

The 'migration' of reality in virtual scenarios: databases and documentation systems for the musealization of complex environments

La 'migrazione' della realtà in scenari virtuali: Banche dati e sistemi di documentazione per la musealizzazione di ambienti complessi

Through the digital survey and the use of specialized software, the elements and the relations of contemporary are made accessible to an increasingly knowledgeable and demanding public. Digital databases, wherein the acquired information is collected, increasingly require the development of narrative systems for the use of information and the preservation of memory. Some experimental research explain how the "migration" of the reality in virtual environment strongly depends on the structure of a design database that tries to reproduce the real space and the structure of the relations during the visit of the place. In the digital space, the user can interface with the structural elements of the database to develop critical analysis models.

Attraverso il rilievo digitale e l'uso di software specializzati, gli elementi e le relazioni della contemporaneità vengono resi accessibili ad un pubblico sempre più consapevole ed esigente. Le banche dati digitali, in cui le informazioni acquisite sono raccolte, richiedono sempre più lo sviluppo di sistemi narrativi per la fruizione delle informazioni e la preservazione della memoria. Alcune ricerche sperimentali condotte spiegano come la 'migrazione' della realtà in ambiente virtuale dipenda fortemente dalla strutturazione di un disegno della banca dati che cerchi di riprodurre lo spazio reale e la struttura delle relazioni che intercorrono durante la visita al luogo. Nello spazio digitale l'utente può interfacciarsi con gli elementi strutturali della banca dati per sviluppare modelli critici di analisi.



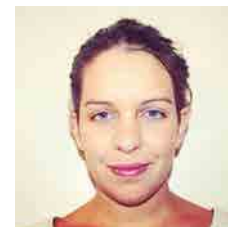
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Keywords: digital survey, databases, virtual reality

Parole chiave: rilievo digitale, banche dati, realtà virtuale

1. THE COMPLEX OF THE DATABASE, SPACE AND CONTENT

Talking about databases for architectural documentation is not just determining the structure of a significant amount of complex data belonging to a specific context, but concerns the configuration of a new system by which understand and interpret the architecture of the space. Until a few years ago the databases were originally fit out the architectural drawings and occupied towering shelves in the public administration offices, today the drawings, critical fundaments for understanding the structure of the place, changed their shape becoming themselves databases, containers of containers. In the field of cultural heritage the technological progress, thanks to the advent of the digital age, have moved in all forms of documentation system towards the realization of digital platforms. With these is possible to collect descriptive systems useful for the development of the most current comparison and commissioning forms of the information report. In parallel, the science of architectural survey, in all connotation and various forms, from archaeological survey up to the urban one, is oriented on the development of methodologies that, using laser scanners or cheaper camera tools, were able to produce points clouds, or databases of spatial and vector coordinate.

The result of this transposition of the data from graphic sign to digital code is the transformation of any digital graphics processing in a database that will have to be processed and organized in terms of management of the maintenance of data.

The possibility of extending the architectural dimension in the digital space, creating three-dimensional shapes that could be met as real spaces, is the basis of the research of video games and virtual simulations of the early '50s [1]. The remote fruition of virtual environments, which, starting from the cyberspace literature Gibson (William G. (1984) saw also generated a wealth of film products that have increased notoriety also in terms of ethical and philosophical reflections, as well as science fiction, moved the '80s through the computer graphics in video games and more sophisticated simulators (for military use as well as commercial) [2].

But what happens today, as news of this virtualization process, involves the action to have put, with absolute certainty, the metric and geometric accuracy of the data inside the digital space, and have begun to build more and more digital archives of our architectural heritage hoping to preserve their memory.

Digital, dimensionally close space [3], is made detached by the conformation of the point cloud where every single piece of the surface is without values if decontextualized, but inside this digital nebula becomes increasingly able to describe the space and all the place and the mutual relationships of its elements. In particular these clouds of points are constituted by dynamic formats, within which the spatiality is resubmitted in its three dimensions: the interaction with the virtual-space allows to change constantly the point of view and to interact with the site, with the object or with the single element, improving the learning and the knowledge of the space.

That post-graphic production process, started some years ago with the modeling that is able to transform the drawing in a spectacular action computing, reach, with the knowledge of an interaction between databases, its highest programmatic expression. The database on the reality, result of a practical action conducted on the site and of an automatic survey acquired by laser or photogrammetric tools, is considered as the new starting point from which conduct renewed interpretation action to develop the drawing. Such critical interpretation process of the data acquires the meaning of a new database at the time when it will work in terms of interactions within the virtual-digital system. The optimization procedure of digital models and the databases export in different output, revolutionize not just the relationship practices with the Art objects, places and heritage, but create also a different trust in Digital field that it must be able to be justified with the definition of methodological protocols and the use of accuracy certificates.

Digital databases for cultural heritage are increasingly necessary, especially because of the development of the runtime systems of such information systems, not only to preserve the memory through descriptive systems, but also to allow various simulations and experiments for the purpose of type control, management and de-

velopment tools.

The 3D database systems are representations of reality characterized by being composed of data of 'pure information', coming mostly from the physical world, capable of generating a new awareness of space, he lived beyond its physical limits. In the new virtual platform, in which is possible to configure the contemporary scenes of our city, of our historical architecture and our open-air museums represented as database systems, acquired, managed and structured in the database space, is possible to structure a new approach to the same survey project and its communicative purpose. The spread of virtual platforms through which our historical heritage can be enjoyed, seems to now be the preferred language of communication for the dissemination of information related to the sphere of urbanism, architecture and art. That 'virtual movement', linked more to the architecture design, has inevitably contaminate the sphere of digital survey, so that now seems impossible to conceive of real and virtual as separate issues: any relevant contract and the historical documentation has always, among the aims, the creation of a virtual system in which this artifact can be received and implemented by different information origin and nature. Virtual reality therefore assumes the task to be seen as the most effective representation of space system, as it allows the user to interact directly with the largest database offered by reality based digital models. (Figg. 1-5).

2. COGNITIVE MODELS AND VIRTUAL PLATFORMS, INTERACTION WITH DATA

"People live and interact into the space, and each action share 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" (Ciastellardi, 2009 , p. 7).

The influence of physical locations on the individual who inhabits it highlights what is useful to consider the space as a dynamic phenomenon, within which there is a mutual influence of limits of action and expression between the 'context' and the subject 'individual'. The virtualization of the physical space has led to a radical revolution in user-space-time relationship: the interac-

tion between the subject and the type of information takes place in cyberspace, "bringing the actions of the individual and the actions of the community to find fulfillment beyond the real space" (Ciastellardi, 2009, p. 8). It is forced to rethink the approach mode of the information content and to their nature, necessarily reshaped according to a new digital setup. Cognitive models, with which the information is acquired, processed and revived within contemporary digital databases [4, play a fundamental role in the management of information content and interaction with users, performing a constant feedback action, removal and rapprochement between the real system and the one that virtually simulates and amplifies the content. Virtual space is able to establish new standards of information and experience, taking shape as a container of multicultural and interconnected information through a form more and more construction subsidiary of knowledge [5. The 'containers' of knowledge constitute innovative spaces, interactive platforms where converge intangible relationships between users and virtual worlds meet the perceived space, implemented the ability to transcend the laws of physics in order to facilitate any possible simulation of the real in terms of use of digital space.

In order to offer a system of interaction between user and container that is as intuitive, challenging and productive as possible for the community, the interface according to which the database will show the operator will assume a specific representative language. The real-time systems, for example, are able to offer different levels of interaction, from the most reduced software (as the systems created with QuickTime VR) to those that provide a high level interaction between the subject and since, as in the case of the latest generation of multiplayer games, capable of mutual sharing spaces and environments also to number of simultaneous users [6].

When the platform joins the playful character of the system function with a high information content, it becomes a teaching tool and dissemination within which more or less complex spaces are able to assume valence of navigable virtual museums. Serious games, namely those "games that have no entertainment and fun as their primary purpose" (Michael and Chen,



Fig. 1. The visualization of the virtual space and the development of technology for immersive reality. In the 90', the science-fiction cinema has been greatly influenced by the virtual reality simulation experiments. The Ivan Sutherland machine, made in 1968 as the first virtual reality system with viewer, has been inspiring of the infinite dimensions of Johnny Mnemonic (1995, by R. Longo director), the head of which becomes extension of digital dimension, and has been inspiring of the instrument used to program and interact with games in Nirvana (1997, directed by G. Salvadores). The development of the Sutherland Machine led to VR glasses offered by the Google company.

Fig. 2. The interaction and movement of the body: Sensorama, the first machine for use of immersive virtual space, which inspired the video games of the 80's, (here an image from the movie The Last Starfighter (1984 N. Castle director), where the game becomes the evaluation tool of the skill of the pilot intended to save the galaxy); up to the autotracking systems for the elimination of the commands and the recognition of the body in the absence of knobs, and finally the dynamic interaction with a joystick that interacts with the movement of the body used for the Nintendo Wii.

Fig. 3. Immersive systems imagined in the film world: from Tron (1982, directed by S. Lisberger); the Lawnmower Man (1992 B. Leonard director); until the most recent Matrix (1999, directed by L. and A. Wachowski) and The Cell (2000, directed by T. Singh).

2006, p. 17), for primarily teaching were developed and knowledge, continuing to be used also as part of the architectural heritage documentation [7]. When dealing with issues related to architectural survey to its representation, it is necessary to consider the advantages and disadvantages related to the real-virtual relationship: create compelling 3D models and high-level simulations involves the use of the best software and hardware. It is therefore essential, in order to optimize timing and costs of production, to be clear what objectives are to be achieved with the creation of a virtual platform.

The immersion experience within the three-dimensional models, designed for use on the World Wide Web (like the Virtual Reality Modeling Language system, VMRL) allows the sphere of representation to pass beyond the sensory limitations of the spectator, offering new opportunities interface with space and allowing the independently configuration of the development, timing and methods of digital approach to the environment in which it interacts. Virtual models and the information appended to them become part of a museum system that, in the case of architectural or big archaeological complexes are configured as real open-air museums, in which the visitor is accompanied to become itself part of the narrative system, in opposition to the traditional use of real space in which the information is made explicit by the same content through various media.

The typology of 'mixed' museum combines the traditional view system, within a museum space, to the possibility to amplify the information content via augmented reality, increasing the sense of satisfaction of the visitor through the emotional involvement offered by a different narrative approach. The public today wants to be the protagonist of 'performance' and this kind of approach to the visit will certainly increase the interest, understanding and respect for cultural heritage.

The hybridization between representative of systems design and photography seems now able to contribute to the representation of the complexity of combining metrics-dimensional information and quantitative aesthetic qualities of character-represented [8]. Therefore we find the photographic image and modeling reality

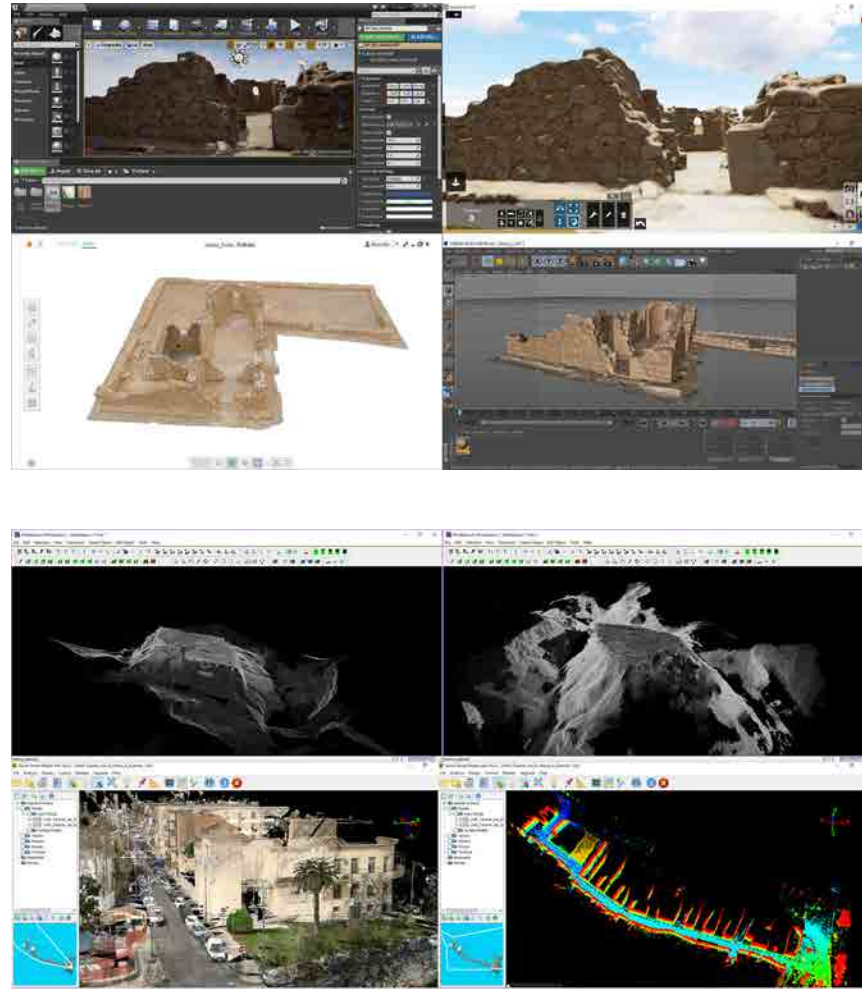


Fig. 4. View of a 3D model of a portion of the plateau of Masada, the Byzantine Church, within various program: SFM, 3D modeling, rendering and for the creation of video games. In the upper left the Unreal Engine program, next Lumion. Below, from left: Autodesk Remake and Maxon Cinema4D

.Fig. 5. View of point cloud within the software Leica Cyclone (above) and within Quick Terrain Reader (below).

based as protagonists of a use not just for purposes of knowledge, but mostly as systems for a more complete and truthful representation of three-dimensional spaces for the use in real-time mode [9]. The virtual models generated by these procedures define three-dimensional database where space is described by HD polygonal models and textures to increase perceptually the geometric detail and increase the simulation inside the virtual space (Basso, 2016, p.151). In this interaction becomes the protagonist semantic procedure for the organization of the 3D model, through the design, it defines the critical interpretation of the virtual scene allowing you to create an organizational structure useful both as to its filing of using visualization systems Web. the cognitive models, as well, allow to find a specific correlation between model, object represented and the graphics system to make explicit the use, or in the drawing, which represent and instructs the virtual space by defining the graphic structure of the scenario. (Figs. 6/7)

3. DRAWING AND BUILDING VIRTUAL SCENARIOS, SOME PRACTICAL APPLICATIONS

Utilizing database obtained by digital survey processes influences the constructive choices of drawings relating to the scale the system refers to, whether it is archeological, architectonic or urban. Definition of methodologies to build interactive database of cultural heritage can be synthesized relating the diverse goals toward the development of models of creation of augmented reality or virtual realities referring to a serious game. In immersive systems, we must consider the interaction processes with virtual space, which may be static, semi-static or dynamic, while for the augmented reality systems we might always consider the filter between user and designed space, the real space, where the virtual informative system is constantly confronting itself.

Augmented reality allows the overlapping of fictional layers, editable and implementable on the basis of real elements, allowing to speculate on different narrative paths relating to different user categories of the website. The user, after being identified through specific targets of the graphic identity project, will be able to

Fig. 6. Interaction between social and information-communication: a confidence in the expressive potential of this organization as opposed to the increase of a relationship with the digital structure of things. Perhaps the ultimate expression of this interaction is Michael Jackson who performs 'post-mortem' in 2014 at the Billboard Music Awards, in the form of a hologram.

Fig. 7. Transposition of the Uffizi museum in Japan. At the beginning of 2016 in Tokyo was set up an exhibition in which there are represented in life-size paintings from the Uffizi Museum in Florence, interactive displays and a small 'theater' in 4K where the visit inside the virtual museum becomes a 'more realistic experience.



visualize with mobile devices as smartphones and tablets the content selected for its specific target in correspondence to sensible elements. More specifically it concerns the issue of simplification of the relationship between the user and descriptive content as photographic documentation and 3d models.

This layer overlapping allows creating a system of data diffusion where for the same object a hypothetic 'tourist' will find different information from an 'expert' visitor, which can access technical information instead. Thanks to the adoption of the 'virtual' it is possible to build any kind of scenario, infinitely editable and updatable, allowing the public to access a vast database, which will otherwise be difficult to consult with other fruition systems. The different interactions between virtual models and its real prototypes belong to this sector. A tactile experience could be combined with the traditional museum visit exploiting technologies available on the market, which allow to 3D print objects capable to reproduce accurately artifacts and make them completely accessible by the public. 3D models of paintings, architectures, landscapes, allow also blind or disabled people to enjoy the cultural patrimony, and



those models can become the access keys arrayed on exhibition routes connecting the visit experience with virtual systems of augmented reality. Concerning virtual reality, the design of both 'content' and museum 'container' is required to valorize the symbolic and cultural strength of a place, implementing with informative content a museum-system that could be accessed virtually.

Generally speaking, the 3D model will be built using both NURBS and mesh techniques, and then connected to a database in which are contained different kinds of information. A common example is represented by the Unity3d platform [10], where along with the principal asset of the model [11] it's necessary to provide a controller associated with an avatar, namely a virtual character that explores space controlled by the user through keyboard commands and mouse inputs. The software allows inserting graphic elements and buttons facilitating navigation and making it interactive, responding to the widespread target and the didactic aim which represents the raison d'être of this serious game. It's possible also to insert information of various nature, historical or architectural, or even content in a quiz form for pedagogic finalities, for example, in the case of a correct answer, the user can access the next room of the exhibition, while in case of a mistake the user will find an explanation of the subject of that specific part of the visit. The user, thanks to a virtual structure of this type, will find himself directly immersed and participating to the unfolding of a narration, and he could at the same time learn information and notions, which is a desirable process for any kind of museum typology.

Content and media present on the web platform are of various nature: text files, explanatory videos, photos and audio tracks, aimed to the comprehension by the user of the place, which becomes virtual. The user can navigate to move through space, questioning the hotspots and attractions linked with specific digital content. With this digital configuration, both museums and cities, generate virtual platforms aimed to share knowledge and to valorize cultural heritage, not only to the advantage of administration, but mostly of the territory they represent and

the entire community: through the simple interface of the website, the digital model allows users of any target an intuitive navigation, promoting in this way the interest and participation to build 'culture-spreading' virtual worlds. [12] (Fig. 8-12)

4. REAL - VIRTUAL - REAL: THE INFORMATION CYCLE

The 'virtual', understood as the new configuration where there are the size of 'urban area' and 'architectural space', "it is one of the main foods of the contemporary cultural creativity" (Unali, 2014, p. 18). The virtual space is the place where it may happen that it is hard to imagine what could happen in reality, within which the drawing must not necessarily be subject to the constraints imposed by the physical space. This is why, in addition to the growing use of digital technologies and the dedicated software, the experimentation of new forms of representation inevitably occurs within the virtual possibilities. In addition, the fluidity of the narrative offered by digital systems allows to increase the value of the 'database' system and storage systems of the information acquired, leading to a virtuous circle where reality and its digitized representation of the object become one of the other enhancement tool.

This process triggers an interest and attention to the forms of management and representation related to digital databases. In some of the research projects described in this paper, have been experimented representations of point clouds or sfm models that incorporated within virtual environments, have allowed the use remotely of architectural or archaeological complex of Cultural Heritage.

The action of synthesis through which the models have been extracted from the scope 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 move from a complex configuration space acquired to a discrete configuration made of dots, lines and surfaces that become sensitive in the interactive space.

The variety with which is possible to configure a 3D digital system (video games, 3D models prints, websites, augmented reality applications), allows a dif-



Fig. 8. Images of the 3D model of the Montesenario Sanctuary (FI), modeled and mapped in 3D Studio Max and imported in Cortona 3D viewer platform in .wrl format for navigation in real-time.



Fig. 9. In this image there are some 3D Models of the plateau of Masada in Israel, used as "interactive containers". (Under) Some augmented reality simulations for some rooms of Masada environments. A descriptive content has been associated with this object 'interrogated'. The column instead is georeferenced and information content can be viewed on your device.

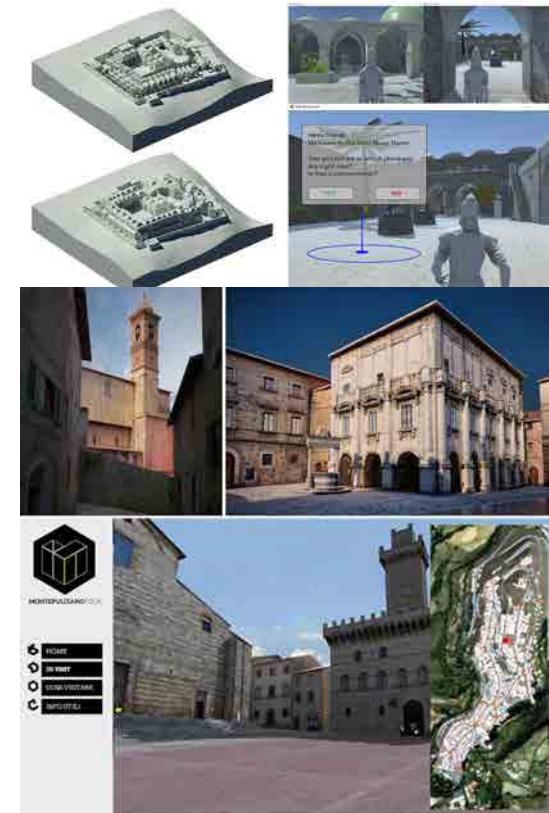
ferent approach to the representation, re-evaluating limits, purpose and expressive potential. The virtual representative systems allow to develop a more involved and aware of the environment and educational path are able to increase the interaction between user and information. The biggest challenge in the development of a procedural process for the realization of efficient virtual platforms, is to seek a key reading, or a design, first mental and then representative, to understand and build relationships of perceived space. In this sense the possible representations do not stand apart from the traditional representation, moving from symbolic contexts, more abstract, but full of meaning that requires greater integration by the user, or representative models that translate the real image in a world virtual, looking for an easy visual emotion into the likeness to reality. The lessons learned from these years persuades us to believe that in any case signs and images can qualify structures that still, in the various virtual forms, produce more and more emotions, more autonomous form, may communicate to a more experienced user, towards a future which in its infinite facets it is already in virtual form.



Fig. 10. Experimentation of the augmented reality relative to the case study of Villa Adriana in Tivoli. The 3D Molel of the Esedra of the Palazzo printed using 3D printer and placed on a planimetry. Through Juniaio App and a QR code you can view the entire 3d model 'textured' area.

Fig. 11. 3D Model of Maqam Al-Nabi Musa in Rhinoceros, then mapped through the use of Cinema4D and subsequently imported into Unity3D software. (On the left side) A view of the serious game of Nabi Musa. The avatar in foreground is in front of a sensitive object and thus activates the quiz for the user.

Fig. 12. Images of the 3D Model of the old town of Montepulciano (SI), modeled and mapped in 3D Studio Max, inserted on a web platform for navigation and use in real-time.



NOTES

The author of paragraphs 1 titled The complex of the database, space and content and 4 titled Real - Virtual - Real: the information cycle is Sandro Parrinello; The author of paragraphs 2 titled Cognitive models and virtual platforms, interaction with data is Francesca Picchio; The author of paragraphs 3 titled Drawing and building virtual scenarios, some practical applications is Monica Bergicli.

[1] Even if the term Virtual Reality dates back to the late 80s early experimentation of ipercognitive interactions with the virtual space have been since the late '60s with the invention of Ivan Edward Sutherland glasses to observe the digital space (then in 1977 the Aspen Movie Map created at MIT to allow to navigate inside a partially static reconstruction of urban space); it is possible be traced back to the 50's the beginning of a specific literature on the subject, excluding the science fiction stories, but more closely related to systems of interaction with cinema (the Experience Theater Morton Heling and analog Sensorama).

[2] In video games 80s' the player's interface was vertical scrolling: in 1942, set in the Asian territory of the Second World War the user had as a goal to reach Tokyo and destroy the entire Japanese air fleet, identifying itself with the pilot, the American Super Ace. Besides shooting, the player can also perform a loop-the-loop to avoid enemy fire. Call of Duty: World at War is instead a next-generation video game, with a dynamic interface and simulation of the player who lives the scene firsthand. The game, developed by Treyarche published by Activision Blizzard Nintendo Wii, Playstation 3, Xbox 360, Microsoft Windows, Playstation 2 and Nintendo's aim is to survive as many rounds as possible, earning points by killing the undead and reconstruction of the defenses.

[3] With 'finished dimensional space' means a virtual control space, dimensionally known, measured and digitally delivered according mindsets foreordained that define the border and of the context limits.

[4] The knowledge of an environmental system, natural or artificial, involves the implementation of a perceptual-cognitive system that uses the view as the primary data capture tool, but at the same time makes use of digital tools to acquire a high number of metrics and spatial information. Communicate with images and with their three-dimensional transposition implies knowing the details of their perception and how they can be implemented by the user to determine common cognitive systems and due to an equally defined behavioral model. The selection of some of the information that is captured, from the sense organs or digitally by the instrumentation used, is the ability to only choose the one that is considered essential to the understanding of the scene and then discretize the data useful.

[5] The next-generation video game is one of the cases where the existing limit between reality and fiction, between the virtual and the real landscape scenery, is annihilated. The user is completely immersed in a parallel reality, in a space that simulates a real environment, fully rebuilt, or totally unreal spaces, but so plausible that it can be classified in full as new contemporary landscapes, within which collaborates and interacts actively in the development of a deployable system with information of various cultural interest.

[6] 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: the simulated object can rotate relative to the observer or be stationary while the

observer will turn around, interacting or not with other users who are in the network simultaneously. At the same time, the scene can be enlarged or reduced and transformed topologically, greatly amplifying the perception of the visitor capacity (Maldonado, 2005, p. 68-69.)

[7] Already since the 70 virtual environments have taken training purposes, in addition to entertaining, especially in the military, experiencing functional flight simulators to learning for the US Air Force. Starting last decade, serious games has also invaded the field of Cultural Heritage because considered a means to represent, learn and spread the knowledge of cultural heritage.

[8] This refers to the many reality based models developed through SFM process and reverse engineering. The photograph, which on one side has reassessed the boundary between art and reality, and the design, which established the rules of a new multimedia figuration, both aspire to become instruments related to obtaining a unified image that transmits most amount of variables and values that characterize the physical landscape (Cianci, 2008, p.22).

[9] The numerical models, consisting of polygons and vertices approximates the shape of each architectural element to a corresponding discrete 3D model, consisting of a certain amount of polygons chosen by the operator depending on the purpose of the database. To be easily shared over the network and unexpended by the user, the models and the virtual places in which are inserted must be carefully planned, in order to be easily recognized and codified. (Marini et al., 2001, p. 494).

[10] Unity3D (or simply Unity) is an engine for the development of video games and since 2005, the year of its first release, it has become increasingly popular. It is called 'multiplatform' because their engine

allows 'write the game' once and realize it or transform it to various environments such as PC, portable devices, and various video games consoles.

[11] The model was built using the modeling software Rhinoceros and mapped in Cinema4D. Exporting to .fbx format has allowed to keep the association with the material mappings.

[12] The research projects to which we refer are the result of the work of the Joint Laboratory LS3D Landscape Survey & Design Laboratory to which adhere the Dida - Department of Architecture of Florence and Dicar the University of Pavia. Are responsible and coordinators of various projects Prof. Stefano Bertocci and Prof. Sandro Parrinello. The project on the Montesenario Sanctuary was conducted from 2003 to 2012, research on Masada and Villa Adriana covered the years 2012 to 2016; the project relating to the survey and rehabilitation of the complex of Al-Nabi Musa was held in 2015 and was supported by the EU and the Ministry of Culture and Tourism of Palestine. The project "Montepulciano Tour" has produced an App downloadable from <http://www.montepulcianotour.it> site; multimedia product was produced in collaboration with the company IDEM ADV.

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