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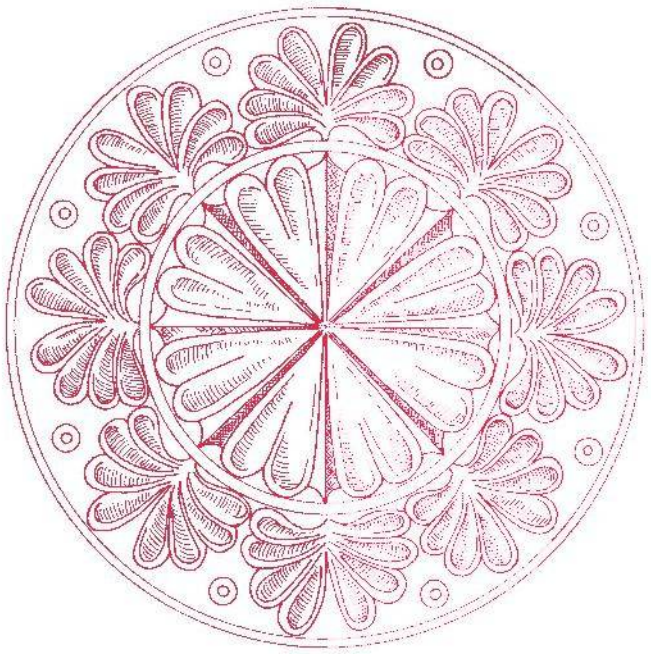

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EDITURA „ARHITECTURĂ. RESTAURARE. ARHEOLOGIE.“, BUCUREŞTI

Caiete ARA

Arhitectură. Restaurare. Arheologie.

Cahiers ARA
ARA Hefte
ARA Reports

11, 2020

Editura ARA - „Arhitectură. Restaurare. Arheologie", București

CAIETE ARA CAHIERS ARA ARA HEFTE ARA REPORTS

REVISTĂ ANUALĂ DE ARHITECTURĂ, RESTAURARE ŞI ARHEOLOGIE, PUBLICATĂ DE ASOCIAŢIA ARA

Editura ARA - „Arhitectură. Restaurare. Arheologie”
ARA - "Architecture. Restoration. Archaeology" Publishing
editura@simpara.ro
www.simpara.ro

Editor / Editor:
Monica MĂRGINEANU CÂRSTOIU

Grafică şi tehnoredactare / Graphic design and DTP:
Cabinet Mihai Păunescu, mpaunescu@yahoo.com

Tipărit / Printed by:
Pro Editură şi Tipografie, Bucureşti

Coperta / Cover:
Sarmizegetusa Regia. Decorated disc.
(Virgil Apostol, Răzvan Mateescu, p. 91, fig. 41).

ISSN 2068-0686

Manuscrisele propuse pentru publicare vor fi adresate redacţiei editurii ARA, pe adresa / Manuscripts proposed for publishing shall be addressed to the ARA publishing, at: editura@simpara.ro

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USE OF LASER-SCANNING ANALYSIS IN PROCEDURES OF HERMENEUTIC RESTORATION

Stefano D'Avino

Key words: Virtual realities, virtual restoration

Abstract. State-of-the-art reality-simulating techniques prompt us to think again of the relationship between reality and its representations: therefore, 'virtual realities' as real worlds. Simulation is opposed to representation, to the re-presentation of something 'that has been', because it does not reproduce any accomplished past but goes back to potential events, to possibilities, to something 'that may be'.

Computer science is the cultural sphere in which such tangible/intangible, real/unreal binomials can best be perceived; a critical/cognitive exercise that is accomplished in three separate but complementary domains: the *aesthetic one*; the *philological* one; the *conservation one*.

Computers and virtual models can be used to place oneself inside as well as outside one and the same field, all at the same time, in a relentless dynamic evolution of the view.

The 'virtual restoration' of an image seems to be an ideal tool for combining different ordinary cognitive means: it can actually be used to optimise the understanding of textual information without acting on the 'matter of the work', so that its impact is reversible at all times and in any case.

Rezumat. Nivelul actual de dezvoltare al tehnicilor de simulare a realității ne îndeamnă să reconsiderăm relația dintre realitate și reprezentările ei în direcția în care „realitățile virtuale" sunt asemenea lumilor reale. Simularea este diferită de reprezentare, de re-prezentarea a ceva „care a fost", pentru că nu reproduce o stare din trecut, dar propune situații potențiale, posibilități, ceva „care poate fi".

Științele informatice oferă această sferă culturală în care noțiuni binomiale precum tangibil/intangibil, real/imaginar pot fi cel mai bine percepute; un exercițiu critic/cognitiv care este îndeplinit în trei domenii separate, dar complementare: domeniul *estetic, filologic* și al conservării. Calculatoarele și modelele virtuale pot fi folosite pentru a poziționa privitorul înăuntru unui câmp, precum și în exteriorul său, în același timp, într-o evoluție dinamică fără oprire a perspectivei.

„Restaurarea virtuală" a unei imagini pare să fie instrumentul ideal prin combinarea diferitelor mijloace comune de cunoaștere: poate fi utilizată pentru a îmbunătăți înțelegerea informațiilor scrise, fără să intervenim pe obiectul studiului, astfel încât reversibilitatea este de la sine înțeleasă.

A reflection prevails when addressing the problem of the relationship between 'virtual modelling' and restoration (in other words, the impact of the simulation of the real result of a critical collection of quantitative and qualitative data from an architectural construction): does reconstructing a virtual space mean implementing a restoration project, or does such operation fall within the sphere of representation? In other words: can one legitimately wonder to what extent intangible reality may be used to accomplish a remarkable evolution in the critical approach to preservation?

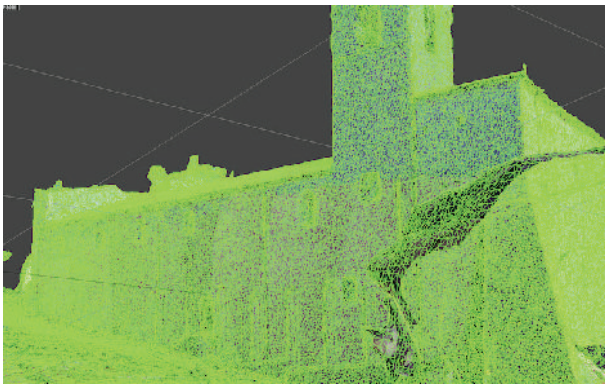

Fig. 1. Monteleone di Spoleto, S. Francesco. 'Cloud of points'.

State-of-the-art reality-simulating techniques prompt us to think again about the relationship between reality and its representations: therefore, virtual realities as real worlds. Simulation is opposed to representation, to the re-presentation of something that has been, because it does not reproduce any accomplished past but goes back to potential events, to possibilities, to something that may be.

The distinction is rather between virtual and potential, 'the potential - Aristotle maintains - is what is not there yet'; virtuality is what allows us to anticipate (in actual fact, to perceive) the reality that is the vision of what this must be, so it belongs rather to the order of the project. They are two very different concepts, potential and virtuality: the virtuality is not something that is not real, but it allows you to pass through time, and it contains the profound purpose; "the virtual is a project, a real project".[1]

So, if the image taken from the list of the traditional is, somewhat, due to the revival of a distant presence in time (presence-absence according to R. Barthes) the virtual image abolished the distance between figure and model, taking on the meaning of re-issuing of an absence; virtuality becomes synonymous with the not-yet, the foundation of an 'aesthetic of the immaterial'.

With better reason the question affects the allocation of the valence of originality of the work. "Even if a reproduction is highly refined", says Walter Benjamin, "a missing element: the *hic et nunc* of the artwork; its existence is unique and unrepeatable in the place where

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[1] Quéau, 1995, p. 26.

Caiete ARA 11, 2020, pp. 209-216.

Fig. 2. Monteleone di Spoleto, S. Francesco, cloister. Reconstruction from laser scan survey.

it is";[2] historical evidence of the artwork is based on the duration of the material. What is missing in the age of mechanical reproduction is the aura of the artwork. The copy subtracts the work within the tradition.

Authentic means that which has authority as capable of acting autonomously, without depending on anything and then have a profound identity. The authenticity can appeal to a size that can be original, generating a significant identity, both from the formal point of view as from the aspect of the substantial. Jasper argued in 1925: "authenticity is what lasts in contrast to what is momentary"':[3] consequently the term authenticity becomes even here the value of substance, in the sense of that which remains.

The reflection seems therefore directed towards the need to identify the sphere of virtuality; this can be defined, according to Gilles Deleuze, as "an extension of all that is reality. The virtual space is added to the real space; a space where the classical notions of geometry or weight do not necessarily apply; although with the new technologies there can be introduced in that size - the notions of time, motion, flow and perform simulations ... this means a huge transformation in our relationship with space".[4]

The virtual restoration becomes, therefore, the graphical representation of an ideal image reconstruction as well as ensued from the interpretation of data; nevertheless it appears quite evident as the graphic representation of an architectural object that is intended to provide an image of simulated reality, although it may be conducted in as much detail as possible, will always, inevitably, be the result of a synthesis.

Modern techniques of virtual reality totally revolutionise the relationship between the observer and the object; therefore they are making available and enjoyable the space-time parameters that were the exclusive privilege of direct experience in real space. "In the scholastic philosophy, the term 'virtual' identifies that which exists potentially and not in actuality. The virtual techniques - tend to actualize themselves, without being passed to a formal or actual realization. Therefore they are not opposed to reality but they are it today: virtuality and actuality are just two different ways of being".[5]

[2] Benjamin 1991, p. 31.
[3] Bianconi, Filippucci 2019.
[4] Eloueini 2002, pp. 21-22.
[5] Lévy 1995, p. 30.

Fig. 3. Norcia, cathedral of S. Maria Argentea. Post-earthquake laser scan survey (2017).

So that virtual reality is not an oxymoron: as the reality is opposed to the potential, as the current is opposed to the virtual; the mechanism of 'virtualization' is in fact mainly employed as a process of transformation of reality. It follows that we should not speak of virtual images, but rather of possible images displayed.

Simulation and Virtuality are therefore two adjoining options: simulation occurs when virtuality replicates a real geometry through a synthetic representation; "on the contrary, 'pure virtuality' occurs when one chooses a hetero-representation, a more complex metaphor adopted to describe the meaning of reality. While simulation simplifies the contents of reality by schematising them (sometimes in a narrow sense), virtuality tends to extend and multiply them".[6]

There is no doubt that computer science, especially its digital-survey applications designed for an insight into historical architecture, is the cultural sphere in which such tangible/intangible, real/unreal binomials can best be perceived; a critical/cognitive exercise that is accomplished in three separate but complementary domains: the aesthetic one, because the document, when represented by an electronic image, is fully rendered in the aesthetic values that it carries; the philological one, because the work of art is also rendered in terms of its meanings and original values; the conservative one, since its iconic representation can be used, at the study stage, to go back through all the stages in previous works, starting from the last state of preservation of such item.

The latest virtual technologies offer the option to use the camouflaging skills and creative power of virtual reality in every field of human action; the digital processing of an image, in the sense of a research method and not just as a mere computer application, can be used to substantially improve knowledge: a multiple screening of shots on all wavelengths, the subsequent comparison between the collected images and the use of the digital technique to separate the texts, can be used, for instance, to reread overlapping texts. A thorough, critically conducted survey can also help find historical processes that are not widely known.

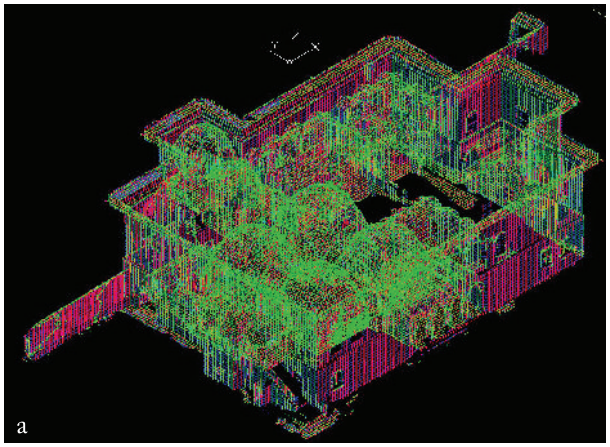
Just like perspective representation can be used to create architectures that can overturn the rules while still staying within a space, computers and virtual models can be used to place oneself inside as well as outside one and the same field, all at the same time, in a relentless dynamic evolution of the view. Automatic design thus becomes a straightforward tool to design virtual environments or to reconstruct, with the aid of a computer, environments that do exist or of which just some traces remain.

Namely, in the area of restoration, computers are not in conflict with working on the matter of a document but are instead effective tools to survey and study the properties and behaviours of materials, to perform analyses and monitor the design process, in parallel with (or, better, in support of) restoration itself. "From a perspective that is sensitive to maintenance and preservation issues (...), an appreciation of survey - as a tool for a 'pre-diagnosis' of the health of a monument and as a special form of non-destructive investigation is gaining ground".[7]

[6] D'Avino 2012, p. 44.

[7] Carbonara 1997, p. 474.

Fig. 4. Norcia, S. Benedetto. Laser scan survey after the earthquake of 30 October 2016.



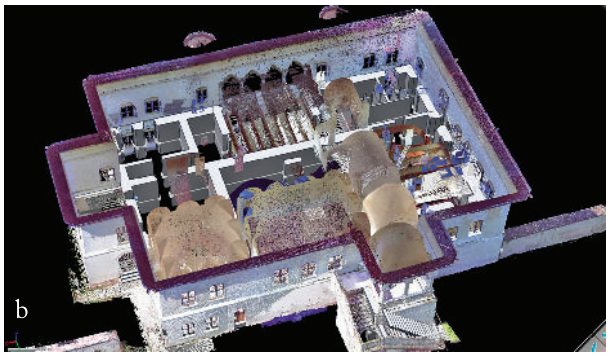


Fig. 5. Potlogi, Brâncoveanu Palace. Laser scan survey (Dept. of Architecture University of Pescara, 2015).

The virtual restoration of an image seems to be, therefore, an ideal tool for combining different ordinary cognitive means: it can actually be used to optimise the understanding of textual information without acting on the matter of the work, so that its impact is reversible at all times and in any case.

The main, albeit not the only, target of virtual restoration is to reproduce the appearance the work would have, once cleaned or restored: The virtual restoration of an image, not of a physical document, can collect information that, although missing in the original, cannot be directly inferred from its current condition. "The added value of using virtual reality methods on the cultural heritage lies in the chance of providing experiences and therefore implementing cognitive processes, even in the absence of physical (real) objects".[8]

The use of digital processing systems in the domain of restoration moves therefore along two main lines of research: placing emphasis on the informative content of an image by transforming its content in order to achieve a gnoseological value; giving documentary value through its synthetic or simulated representation in the most realistic sense ever. Digital information, whether it consists of images or written texts, does not therefore aim at making up for the deterioration of the original artistic material, but at being able to preserve at least its form, i.e. the diachronically-created image, untouched by time.

Simulations that are included in the graphics in support of a project are designed for providing more accurate control over a restoration project. These are operations that involve the processing and analysis of digital images from photo shots that, as well as being usable to more accurately weigh up some design assumptions, have made it possible "to perform a number of assessments on the materials and procedures to be selected for a project".[9]

The distinctive features that are innate in the use of computers, in the virtual restoration of a lost image, can be appreciated by looking at their peculiarities: if one works on a digital piece of information, one can work with the greatest freedom; as a matter of fact, it can be altered and copied countless times without any impact, as we said in the beginning, on the material of the item; this has major consequences on the principles of restoration: reversibility, compatibility and minimal impact.

Such work can be compared to a veritable virtual restoration project that can be helpful in recording or transferring technical requirements, while reducing the risk of an incorrect or restrictive understanding of such requirements; the results thus obtained can actually be used for a sort of preview of a restoration project; so

[8] Forte, Guidazzoli 1992, p. 51.
[9] Cardaci, Gallina, Versaci 2013, pp. 221-222.

much so that one could even predict potential solutions for filling a gap. Basically, the typical virtual-restoration method can be used to simulate a project, while preliminarily (as well as 'safely') reviewing its results; through such process, one can also carry out projects that are not possible in the ordinary conservative practice: a controlled alteration and characterisation of chromatic values in order to recover hidden, abraded or effaced signs, filling gaps on un-drawn parts, reading information that is no longer perfectly visible.

Laser scanning is utilised in a number of different analytical methodologies. The most widely employed application, which results in the construction of a model for virtual restoration, is three-dimensional laser scanning, a system that makes possible the rapid acquisition of data, as well as permitting access to such data in real time.

A laser scan automatically plots all three dimensions of an object generating a cloud of points that can be viewed directly on a computer screen as a 'three-dimensional photograph' whose millions of points provide a detailed description of the surface of the object being observed, making it possible to obtain information on dimensions and colouring, as well as detailed analyses of structural instability, plus an updated overview of the surface deterioration. By utilising photographic texture-mapping, which involves the reproduction of photographs on the surface of a 3D model constructed from laser scans, extremely valuable information can also be obtained on the state of preservation of a structure, as well as its colours, traces of moisture, small-scale damage etc.

Comparative analyses of laser scans can be repeated over time, in order to detect any modifications in the geometry of structures caused by seismic events, including changes not normally picked up by analyses conducted with traditional methods.

The use of laser scanning to analyse examples of historic architecture affected by seismic events makes it possible, for example, to create a virtual representation, in the form of a 3D model, that can serve as an archive of the structure, so that its every feature is kept 'on file', preserving its memory in a stable fashion that also allows for on-going measurement of instances of structural deterioration while providing accurate data, in terms of dimensions, on cracking, subsidence of the terrain and walls that are becoming detached.

Of key importance, when it comes to constructing a three-dimensional model using laser-scan measurements, is the chance to complete it by means of photogrammetric modelling, through which information on measurements can be obtained directly from the computer.

Computer simulations of a project make it possible to more precisely control the restoration effort. Thanks to such operations, the digital images produced by photographic surveys can be processed and analysed, allowing for heightened accuracy when it comes to selecting design options, as well as with the assessment of the materials and procedures to be used in projects.

A *virtual restoration* reduces the risk of erroneous interpretations, as its results make possible what amounts to a pre-visualisation of the restoration work to be done,

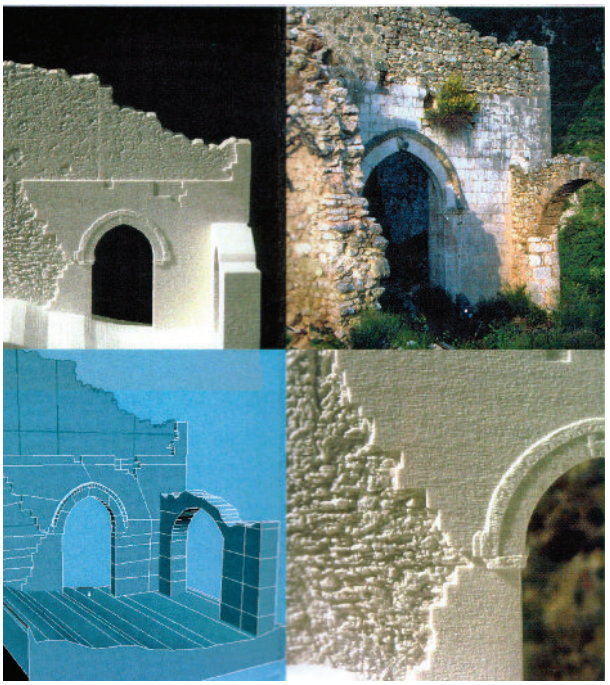


Fig. 6. Castelfranco di Norcia (Perugia), ruins of S. Maria del Redentore church. Example of 'texture mapping'.

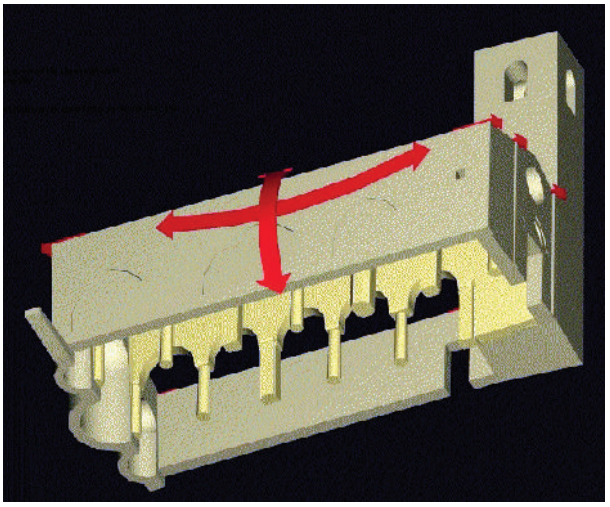


Fig. 7. Pianella (Pescara), S. Maria Maggiore. Virtual reconstruction of the structural model.

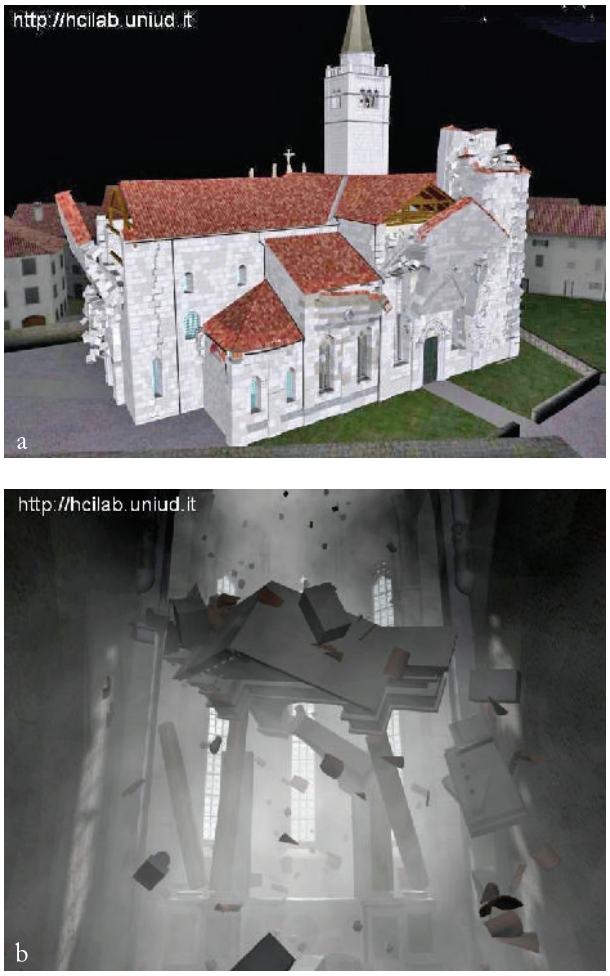


Fig. 8. Venzone (Udine), cathedral. Simulation of the collapse produced by the 1976 earthquake.

to the point where possible solutions for the repair of a lost element can be weighed, or the conditions of light that will hold following the restoration can be assessed. The application of computer technology to architecture makes it possible to create an 'informed' model able to simulate the behaviour of a structure, in order to arrive, for example, at assessments of the potential damage resulting from a seismic event or at preliminary estimates of the effectiveness of reinforcement efforts.[10]

Finally, a further procedure made possible by virtual restoration is the processing of the data obtained through 'time-of-flight' 3D laser scanning, plus the subsequent translation of such data into a scale model (by using technologies of rapid prototyping, for example, or through the application of CAD modelling systems) that can be used to document the complex form of each architectonic element while studying the solutions best suited to its restoration, making the application particularly useful in the case of restorations based on indirect *anastylosis*.

And yet, the stock of information on measurements contained in the 'cloud of points', precisely because it is so markedly heterogeneous, is not enough, on its own, to provide adequate 'knowledge' of the architectonic structure. A process of critical interpretation must also occur, in order to selectively match the information generated by the scan with that produced by the historical/documentary research and the structural analysis, in this way "bringing forth, from a set of walls that can often prove illegible upon initial examination, documents of an exceptional nature, all of them guaranteed to be authentic", so as to guarantee "an intimate, all-encompassing knowledge of the monument" that can be used "to carry out an in-depth study of what exactly it consists of, observing features and distinctive characteristics (alignments, differences in thickness, interruptions and variations, including minor ones, of the walls) that might otherwise escape notice. Such details always point to some historical-artistic dilemma or chronological consideration, or even a mere construction issue, though whatever the concern, it cannot be neglected, must be resolved".[11] And so the representation generated by the scan of the monument (together with its 'direct' observation) constitutes a "key condition" to a proper historical analysis of the architectural structure, serving as an "expression of the historical-critical investigation that constitutes the irreplaceable groundwork for the act of preservation".[12]

The reasons for scans (and in particular three-dimensional scans of the measurements of structures) are not limited, therefore, to their operational function as records of geometric data and dimensions, seeing that they also serve to 'unveil' the structure, fulfilling the phase in the process of hermeneutic investigation meant to study the syntactical ties between the parts, in what represents a moment of critical importance in preparation for the preservation effort.

To conclude, what is referred to as virtual restoration can be considered a technique to be applied in parallel with traditional restoration, a complementary effort that provides a useful tool for textual analysis and historical research, "in the interests of perfecting and investigating in depth a plan that, to cite Riegel, can be used to pursue a design exercise performed, first and foremost, through thought and images".[13]

[10] Bertocci, Parrinello 2015.

[11] Carbonara 2012, p. 24.
[12] Carbonara 1997, pp. 473-474.
[13] D'Avino 2007, p. 84.

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