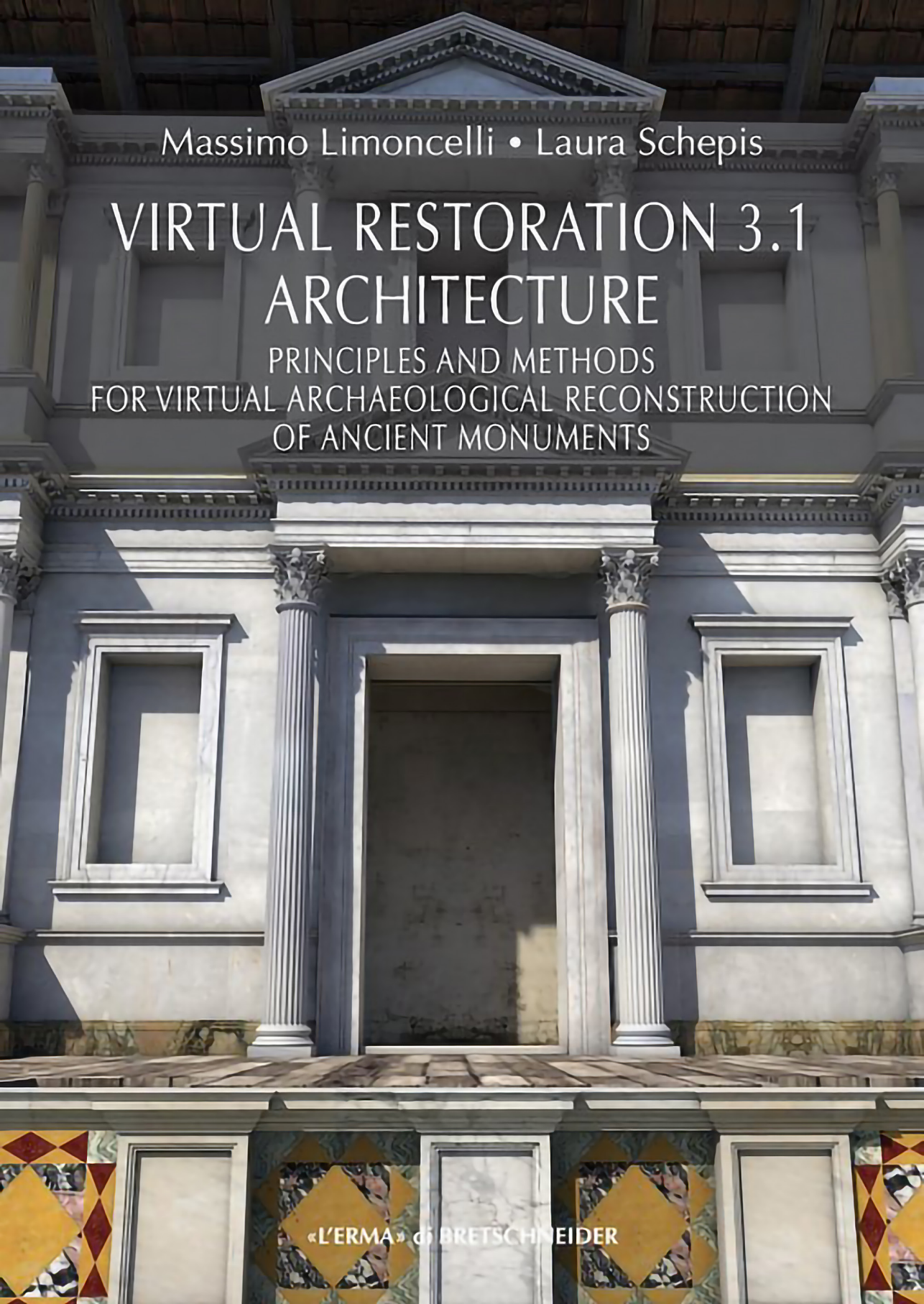
Massimo Limoncelli • Laura Schepis
VIRTUAL RESTORATION 3.1
ARCHITECTURE
PRINCIPLES AND METHODS
FOR VIRTUAL ARCHAEOLOGICAL RECONSTRUCTION
OF ANCIENT MONUMENTS
«L'ERMA» di BRETSCHNEIDER

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Massimo Limoncelli, Laura Schepis

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«L'ERMA» di BRETSCHNEIDER (USA)

Virtual Restoration 3.1. Architecture

Principles and methods for virtual archaeological reconstruction of ancient monuments

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To
Noemi, Martina, Grazia Rita, Claudia, Marco
and all the students of the Virtual Archaeology course at the University of Palermo,
this book was written for you, but above all, thanks to you.

FOREWORD

Il Virtual Restoration is a «recent and constantly evolving discipline that promotes the development of formalized investigation procedures for acquiring, representing, processing, and communicating data, while simultaneously producing new information and tools for research that go beyond traditional forms and contribute to the advancement of archaeological practice. Therefore, archaeology has embraced scientific and technical investigation methods, initially derived from other sciences, and then adapted them to the specific needs of its own research».

In the field of archaeology, the increasingly widespread use of ICT (Information and Communication Technologies) has opened up new research possibilities, mainly thanks to the transition of computer science from a tool for data management and documentation to a tool for data production and analysis. Consequently, the development of computer technologies in recent decades has led to the emergence of new disciplines characterized by the combination of activities and research methodologies typical of hard sciences with those of more traditional humanistic extraction, including Virtual Restoration.

Following the uncontrolled proliferation of virtual and three-dimensional reconstructions from the mid-1990s onwards, some issues emerged, including the lack of scientific transparency of the reconstructions and hyperrealism. In the first case, virtual reconstructions were presented as a product to be accepted without the possibility of critical analysis and without explicitly explaining their principles and formative methods. In the second case, virtual reconstructions were presented as the unique and undisputed representation of the past, rather than as virtual hypotheses that could be supplemented by many others. There was therefore an awareness of the need to critically analyze the impact of the rapidly spreading virtual reconstructions within the scientific community.

Therefore, it was considered appropriate to create the first volume of the two books dedicated to architecture, the third volume of the "Virtual Restoration" series, which addresses the "Principles and methods" for the virtual reconstruction of an ancient monument through a methodological process that follows a well-defined sequence of operations: from acquisition to processing, up to the presentation of the data. Virtual restoration of an ancient monument should not be understood as a mere ideal restitution of an architectural artifact, but rather as a method for verifying archaeological data.

The use of methodologies and ICT technologies applied to ancient architecture represents an advancement of traditional studies aimed at reconstructing partially preserved or, in some cases, no longer existing monuments through three-dimensional models. These models provide

information that is not always easily deducible from traditional methods of studying ancient architecture.

Within the broader discipline, virtual restoration of ancient buildings is certainly the most complex field of application, as it encompasses all sectors of virtual restoration. This includes the pictorial aspects (frescoes, painted plaster, and stucco), the stonework (for any sculptures or plastic works in architectural decorations), woodwork, mosaic, and ceramics (roof tiles and tiles for the covering, etc.). Each of these areas has its own autonomous intervention methodologies, which are combined to create the complete 3D reconstruction of the building.

This book illustrates all aspects and issues related to virtual reconstructions of ancient buildings through 28 specific case studies. The aim is to propose a correct use of digital visualization of an ancient monument, showcasing the sources used for 3D reconstruction. It explicates the logical process followed in reconstructing various hypotheses, and in the most controversial case studies, it proposes different reconstruction hypotheses or one for each chronological phase of the ancient object under study for reconstruction.

Palermo, april 2024

PART 1

ARCHITECTURE AND VIRTUAL RESTORATION

I
PRINCIPLES AND METHODS FOR VIRTUAL ARCHAEOLOGICAL RECONSTRUCTION OF ANCIENT MONUMENTS

1. Introduction

The word "architecture" encompasses a broad and multifaceted meaning. It derives from two ancient Greek linguistic roots: the first, "Arch-," expresses the concept of foundation, while the second, "Tekton-," alludes to the activity of inventing, creating, consolidating, and building[1].

Gottfried Semper (1803-1879) defines architecture as «"pure art of invention," since its forms have no defined prototypes in nature; they are free creations of the imagination and human reason. Therefore, architecture could be considered the freest among the visual arts, were it not for its absolute dependence on the general laws of nature and the mechanical laws of materials. This is because, no matter what the object of architectural art we consider, its initial conception always arises from the necessity to satisfy some material need, especially the need for shelter and protection from the adversities of climate, elements, or other hostile forces; and since we can achieve this protection only through the solid combination of materials provided by nature, we are compelled to strictly observe the static and mechanical laws for our constructions. This material dependence on the laws and constraints of nature, which remain the same at all times and in all places, gives architectural works a certain character of necessity and allows them to appear as works of nature itself. However, they are such as nature can create through the medium of a being with reason and free will»[2].

Architecture, understood as the expression of the built environment, manifests itself as an artistic expression in its broadest sense. It encompasses a complex activity that involves a wide range of fields such as political, economic, legal, technical, scientific, artistic, and social

realms. Its objective is the human settlement in a specific space, more or less extensive, according to the peculiar characteristics of the geographic area affected by the settlement itself, such as geographical location, hydrogeological layout, and climate.

Therefore, architecture constitutes the operational aspect, which translates into constructive reality, of the organization of the territory encompassing human settlements in their overall structure, known as urban planning. Urban planning is identified in various types and functions of built objects, including religious, private, and public buildings, as well as infrastructure such as roads, bridges, ports, etc.

Today, virtual reality techniques applied to archaeology and ancient architecture have been an update to traditional studies aimed at reconstructing partially preserved monuments for many years. This has led to two main research strands: the scientific verification of archaeological data and the preparation of materials used as a basis for dissemination works across various media platforms.

In the first case, reference is made to the virtual reconstruction of an ancient monument, understood as the set of operations aimed at recovering, through a digital model, the original conditions of the building, respecting the spirit of the era by reconstructing the presumed original, degraded, or missing parts. Therefore, virtual archaeological reconstruction of a building indicates the methodological process that, starting from a heterogeneous quantity of data (the sources)[3], leads to the production of a 3D model. Such methodological process, linked to the interpretation of data and their representation within the reconstruction, can be defined as "digital anastylosis," which occurs through a true action of "virtual redesign" of a building.

In the second case, however, current trends in research in the field of Virtual Archaeology, particularly in scientific visualization, aim to deepen the understanding of the visualization process in order to use knowledge of perception psychology along with graphic design techniques to intervene in the design of increasingly effective visualization systems. Indeed, the availability of increasingly advanced computer tools has shifted attention to digital communication, new learning modalities in VR, shared consumption, and even the current universe of Extended Reality (XR)[4].

Within the discipline of Virtual Restoration, the virtual reconstruction of buildings represents the most complex field of application, as it encompasses all sectors of virtual restoration: in addition to architectural restoration, it includes stone restoration, such as sculptures and plastic works, as well as mosaics, frescoes, painted plaster, and stucco, extending to wooden restoration. Each of these areas has its own

autonomous intervention methodologies that add to the actual 3D restitution of the building.

Similarly to what has been observed in the history of physical restoration of a monument, within the field of Virtual Archaeology and Restoration, there has been a theoretical evolution of the methodology to be applied to a virtual archaeological reconstruction of an ancient building based on the philological method[5]. This evolution channels towards greater scientific transparency within rigorous methodological boundaries. Indeed, one of the main issues related to the reconstructive study of an ancient monument, among the most debated and controversial, is certainly attributable to the reliability of the results in a 3D reconstruction of an ancient building[6].

In scientific circles[7], one of the major criticisms leveled against virtual reconstructions is that they often represent mere technological exercises where the effect of spectacularization is entirely detached from the context of research and data analysis. The most glaring deficiency lies in the fact that the proposed models fail to answer certain questions, such as "what data were used as a basis?" Furthermore, "unique reconstructions" are proposed, meaning they lack opportunities for critique by observers, without offering alternative models or any explanation of the reconstruction choices.

In scientific circles, a second criticism concerns digital communication, particularly the use (or perhaps better, the overuse) of computer technologies that may "empty out" the contents of the disciplines to which they are applied: there is a risk of reversing the relationship in which technologies no longer remain merely tools, or means, but become the end of research. Furthermore, there is the additional inconvenience that these technologies take control of the discipline with which they come into contact, becoming in some measure the predominant element.

These risks have been effectively defined as the "Star Wars Syndrome," which occurs when the developmental potential of a technique takes precedence over the content, and the "Cinecittà Syndrome" when a virtual reconstruction risks imposing itself solely for its suggestive capacity[8]. In addition, «it is worth noting that the majority of Virtual Archaeology applications developed to date lack significant archaeological content and, as would be appropriate, do not answer precise questions. Instead, they float in a generally informative and multimedia environment, or with specific intentions of technological exercise and spectacularization, completely detached from the context of research and data exegesis»[9].

The same criticism was already expressed over five centuries ago, in 1475, by Leon Battista Alberti who wrote: «I would like to add a recom-

mendation that seems very appropriate: displaying colored models or making them attractive with paintings indicates that the architect does not simply intend to represent his project, but rather, driven by ambition, seeks to attract attention with the exterior appearance to captivate the eye of the beholder, distracting the mind from a thoughtful examination of the various parts of the model to fill it with wonder. Therefore, it is better not to make models that are impeccably finished, polished, and shiny, but rather naked and plain, in order to highlight the acuity of the architectural conception, not the accuracy of the model's execution»[10].

Today, technologies have progressively moved in a specific direction: representing an architectural artifact in the form of a synthesis of collected data and as the final result of a critical re-evaluation of the information gathered through a 3D digital model. Therefore, the editing of a virtual reconstruction must highlight the knowledge data contained therein through forms of scientific visualization that allow reading, recognizing, and verifying the informational and knowledge content of the model itself. Scientific visualization is precisely the transformation of information into a perceivable form that should assist the researcher in understanding the analyzed building and help the user perceive the nature of the information present in the analyzed data[11].

The need to constrain a virtual reconstruction within strict boundaries has therefore become even more pressing, as expectations are high and the available tools are powerful. Therefore, the objective of this book is to emphasize the level of final reliability, which should always occupy the center of every reconstructive process and rigorously formalize every interpretative solution with scientific rigor[12].

2. From the London Charter to the Principles of Seville

The general methodological principles underpinning a correct archaeological reconstruction were set out in the early XXI[th] century, first in the *London Charter for the Use of 3D Visualisation in the Research and Communication of Cultural Heritage* (2006)[13] and subsequently in *Principles of Sevilla. International Principles of Virtual Archaeology* (2011)[14]. Indeed, these documents establish the principles and methods that need to be adopted in order for the virtual reconstruction of an ancient monument to be considered scientifically correct. In other words, they present a coherent set of methods characterised by a precise sequence of measures, operations and analyses to be performed in accordance with a pre-established order centred on the acquisition, processing and presentation of data[15].

The need to draft a "charter," a term usually reserved for documents that enunciate principles of very broad generality, such as the well-

known Venice Charter on Conservation and Restoration[16], It originated from the necessity to articulate rigorous methodological principles for communities of researchers and technical experts in the field. The most challenging aspect involved providing answers to some of the questions regarding the applications of Virtual Reality (VR) in the archaeological domain. In particular, the credibility and validity of the reconstructive models of objects, monuments, sites, or landscapes, partially or completely modified or destroyed, and virtually reconstructed based on archaeological interpretation[17].

Following the uncontrolled proliferation of virtual reconstructions in the archaeological field from the mid-1990s onwards, several issues emerged, including the lack of *transparency in the reconstructions*[18] and *hyperrealism*[19]. In the first case, virtual reconstructions were presented as a product to be accepted without the possibility of critical analysis and without explicating their formative principles and methods. In the second case, virtual reconstructions were presented as the unique and unquestionable representation of the past, rather than as virtual hypotheses alongside which many others could be considered.

There was therefore awareness of the need to critically analyze the impact of the virtual reconstructions that were rapidly spreading in the scientific community[20].

Thus, in 2006, following the Symposium and Expert Seminar "Making 3D Visual Research Outcomes Transparent," organized between February 23rd and 25th by The British Academy of London and The Centre for Computing in the Humanities at King's College London, concerning various aspects of the issue of intellectual transparency in virtual reconstructions, it was proposed that the community could draft a Charter outlining the principles that should underlie the use of three-dimensional visualization technologies in cultural heritage research and dissemination[21].

In March 2006, the first draft of the London Charter for the *Use of 3D Visualization in the Research and Communication of Cultural Heritage* was presented. It included the fundamental principles agreed upon at the Symposium and added new principles. Finally, in 2009, the final version was published on www.londoncharter.org. The initiative of the Charter did not aim to propose radical new proposals but rather to consolidate principles that had been published by numerous authors, yet not fully embraced by the scientific community.

The Charter aims to define the basic objectives and principles of the use of 3D visualisation methods in relation to intellectual integrity, reliability,transparency, documentation, standards, sustainability and access.

The Charter therefore does not seek to prescribe specific aims or methods, but rather seeks to establish those broad principles for the

use, in research and communication of cultural heritage, of 3D visualisation upon which the intellectual integrity of such methods and outcomes depend.

Although the objectives and principles of this Charter may equally apply to the use of 3D visualisation in other contexts, such as in the creation of mass entertainment products, its main focus is upon research into cultural heritage and the communication of such research.

The Charter seeks to enhance the rigour with which 3D visualisation methods and outcomes are used and evaluated in the research and communication of cultural heritage, thereby promoting understanding of such methods and outcomes.

The objectives of the London Charter seeks to establish principles for the use of computerbased visualisation methods and outcomes in the research and communication of cultural heritage in order to: Provide a benchmark having widespread recognition among stakeholders; promote intellectual and technical rigour in digital heritage visualisation; ensure that computer-based visualisation processes and outcomes can be properly understood and evaluated by users; enable computer-based visualisation authoritatively to contribute to the study, interpretation and management of cultural heritage assets; ensure access and sustainability strategies are determined and applied; offer a obust foundation upon which communities of practice can build detailed London Charter Implementation Guidelines.

In the London Charter, 6 methodological principles are outlined which are necessary for digital visualization of cultural heritage to be intellectually and technically rigorous, like all other research activities related to archaeological heritage.

Principle 1: Implementation. The principles of the London Charter are valid wherever computer-based visualisation is applied to the research or dissemination of cultural heritage.

Principle 2: Aims and Methods. A computer-based visualisation method should normally be used only when it is the most appropriate available method for that purpose.

Principle 3: Research Sources. In order to ensure the intellectual integrity of computer-based visualisation methods and outcomes, relevant research sources should be identified and evaluated in a structured and documented way.

Principle 4: Documentation. Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed.

Principle 5: Sustainability: Strategies should be planned and implemented to ensure the long-term sustainability of cultural heritage-relat-

ed computer-based visualisation outcomes and documentation, in order to avoid loss of this growing part of human intellectual, social, economic and cultural heritage.

Principle 6: Access. The creation and dissemination of computer-based visualisation should be planned in such a way as to ensure that maximum possible benefits are achieved for the study, understanding, interpretation, preservation and management of cultural heritage.

The London Charter recommends the creation of specific implementation guidelines for each community of experts (London Charter Preamble and Article 1.1). The International Forum of Virtual Archaeology has agreed to take up this challenge by drafting an international document governing the implementation of best practice in computer-based archaeological visualisation. The new document, written in 2011, is called *Principles of Sevilla. International Principles of Virtual Archaeology,* shortened to The Sevilla Charter.

Since the theoretical framework for the Seville Principles is the London Charter, this document would adopt all the objectives approved by the Advisory Board of the London Charter. These general objectives should be accompanied by some new objectives, namely: generate easily understandable and applicable criteria for the whole community of experts; including indistinctly computer experts, archaeologists, architects, engineers, general managers or specialists in the field; establish guidelines aimed at giving the public a greater understanding and better appreciation of the ongoing work of archaeology; establish principles and criteria for measuring the quality of projects carried out in the field of virtual archaeology; promote the responsible use of new technologies for the comprehensive management of archaeological heritage; Improve current archaeological heritage research, conservation and dissemination processes using new technologies; open new doors for the application of digital methods and techniques in archaeological research, conservation and dissemination; Raise awareness of the international scientific community of the prevailing need to make concerted efforts worldwide in the growing field of virtual archaeology.

The Seville Charter presents 8 methodological principles:

Principle 1: Interdisciplinarity. Any project involving the use of new technologies, linked to computer-based visualisation in the field of archaeological heritage, whether for research, documentation, conservation or dissemination, must be supported by a team of professionals from different branches of knowledge.

Principle 2: Purpose. Prior to the development of any computer-based visualisation, the ultimate purpose or goal of our work must always be completely clear. Therefore, different levels of detail, resolutions and accuracies might be required.