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The double dynamics of knowledge: reality and virtual reality in the enhancement project of Torre Maggiore of Villa Rufolo, Ravello.

La doppia dinamica della conoscenza: realtà e realtà virtuale nel progetto di valorizzazione della Torre Maggiore di Villa Rufolo a Ravello.

This paper aims to tell a crucial experience in the field of research and innovation for the communication of knowledge through advanced technologies, with the aid of new methodological forms contributing to a progressive cultural advancement of society, thanks to easier access to knowledge and understanding, assisted by historical research about territory, city, and architecture. Here we present the outcomes of an enhancement project of Torre Maggiore of Villa Rufolo in Ravello, with the purpose of an immersive-reconstructive journey, made through the construction of a steel staircase that can accommodate simultaneously the technological systems, the finds of the villa collection, and lead visitors to the panoramic terrace at the top of the monument.

L'esperienza descritta nel contributo si propone come riflessione nel campo della ricerca e dell'innovazione per la comunicazione del sapere dove tecnologie avanzate e nuove forme metodologiche, la ricerca storica sul territorio, sulla città e sull'architettura, contribuiscono ad un progressivo avanzamento culturale della società, grazie ad un accesso semplificato alla conoscenza. A tale scopo sono presentati gli esiti del progetto di valorizzazione della Torre Maggiore di Villa Rufolo, a Ravello, che ha avuto come obbiettivo un percorso immersivo-ricostruttivo, reso attraverso la realizzazione di una scala in acciaio capace di ospitare gli impianti tecnologici, i reperti della collezione della villa e di condurre i visitatori al terrazzo panoramico in sommità del monumento.

key-words: three-dimensional survey, representation, immersive spaces, exhibition design.

parole chiave: *rilievo tridimensionale, rappresentazione, spazi immersivi, exhibition design.*

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1. INTRODUCTION

The specific requests of the customer - the Ravello Foundation, Director S. Amalfitano -, the geometric characteristics of the building - the Torre Maggiore of Villa Rufolo in Ravello -, the technological requirements related to the construction of a staircase that supports a considerable flow of visitors, the intention of verifying the compositional idea of a vertical museum defined by a 'promenade' between the stories that built these places made through the digital, all these are the topics involving additional issues, not only disciplinary: at first, a 3D survey of the Tower, and then, from digital, draw out the project. A project defined through a rigorous methodology, bringing together technological and structural needs, use and management purposes, the aesthetic, together referring to the spatial suggestions of recurrent forms by Maurits Cornelis Escher - who attended often these places - and to the narrative intentions defined by the idea of the Gesamtkunstwerk of Wagner - who imagined here the end of his Parsifal (Fig.1).

2. FROM REAL TO VIRTUAL FOR CULTURAL TOURISM

Cultural tourism, as growth for the individual and the economy, appears to be the real socio-economic innovation impetus for Italy and the role that interpret the sites with a high presence of the Cultural Heritage - whether artistic, architectural, environmental - is crucial, even becoming destination chosen by more than half of the tourists enjoying Italy. In fact, the number of arrivals in the art cities is increasing (except for the reduction of the early global economic crisis) in 2014, overcoming the 8.6 mil. of tourists. It should be emphasized that the international presence characterizes the cultural tourism of the art cities (70% of arrivals and presences) which ensures, also for the future, a growing demand: an average of 600thousand Americans, followed by Chinese and Russian (with the higher per capita daily expenditure) and then French, German, and English. As reported in the Foundation Symbola "I am Culture" 2014-15, the effects on the economy of a territory can be identified with four kinds of activities related to the Historical-Artistic Heritage: the Performing and Visual Arts, the Cultural Industries, the Creative Industries, activities fully compatible with the Research & Innovation Smart Specialization Strategy RIS3 of the European Commission, which identifies as lines of development for regional Research and Innovation precisely the enhancement of productive sectors of excellence, taking into account the territorial strategic positioning and development perspectives.
Nodal goals of the project are therefore: promoting development of Cultural Industries, especially Cultural Tourism; increase the use of ICT-Information Communication Technologies, a strategic point in accordance with the 'desiderata' of the European Union; encode an exhibition process that may 'express' multiple research topics, which have as their reference those concerning the Representation; make possible changes within social dynamics, enhancing, in this specific case, the accessibility to the Cultural Heritage; raise public awareness towards the value of Cultural Heritage, also in view of preservation, renovation, or restoration. Among the expected results we can also highlight the strengthening of the circularity between theory and practice, precisely where collaboration - as in this case - between universities and companies involved can generate a positive impact on: scientific research, quality of culture and citizens' awareness, attractiveness towards the visitors and towards the world of business and markets, with specific reference to the sector of cultural tourism. The project therefore intends to set up an innovative museum experience, which relates the real with the virtual through a methodology - already established - that, starting from the acquisition of Cultural Heritage data, provides the development and the subsequent communication through multimedia products, with high technological content - coming from the ICT -, with real achievements on socio-economic activities and innovative communication possibilities for cultural content, by facilitating access to public services. The nodal coordination activities, from both the operational and organizational point of view, given the complexity of the project-related actions: using equipment, software and meetings, each 'actor' carried out the research with his own expertise, each central to the disciplinary areas involved: from the Representation to the History of architecture and the city, aimed at the enhancement of the Cultural Heritage in terms of: knowledge, dissemination of the relative cultural contents, architectural and technological design of interventions for the protection, conservation, and to improving the intelligent fruition. The chosen case is configured as well as tourist and cultural attractive pole of Ravello, where multiple interests are presently focused, awaiting a socio-economic and employment returns, becoming attractive location even for the average citizen, with beneficial consequences in terms of cultural awareness and dissemination of knowledge. Dissemination that an innovative museum organiza-

Fig. 1. Bottom view of the steel staircase

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tion - overlapping to the experience of reality the virtual and immersive one, can generate positive feedback.

3. STATE OF ART

In opposition to the idea of 'cultural museum' that, from the beginning in late Middle Ages and in the first part of Italian Renaissance and over the Europe of counterreformation – between these the spectacular Kunst und Wunderkammer – reaches the Nazi period, the museum today is the place where the viewer can meditate about himself as he is involved in the reality of his cultural context, being able to do it 'in presentia' and 'in absentia' and, due to new technologies, analogically and digitally: the museum organization has been enriched in terms of processes (constitution of databases and archives, media and hypermedia data organization, media and multimedia organization, signage rationalization), of systems (Information Retrieval for data storage, networks, systems for virtual and holographic telepresence) and instruments (signage, infocenter, work-station, optical memories, virtual classroom, Digital Libraries, educational and fun workshops, digital workbenches) subverted the idea of Cultural Heritage and its experience. Indeed the notion of Cultural Heritage goes "[…] from the ideal and particularly aesthetic value of rare and fine historical and artistic items to the evidential value of Beni Culturali in the systemic and anthropological sense" (Montella, 2014, p. 36). And that step "[…] from the value in itself to the value of use, from cultural heritage as wealth to be preserved to cultural heritage as a resource to be used for social benefit" led not only to an extension of the field, which now includes also the idea of immaterial cultural heritage, but also to a significant impact from a management point of view, with a great involvement of new technologies. However, here we want to refer to those exhibitions, that ensure a double level of involvement of the public, leaving the viewer in direct relation with bystander reality of the exhibition and at the same time, involving him in to a virtual experience. Perhaps a precursor in this regard was Frank Lloyd Wright who, with the Guggenheim in New York, 'invents' a dynamic fruition path of the exposition: the inner space of the museum indeed is configured by a conical helical ramp which can accommodate the walk of the viewer inside an architecture that became emblematic for the organismic 'niche' of Modern Movement. Simultaneously to architecture, the public admires the 'show' of the exhibition in it conceived, show that – as it involves the eye [1] – assumes virtual connotations. Likewise, in 2015 an extraordinary motor/perceptual experimentation: inside the World Trade Center Elevator, going in the elevator to the top floors of the skyscraper, we are witnessing an immersive experience that allows to see the New York panorama change from 1500 till today. And if the start intentions are similar to the American ones, the innovativeness of the Torre Maggiore development project is to include in a single performance the architecture in its physical shape and an immersive tech facility – with 3D videomapping and sound spatialization – generating an intense suggestion of places within the generative and projective virtual processes. The architectural organization and digital content were created through compositional process where virtual has defined and changed the conformation dynamics of substance, allowing to retrace the steps of a continuous dynamic description, by real elements (the Tower, the finds, the scenarios) and visions that refer to Wagner, Escher, and the magic of the Amalfi Coast.

4. THE EXHIBITION DESIGN OF TORRE MAGGIORE IN RAVELLO

The enhancement project of the Torre Maggiore of Villa Rufolo at Ravello has experienced a methodology aimed at integrating the architectural design of a steel and glass staircase inside the building with the multimedia exhibition of the museum, in close relationship with the places, the archaeological finds, the memories of the Villa: an exhibition according to the current idea of virtual museum (Riemer & Callery, 2013), where test new forms of Cultural Heritage fruition. For the his intrinsic nature, full of semantic associations, a virtual museum must support an interdisciplinary approach, which allows the visitor to understand the culture that is "behind" objects, also virtual, contextualizing them (Signore, 2008). In addition, in the case of the Torre Maggiore, the realization of the staircase be-

Fig. 2. Three-dimensional survey phases using the laser scanner Riegl LMS

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comes the place in which "develop" the virtual museum visit, by relating the light of the video projections, the sounds of Wagner, the stories of the finds, over the possible animations, notes and objects. The project consists in the realization of a staircase, inside the Tower [2], hosting the collection of the villa's finds and lead visitors to the panoramic terrace at the top of the monument through an immersive journey. The limited size of the tower, 5.80 x 6.60 meters, the presence of two cross-vaulted floors, the reduced size of the windows and the openings within the vaults for access to the floors at 9,28 and 20,45 height, the irregularities of the wall surfaces, all these elements required an accurate survey of the building in order to guarantee the exact scale of the sizing, the minimum intervention on the building structures and a detailed study of the organization of the construction site for the transportation and handling in the tower of the iron parts. The 3D survey of the external and internal surfaces of the building through (time of flight Riegl LMS-Z420i and a phase-shift Zoller Fröhlich 5006 scanners) tested a new representational method of numerical data directly facilitating the design phases of the new staircase and of the museum exhibition, specifically identifying and producing 22 survey points, 13 internal and 9 external (Fig.2).

The point clouds, textured with the acquired images by digital camera Nikon D70 - Optical 14 mm, were aligned through cylindrical and flat markers arranged around the monument (Fig. 3).

The aligned and high resolution model has been divided for each level of the tower according to the different facades, both internal and external, and to architectural elements, such as the mullioned windows, the circular oculi, cross vaults, the passage openings. Subsequently, the cloud points have been filtered to erase noises and disturbing elements, and processed for defining levels of 25%, 50%, 75% and 100% of the initial instrumental data. Four polygonal models are thus obtained according to parties at different resolutions, from which generating the virtual objects by conventional processes of reverse engineering, and NURBS for simplified and motivated management (Fig.4).

NURBS, in fact, allowed a dynamic use of the models, through different modeling and simulation software, letting an 'inclusive' (Deleuze, 1990, p. 34) understanding of the artifact. The possibility of managing in a virtual environment the different parts of the building, interpolating visions of the building as a whole with plans and architectural elements rendered with degrees of transparency, as well as with photos and sketches representative of suggestions - collected during the days of survey -, have in fact defined a representational process not driven by a simple technical product but strictly active, dynamic. The opportunity to directly manage, in a digital environment, the cognitive data has included in individual virtual dimension (Levy, 1997, p. 6) [3] technical data, measurements, suggestions, sketches, in continuous change scale and views modifications. Both design and modeling of the staircase followed the evolutionary dynamics of the forms, a kind of parametric modulation [4] in which to gather technical and aesthetic, aspects within a single dynamic of architectural object *variation* (Fig. 5).

The knowledge, the representation and the project composed a process punctuated by the virtual degrees in the folds of substance. Stones, light, sounds, memories of the places are redefined as overlapping images of the earth steps between the trees, shadows on the paving stones, climbs on the endless ramps, as in the Escher's *Relativity*. They were recomposed as a leitmotif along the unfolding of the works of Wagner, as dancing lines of an *Eternal Return* (Deleuze, 2002).

The formal development of the staircase was made, after the first sketches, directly in the 3D CAD environment, and specifically through the Rhinoceros software, in which low resolution polygonal models (generated by laser scanners) were imported. The mesh discretization was performed for curvature priorities, namely polygon reduction is mainly related to flat parts of the tower, such as floors, the surfaces of the vaults and to a lesser extent of the walls. The edges and the greater curved parts, however, retained a greater number of polygons, thus obtaining a reconstruction of the geometries, very close to the real. Starting from the corners and from series of progressive sections, obtained with parallel planes, the *relevant* geometries have been generated directly in three dimensions, representative of the critical points of the staircase project, such as openings through the vaults, openings to the outside,

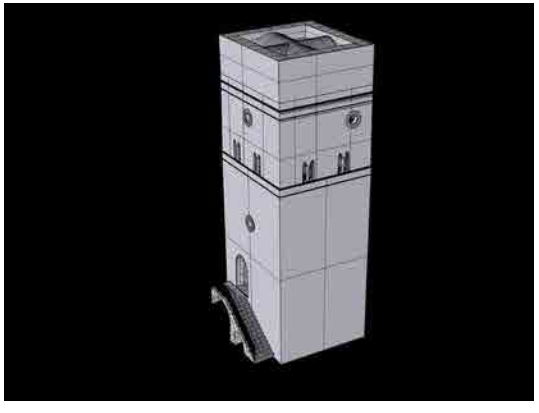

Fig. 3. Textured point clouds of the tower and part of Villa Rufolo
Fig. 4. NURBS Model

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niches, and the protruding points of the stones. In this way the real numerical model of the tower has been obtained within a single virtual space, divided by floors (the four internal and four external facades, horizontal and vaulted surfaces) and at multiple levels of resolution, and all the geometries of the building related to the drawing of the staircase in the same time of its conception and verification (Fig. 6).
The graphic representation system, here defined starting from three-dimensional acquisitions of the monument, made possible the testing of a creative design methodology, within a space of real representation and at the same time technical illustrative, where overlapping 'layers' of geometries in the virtual space, remembering the visions of the architectural object (Fig. 7). The digital space is considered, in this way, as a place of coexistence of real forms, fixed in the materiality of the elements, of development of the 'actuals contingent' [5] thanks to virtual action. In this way it was possible to experience a variable composition process of the space, inside of the tower, where may coexist a real object as digital copy, geometric elements derived from the analysis of the artefact related to the ideation gesture of staircase, the shapes of the new architecture related with the light in the space of the tower. In fact, thanks to this representational device, starting from the geometrical quality and space constraints, the first trajectories of the staircase have been developed, due to the presence of the orifices in the wall and to the curvatures of the vaults. These first geometries project was reported in the models and started developing in the virtual space of the other flights, following the idea of keeping the stair free from the walls, allowing continuous view towards different levels of the tower or outside. Small landings have been distributed along the possible trajectories of the steps, whose shapes resulted from the need to link the twists of the stair and to allow views into the space between the ramp and on the walls naked plans (Fig. 8).
The final effect of the stair was therefore designed as a metal tape unfolded from the top to down, as generated by the cutting in the vault and held by the space of the Tower. To accentuate the lightness of the ramp, there are no beams or structural elements: the same pillars, not specified in a first version of the project, were incorporated due to the recommendations of the Soprintendenza per i Beni Architettonici e Paesaggistici di Salerno e Avellino. Tested the coherence of the geometry in relation to the wall and to the different floors height, the modeling of the staircase shifted using the lines of design as generators of NURBS, whose spatial effect was progressively verified, in a dynamic way, for the variation of the point of view between the virtual elements in relation to the numeric-real surfaces of the Tower, produced by laser scanning. The project surfaces were used to continuous rendering, achieved within the high-resolution polygon model of the Tower (Fig. 9).
In this way, aligning the models to the actual orientation of the tower according to the cardinal axes, it was possible to control the role of natural light in the perception of the stair - along the imagined fruition paths - and of the shadows of the steel elements on masonry. Defined a map of natural light, active only for the mutual interaction of the monument with the new architectural object, it was developed the two artificial lighting systems corresponding to the headlights and multimedia devices of the exhibition. The lighting systems defined in the project phase were imagined in order to allow two kinds of visit, one aimed at the use of multimedia content related to real finds exhibited along the stair, the other only to ascent to the panoramic terrace. For this reason, the directional spotlights were provided, with beam optics in different widths, for both of the staircase and the exhibits illumination, led strip, to be placed directly along the edges of the steps for only one side near the wall, in order

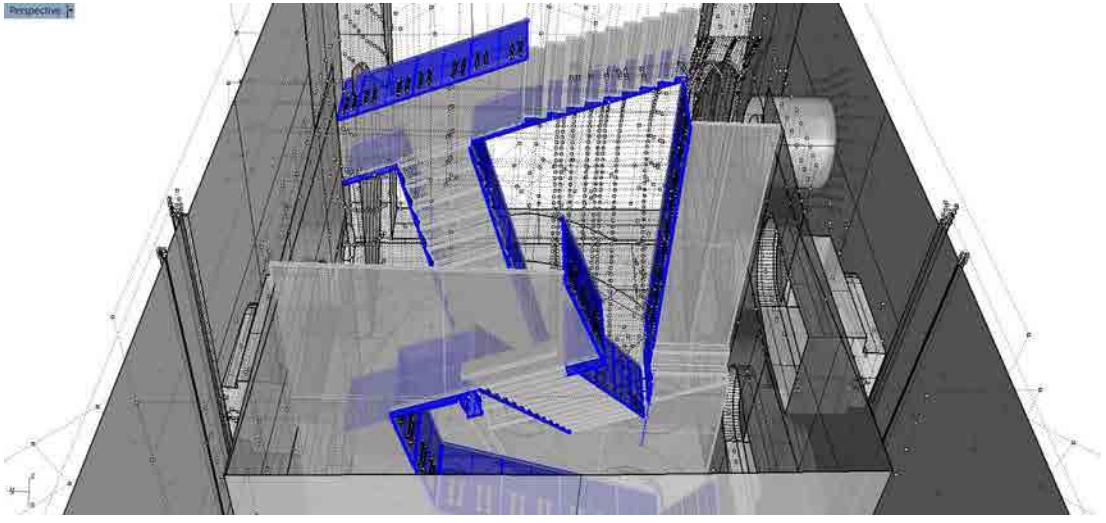

Fig. 5. NURBS during modeling

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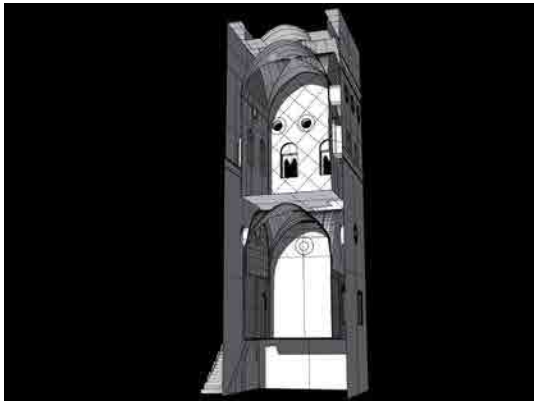

Fig. 6. NURBS of the interior of the Tower
Fig. 7. Model of the staircase integrated to NURBS of the Tower

to strengthen the stair geometries in low brightness. Other light sources installed in the Tower are projectors 6200 ANSI lumens for video mapping and different screen sizes, to whose content - managed by a single software in order to ensure synchronization of events and the programming of the content for the different types of views - were coordinated the performance of the lamps and LEDs. The sounds are strictly connected to the lights and to the mapped video projections. The system provides, in a single perceptual experience, the management of lights in sync with the voices, dins and music, through a plan for the 3d sound composed of moldable linear sources ANAKONDA - KAN200 and high efficiency dynamic exciters, installed along the glass balustrades. The 3D sound systems, the trajectory control and the movement of sounds, who may pass along the spaces between the vertical ramps, brush the landings dismount, bump into the crystals and become 'fine'. The system has been designed as integrated, in which to manage lights and sounds simultaneously, both in composition and representation phase. It allows the modulation of sound frequencies and volumes in each place of the Tower and it allows to manage the time sequences of the video contents within a single control device. The technological system, a fundamental tool for the virtual computing, allows through mapped video projections progressively the composition of bright areas, reverberating on adjacent walls, giving a new meaning to the volumetric spaces. The temporal progression of the lights takes into account simultaneously the different points of view that the surfaces of the staircase make possible on the walls, on the floor, on the objects and on the crystal balustrade. Digital content and staircase shape in the physical space allow, as well, a single perceptual experience of places, architecture, and exhibition (Fig. 10).

The exhibit design moves from the intention to overcome the artificial separation between real and virtual, freeing him from the only role of passive simulation of contexts. The 'reduction' of the concept of virtual suffered progressive standardization moments, aiming a real intelligibility model based on the exclusive use of control schemes of stabilized contexts. The digital revolution torn this deterministic system of recurrent values, where Leibniz, Nietzsche, Deleuze, defined the conceptual horizon. It is therefore necessary that the technologies become tools not only to understand the real, but also the experiential amplification, along the dynamics of co-existing languages and the arts, as a new mechanism to increase life and scenarios. The digital as a storytelling tool produced new experiences, realizing them in multiform virtual places. In the era in which the concepts of space and time broadened the

Fig. 8. View from a landing of the stair to the wall and the lower ramp

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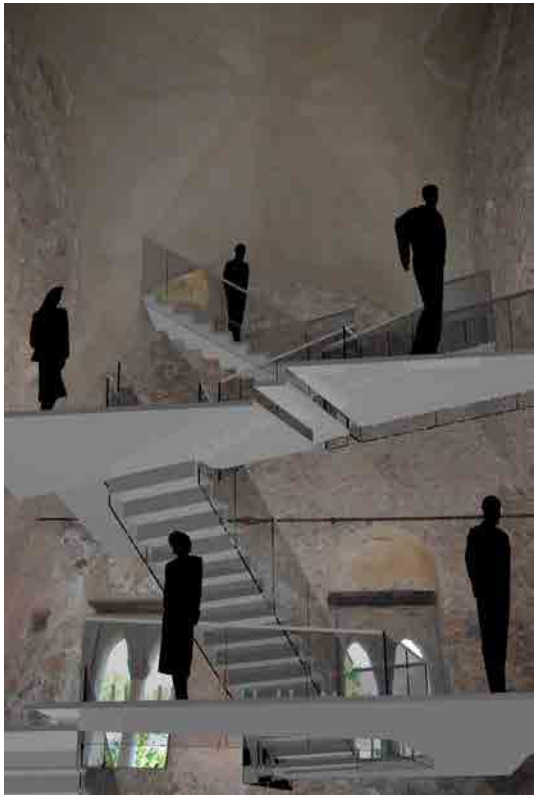

Fig. 9. Rendering

possibilities of movement making it variable between the infinite dimensions, it is necessary to use the digital as a direct instrument of compositional event, in a dynamic that aims to represent in the architecture the ideation mark as expressive language, shape and content, becoming aesthetic value. Digital content is defined within a generative approach: a diagram that is given from the places; a principle which is the co-existence of the real and the digital, stories and imaginations; a tool that is the scattered technological system, made through independent channels of sound and projection systems.

The multimedia exhibition has been developed to integrate virtual and reality of the Tower and of the finds, in a dynamic in which the technology become the project and the system of representation become instrument of storytelling. The point clouds of the interior walls of the building and digital copies of the objects were the basis for the creation of animation, three-dimensional videomapping and spatialized sounds, for fruition contexts products. Digital and real are designed as overlapping perceptual paths along a promenade inside the Tower, through the virtual dynamic visions. The continuous variation of the views on planes and objects at different distances (close, as the artifacts and interiors of the Tower; gradually distant, Villa Rufolo and the lines of the coast and mountain; augmented: from light forms of video projection and digital sound) experiments the new languages of representation in the digital age. In the sequence of these representative languages, the views are changing according to three levels of movement: physical, along-ramps of the stair, optical, through the views from the windows and from the terrace, imaginative, for the unfolding of digital contents on the real. The perception of augmented space appears for the coexistence of the three levels of movement, in which the virtual becomes a variable lens between the actuality of the stones and the lives told. The project achieved an *abstract machine* for the augmented reality in which digital contents can be updated and changed as texts that tell endless stories, as phrases between different languages [6]. The project aspired to build a museum as an experimental laboratory of digital contents production, augmented from the real, in this place where Wagner touched the phys-

Fig. 10. Videomapping inside the Torre made by the Consortium Arte'm

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ical perception of imagined forms, where music runs through the infinite recesses of the Klingsor's garden to the folds of the valleys between the suspended mountains of the Coast (Fig.11).

5. CONCLUSIONS

The intent of the project was therefore to get a single narrative tool, in which to connect forms in real space with the virtual one. Although represented in view of their different nature and matter, light, stone, iron, sounds and historical information of the site, here they are reassembled into a single sequence of variables moments, where ICT - together with modeling operations, calculation and geometric configuration - made them sequences of interactive virtual images, directly superimposed on the reality of the exhibition container, communicating the lives proliferation and meanings that the project feeds, with the intent to inform and educate the public about the expressive quality, aesthetic and innovative charge, and the transformations that mark the history of a specific cultural heritage.

Fig. 11. View of the staircase to the upper floor of the Tower

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NOTES

The paragraphs 1, 2 and 3 are attributed to Andrea Giordano and the paragraphs 4 and 5 to Leopoldo Repola.

[1] The term 'Show' involves in its meaning the action of watching and then the involving of an observer.

[2] The Torre Maggiore, or donjon, dating from the 1280s, istands near the Moorish cloister of the Villa, has a total height of 25.80 meters, while the volume subject to intervention, ie net of the premises in partially buried, measuring 20.45 meters.

[3]'Virtual' here is used in the meaning that Pierre Levy according to the Gilles Deleuze's thought.

[4] "The new status of the object does not relate it to a spatial model, ie a form-matter relationship, but to a temporal modulation that entails a continuous variation of matter as a continuous development of the form " (Repola, 2008, p. 25).

[5] "Actualization is creation, invention of a form from a dynamic configuration of forces and purposes" (Levy, 1997, p. 7).

[6] For this reason, the low value that is given to the existing digital contents exhibited, temporary manifestation of a storytelling endless in a simple digital product, but it will require for 'each' future representation of the physical experience and compromised.

Photos: Leopoldo Repola

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