technologies: through an application for smartphones it is possible to digitalyze the object of a collection, storing metric and colorimetric data associated with a low poly virtual model, easy to be explored and shared on web platforms.

The presence of a BIM model of the building that hosts the objects of the collections (museum), could allow, in a virtual environment, to highlight any inconsistencies between the environmental needs of the objects to be exhibited and the real conditions possessed by the exhibition spaces of the building. The construction of this system, suitably designed, will facilitate the scientific/cultural dissemination of the objects present in the museum deposits and will facilitate the future management and care of the museum collections: the experimental nature of the research is therefore confirmed, aimed on the one hand at optimizing the management procedures through structured databases, and on the other hand at making part of the data available for consultation, further enriching the visitor experience (virtual exploration can also be remotely used according to a view to maximum social inclusion).

Through the construction of digital models for management, maintenance, conservation and dissemination purposes, the objectives set for 2020 by the European Community's development programmes will be achieved, tackling problems related to the growing need to create protocols for documentation and management of the architectural heritage in order to organise information systems relating to Cultural Heritage in a virtuous manner.

The longer term impact is the digitization of larger collections accompanied by the virtual reconstruction of the environments that contain them, capable of foreshadowing design hypotheses of preparation in relation to the characteristics of the exhibition space.

In this regard, the process of digitization and collection of data useful for management purposes will be followed by reasoning on a wise use of recent digital technologies for popular purposes, in the direction of greater inclusiveness. Digital environments are particularly attractive not only to the new generations, but also to those of orevision of the

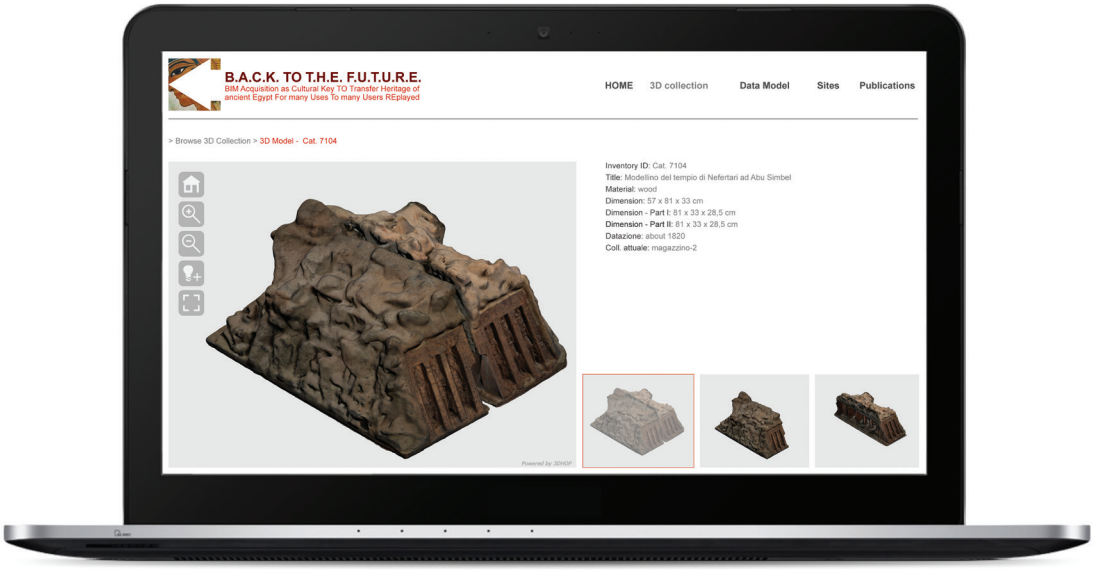


Fig. 13 - Interactive Web presentation of high-resolution 3D models.

installations are countless. A wise rigour is therefore needed in their applications for the creation of digital envlder age: the potential of the application of innovative technologies related to museum collections and the necessary radical ironments that leave time and ways for a direct contact with the artworks; at the same time, it's crucial to create effective opportunities to remotely obtain some information tools to prepare oneself for the face-to-face confrontation with the masterpieces, rather than tools for ex-post in-depth analysis, avoiding the risk of a simplification that could lead to trivialisation[11].

Notes

[1] D.L.42/2004: Capo I-Titolo II - Fruizione del patrimonio culturale.

[2] Art.1 "Definizione e missione del museo" of the D.M. 23/12/2014, titled "Organizzazione e funzionamento dei musei statali"; UNESCO 2003, Convention concerning the Protection of World Cultural and Natural Heritage.

[3] Cf. Antinucci 2014, p.178.

[4] Cf. Apollonio, Gaiani, Zheng 2012.

[5] Cf. Bianchini 2007.

[6] Cf. Hervy et al. 2012; Hervy et al. 2014.

[7] Cf. Tommasi Vitali 2013.

[8] Cf. Crofts et al. 2011.

[9] Cf. Bruwier, Claes, Quertinmont 2014.

[10] Cf. Einaudi 2016.

[11] Cf. Lampis 2018.

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08 THE DIGITAL DOCUMENTATION OF ALHAMBRA

A RESEARCH PROJECT FOR THE IMPLEMENTATION OF THE MUSEUM COMPLEX

Abstract

The process of digitization of the heritage, a proponent of new information contents, constantly re-proposes the architectural space in other forms, representations and systems of fruition.
In order to combine the aspect of digital heritage documentation with the realization of those information systems able to accurately describe the "real" space and, on the other side, to implement the contents within its "virtual" transposition, the DAda-Lab Laboratory of the University of Pavia, in collaboration with the SMlab Laboratory of the University of Granada, is carrying out an experimental research activity aimed to create a virtual exhibition of the Alhambra monumental complex.
The experience, planned on multi-year research activities involving professors, researchers, PhD students and students of the universities involved, as well as enterprises related to the documentation and management of architectural heritage, is aimed to experiment the methods of implementation of the information contents, links to the 3D database produced by the digital survey. This paper illustrates the results of the first phase of the research project on Generalife Palace. The documentation and management of the 3D database produced were combined with immersive reality experiments within the three-dimensional reconstructed complex, to offer new ways of using the museum site and to generate an alternative system to the current experience of the visit.

Il processo di digitalizzazione del patrimonio, fautore di nuovi contenuti informativi, ripropone costantemente lo spazio architettonico sotto altre forme, rappresentazioni e modalità di fruizione. Al fine di coniugare l'aspetto della documentazione digitale del patrimonio alla realizzazione di quei sistemi informativi capaci, da una parte, di descrivere fedelmente lo spazio "reale" e, dall'altra, di implementare i contenuti all'interno della sua trasposizione "virtuale", il Laboratorio DAda-Lab dell'Università di Pavia, in collaborazione con il Laboratorio SMlab dell'Università di Granada, sta svolgendo un'attività di ricerca sperimentale finalizzata alla realizzazione di un percorso espositivo virtuale del complesso monumentale dell'Alhambra.
L'esperienza, programmata su attività di ricerca pluriennali alle quali partecipano professori, ricercatori, dottorandi e studenti delle università coinvolte, nonché imprese afferenti al settore della documentazione e della gestione dei beni architettonici, è finalizzata a sperimentare le modalità di implementazione del contenuto informativo collegato alla banca dati 3D prodotta dal rilievo digitale. Il presente contributo illustra gli esiti della prima fase della ricerca intrapresa sul Palazzo del Generalife. Alle attività di documentazione e gestione della banca dati 3D prodotta sono state affiancate sperimentazioni di realtà immersiva all'interno del complesso ricostruito tridimensionalmente, per offrire nuove modalità di fruizione dello spazio museale e generare un'alternativa all'attuale esperienza di visita del complesso.

Introduction

The revolution which began with the Digital Era has translated the whole representation sphere towards an immaterial communication system, able to propose virtual scenarios and to represent the complexity of contemporary urban, archaeological and architectural sites[1]. The realization of virtual spaces fruition is increasingly involving widespread monumental complexes, extended over large portions of territory or considered, due to the extension of their expositions, open-air museums. Many of these complexes, which often are classified inside the UNESCO List, present several problems related to the difficult of the accessibility and to the increasing of the tourist flow[2]. The most visited site of Spain, the monumental complex of the Alhambra in Granada, presented each year a tourists increasing of almost 5%, registered 2,615,188 visits in 2016[3]. Despite the Patronato of the Alhambra has provided for a control of the tourist flow through the online reservations and sectorial tickets and programmed expositions in different parts of the complex[4], the visits are often crowded, so as to preclude the pleasure of the tour itself.

In these case, more than ever, the purpose of the digitization process is aimed to guarantee, through digital documentation and monitoring over time, both the conservation of the heritage and an alternative fruition in a virtual transposition of the environment. With these purpose, in 2017, a collaboration project has been launched between the University of Pavia and the University of Granada. The project undertaken is the result of the first step of collaboration activities between the DAda Lab (Drawing Architecture DocumentAction Laboratory) and the SMlab Laboratory (Survey and Modeling Lab of Architectural Heritage), together with the support received from the Patronato de la Alhambra and the Generalife.

The research included a first methodological experimentation on the Generalife Palace, the outcome of which could subsequently be replicated on other areas of the Alhambra complex. The aim of the research was, from one side, to respond to the need to organize new information systems on this digitized architectural heritage, aimed to describe the historical-evolution and to improve the knowledge on the building for a conservative purpose. On the other side, the information systems produced has been aimed at amplifying the interaction between space and users, defining new remote visit paths, capable of generating a new visit experience, implemented of a whole series of informative contents that enrich the knowledge of the place. Theoretical and practical reflections on the digital architectural survey have allowed to compare the different three-dimensional data formats, in terms of their capacity to be interpreted in the process of conservation, management and valorization of architectural heritage.

Description of the case study

The Generalife Palace has been chosen as the base from which to start a dialogue about the values of Alhambra architecture, its function, its meaning, its materialization and also its maintenance. The choice of Generalife as a first case study of this sperimentale project find its motivation inside the *Manifesto of Alhambra*[5], in which the Palace has been described for the richness of its decoration, its diversity of materials and construction systems, its gardens and, especially, its formal qualities, which makes it a valuable reference for experimentation. Through analysis, documentation and archiving of each structural, technological and decorative element, the will of the project was to build a digital database of archetypal models, comparable and/or replicable on other buildings of the Alhambra monumental complex, as well as using them as elements of a computerized virtual model of the complex.

Undoubtedly, the reflections on the Alhambra architecture, poured into the Manifesto and defined by the objectives of this research, have encouraged and influenced the organization of the documentation research project described below[6].

Built between the XII and the XIV century by the Nasridi sultans as the *almunia real* closer to the Alhambra, the

Generalife Palace has changed its original image during the century, considerably transforming the conformation of the architectural spaces, of the gardens and the orchards arranged on the numerous terraces that distinguish the site.
Nowadays, the Palace appears constituted by several private patios, accessible from distribution and service areas, located on different levels. The core of the building consists of a large central courtyard, endowed with a hydraulic system, the Canal of Acequia, around which a panoramic porch and sultan residential buildings are located.
This site represents the greatest point of tourist attraction of the Generalife Palace, that crowd the narrow sidewalk on one side, that connects the south to the north building. Currently, the visit follows a "forced" path which, from the main entrance (Patio de las Cabalerizas) leads to the North Pavilion passing by the Patio de la Acequia, then reaching the Patio de la Sultana and the high gardens, where the visit is bound by a single path, definitely slowing down the walk time.

Documentation methodology and data management

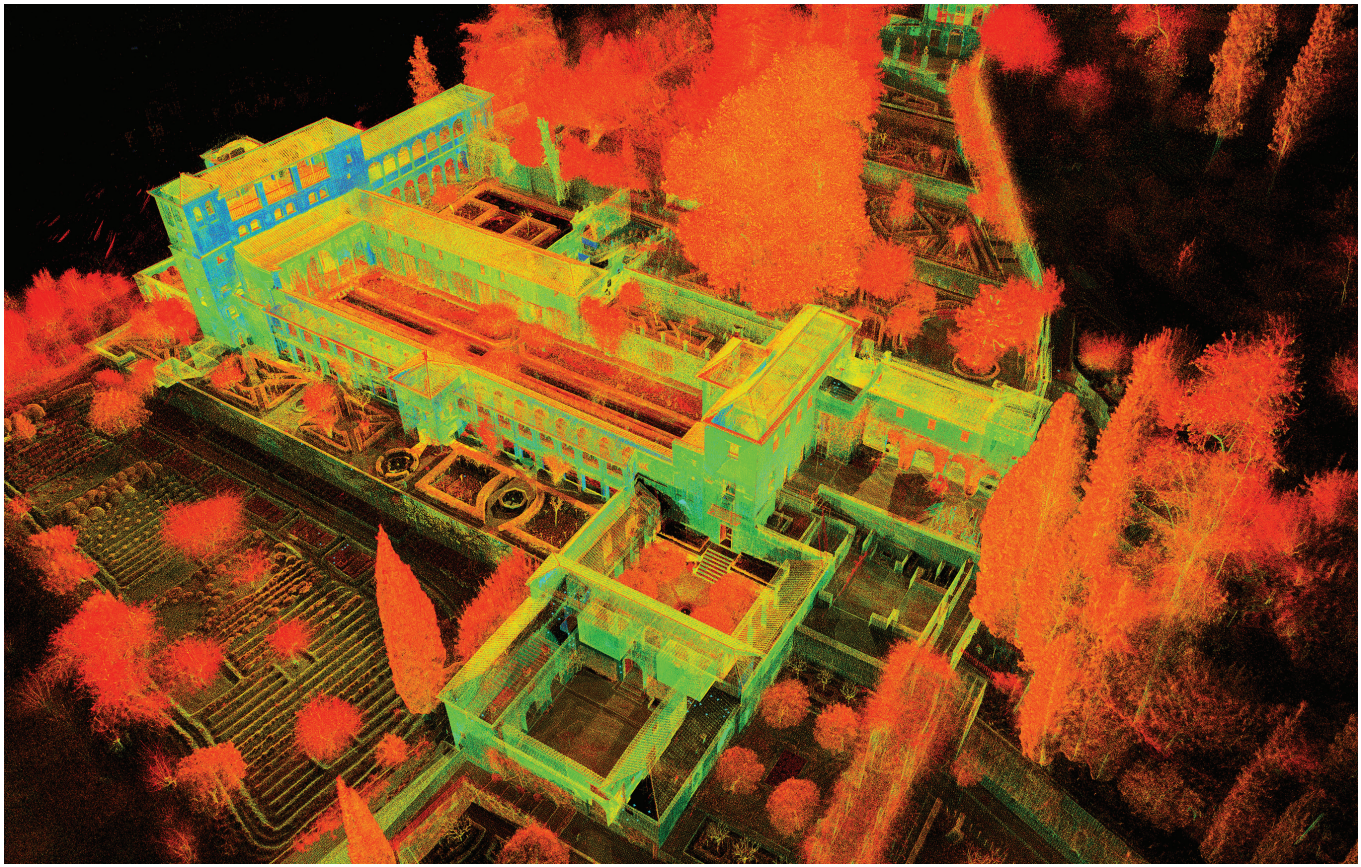
With the aim to digitize the Generalife complex and define a strategy to improve the quality of the visit, during the first survey campaign, in 2017, an integrated survey system was chosen to exploit the qualities of the Z+F 2010c laser scanner and incorporate the colorimetric information from the SfM photogrammetry, by using different cameras.

Fig. 1 - Image of the Generalife Palace, seen from the garden of the lower level, overlooked by the gallery and the mirador, beyond which is the Patio de la Acequia.

Fig. 2 - On the left, some views of the monumental area, with the North Pavilion, the Patio de la Sultana and the South Pavilion. Above, some images of visitors to the Generalife Palace and to some monumental areas of the Alhambra complex. The "narrow" dimension of many spaces and the high tourists flow during the day limits the full visibility of the monument, focusing more attention on the architectural detail than on the spatial relations between the various environments.

Fig. 3 - In the following page, a general view of the point cloud of laser scanner of the Generalife complex. The database contains the internal and external environments of the various architectural blocks, but also the gardens, to analyze their reciprocal spatial and constructive relationships.

The digital documentation of the monumental architectural complexes implies the need to evaluate, in a global way, numerous constituent entities related to the architectural, technological and landscape areas, which must be encoded and transposed into simplified geometric entities. Thanks to different output obtained (3D metric database and a photogrammetric images), it was possible to create a general point cloud archives of the Generalife complex, organized in a macro-zoning process, aimed to communicate the different entities that constitute the volumes and environments, in a unique subdivision scheme of the site[8]. A second subdivision of each macro-block in Units (U) and Locals (L) would differentiate the different spaces and architectural elements.
These codes of identification of elements, that allows interacting with the data archive, defining a semantization process capable of adapting to multiple research scenarios, especially in order to process the datas through NURBS and Mesh geometric surfaces of each elements. In 3D modeling, the two different techniques were integrated to improve the real-time visualization and reverse modeling procedure



(based on the data provided by the laser scanner and photogrammetry). To the general model, constituted by the macro-blocks into which the complex was divided, the detailed models which constitute the typological archive of the shapes and geometries identified in the complex, have been integrated. The general system, simplified by regular plans and surfaces with a low number of polygons (NURBS surfaces), has been completed with mesh elements with a greater number of polygons (obtained by SfM data acquisition and optimization procedures). The model thus constituted remains semantically subdivided, queriable and implementable of information contents, linked to its corresponding catalog database, accessible for each element, block or macro-block of which the model is constituted. This information system, realized through technical sheets for construction and decorative elements, pavements and the natural system, constitutes a data archive that enriches and integrates the 3D model, allowing the development of research towards restoration and management practices[9].

Another aspect that has been considered in order to realize

Facce: 377.554 Vertici: 189.428

Facce: 10.000 Vertici: 5.002

Facce: 1.000 Vertici: 502

Fig. 4 - On the left, optimization of the mesh for a capital of the Southern Pavilion, realized with SfM methods from 3D Eye rods.
Some views of the capitals of the Northern Pavilion and of the Southern Pavilion, realized as mesh 3D models, and optimized in the number of polygons. Each capital and architectural-decorative element is associated with identification codes that allow to associate an information sheet with each element.
Below, NURBS modeling of the Palazzo complex, based on Rhinoceros software, and the texturing phase on Cinema 4D software.

1. Capitello 01
Padiglione Nord
(B02_U05_P00_L01_C01)

2. Capitello 02/05
Padiglione Nord
(B02_U05_P00_L01_C02)

3. Capitello 03/04
Padiglione Nord
(B02_U05_P00_L00_C03)

4. Capitello 01/02
Padiglione Sud
(B02_U01_P00_L02_C01)

5. Capitello 01/02
Padiglione Sud
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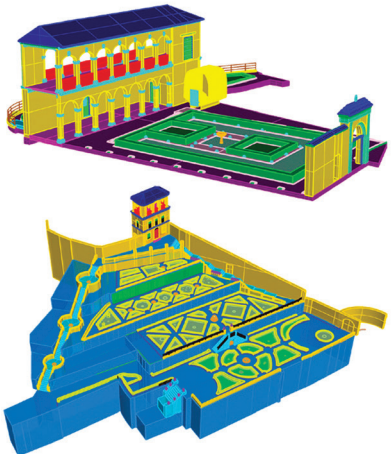
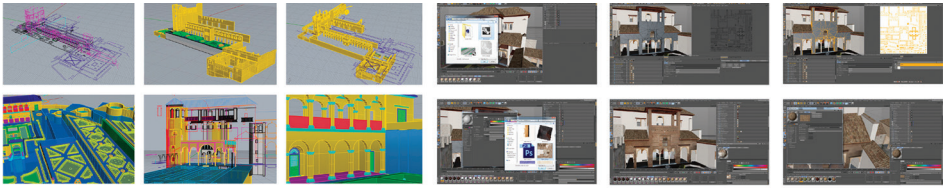
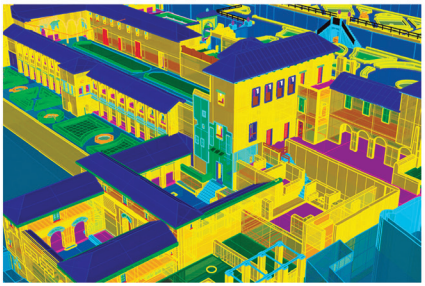
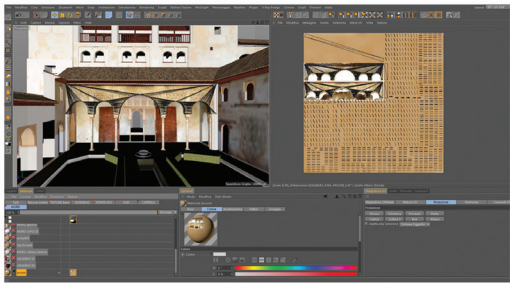








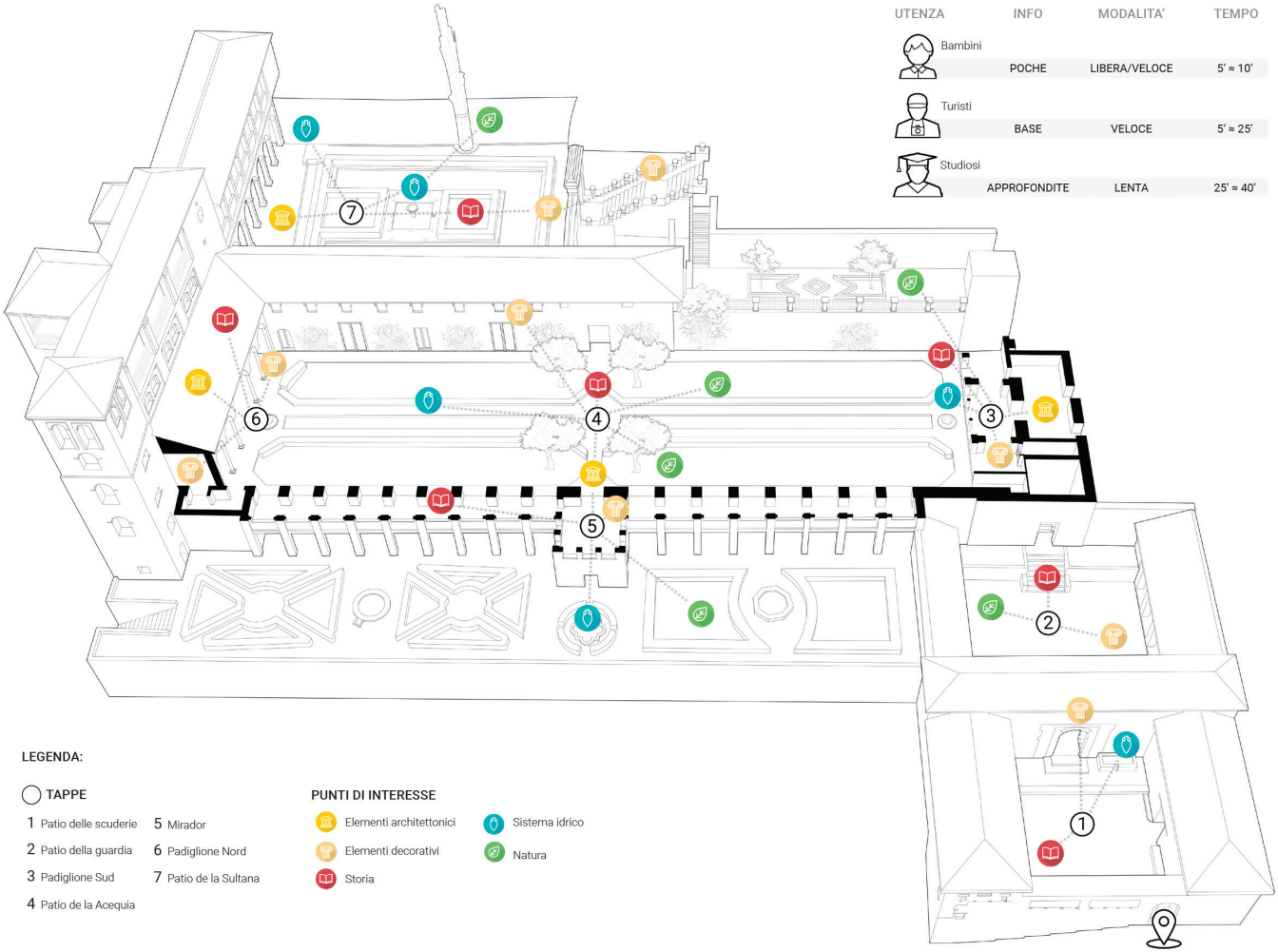
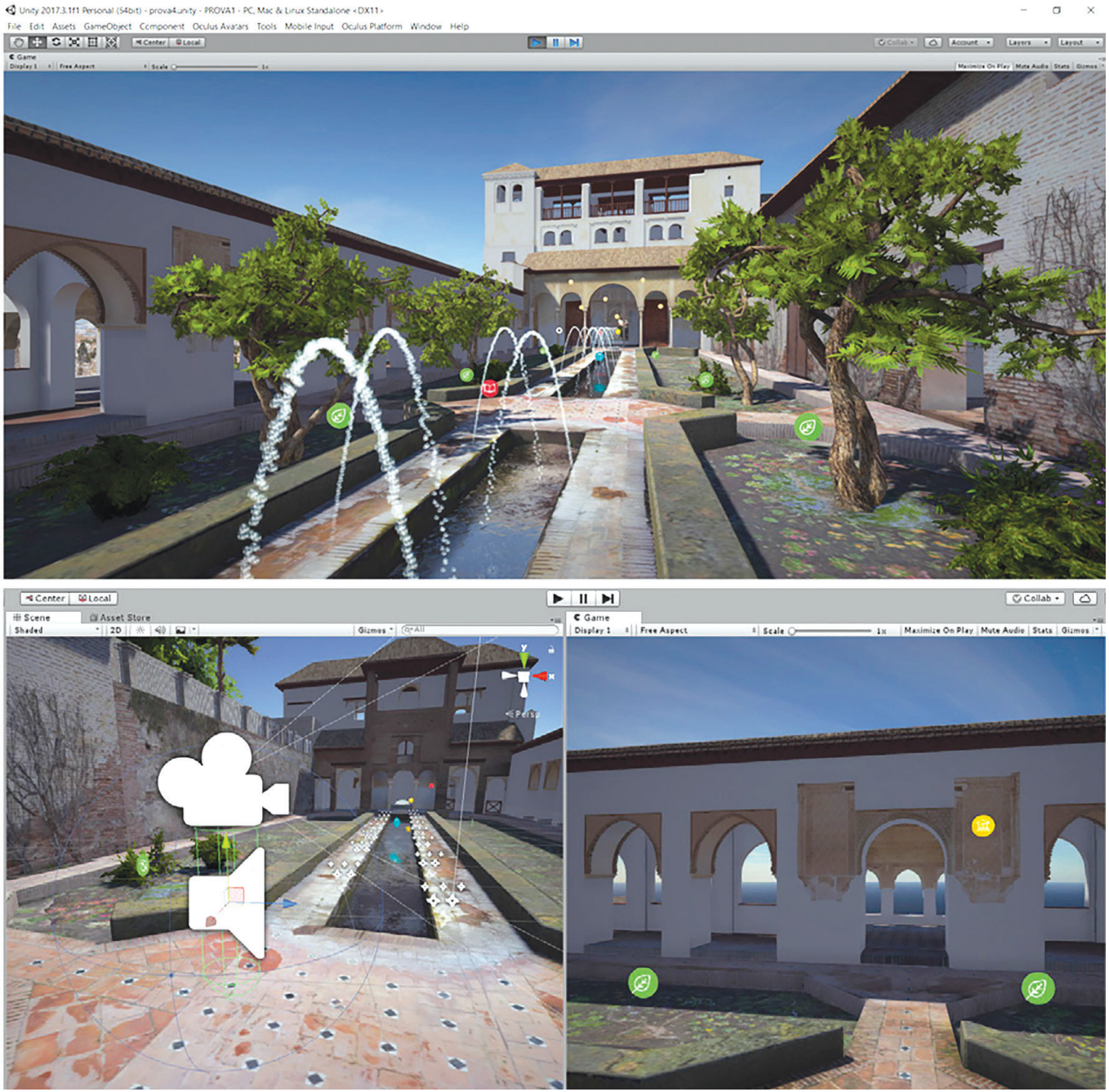


Fig. 5 - Planning of the virtual visit with entertainment, educational and information function. In the environment there are some interactive information points, corresponding to the main elements of interest. The symbols indicate the themes in which the information contents have been divided (history, water system, nature, architectural spaces and decorations). With this classification, the visit can be subdivided by specific topics, or follow the logic of the exhibition path, depending on the type of user, the ways in which the space is used and the time available.


Unity 2017.3.1f1 Personal (64bit) - prova4_unity - PROVA1 - PC, Mac & Linux Standalone <DX11>
File Edit Assets GameObject Component Oculus Avatars Tools Mobile Input Oculus Platform Window Help
Center Local
Collab Account Layers Layout
Game
Display 1 Free Aspect Scale 1x
Maximize On Play Mute Audio Stats Gizmos
Center Local
Collab
Scene Asset Store
Shaded 2D Gizmos All
Persp
Game
Display 1 Free Aspect Scale 1x Maximize On Play Mute Audio Stats Gizmos

a functional navigable virtual model, was the attempt to lower the number of polygons (Low-Poly) of the three-dimensional decorative models while maintaining a high conformity to the "real". For each capital, 3 mesh models were created, each with a different amount of triangles geometries in order to use the LOD (Level of detail) technique in rendering the final model. This technique increases rendering efficiency by decreasing the complexity of the mesh as the element moves away from the viewer[10].
To improve user immersion into the model, the *Rhinoceros* model has been enriched with the colorimetric information obtained by photogrammetric SfM campaign. The texturing operations has been supported by *Cinema 4D* software[11].

Outputs and products development

The digital architecture, which converts every information into a specific graphic sign, belongs to a virtual space that is virtually inhabited, but also in which this immaterial architecture can assume, over time, its own identity and its own autonomy with respect to real architecture. The goal of the virtualization of the Generalife was precisely that of trying to give meaning to those geometric and decorative forms that, if correctly reproduced in the digital space and interpreted by the user, could give meaning to a complex but codified space with multiple dimensions.
The graphical understanding of the three-dimensional models then finds a natural similarity with the decorations of the ornamental motifs that describe the Generalife and the other palaces of the Alhambra complex, structuring a grammar of language useful for a better understanding of the logics composition of the building itself.
For this reason, the objective of the experimentation on this first case study was to create not just a functional and entertainment virtual visit, but also a system capable of containing an educational and informative component[12].
Analyzing the areas of tourist concentration and the categories through which to spread specific educational contents, a series of information points have been identified within the 3D virtual space. An information sheet has been created for each of them, according to five macro themes through which to educate and involve users: architectural elements, decorative elements, history, the water system and the natural system. The different categories, identified by distinguishable symbols during navigation, allow the user to choose the theme associated with them, calibrating the visit on their needs, times and interests. The virtual tour takes place following the predetermined path offered by the "real" visit, implemented by the possibility of movement in spaces closed to the public, such as the central path to the Patio dell'Acequia. The "main" themes that the user can interact with along the way consist of multimedia content, 3D models of details, videos, photographs and in-depth information sheets on the single element. For each stage, a series of in-depth points were also provided to increase the amount of information available, providing in-depth knowledge of the environment, expanding the sphere to specialized user which can personalize the visit based on specific needs.
Based on the device available, two different methods of visit were hypothesized. The use of the PC and Head-mounted display, like Oculus, offer the user the possibility to move freely in the three-dimensional environment, without necessarily following the pre-established visit route. The second planned visit is based on the use of 360° spherical panoramas. The lower graphics performance required by this type of mode allows access to the visit also via devices such as smartphones and tablets. In this case the user follows a pre-established visit, moving within static images and interacting with the surrounding environment through points of interest. This visit solution, structured "by points" and concentrated only on the main spaces, is disconnected from the need to travel the entire model, making it preferable for casual users.
To make it possible to navigate within the 3D space and

Fig. 6 - The construction of the scene and of the interaction with users in Unity 3D multi-platform.

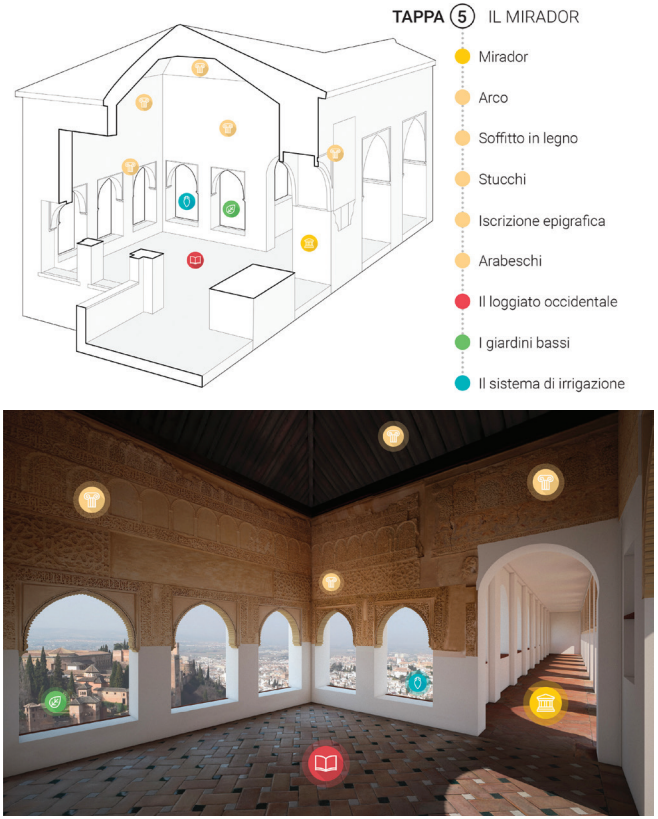


Fig. 7 - Example of the point of interest of the Mirador, with the different topics for further information.

enrich the model of all the information components created for the virtual tour, Unity 3D was used, a software that allows the realization of the project developed for different platforms and operating systems. Thanks to the use of a FPS Controller, the presence of a character within the virtual space was simulated[13]. At the end, to connect the different icons near the element contained with the corresponding information sheet, they were transformed into Buttons and made interactive, using specific Unity 3D Scripts[14].

Conclusions

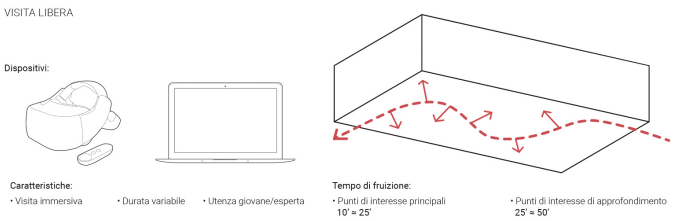
The virtual model thus configured is aimed at responding to multiple communicative purposes. On the one side, the intent is to implement the experience of visiting, configuring as an expandable system that can be implemented towards multiple research and fruition scenarios. On the other, the digitization and codification of complexity in archetyped forms and symbols can provide the basis for a more in-depth study of the building. These databases, if we think especially about the risks to which the real heritage is exposed, can themselves be heritage to be protected as they preserve the memory, the shape and size, the physical aspect and the intrinsic problems of the object in a form very close to that of the real object. The monument "virtual twin", deprived from the characteristics and physical risks of the real place, can be preserved and enjoyed in another, more secure, abstract place, the maintenance of which lays the foundation for future research developments.

Notes

[1] The relationship between the changing of communication system and the advent of digital technology is part of topics undertaken inside the DAdaLab end LS3D research laboratories. In particular, the problem of discretization and the description of digital datas acquired with different instruments has been synthesized in Parrinello, Picchio 2017.

[2] Some of the UNESCO World Sites in which the DAdaLab and LS3D research laboratories are nowadays involved for documentation and valorization projects, record tourist flows that increase from year to year: the archaeological site of Masada, in Israel, records almost 725.000 visitors a year, as well as Villa Adriana in Italy, with almost 250.000 attendance in 2018. For a more detailed treatises about the research project, carried on by the Laboratories, in which these sites are involved, cf. Bertocci, Parrinello 2015.

[3] *Datos de la Actividad Tusística y Cultural en el Conjunto Monumental de la Alhambra y Generalife. Año 2016*. Observatorio Turístico of



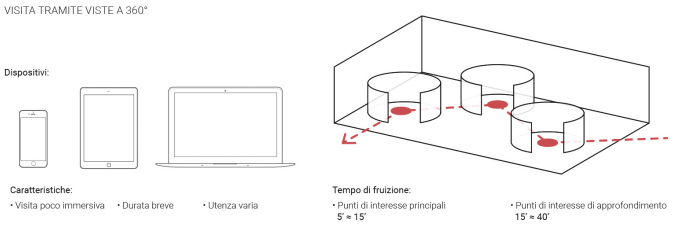
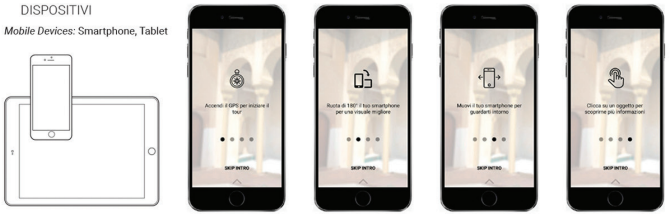


Fig. 8 - Design of the visit mode. The visit inside the virtual museum of the Generalife provides for a free mode of use of the digitized space, through the use of PCs and Head mounted displays, and a more restricted mode, which is performed within panoramic 360 ° views, taken on various points of the route and accessible from smartphone and tablet devices.
Below, the ways of using the space digitized through Virtual Reality, on the left, and Augmented Reality, on the right.



Patronato de la Alhambra.

[4] Every half an hour only 300 people are allowed to visit the Nasrid Palace, booking the entrance ticket in advance and having only an hour available.

[5] Manifesto of the Alhambra, by Fernando Chueca Goitia, is a document of 1953. Its important is due to the will to deliberate "the bases of a new Spanish architecture". Cfr. Chueca 1993, p. 53.

[6] For a better understanding of the assumptions of the research and development of the collaboration project, Cf. Parrinello, Gómez-Blanco, Picchio 2017.

[7] During his reign, the Nasrid Muslim elite took possession of large estates, called *almunias*, located in the peripheral areas of the city and consisting of a residential core surrounded by vast expanses of land for agriculture and livestock. Cf. AA.V.V. 2016, p.132.

[8] Cf. R. De Marco, La construcción del archivo 3D, in Parrinello, Gómez-Blanco, Picchio 2017, pp. 80-83.

[9] In parallel, the research project tried to develop, starting from the point cloud database, an informative system for the management of the building, in which the different typologies of informations acquired and organized constituted the support. For a better understanding of what has been managed for this research topic on the Generalife Palace, cf. Parrinello, Gómez-Blanco, Picchio 2017; Rodriguez-Moreno, Pérez-Garrido, Roda-García, 2018.

[10] Cf. Bordini 2018.

[11] For a better description of the modeling techniques applied for the creation of a 3D model of Generalife Palace, Cf. Dell'Amico 2018; Parrinello, Gómez-Blanco, Picchio 2017.

[12] Cf. Bordini 2018.

[13] The height, speed, size and sounds of the Avatar were set: for the virtual visit project, a character of 1.70 m tall was chosen and a low speed was set for the movements, to allow a correct perception of the surrounding spaces.

[14] Cf. Bordini 2018.

Credits of the research project

Scientific director: Prof. Sandro Parrinello (University of Pavia), Prof. Antonio Gomez-Blanco Pontes (University of Granada)
Scientific coordinator: Dra. Francesca Picchio (University of Pavia)
Research Team: Historical analysis, digital survey and datas post-production
Dra. Concepción Rodríguez Moreno, Arq. Ágata A. Michot Roberto, Est. Emilia Navarrete Ruiz, Est. Doc. Pietro Becherini, Est. Doc. Matteo Bigongiari, Est. Doc. Raffaella De Marco, Est. Doc. Federico Cioli, Est. Doc. Anna Dell'Amico, Est. Eugenia Bordini, Est. Doc. Kseniia Mezenina, Est. Doc. Monica Bercigli, Arq. José Pérez Garrido, Arq. Carlos Roda García, Dr. Juan Francisco Reinoso Gordo, Dr. Esteban Rivas López, Dr. Rafael García Quesada.

Credits of the images

All the images present in the paper are part of the research project developed and published inside the volume Parrinello S., Gómez-Blanco A., Picchio F., (2017). El Palacio del Generalife. Del levantamiento digital al proyecto de gestión. Pavia: Pavia University Press. The images related to the virtual museum project are developed inside the Degree Thesis of Bordini E., Il Palazzo del Generalife a Granada_ Documentazione e rilievo per lo sviluppo della visita virtuale, Degree Thesis in Architecture, University of Florence, 2017-2018.

Fig. 9 - Some views of the computerized 3D model with interactive Buttons, designed and built within the Unity 3D multi-platform engine.

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Her research activity deals with: Application of BIM methodologies in the field of Cultural Heritage (H-BIM); Experimentation of image-based modeling techniques for the digitization, documentation and monitoring of Cultural Heritage; Survey and analysis of architecture and archaeology through techniques of digital survey and reverse modeling; Virtual museums and crowdsourcing of museum collections.
Author of monographs, articles in national and international journals indexed by ISI and Scopus, contributions in books and proceedings of international conferences.

09 UNIVERSITY MUSEUMS AS DIGITAL INNOVATION HUB
THE EXPERIENCE OF MUSEO DELLA RAPPRESENTAZIONE IN CATANIA

Abstract

The primary function of museums is to contribute to the cultural growth of society and its sense of belonging and rooting in the territory. This is all the more true in the presence of university museums whose aim is to preserve, protect, enhance and make accessible to the scientific community and the surrounding area the tools and results of research, teaching and the dissemination of knowledge. The paper deepens the results of the educational and research activities carried out within the Digital Surveying Representation and Reconstruction Lab of Museo della Rappresentazione (MuRa), pertaining to the Department of Civil Engineering and Architecture of the University of Catania.
The socio-cultural impact of this experience has strengthened the role of MuRa as a digital innovation hub for the development of the territory.

La funzione primaria dei musei è quella di contribuire alla crescita culturale della società e del suo senso di appartenenza e di radicamento al territorio. Ciò è ancor più vero in presenza dei musei universitari il cui obiettivo è quello di conservare, tutelare, valorizzare e rendere accessibili alla comunità scientifica e al territorio circostante gli strumenti e i risultati della ricerca, dell'insegnamento e della diffusione dei saperi. L'articolo approfondisce i risultati delle attività didattiche e di ricerca svolte nell'ambito del Laboratorio di Rilievo Rappresentazione e Ricostruzione del Museo della Rappresentazione (MuRa), di pertinenza del Dipartimento di Ingegneria Civile e Architettura dell'Università di Catania. Le ricadute socio-culturali di questa esperienza hanno rafforzato il ruolo del MuRa quale hub di innovazione digitale per lo sviluppo del territorio.

Introduction

The primary function of museums is to contribute to the cultural growth of society and its sense of belonging and rooting in the territory. This is all the more true in the presence of university museums whose aim is to preserve, protect, enhance and make accessible to the scientific community and the territory the tools and results of research, teaching and the dissemination of knowledge. Indeed, university museums, testimonies of the path and evolution of science and knowledge, are one of the fundamental institutions for the relaunch of the country's scientific and technological activities. They play a fundamental active role towards the civil society awareness linking the cultural function of the collections, the tools and the results of research, teaching and the dissemination of knowledge to the territory. The combination of a vibrant environment of research and experimentation with the use of current IT tools brings towards novel approaches in terms of digital innovation for Cultural Heritage enhancement and communication as well as novel ways of curation and visitor engagement.

The paper deepens the results of the educational and research activities carried out within the Digital Surveying Representation and Reconstruction Lab of Museo della Rappresentazione (MuRa), pertaining to the Department of Civil Engineering and Architecture of the University of Catania.

The Museo della Rappresentazione (MuRa) and University of Catania Museum System (SiMuA)

The Museo della Rappresentazione (MuRa) is part of the Sistema Museale di Ateneo (SiMuA - University of Catania Museum System) which was established in 2015 with the scope to systematize the 22 potential museums, historical collections and instruments belonging to the university departments. The aim was to preserve, protect, enhance and make available to the scientific and the wider community, those assets, tools and results achieved during centuries-old research, education and dissemination activities.

Fig. 1 - Museo della Rappresentazione. View of the exterior of Villa Zingali Tetto.

Fig. 2 - Museo della Rappresentazione. View of the winter garden.

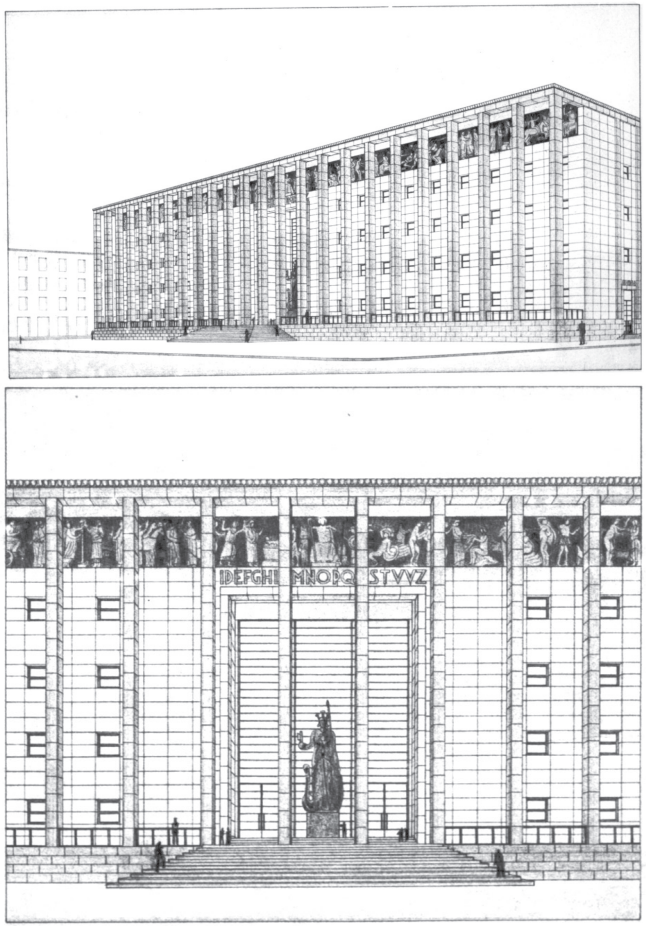

Fig. 3 - Francesco Fichera Drawings. Project of the palace of justice, perspective and elevation.

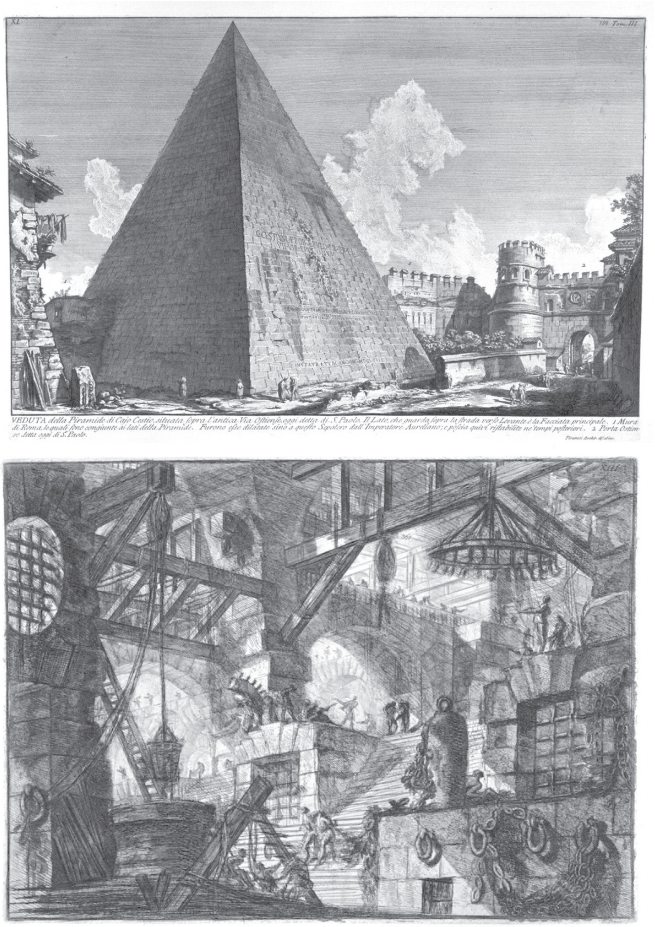

Fig. 4 - Giovan Battista Piranesi collections. View of "Piramide di Caio Cesto" and "Le Carceri".

MuRa is located in *Villa Zingali Tetto*, a Liberty palace designed by architect Paolo Lanzerotti and built in 1930. The building has being owned by University of Catania since 1975. The museum was originally established in 1996 thanks to the Catania-Lecce Coordinated Project. The project was aimed at the preservation, conservation and use of the tangible and intangible heritage of the University through several initiatives. Indeed, the initiative number 15 assigned Villa Zingali Tetto to the Department of Architecture and Town Planning (DAU) with the aim to set up the *Laboratorio e Museo della Rappresentazione* (Laboratory and Museum of Representation). The museum

would keep, preserve and exhibit the graphical historical archives and collections owned by DAU, among which Francesco Fichera projects and Giovan Battista Piranesi engravings. The project foresaw an intervention of restoration and refunctionalisation of the villa to be used as a museum.

In 2006 the spaces of Villa Zingali Tetto have been allocated by the central government of University to be used as offices, and the exhibition at the noble floor was closed. Then, in 2016 the noble floor of Villa Zingali Tetto has been reassigned to the Department of Civil Engineering and Architecture (DICAr) to restart the museum activities. This action can be seen as the result of the renewed interest of the university on the role that university museums can play as an active part of the cultural system of the territory, promoting the spread of culture.

The mission of Museo della Rappresentazione (MuRa) is to pursue the promotion, knowledge and understanding of Cultural Heritage for a wider audience, improving the use and public fruition of Cultural Heritage, promoting innovative communication ways. In this regard, a lot of attention has been paid on visitors needs, developing a culture of hospitality, understanding and participation shared by citizens and institutions[1].

Furthermore, MuRa is not only a container of historical and cultural heritage but also a "container of innovative content" aimed at improving the overall experience of communication of Cultural Heritage. This is strictly in line with the university third mission objectives: to get in direct contact with a broader set of persons and social groups instead of students and research institutions, through dynamic and variable contents and interaction.

With this in mind, two laboratories have been set up to support teaching and research activities: Digital Surveying, Representation and Reconstruction Lab and Tools for Architecture project lab. The aim of this laboratories is to carry out their actions in the field of architecture design and Cultural Heritage, for its conservation, enhancement, communication and fruition.

Educational and research activities of the Digital Surveying Representation and Reconstruction Laboratory

The Laboratory of Digital Surveying, Representation and Reconstruction was established to support the research and teaching activities of the Museum and DICAR's courses of study. At the same time, it is an experimental centre open to dialogues of common interest with external bodies (schools, the municipality, the province, the superintendence, private bodies and professional studios), whose field of application is the conservation, protection and enhancement of Cultural Heritage. The activities are aimed at experimenting the most current technologies of 3D acquisition/modeling/gaming/ virtual reality for the knowledge, protection and enhancement of the documentary heritage of the museum itself as well as of the university and territory museums and collections[2].

Technology seen not as an end in itself but as a means within a more complex strategy, to increase the museum public and its relations on the territory to ensure a greater social and technical-scientific sustainability of the institution, to train new professionals able to manage the innovative potential of ICT for Cultural Heritage.

Among the main activities carried out we could cite: Internships for University of Catania students; support at the teaching activities of the course of 3D Modelling and Digital Surveying (thesis, workshops); External Workshops; Educational projects with High Schools; Collaboration with other museums.

Fig. 5 - 3D models of Museo Civico Castello Ursino collections created during the didactic activity #invasionigitali3D.

Participatory design of the exhibition related to the Digital Surveying Representation and Reconstruction laboratory activities

For the design of the exhibition linked to the Digital Representation, Surveying and Reconstruction Laboratory, a participatory design methodology has been applied according to a strategy that would consider the potential "visitors". The design process actively involved the museum interns (university students) who played as protagonists, in their dual role of future curators/designers and representatives of the younger generations, future visitors of the museum. Another similar experiment has been carried out within the Whale HUB Audience Development, Sustainability and Contemporary Art project, that has involved twenty students and four contemporary artists, united by the objective of developing the interest of young audiences in the Sala della Balena: a true jewel of the Museum System of the University of Florence - Section of Geology and Palaeontology, which reproduces around a skeleton of fossil whale the evolution of marine ecosystems. Conceived as a contest, the project was specifically aimed at creating a multimedia communicative prototype.
In our case, the contents to be exhibited deal with the research and the didactic activity carried out in the in the field of cultural heritage documentation, communication and enhancement by means of integrated 3D acquisition technologies (3D models acquired via laser scanning and digital photogrammetry).
Being the content itself digital born the need was to give to the visitor both information on the selected exhibited items[3] in form of graphical content as well as to allow for the interaction with the digital dimension of the models. The students (millenials and potential museum visitors) have been questioning on the concepts of "virtual museums", "citizen science 2.0" and "open science" reinterpreting them according to a sustainable logic of reuse and optimization of digital assets linked to the socalled orange economy according to a continuous exchange of ideas and visions for the future[4].

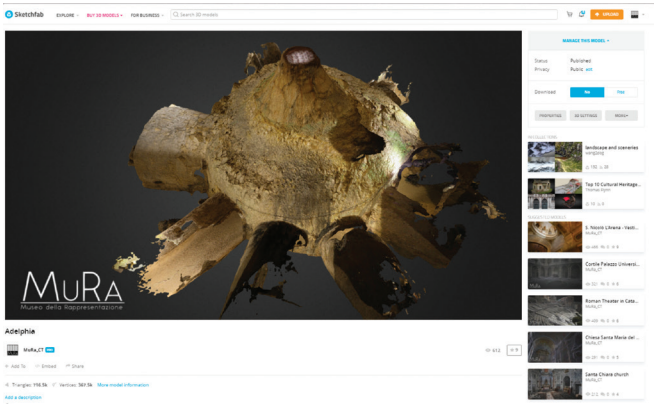

Fig. 6 - Rotunda of Adelphia, 3D model uploaded in Sketchfab platform.

With regard to the web accessibility of the models produced, various solutions were examined, including the use of Sketchfab, Europeana, and 3DHop. The online platform Sketchfab was chosen as it is the most widespread platform that has been used for years by various museums, for the ease of embed 3D content on websites and platforms and for the possibility of direct access to social networks or the connection to guided tour apps (GuidiGO).
In particular, the potentialities envisioned in the use of Sketchfab platform as a of low cost and easily accessible tool, has given the catalyst towards new contents/ways of communication for augmenting audience's experience (in terms of immersivity and interactivity).
Through the eyes of the students, in a continuous experimentation process, the digital exhibition has taken shape unlocking the hidden potential of creativity and developing novel digital skills for the future[5].
Indeed, they envisioned and tested a workflow through which a visitor entering the room of the temporary exhibition would first be confronted with the graphic content of the exhibition board and then, through a QRCode placed near each object, would have access to the digital dimension of the model

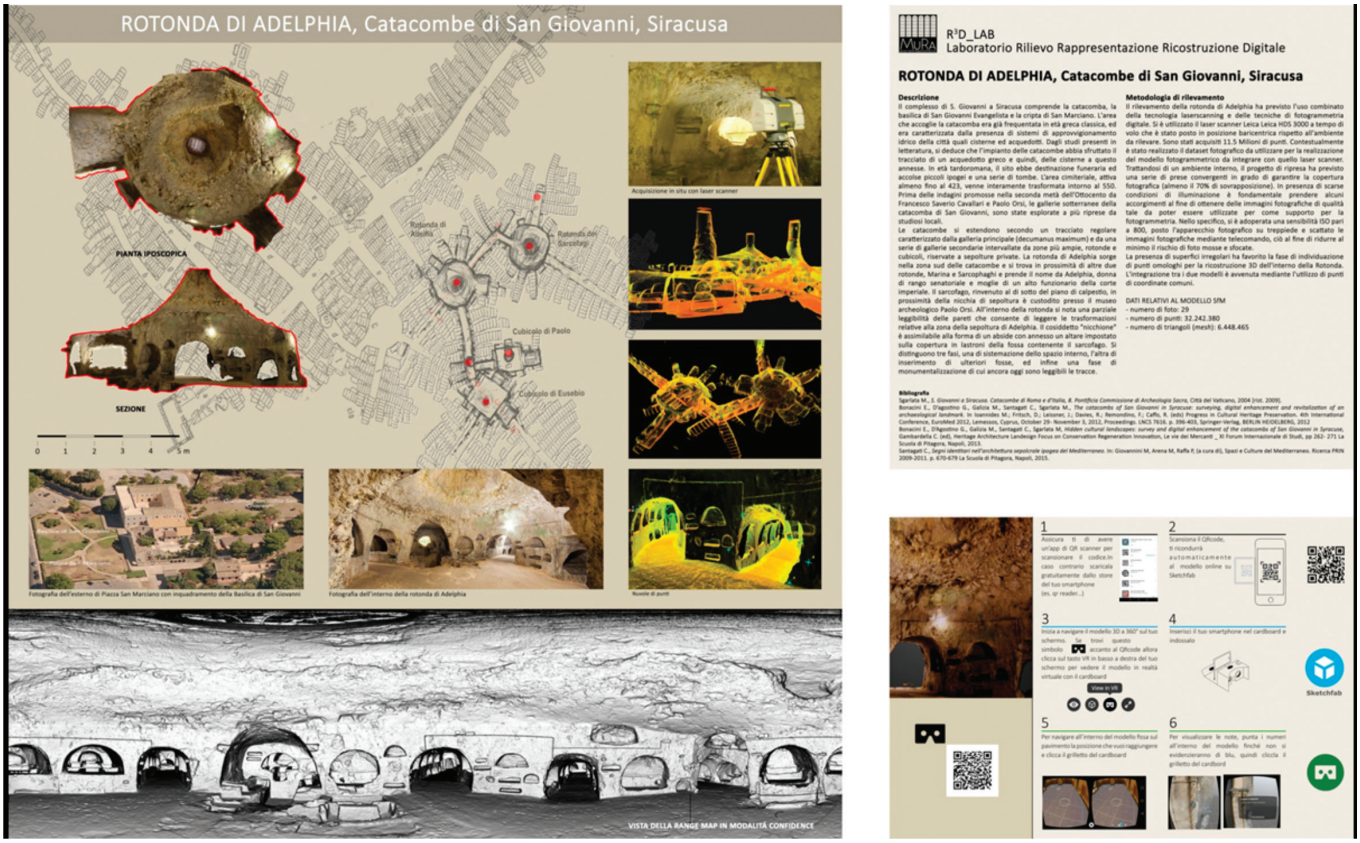

Fig. 7 - Rotunda of Adelphia, graphic board layout.

itself. In fact, by scanning these QRCodes, the smartphone is redirected to the Sketchfab platform that allows you to explore the three dimensions of the models loaded. The digital models not only faithfully represent the geometries of the real models, thanks to the application of textures on the meshes obtained by photogrammetric techniques (SfM: Structure from Motion) also allowed a critical reading of the same especially if in the presence of frescoes and similar painted surface.

In addition, the models can be enriched with text annotations and audio content, and be explored in VR/AR allowing a more engaging use of the collections on exhibit, through a dynamic exploration, that is multisensory and particularly effective from the communicative point of view. So, after this exploration phase it is also possible to allow an immersive navigation of the models in virtual reality by means of user's smartphone with Cardboards. According to

this workflow, the user experience in terms of interactivity and immersivity with the graphical representations of the exhibition is gradually growing and can be even improved. Till now, the visitors feedback from these activities have been very positive, they really liked the possibility to interact and visualize the 3D models of the exhibited boards easily and directly on their mobile and to get immerse in the 3D reconstructed environment through the use of cardboards. Furthermore, in most cases they did not have too many difficulties in interacting with these technologies.
However, the workflow is still under testing, several expedients have been taken for augmenting audience's experience. One of the main problems is the optimization of the models in terms of number of polygons, because it affects the loading times and the fluidness of the navigation (then of the immersive experience). In this direction training activities have been carried out in order to deepen retopology workflow currently used in the field of Computer Graphics and Virtual Reality
Another critical aspect of this mode is the quality of the mobile data connection to which the device that uses the user must access in order to view and explore the models. In the next section a fluid workflow for virtual transfer on interactive platforms that has been developed is shown.

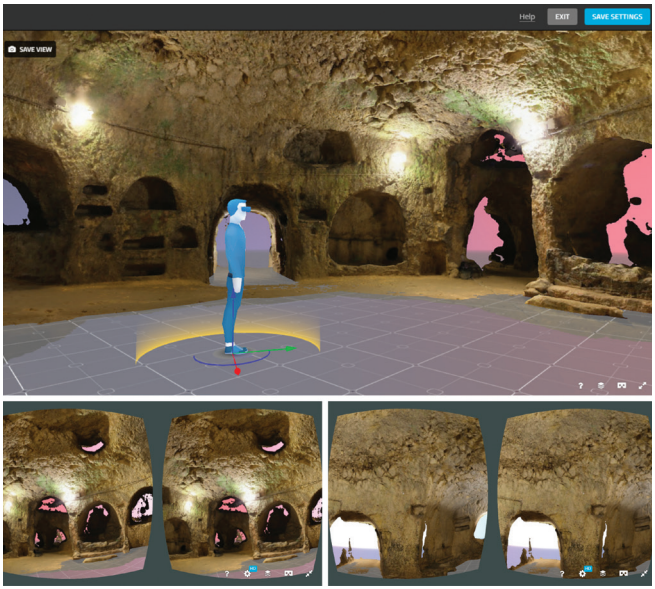

Fig. 8 - In this page. Rotunda of Adelphia. Setting up of the virtual scene in Sketchfab.

Fig. 9 - In the following page. From the triangular mesh model to the retopologised model.

Conclusions

The educational and research activities carried out at MuRa within the Digital Representation Surveying and Reconstruction Laboratory are enforcing the role that the museum can play as a hub of digital innovation. Indeed, the actions aimed at the study, promotion and enhancement of the collections and of Cultural Heritage broadly speaking through the experimentation and use of digital tools have an impact both for the University research and even more for the territory. Training young students towards new professional avenues and giving practitioner the latest updating in terms of digital skills for the conservation and enhancement of architecture and Cultural Heritage brings to virtuous paths for a sustainable development of territory.

Furthermore, the engagement strategies developed and carried out, which are focused on participatory approach envisioning the co-creation of cultural contents, go towards the construction of a sense of belonging, awareness and community that involves not only university and high school students but also young generations and citizens.
The results of this experimentation are promising both in terms of visitor's response and in terms of stimulation for the new generations. Visitors are enthusiasts of seeing the tangible results of digital technologies innovations getting aware of the role that university plays in terms of developing new skills for the territory and of experimenting novel immersive

and interactive ways for Cultural Heritage communication and fruition (both on line and on site). From the other side the students have developed a strong sense of belonging to the museum and the research and teaching laboratories, becoming aware of the importance of the active role that they can play in the study and enhancement of Cultural Heritage.
The path taken aims to transform the data acquired into information, information into knowledge and knowledge into action, experimenting and testing innovative ways of communication and use of Cultural Heritage as a guide for improving the quality of dissemination of cultural contents and reinforcing citizens cultural identity.

Notes

[1] Cf. Antinucci 2014; Luigini and Panciroli 2018.

[2] Cf. Santagati et al 2018.

[3] Cf. Magnano et al 2012; Bonacini et al. 2017; Bonacini et al. 2018.

[4] Cf. Levy 2001; Godbersen 2008; Candy and Ferguson 2014.

[5] Cf. Anderson et al. 2010; Sensi 2010; Basso, 2017; Hossaini and Blankenberg 2017.

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POSTFACE
Digital Bodies. Digital Experiences. Digital Heritage.

It has been 50 years since, on July 20, 1969, a man first laid his foot on the moon's surface. This real event, this chronicle fact realized the dream of much of the previous science fiction and gave new impetus to the next science fiction. A little earlier - released in 1968 and filmed since 1965 – the Stanley Kubrik's masterpiece *2001: A Space Odyssey* tells of an interplanetary journey as an opportunity to reflect on the meaning of our *human beings* also in the light of the development of artificial intelligence. Although deeply rooted in the narrative structures of all times, the Homeric journey in space is an introspective journey where the possibility of interaction with a sentient being like the HAL 9000 computer undermines the very condition of Human.

In this case, film fiction and aerospace reality pose the same questions, and both pass through the same process of distancing themselves from the historical condition of Humans, caressing the possibility of dislocating our bodies elsewhere than in our natural environment. On the Moon, in space between the planets of the Solar System, or from an intergalactic ship to the nearest planet with the successful *Star Trek* series teleport, much of science fiction literature feeds on man's desire to be elsewhere than on Earth. Technology, here in projection to the future, is seen as an expression of man capable of overcoming the limits of the body, as well as biologically determined, creating previously impossible experiential conditions. This is how glasses, surgical instruments, cars, loudspeakers and any other technical object. Increasing prostheses of our body, which in the meantime has become a digital body.

The technologies of digital representation, since the beginning, have instead had the capacity to widen our sensorial experiences (first of all the sight), making us present with forms in the space otherwise not usable and, in the most recent developments, making us experience other places or widening the experiences of the places we visit. There is no longer any need to imagine our bodies elsewhere, because digital representation has allowed us to experience elsewhere with our bodies: a new sense of the ancient *hic et nunc* pushes us to design experiences from a point of view never experienced before. Digital experiences in digital environments.

In this sense, this book offers us exemplary reflections and case studies to ask ourselves about our relationship with the experience of heritage today. And it does so with certain merits.

The first merit is to address the issue with a collective and not monographic work. Even though the Italian research evaluation system does not reward curatorship, there are collective books that deserve great attention for their contents but also, if not above all, for the cultural project that generates them. Moreover, scientific research in our time is no longer only the prerogative of large disciplinary groups in the same place but it is increasingly carried out in inter-Athenaeum and international networks. This relational

mechanism allows a much wider exchange of visions and generates, in fact, that *collective intelligence* theorized by Pierre Levy (1998) at the end of the last millennium. Even more so for a complex theme such as digital heritage, which is the subject of rapid and multifaceted development. How could it be possible to keep under deep control the development of research in the field of digital heritage applied to historical-artistic heritage and to cultural heritage, applied in museums or in education, for documentary purposes or for recreational purposes? Of course, in contemporary society, these case studies, fields of application and objectives are often hybridized, but this makes it even more necessary for a network of researchers to work together.

The second merit is the tripartition of the volume, where the first part is proposed as a theoretical prerequisite for understanding the state of the art and the starting point of the subsequent treatment, not without some ideas of a certain interest, the second part questions the contribution of digital representation in design expression, evidently with a vision of the future, and the third part on digital museographic experiences, with diversified case studies referring to both didactic and research experiments. This structure, even if at first glance it might appear at the limits of the obvious, is already in itself a clear methodological proposal, which on the theoretical basis bases the look at the future of the project and the approach to the complex values of the heritage. "*Doing*" is always accompanied by "*knowing*", "*knowing*" is always validated by "*doing*".

The third merit is the attempt, largely successful, to balance the technical characters of digital representation, too often predominant, and the humanistic characters of digital heritage. This point is the central point of the discussion, and it is what makes this book an excellent snapshot of the state of the art.

The use of digital technologies of representation in every context in which heritage is documented and communicated, in a far from positivist perspective, is now inevitable, but the tool should never be mistaken for the objective: even the attractiveness of the device (understood as everything that helps to arrange the image in space and to organize its relationship with the viewer[1]) when the spread of touch screens, multimedia totems, haptic installations or immersive visits becomes more intense, it risks turning into an anesthetic state due to the excess of visual stimulation. Technological progress should not be exchanged with the effectiveness of the device, where the effectiveness of the device means a set of evaluations that the designer of the digital space makes, so that the observer, the user, can make a real *cognitive experience* in the designed device. This is the symmetrical objective of the documentation, its completion, the aim of our technological efforts. But it is not enough to communicate, it is not enough to make our digital spaces accessible and interoperable. We need to design experiences capable of educating people about heritage, of giving innovative tools to scholars, of bringing together sceptics and disinterested people, of deeply *questioning* heritage itself in its deepest meanings. Using Virtual or Augmented Reality must ask us about our relationship with our history, about the expressions of our civilization, about our human beings.

This central aspect will be helped by Longo's gnoseological reflection in *Il nuovo Golem*, which tells us about the two different ways in which our civilization implements knowledge. In the archaic profile "*knowledge [is] tacit, global and immediate, implemented by the body and embodied in its structure and its biological functions [...] guided by the affective and emotional system*", while the second, "*most recent from the evolutionary point of view, is explicit knowledge, implemented in the forms of abstract logic and in general in rationality*"[2]. So also, from the gnoseological point of view, emotions and rationality seem to be opposed and introduce us to two worlds that speak to each other but with two different languages: the first is sensory and deep, rooted in our being biologically determined, and the second is conscious and superficial. But to make a visit to a museum, a virtual tour on a mobile device, an immersive visit through a digital stereoscope a *real cognitive experience,* on what level should we operate? Is one of the two levels (emotional/rational) sufficient or is it necessary to question the disparity of strategies that the two levels of knowledge follow?

In any case, design strategies can be affected by two types of limits: *narrative limits* and *technological limits*.

In the case of *narrative limits* it will be superfluous to remember the importance of storytelling in the museum experience, for example, but perhaps it will be less obvious to point out that often one of the limits of some narratives is the need for entry skills on the part of the user, if not even a specialism, which is the first of the limits in the creation of a truly inclusive storytelling. The adaptability of the devices to the user or, more simply, the hypothesis of a differentiation of paths according to the different ages of life, of the different socio-economic extractions, of the different degrees of computer literacy. Putting the user at the center of the experience must be the starting point for the design of an effective exposure, temporary or permanent, physically defined or usable online. In this, among the many disciplines that contribute to the development of effective exhibition paths, we are helped, for example, the *theory of cognitive load*, which tells us how the optimization of the quantity and quality of information that is communicated is crucial for the effectiveness of the message, especially in the educational context. This theory of psychological nature is useful also for some aspects that we can evaluate to reduce the *technological limits*: the interface system is crucial to characterize the navigation experience of a digital space, whether it is immersive or not. So it happens that, for example, although *joypads* are very widespread, it might be preferable, in certain contexts and with certain users, the preference for devices that make the interface more "transparent", for example with a technique of "point and click", where navigation exclusively oculo-motor is able to return a remarkable realism, provided that this is the intention.

In an immersive environment, especially with stereoscopic projection, there is the risk of running into various limits of a technological nature, such as the poor adaptivity of subjects with even slight problems of strabismus or the onset of cybersickness, so widespread as to have involved pharmaceutical companies that, it seems, are verifying the possibility of producing drugs capable of reducing nausea

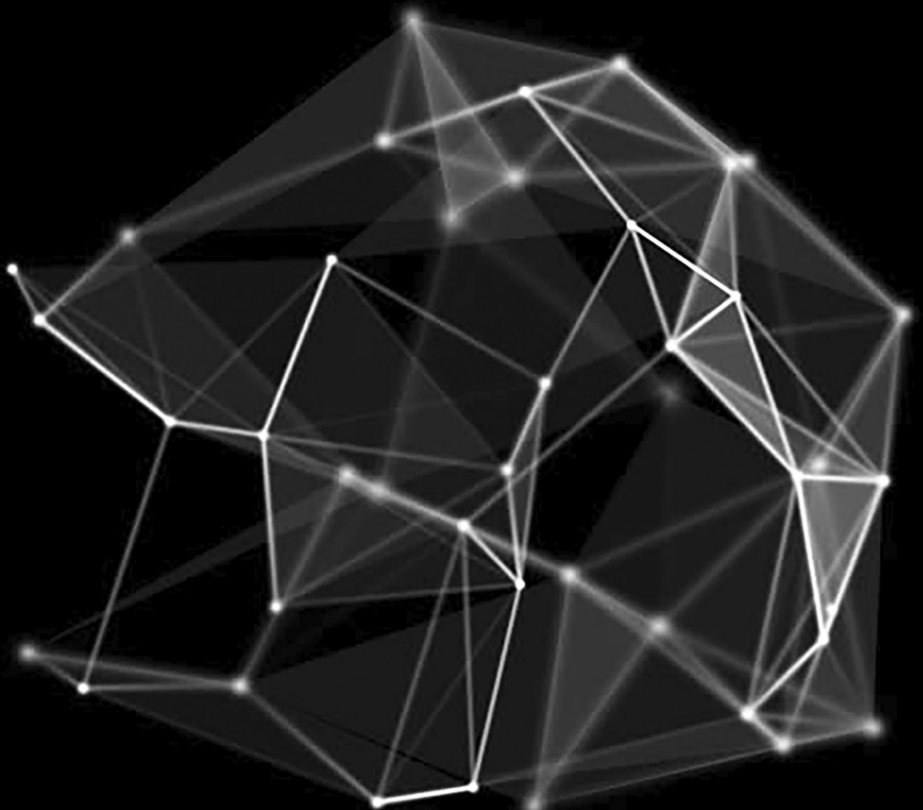
due to excessive exposure to binocular vision, to be taken shortly before immersive sessions.
But perhaps an even deeper aspect, from the point of view of the study of the real innovations of the most recent technologies of digital representation, lies in having questioned the cultural tools with which for centuries we have studied the world of significant images. Just as perspective in the early fifteenth century changed the way we saw the world, so probably the most immersive and convincing digital stereoscopic vision available today has changed the relationship between the subject and representation. In a recent essay, Andrea Pinotti[3] presents a theoretical hypothesis of great interest and not little fascination: the need to overcome iconology, valid for the images that man has produced from rock paintings (painted in immersive environments and with divinatory and pedagogical purposes) to date, to lay the foundations of an an-iconology for digital stereoscopic images. The reason for this negation of iconology lies in the presence of a triad of negations of characters constituting the previous images, whether analog or digital: the first is their lack of *mediumship* (they are not perceived as part of a material support unlike what happens to a digital image displayed on a screen) the lack of *separateness* (they do not have an element of "framing" and engage, substantially, the entire visual field) and *their self-referentiality*. This triad of negations of the status of non-immersive images (whether analog or digital) lays the foundations for the creation of a device capable of presenting the viewer with a sensory experience that tends to be all-encompassing (at least from a visual and sound point of view, according to current commercial technologies) and which, by isolating the individual from "other" experiences in his field of vision in real time, achieves the end of the re-presentation process by placing on a new cognitive category the demands of graphic representation. Users of immersive spaces, in fact, do not necessarily grasp the distance between what they see and what the image they see represents (even in cases where the realism of the rendering algorithm is not particularly convincing) but they certainly build interaction exercises that, in fact, make the navigation of the space in immersive VR, an actualization of a real experience.
These and many other observations could be proposed here, because the digital heritage affects so many aspects of our civilization (technology, history, art, etc.) that it is unthinkable to think of controlling them all. But a small certainty we can condense from this book and from the research presented in it: that *heritage* is handed down through the construction of an *experience* and that experience is the result of the relationship between the device of representation and our *body*. A digital body, for digital experiences of digital heritage.

Notes

[1] Cf. Pinotti, Somaini 2016, p.172.

[2] Cit. Longo 1998, p.58.

[3] Cf. Pinotti 2017.



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01_PRESERVING MEMORY THROUGH IMAGE LANDSCAPES AND DIGITAL DATABASES FOR DOCUMENTATION

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02_KNOWLEDGE AND REPRESENTATION: NOTES UPON A JOURNEY FROM MEMORY TO DESIGN

Marco Morandotti

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Laura Inzerillo

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DIGITAL BODIES. DIGITAL EXPERIENCES. DIGITAL HERITAGE.

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