

## 3D RECONSTRUCTION OF CLASSICAL ARCHITECTURE

*Computer Aided Design Techniques for the Digital Representation of Ancient Buildings.*

ALBERTO SDEGNO  
*Istituto Universitario di Architettura di Venezia*  
*Department of Architectural Design*  
*Dorsoduro 2136*  
*30123 Venezia - Italy*  
*<http://www.iuav.it>*  
*Email Address : [sdegno@iuav.it](mailto:sdegno@iuav.it)*

**Abstract.** This paper shows some results of a research carried out at the Istituto Universitario di Architettura di Venezia, concerning the reconstruction of the main architectures of Classical Rome.

### 1. Introduction

The research described in this paper refers to some CAD and rendering techniques for constructing digital architecture of Ancient Rome. To do this we have interpreted and elaborated Andrea Palladio's different kinds of drawings.

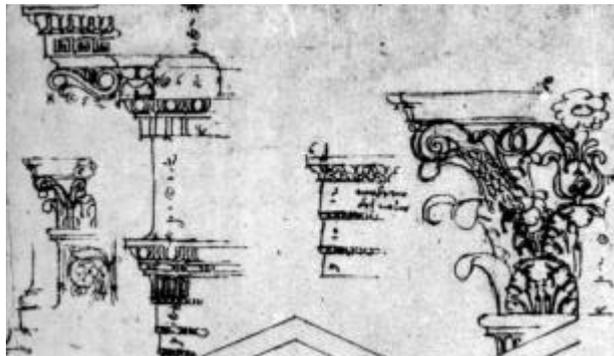


Figure 1. Sketches by Andrea Palladio.

We have taken into account and carefully analyzed both the relief drawings, which are hand-sketches, used by Palladio during his direct method surveys; and his woodcuts from his treatise *I Quattro Libri di Architettura*, published in Venice in 1570.



Figure 2. Drawing of Temple of Marte by Andrea Palladio.

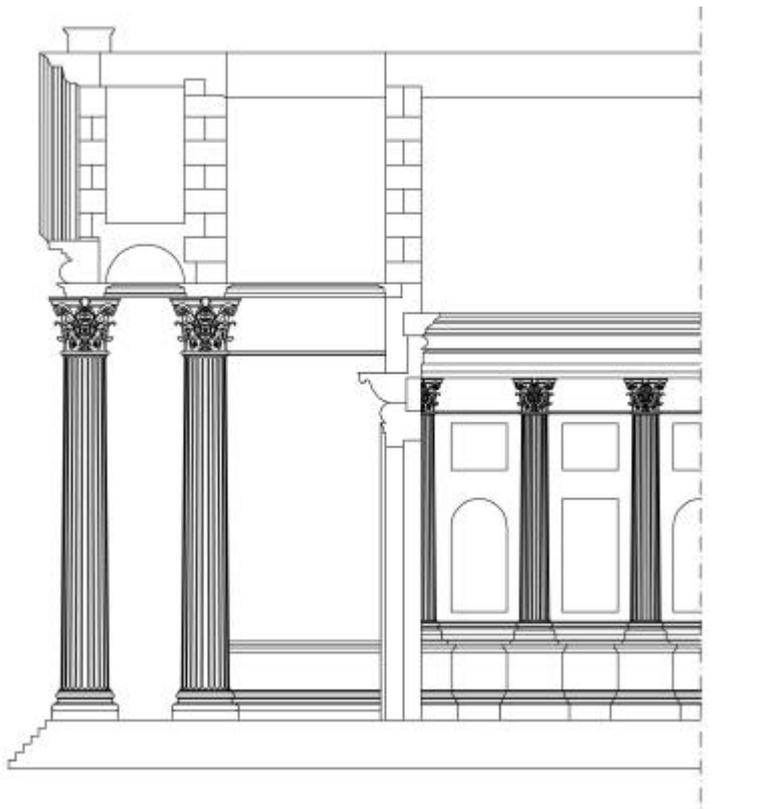
## 2. Analysis of Palladio's drawings

From these drawings we have firstly drawn some useful information concerning the unit of measure. The main metric reference is the Venetian foot, which corresponds to 34,77 centimeters, and is indicated with a letter *P*, followed by the number corresponding to its value; sometimes, after it, we have a little spiral, which can be read as the letter *O*, indicating the length in ounces (1 ounce is about 2,9 centimeters, the twelfth part of a foot). Finally

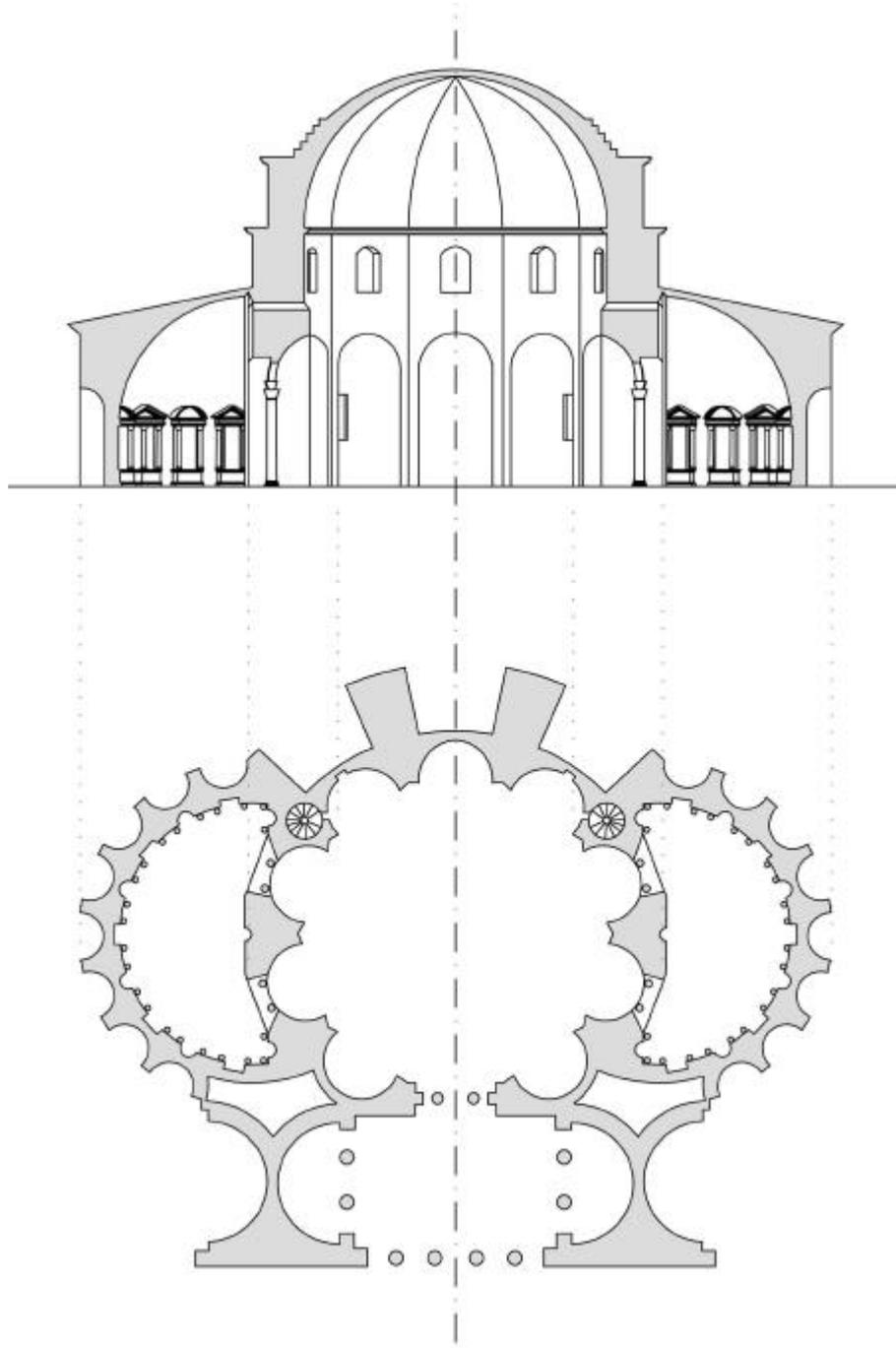
there is another unit, the minute, signed with an  $m$ , which is the fourth part of the ounce.

As is known, all architectural orders are measured, instead, by the Vitruvian Module. Vitruvius gives a type of measure disjointed from any anthropometric dimension. The Module, in fact, is an abstract unit of measure, which is equivalent, in the case of the Doric Order, to half the diameter of the column. Therefore, the height of the column is equal to 7,5 modules. Instead, the Ionic Order, the Base, the Shaft, and the Capital all have a full height of 9 modules, considering that in this case the Module is the full diameter of the column.

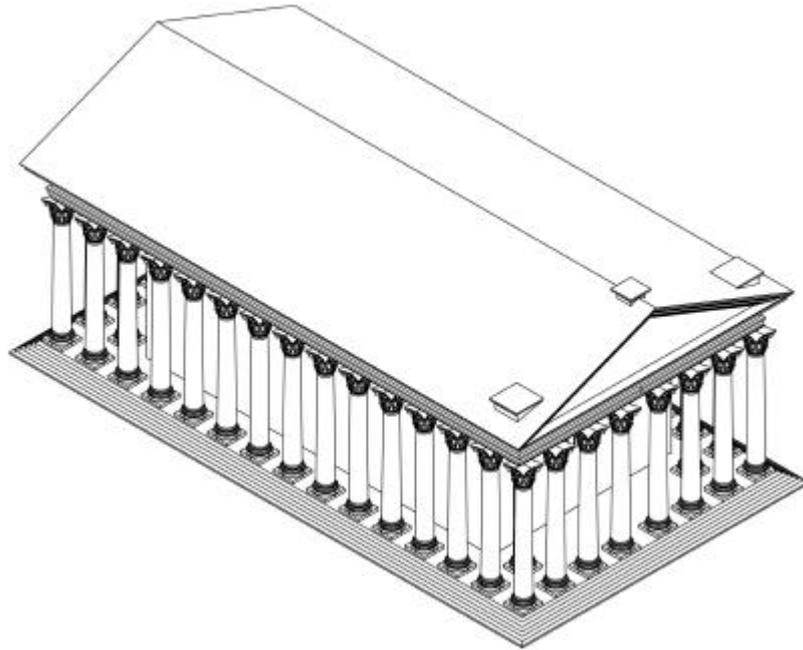
Starting from this basic information, we have constructed the first and the second Mongean Projections from which we began to generate 3D models. The digital architectures that we have already accomplished are the Temple “Le Galluce”, named also of Minerva Medica, the Temple of Marte and the Temple of Jupiter.



*Figure 3.* Digital reconstruction of Temple of Marte.



*Figure 4.* Digital Reconstruction of Temple "Le Galluce".



*Figure 5.* Digital Reconstruction of Temple of Jupiter.

### **3. CAD techniques for 3D models**

The method used for the construction of solid architectural models is based on the principles of boolean space geometry, while for the creation of single or double curvature solids we used surfaces of second or fourth degree.

In the case of particular decorative elements, such as mouldings, masks, helicoidal components, achantus leaves, we used NURBS (Non-Uniform Rational B-Spline) structures, which appeared to be the best choice having studied the basic geometric genesis of Palladio's drawings.

As for the relief surfaces, such as the bas-reliefs of bucrania, of metopes and of triglyphs, we have used "shape from shading" algorithms, which allow to control the morphing of a surface directly through interpolation of points in a three-dimensional space, thanks to the manipulation of raster images that we had numerically elaborated.

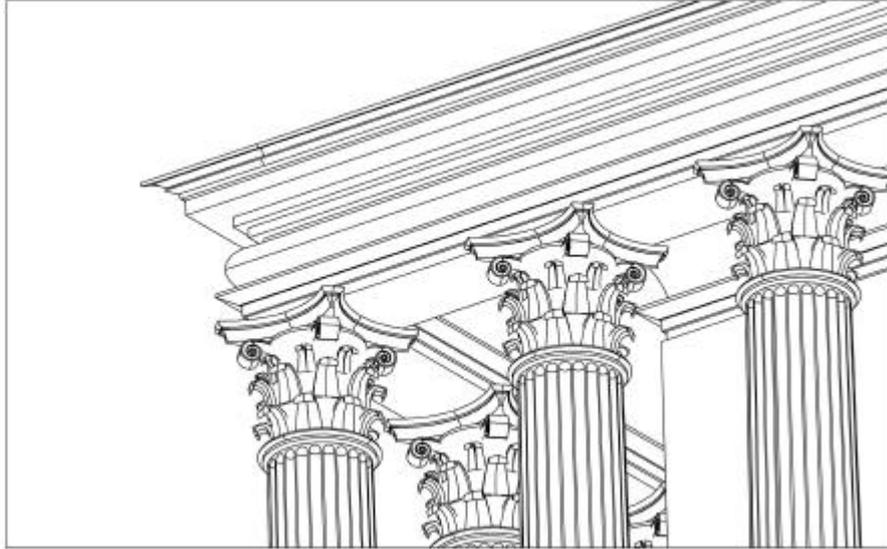


Figure 6. Detail of digital reconstruction of Temple of Marte.

As for the relief surfaces, such as the bas-reliefs of bucrania, of metopes and of triglyphs, we have used “shape from shading” algorithms, which allow to control the morphing of a surface directly through interpolation of points in a three-dimensional space, thanks to the manipulation of raster images that we had numerically elaborated.

Another phase of the work consisted in the presentation of the materials by employing a graphic non-photorealistic rendering technique: instead of trying to produce a photographic representation, we decided to visualize virtual architectures by means of some traditional drawing techniques, which are usually employed at the *École des Beaux Arts* or at the *Gran Prix de Rome*. In this way we managed to accomplish an evocative didactic representation, where also shadows have a particular informative function.

#### 4. Conclusions and future expectations

A further development, which is still in course of realization, will be the processing of data with some CAM (Computer Aided Manufacturing) machines. We think of employing machines that work with LOM (Laminated Object Manufacturing) techniques, and that can directly create stereometric models on thermic adhesive paper, a paper cut by employing the method of progressive sections, so that we can construct a *maquette* which is materially similar to the traditional ones on wood, even though it is elaborated with a sophisticated electronic procedure.

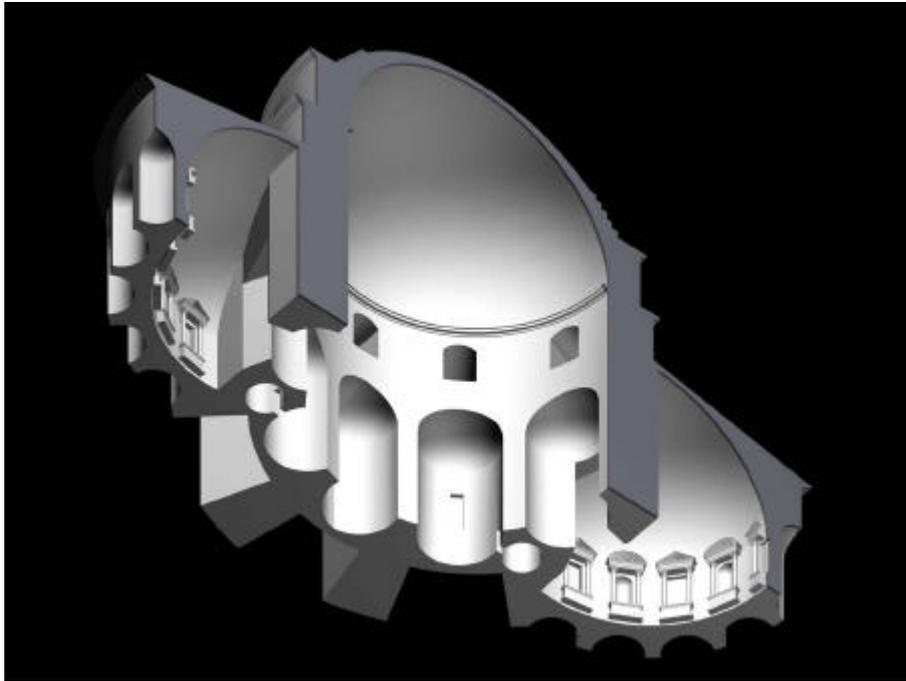


Figure 7. Rendering of Temple "Le Galluce".

### Acknowledgements

The work is developed during the Course of Computer Graphics (Disegno Automatico) led by the author at the Istituto Universitario di Architettura di Venezia, a.a. 2001-02. The images of Figures n. 1 and n. 2 are taken from Zorzi (1958) and Palladio (1570). The construction of digital models is by Luca De Gol (Temple "Le Galluce"), Sebastiano Cestaro (Temple of Marte) and Andrea Deppieri (Temple of Jupiter).

### References

- Barbieri, F.: 1992, *Architetture palladiane. Dalla grafica di cantiere alle immagini del trattato*, Neri Pozza Editore, Vicenza.
- Beltramini, G. and Padoan, A., (eds.): 2000, *Andrea Palladio. Atlante delle architetture*, Marsilio, Venezia.
- Burns, H.: 1973, I disegni del Palladio, in *Bollettino Cisa*, XV, pp. 169-191.
- Cevese, R (ed.): 1973, *Palladio. Catalogo della mostra di Vicenza*, Electa, Milano.
- Gioseffi, D.: 1978, Dal progetto al Trattato: incontro e scontro con la realtà, *Bollettino CISA*, XX, pp. 27-45.

- Gioseffi, D.: 1980, I disegni dei “Quattro Libri” come modelli; modellistica architettonica e teoria dei modelli, *Bollettino CISA*, XXII (I), pp. 47-64.
- Lewis, D.: 1981, *The Drawings of Andrea Palladio*, International Exhibitions Foundation, Washington.
- McCullough, M., Mitchell, W.J. and Purcell, P. (eds): 1990, *The Electronic Design Studio. Architectural Knowledge and media in the Computer Era*, The MIT Press, Cambridge Mass.
- Mitchell, W.J. and McCullough, M.: 1995, *Digital Design Media*, Van Nostrand Reinhold, New York.
- Mitchell, W.J.: 1990, *The Logic of Architecture*, The MIT Press, Cambridge, Mass.
- Mitchell, W.J.: 1992, *The Reconfigured Eye: Visual Truth in the Post-Photographic Era*, The MIT Press, Cambridge, Mass.
- Palladio, A.: 1570, *I Quattro Libri di Architettura*, Dominico De Franceschi, Venetia.
- Pérez-Gómez, A. and Pelletier, L.: 1997, *Architectural Representation and the Perspective Hinge*, The MIT Press, Cambridge, Mass. and Londra.
- Puppi, L.: 1999, *Andrea Palladio*, Electa, Milano.
- Rupprecht, B.: 1979, Proiezione e realtà architettonica nei disegni dei “Quattro Libri”, *Bollettino CISA*, XXI, pp. 159-175.
- Schmitt, G.: 1996, *Architektur mit dem Computer*, Vievog, Wiesbaden.
- Schmitt, G.: 1988, *Microcomputer Aided Design. For Architects and Designers*, John Wiley and Sons, New York.
- Sdegno, A.: 2002, *Architettura e rappresentazione digitale*, Cafoscarina, Venezia.
- Sdegno, A.: 1997, Geometry and Projection: notes on Digital Design, *Quaderni LAR*, 2, pp. 27-35.
- Stiny, G. and Mitchell, W.J.: 1978, The Palladian Grammar, *Environment and Planning B*, 5 (1), pp. 5-18.
- Vitruvio: 1987, *I Dieci Libri dell'Architettura tradotti e commentati da Daniele Barbaro 1567*, Il Polifilo, Milano.
- Wittkower, R.: 1962, *Architectural Principles in the Age of Humanism*, Academy Editions, London.
- Zorzi, G.G.: 1958, *I Disegni delle Antichità di Andrea Palladio*, Neri Pozza Editore, Venezia.