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FROM DIGITAL DRAWING TO DISSEMINATION OF THE COLLECTED DATA, REFLECTIONS ON THE VIRTUAL CREATIVE PROCESS

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Abstract

The research presented here focuses on the understanding of the act of drawing not only as a means of restitution of the architectural survey but also considering the modernization of the representation techniques. This must be considered as a first step for the creation of virtual environments capable of offering advanced methodologies for the dissemination of the collected data. Expanding the techniques that can be referred to drawing will not only be a necessary process, and one that is already underway, but it will have to strengthen the intrinsic potential of representation. The aim is to communicate and record information with common codes facilitating reading and dissemination. Central to this is the use of drawing as a means of connection between different figures researching a topic. Drawing must be interpreted as the restitution and result of processes of elaboration and codification of the information collected with the survey, that leads us to the modeling and realization of exhaustive elaborations, containing the greatest amount of information useful for the dissemination of the existing architectural heritage and beyond. Its digital evolution, an opportunity to increase the potential and strength of the scientific dissemination of knowledge.

Key words: Digitalization; Photogrammetry; Dissemination; Augmented Reality; Virtual Reality

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1. INTRODUCTION

When talking about architecture, the way how the digital revolution has "conquered" the whole environment of architects and engineers is almost superfluous, it is extremely clear how it operated changing behaviors, integrating all the process, it is clear and the depth of the transformation comes not from a recent event, but from an expansion growth in time. The dates on which the various development and enhancements applied to many digital solutions talk by themselves: first real CAD: 1963 (i.e. Sutherland 1980), first Geographic Information System (GIS): 1963 (i.e. Fazal 2008), first virtual reality headset connected to a computer: 1968, definition of the "desktop" metaphor: 1970 (i.e. Baecker et al. 1995), first (non-smart) Mobile Phone: 1973, first home or small office Personal Computer: 1974, first software aimed at drawing architecture for BIM solutions: 1982. So it would make no impression how such a long diffusion and gradual growth have entered little by little all the aspects of representations. Our present maybe should be considered a first phase of the complete replacement of all the traditional and well consolidated past procedures of representation. Considering the whole scenario may be fascinating, but looking with a narrow view to the present it seems that using digital technology should configure the way to increase the information contained in each single product.

To evolve the practice of collecting more specific papers describing individual themes, conventional graphic works, in favor of a generic digital base on which to activate one or more levels of information. The focus has been on the complexity-accuracy ratio of this return operation. To achieve digital alternative realities sufficiently structured to ensure the flexibility of the themes in reading, an elaborate and complex programming of the construction system is necessary. This has been a subject of great attention in the development of research, since it is essential for us to give an example of complexity that can be easily used by all the figures who cooperate in scientific research.

To enhance results and workflows it seems that a procedural methodology should be defined, allowing it to be applied in various topics of study. Such a definition should be intended not to bind the will and creativity of researchers and scholars, but as a tool to speed up all the "digital construction" phases and better focus on contents and inner values connected to each specific case study. So, such a procedure should be intended as a connection between the research subjects from different themes enclosed in the reading of the drawing and the potential increase in the results of architectural and built heritage research. Hopefully, the results of multidisciplinary research should be usable through technologies that are easy to find for anyone interested in the study of these objects, and a procedure, aimed to contents more than on tools, should better fit architects and cultural heritage scholars, keeping the center on the subjects instead than on the tools and then making more easy to adapt solutions to new software/hardware.

1.1 EVOLUTION IN THE LANGUAGE OF DRAWING

In the past the illustrators, or the designers, had (as they still have) a strong recognizability within the process of studying an architectural object. This figure, who knows the technique to the full and masters it at the level to be customized without losing its effectiveness, is approached by the identity of the generic scholar. Whatever the specialization of the scholar of architectural objects, through the mediation of drawing, observes and rationalizes the parts, carping the essence of the subject in the studio. He knows the state of the state and, regardless of his sensitivity and personal experience, finds the dynamics that constituted the state under observation. This reasoning on the technique of drawing must now be extended to digital. Not only to evolve the development of thought and imagination to virtual dynamics but to use digital rationalization in order to increase the cognitive speed of architectural systems.

1.2 DIGITIZATION OF THE SURVEY

The important process is born and grows in parallel with a historical and cognitive research of the artifact or architectural object to be analyzed. It is essential to have a clear image of the environment that we will investigate to better understand the methodologies that will be applied during this first phase. It is always desirable to be able to face a field investigation path knowing the aspects surrounding our theme, history, construction, evolution.

The instruments of the survey at our disposal are multiple and functional, but they are not always all necessary; it is often the case that we must

choose what is best considered appropriate according to the current situation, the result, the media or the dissemination support and the ultimate user.

When it comes to digitizing the survey, we cannot just think about the survey through manual measurements reported on paper and then digitized.

A prominent tool such as the laser scanner, for example, already develops digital data: the point cloud. The point cloud created by the scanner gives a three-dimensional view of the detected object, and can return to a two-dimensional "reading" when applying point re-riveting through the planes of interest.

As for a tool such as the camera, since it develops the digital data of the two-dimensional image, the discourse is inverse to the scanner when it comes to the treatment of the data collected for a survey, if the data is processed with the method of photogrammetry (i.e. Guidi 2010). In this case, through the SFM (Structure from Motion) software, the two-dimensional digital image processed will develop the three-dimensional data of the point cloud, which calculated in a mesh and textured will lead to the realization of a 3D model, which in turn can return a two-dimensional data in the graphical elaborate suitable for reading and describing the detected object.

The data produced by the laser scanner and the photogrammetry (through the camera tool) can be used and treated independently, in fact, in a survey it may happen that they do not have the opportunity to use both; if, on the other hand, the data of these instruments are treated in synergy, an excellent quality of survey can be achieved through the accuracy of the scanner data and the reliability of the colorimetric data defined by the photograph.

In both cases, then, the three-dimensionality of the data, whether it is point cloud or textured 3D model, will be usable in the next step of modeling to look at virtual models that are easy to disseminate and use.

It is important to stress how the photogrammetric product of photographic survey is a fundamental tool for the study of the architectural heritage, from which we can obtain information about the shape, position and conservation status of an object and that photogrammetry is an economical, non-invasive technique that provides rapid and very effective results.

Through the example of our case study, the medusa heads of the Basilica Cistern in Istanbul, we can appreciate the characteristics of the photogrammetric survey applied to a sculptural object, therefore comparable to experiences focused on small objects. Or another case presented, the Domus Horrea Agrippianna in the Roman Forums (i.e. Rickman 1971), an experience in which an architectural object of high cultural value is recorded and processed.

1.3 MEDUSA HEADS, THE CASE OF THE BASILICA CISTERN

The Basilica Cistern, in Turkish Yerebatan Sarnici, is one of the biggest ancient buildings below the ground of Istanbul. The cistern has the size of a cathedral and the ceiling is supported by 336 marble columns, 9 meters high, arranged in 12 rows of 28 columns.

These architectural elements are clearly fragments coming from a previous building, although their origins are unknown. One of them is positioned upside down and the other sideways, losing in that way the mythological capability to petrify an enemy, gaining the pragmatic meaning of supporting the columns.

The instrumentation available for the survey was a NIKON D800E full frame 36.3 Mp Reflex and a tripod. The images were always taken in self-portrait mode to avoid micro-blurred effects. As for image capture, 24 photos were taken with focal length 12 and focal ratio 4.5 for the first head and 109 photos, with focal length 22 and focal ratio 5.6 for the second.

The data acquired during the photogrammetric survey campaign was subsequently processed through automatic photogrammetry software Structure from Motion (SFM) such as Agisoft PhotoScan, thanks to which it was possible to obtain textured mesh models of the detected elements (i.e. Ricci et al. 2019).

The calculation data for the two Medusa Heads of the Basilica Cistern are listed below.

Medusa Head sideway: Point Cloud 54,139 points; Dense Cloud 3,188,699 points; Mesh 4,874,550 faces and 2,505,574 vertices; Texture 4,874,550 faces and 2,505,574 vertices.

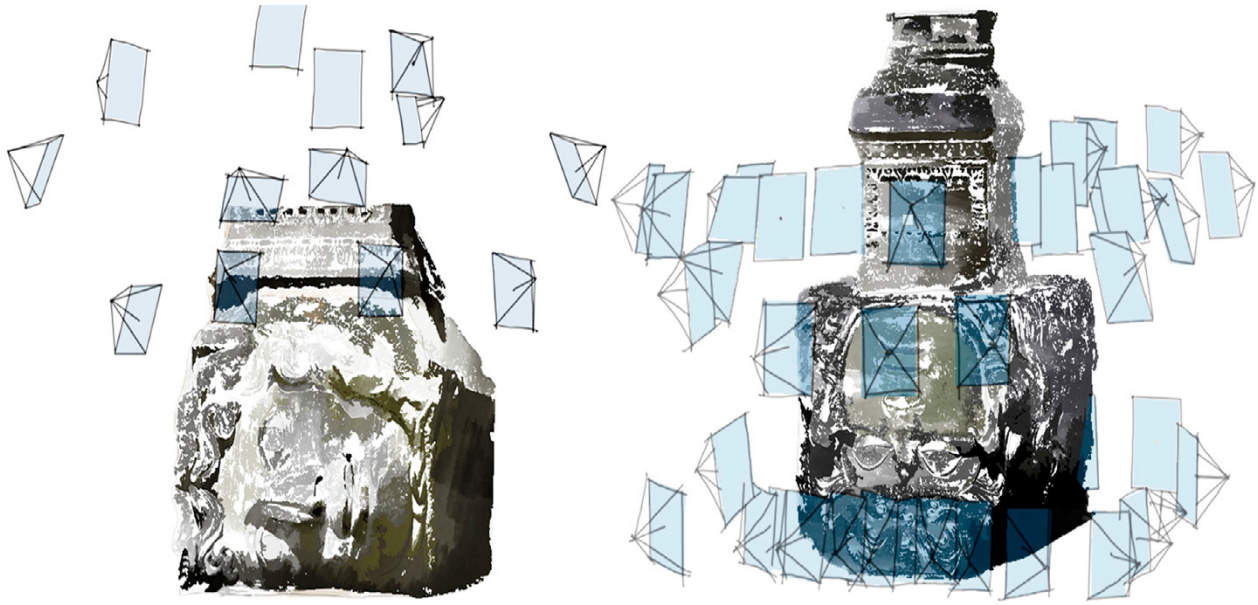

Fig. 1. Medusa's heads, photogrammetry survey, scheme of the shots.

Fig. 2. Medusa's heads, steps of the digital photogrammetry processing.

Medusa heads upside down: Point Cloud 187,503 points; Dense Cloud 20,684,143 points; Mesh 5,320,940 faces and 2,660,472 vertices; Texture 5,320,940 faces, 2,660,472 and 2,660,472 vertices.

2. DIGITAL MODELING AS THE BASIS IN SURVEY COMMUNICATION

A premise is a must. From the accumulated experience, although young, there are no capable virtual modeling operators who do not know the traditional techniques of drawing. The ability to simplify and speed up graphic reasoning, in the immediacy of the gesture on paper, facilitates and simplifies the management of objects in a digital environment. However, the growth of the digital environment management capacity results in a contraction of physical reasoning, reducing the preparatory design because it is discounted in certain dynamics associated with experience.

Managing the three-dimensional model is a largely complex topic. Studying and observing the result of a modeling process it is never possible to know its construction dynamics but only to find the "cleanliness" of the parts and any hierarchies of organization. The interest of this chapter is to emphasize how attention in the construction of a three-dimensional model directly influences the usability of the same. A "clean" and well-organized model will be usable for different purposes. The ease of reading the components and the absence of errors (e.g. redundancy of polygonal surfaces) allows the easy reading of the three-dimensional object by any operator. So a simplification of the cognitive phase and a streamlining in management. With the growth of computer technology, this is especially important because in the process of modeling and virtualizing an object the affected figures are increasing. Creating a phased working scenario, involving operators specialized on the different, banally an assembly line.

In addition, understanding and knowledge of the software tools involved in the treatment of data will allow the optimization of processes. Especially when they will be aimed only at specific outputs. By this we mean that the wide possibility of digital data processing must be anticipated by the choice of the type and method of survey. A choice guided mainly by the result that you want to obtain. This will lead to the creation of a scarcely elastic but strongly optimized product. And from this, the researcher will evolve his know-how, through the knowledge of the different workflows of calculation, up to the best control of the digital model. Making the 3D model and its environment increasingly flexible to different study scenarios.

In addition, as we will read in the next chapter, dissemination through virtual environments requires special attention in the organization of the digital model. The careful structuring of the modeling phase allows maximum flexibility in the use of the model, or at most minimal or facilitated adjustment interventions.

In this chapter we must also open up an argument. Awareness in the inclusion of BIM (Building Information Modeling) techniques, in the heritage BIM specification. A not insignificant component today as a communication of analysis and survey. That to the management of the BIM environment integrates the dedicated modeling of the special and specific components that identify and compose a Cultural Heritage. The management in the form of a database integrates the compilative phase increasing its importance in the architectural survey. Both for the organization of the virtual environment or reading and information levels with in-depth phases on a variable scale and with themes of different specificities.

2.1 DIGITAL MODELING FOR VIRTUAL ENVIRONMENTS

Technological development and innovative methodologies adopted in the field of digital drawing together with the high quality of the papers deriving from the survey must be used to develop tools for the use of information and all the data collected during the documentation and research phase.

The intent of this paper is to show how much the communication ways, that of drawing, that of Virtual Reality -VR- and Augmented Reality -AR- are connected and how important an interpenetration between the two is to improve and offer more comprehensive data processing.

To offer the most precise return of the digital survey within a virtual environment, the first phase, the most delicate and complex, is precisely the methodology of modeling and optimizing the data obtained, which is based on the accuracy of the drawing.

The cases proposed in this contribution address both the theme of the return of the survey through the creation of virtual environments, and the dissemination of notions and data concerning an architectural project using Augmented Reality.

In the first case, the virtual return of the two Medusa Heads located inside the Cistern Basilica in Istanbul, was developed starting from a Photographic survey for photogrammetric calculation, combined with the manual modeling process of architectural environment, based on traditional documentary sources. All aimed at obtaining a mixed scenario. Scenario in which the high concentration of detail (digital weight) is concentrated on the portions of the Heads of Medusa and the container environment is described with minimal mesh surfaces (with deliberately simple density) useful to describe the characteristics, creating the emotion of the place, without weighing down the virtual system. That allowed us to study the forms and state of conservation.

Fig. 3. Medusa's Heads, view from the Virtual Reality Design/Management software

Fig. 4. Medusa's Heads, image from the Virtual Reality environment.

The other case, about the Domus Horrea Agrippiana in the Roman Forums, is equally important because it focuses attention on the dynamics of photogrammetric processing. Creating a set of final 3D models, organized on various levels of detail, which allow for interconnected management on virtual reality platforms. Facilitating the management and operation of virtual platforms and enabling easy visibility into the 3D environment, resulting in rapid product deployment. After that, by structuring a series of steps ranging from mesh modeling to virtual environment modeling, it was made possible to disseminate all the data collected at the survey stage, expanding the result with historical and architectural data collected during the research phase. This was possible thanks to the use of Virtual Reality that allowed an interpenetration

of search themes all enclosed in a single virtual process, usable and explorable by a large number of users.

The design played the unifying role between the survey phase and the creation of the virtual space, thus allowing it to obtain a complete and indexable data, creating a modus operandi that can be re-proposed on other case studies.

Starting from the data obtained through the survey, and passing through a careful optimization of the meshes, it is possible to use the element also using Augmented Reality, offering the user an interaction not only concerning accessibility to the various notions regarding the object in question, but giving him the opportunity to relocate it in any environment he chooses.

3. VIRTUAL REALITY AND AUGMENTED REALITY, WAYS OF CODING THE COMMUNICATION OF DRAWING

The technologies for the visualization of digital works are to be considered excellent tools for the use and enhancement of cultural heritage and the different case studies taken into account in the field of scientific research. (i.e. Cioli & Ricci 2020).

The aim of VR is to simulate a real environment through new technological means, to give the user experiencing it the impression of actually being immersed in that environment. To achieve however, a virtual environment is not easy and requires time, research and investment. An important role in the growth of this sector have been video games, which have created a huge market by acting as a driving force for technological development. The software used during this interesting process of virtualization of the architectural element is Unreal Engine. developed by Epic Games.

Regarding Augmented reality, it turns out to be one of the most immediate dissemination techniques thanks to the type of device it needs for its use. The easy availability by a wide range of users of means dedicated to the fruition of Applications built for Augmented Reality content is growing exponentially allowing for greater participation and interest in the dissemination of the architectural heritage and beyond.

3.1 THE CASE OF THE THEATER OF THE WORLD, BY ALDO ROSSI

This iconic temporary architecture was realized between the end of the ‘70 and the early ‘80, it has a strong link with Venice and with the maritime theme. The Theatre of the World (*Teatro del Mondo*) was built in Venice in 1979 by the architect Aldo Rossi. It was assembled on the occasion of the Venice Biennale of Architecture;

Fig. 5. Teatro del Mondo, image from the Virtual Reality environment.

Fig. 6. Teatro del Mondo, interior detail.

it can be considered as the most representative symbol of the Biennale and of the work of Rossi himself.

This case represents the workflow that can demonstrate how the traditional drawing technique, supported by digital drawing and modelling, can lead us toward a final output which contains the dialogue between the tradition and innovation.

The experience was structured through various steps, starting from the documentation. Since the structure was dismantled, it was necessary to collect information on its formal and structural characteristics, consulting the architect's drawings and the various photographic sources. From this knowledge, it was possible to carry out digital modelling of the object, performed with Maxon Cinema 4D.

The next step was the creation of the Virtual environment in Unreal Engine 4.

The experience led to the digital rebirth of this disappeared Architecture. An operation that will make it accessible even to people who have never had the opportunity to see it or to retrace memories passed to those who were present at that time. The experience obtained is a complete perception of the physicality of architecture.

It was also developed a Beta Application for iOS devices, using Reality Composer, for the visualization of the model through AR means, giving the opportunity to interact with it directly on the screen. It is a less deep kind of immersion than the one offered by content

displayed in VR, but still delivers an innovative experience for the users.

3.2 FARNSWORTH HOUSE, MIES VAN DER ROHE AND THE CAPABILITIES OF AR CONTENTS

Discussing the use of augmented reality as a way of coding the communication of drawing, we propose as a case study one of the iconic architectures of the architect Mies Van Der Rohe, symbol of the modern movement, the Farnsworth house.

Built between 1945 and 1951, characterized by a glass and steel structure and the presence of the service block in the center of the space, it is surrounded by windows, which allow it to create a direct link with the context in which it is located.

A case of exceptional conflict between the autonomy of architectural language and the housing model proposed, is one of the paradigmatic residences of 20th century architecture. Transparency and formal rigour

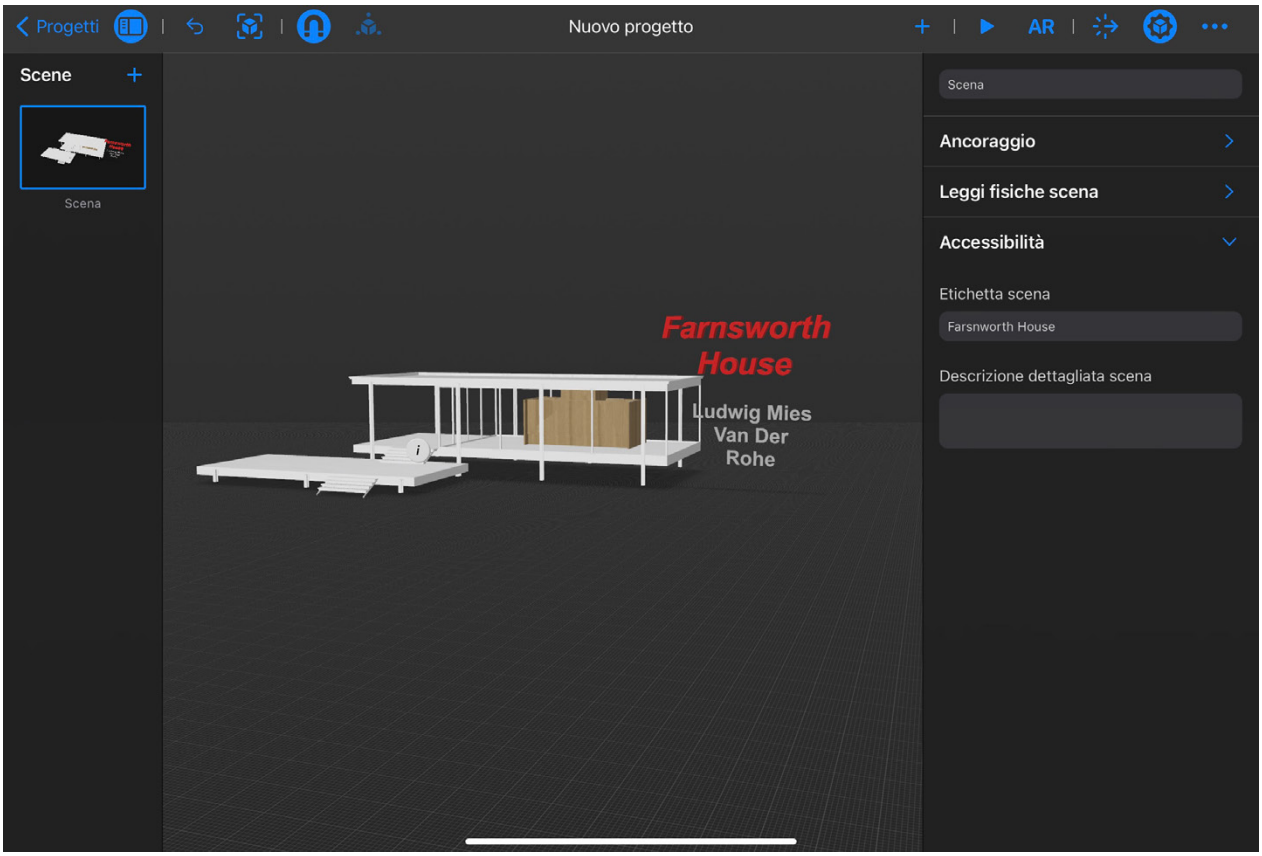

Fig. 7. Farnsworth House, model preparation.

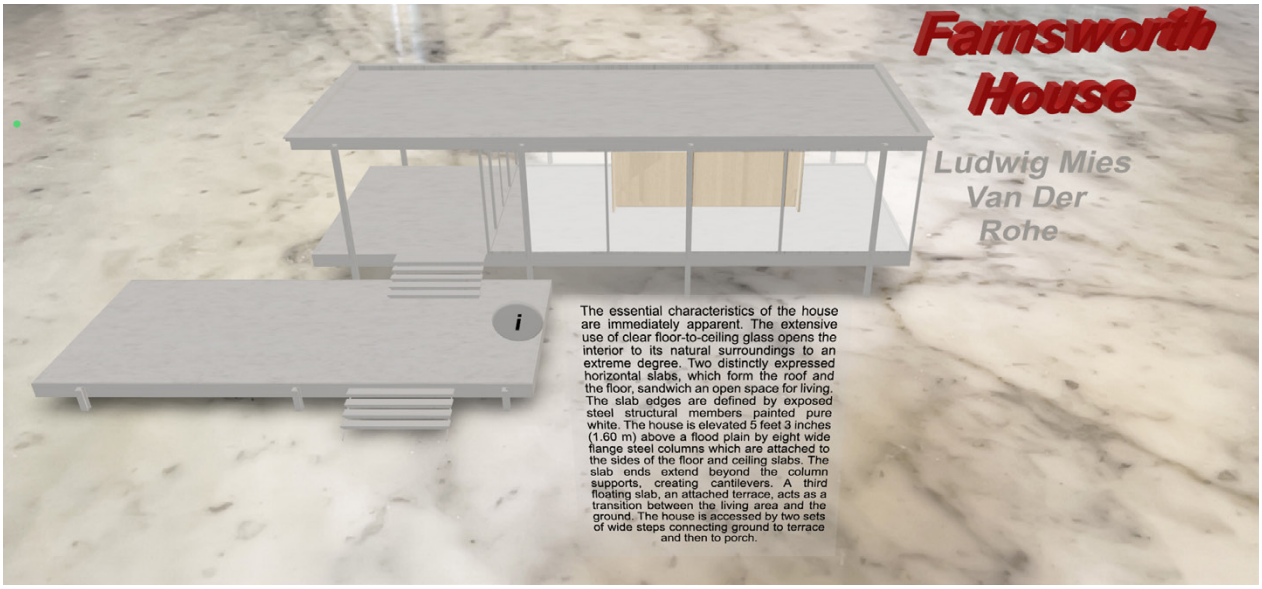

Fig. 8. Farnsworth House, Augmented Reality.

meet in a forest near Plano, Illinois, the backdrop against which the slender white structure of the house emerges.

Starting from the digital drawing of the building, an optimized 3D model was created using Maxon Cinema 4D, for the following import into the ARKit software (for IOS devices). A further application was carried out in parallel, but in this case unity was used, to test and study the different results that can be obtained from this kind of process.

The last step was carried out with the aim of developing an App, in beta version, which contains all the information regarding the project and that can be used in Augmented Reality and allowing the user to encode the model, thus exploiting the potential of this technology (i.e. Pescarmona 2020).

During the use of the content, the researcher has the possibility to interrogate the model, interacting with it in a simple way, through the screen of the phone or handheld device, thus accessing a series of contents and information that can give him a broader and more complete picture of the architecture under examination. This creates an interactive and engaging moment of cultural growth, different from what has been seen so far in the field of traditional learning.

5. CONCLUSIONS

This paper aims to share and disseminate the experiences in the digital field and to show a procedural process that leads to the realization of a complete product, integrating the main data, the optimization of digital works, the accuracy of the virtual environment, and finally the use of the VR and AR solutions in Cultural Heritage (i.e. Addison 2000). This is a tendency to be considered positive and probably one of the most productive variations in the scenario of representation. Most of all, the many variables of processing between survey and final representation leaves a significant space and many choices in the language of architecture and architects. The traditional relationship between concepts, ideas and drawings is altered and reformulated into a new paradigm, different from the past and all aimed to be extremely communicative.

The point of view considered fundamental in the approach to digital technique and drawing was illustrated in its main structure, underlining the results. Aware of the ferment and evolution of contemporary technology, an argument is proposed about the potential of the method. Trying to observe it from a theoretical point of view. At the same time, these cases are an example of products which aim to apply the reasoning presented. Trying to get to stable and complete final configurations.

The current state of the art of some methods of digitization and digital communication of Cultural Heritage is the first significant part of this processing. It shows the whole panorama of possible choices. It emphasizes the processes, and the results, that even when representing just a part of a much larger whole are the emerging aspects for most of the final users, and then they have a fundamental importance. (i.e. Verdiani 2010).

Keeping an eye on traditional techniques allows to develop a common theoretical-practical basis and branches out into a plurality of customizations and methodologies. A plurality, however, strongly reduced if compared to current digital methods. The processes, the software and, above all, the possibilities of using the tools of the same digital platforms form a vast scenario of possible workflows. In some cases used improperly, in others not optimally, but all aimed at achieving an interpretative product describing the case under study. The deepening of digital drawing for the dissemination of knowledge will allow involvement in the search for new exploratory paths. Insights of multiple interest, with appreciable results in the reconstruction and study of landscapes, cities, monuments and artworks.

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