



eCAADe 22

# Architecture in the Network Society

Copenhagen 2004

Edited by Bjarne Rüdiger, Bruno Tournay & Henning Ørbæk

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School of Architecture

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The Royal Danish Academy of Fine Arts  
School of Architecture  
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# 3D Reconstruction of a Canaletto Painting

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*The objective of this research was the analysis of a Canaletto painting that depicts Palladio's plan for the „Convento della Carità“ in Venice, a plan that was only partially executed. Through the implementation of traditional techniques and digitally controlled instruments, the three dimensional model was reconstructed. It was compared with both Palladio's original plan, and with the constructed version. A notable difference between the three projects emerged which allowed for a better comprehension- using photogrammetric restitution procedures- of Canaletto's pictorial work and the corrections that the painter brought to the piece to improve the rendition of the painting. The study ends with an analysis of the natural light painted by Canaletto, and a simulation of sunlight with digital techniques.*

**Keywords:** *Geometric Modeling; Representation Theory; Perspective; 3D Reconstruction; Painting Techniques.*

## Canaletto and Palladio

Antonio da Canal, said Canaletto (1697-1768), painted many works in which architectural subjects designed by Andrea Palladio (1508-1580), are present. The most noted are “Capriccio with the Palladian project of the Rialto Bridge“ (in three slightly different versions) and the „Capriccio with the Church of San Giorgio“. There is, however, another painting of little fame but of great interest that deals with a partially finished Palladian intervention, which was interpreted by Canaletto for completion of a piece which had been requested by his principle English client, consul Joseph Smith of London: it deals with the „ Veduta del Chiostrò del Convento della Carità“. The importance of this piece is related not only to its pictorial quality, or to the alterations contributed by the artist to the Palladian hypothesis,

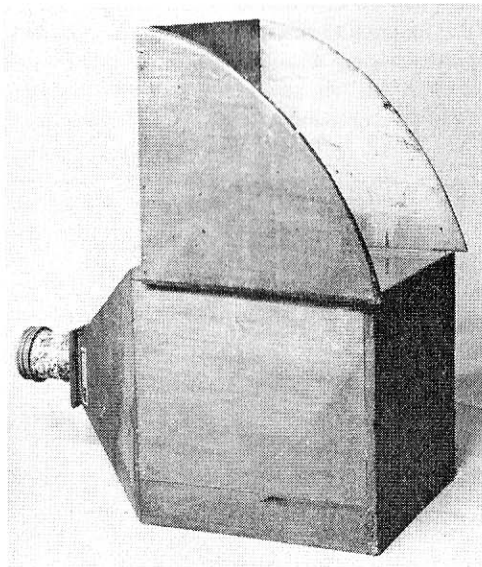
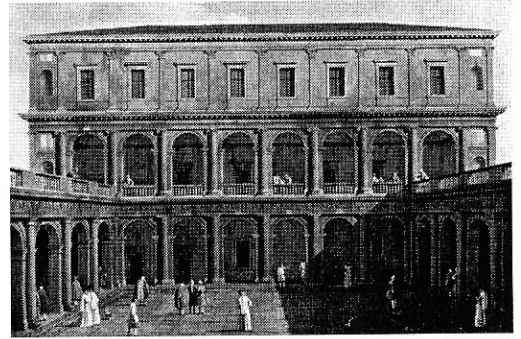
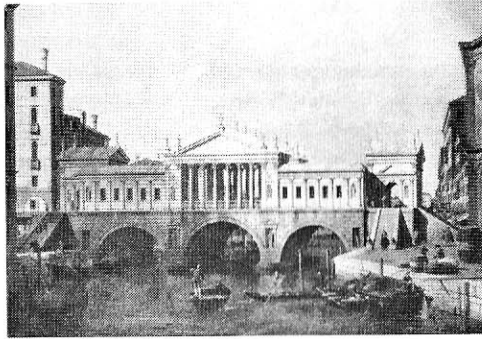
but also to several subtle visual deceptions that are revealed thanks to the instruments offered by digital representation.

It is well known that Canaletto frequently used the “camera obscura“, an optical device that allowed for the projection of the scene in the form of an image on a small screen, which was then traced- with a pencil transfer technique- to generate a sketch that would be successively translated into a painting. However, the sketch produced by this instrument was not precise, as is documented in Canaletto's autograph notebook- found in 1949- and it is probable that, due to the use of this instrument, many of his works break away from reality in an obvious manner. Numerous studies highlight these visual inconsistencies, yet the study conducted by André

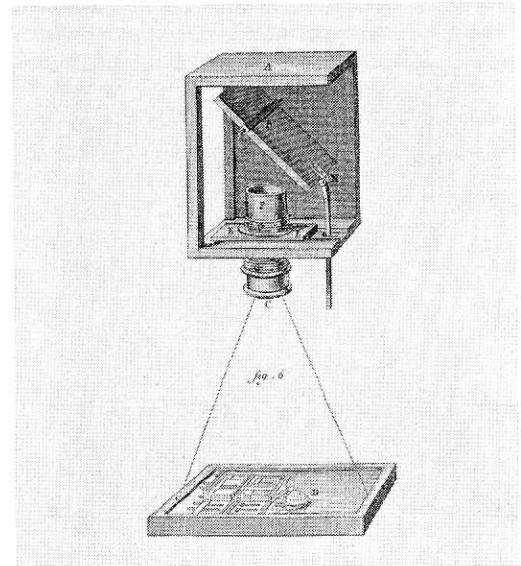
Corboz is surely the most accurate. Thanks to the use of representation techniques, in particular to those relative to digital reconstruction, it is possible to analyze works of art to attempt to understand the methods used by Canaletto to create a piece, his motivation for the creation of the distortions that we will see, with respect to the constructed version, and the methods used to simulate the perception of the third dimension of the painted scene. A useful example to indicate Canaletto's

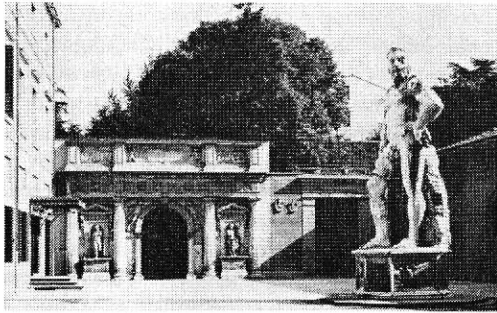
operative method is given by the comparison of the photographic image of the „Arco di Trionfo“ with the statue of Ercole Benavides, work realized in the city of Padova by Bartolomeo Ammannati under the mandate of the humanist Marco Mantua Benavides in the XVI century, and the drawing created by the painter. From the comparison of the two perspectives it becomes apparent that Canaletto elongated the height of the front of the Arch and changed the posture of the sculpted figure. This is a simple con-

Figures 1 and 2  
Canaletto, „Capriccio with the Palladian project of the Rialto Bridge“ and „View of the Cloister of the Convento della Carità“.



Figures 3 and 4  
The „camera obscura“ and the procedure for making projection.

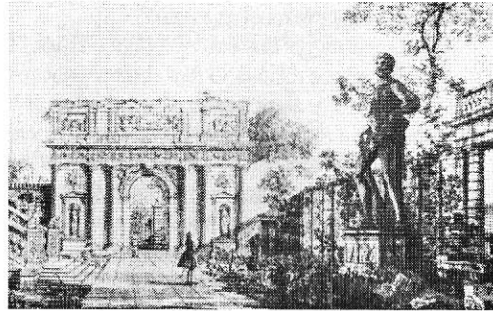
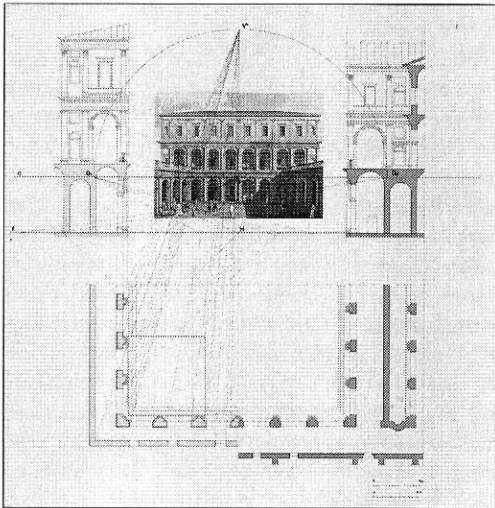




firmation of the pictorial approach of the artist.

### Restitution of the painting's perspective

The objective of the research is the analysis of the painting through the inverted construction of perspective, using methodology that allows for the reconstruction of a plan beginning from a perspective view. Three-dimensional spatial references contained on a two-dimensional surface of the painting were, in fact, individuated through the construction of significant perspective elements. This allowed for the understanding of the rigorous rules of composi-



Figures 5 and 6  
Benavides Gardens in Padova: photographic image and woodcut by Canaletto.

tion based on the positioning of the horizon line or, that which is shown to coincide with the intrados of the entablature at ground level, while the vertical axis of the painting results in being placed exactly in the middle of the central column. The vanishing point coincides with the intersection of the two above cited lines and the points of distance, D1 and D2, were determined with the applications of the well-known rules of reversal employed in descriptive geometry.

From this emerged a very rigorous perspective plan that could presume the use of the plan and frontal view for the construction of perspective as it occurs, thanks to the elementary rules indicated by

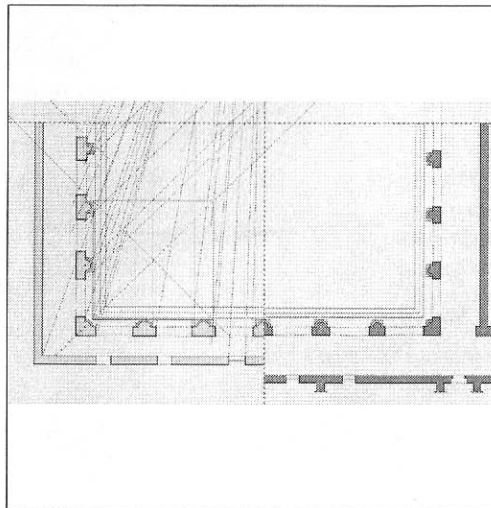
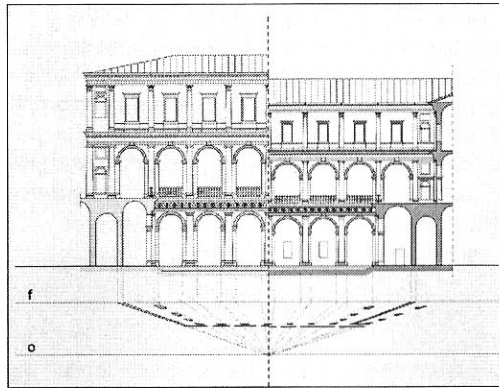


Figure 7  
Restitution of the painting by Canaletto.

Figure 8  
Detail of the plan from the restitution of fig. 7.



Figure 9  
Front elevation from the res-  
titution.



Leon Battista Alberti, as an intersection of the visual pyramid.

The reality is that a thorough analysis demonstrated how the artist, precisely due to the inconsistencies present on the canvas, might not have adopted such a rule.

In fact, critical editing brought to light the following dissimilarities between the drawings of Palladio - that coincide with the realisation in stone, at least relative to the form and dimension of the module of the frontal view- and Canaletto's painting: the distortion in the plan of some of the shafts of the semi-columns that are set against the walls and of the relative plinths; the inconsistency of the the inter-axis between the columns; the contraction of

the archway which is much narrower and of variable dimension; the height of the building, which is greater than the existing version (as is the case with the aforementioned reproduction of the „Arco di Trionfo“), and finally, the contraction in the frontal view of the module.

### Construction of the digital model

Following this first analysis of the pictorial space came the construction of the three- dimensional model of the elements shown in Canaletto's painting. In an analytical manner, this determined the distortions that the Palladian scene underwent at the hand of the painter. The most evident is tied to the altimetrical projection of the frontal view that shows a greater height with respect to Palladio's project, following with a contraction in width of the resolution of the façade, with the contracting of the dimensions of the archway. In particular, with respect to the original project and its representation in the painting, there emerges both a variation in width, and a variation in height.

Further investigation was conducted regarding the study of the position of the observer. The inquiry into the location of the vanishing point, and into the relative spatial references of perspective, permitted the exclusion of the hypothesis that an optical camera was implemented; even though it is well

Figure 10  
Digital model of the Convento  
by Palladio.

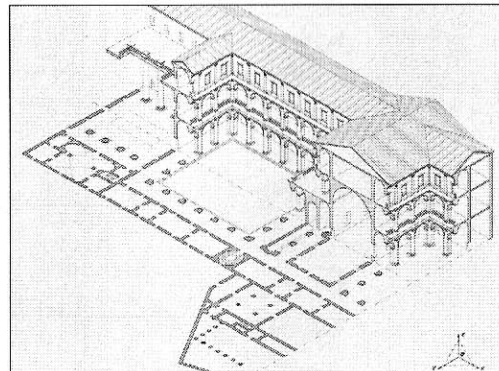
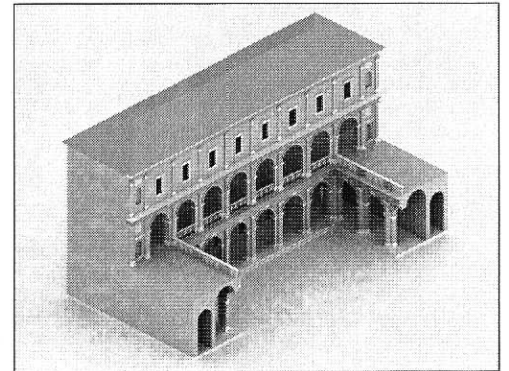


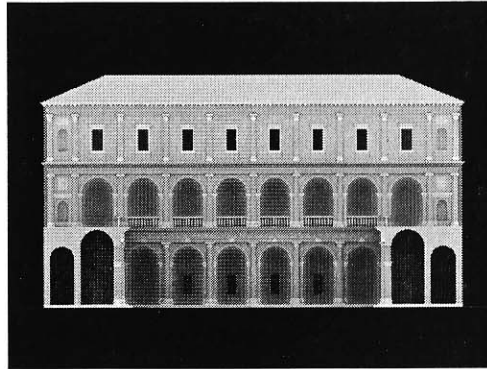
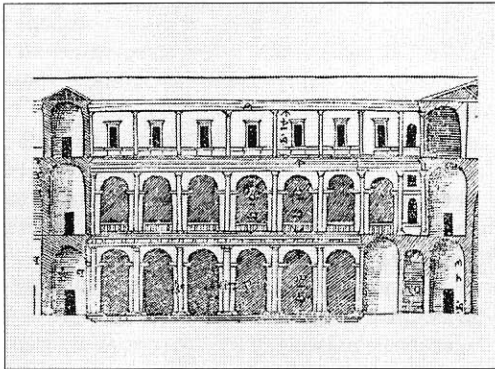
Figure 11  
Digital model of the Convento  
from the Canaletto's painting.



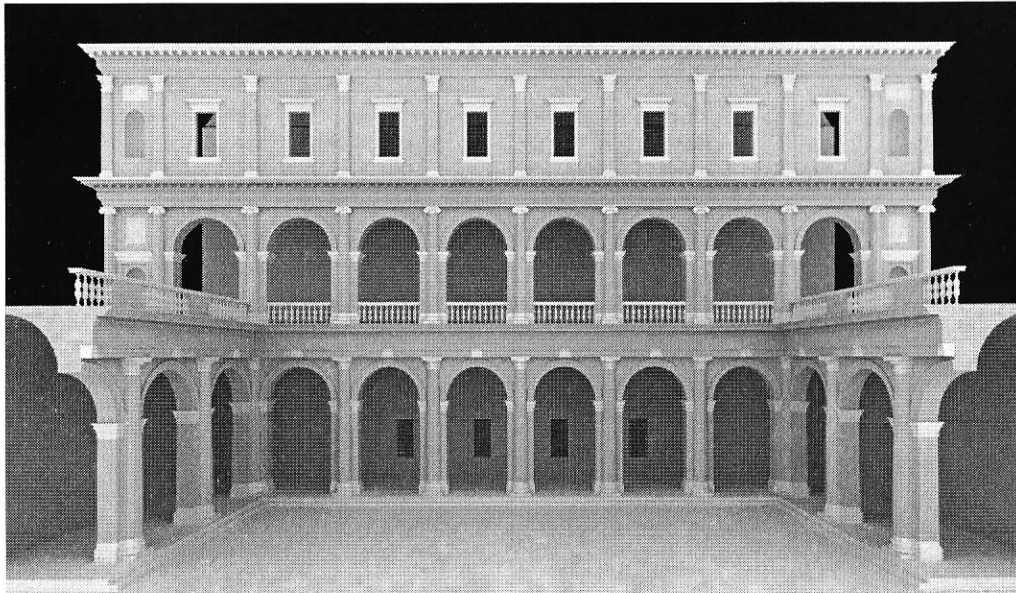
known that Canaletto generally used one. Indeed, notwithstanding that a small optical camera with the inscription „A. Canal“ is deposited in the archives of the Museo Correr, (but it is not sure that it was in effect his property and therefore used by him), in this specific case it was not used, because it would have been impossible to photograph the entire

scene as it was painted. In fact, the use of reduction lenses would have been necessary, which would have excessively distorted the perspective image, in a different way than can be ascertained from the painted image.

Therefore, the procedure that was adopted by Canaletto, saw a precise operation of optical correc-



*Figures 12-13  
Comparison between the elevation of Palladio's project and Canaletto's.*



*Figure 14  
The perspective from the same point of view used by Canaletto.*

tion of some elements of the scene, that otherwise would have undergone the visual distortion known by the name of marginal aberration. In fact, if the columns of the side wings, had been projected in a perspective manner, they would have appeared much more dilated in width than that which is shown.

The comparison of the models of the scenes, like that of single architectural elements (base, column, capital, for the orders Doric, Ionic and Corinthian), has allowed for the visible understanding of the distortion introduced by the painter. Thanks to the use of the digitally controlled instrument, it has also allowed for the measurement of dimensional variations of single elements.

## The simulation of light

One last consideration was made regarding the analysis of the direction of light of the architectonic scene. Supposing that the principle façades that are visible on the painting are orientated towards the west, an orientation that corresponds to that of the only façade realised by Palladio and that, therefore, the two side wings are north and south respectively.

One could georeference the model in such a way that the geographic co-ordinates, corresponding to a latitude of 45,25 and to a longitude of -12,18 (Venetian coordinates), allow for the analysis of the natural illumination of the scenography. The warm

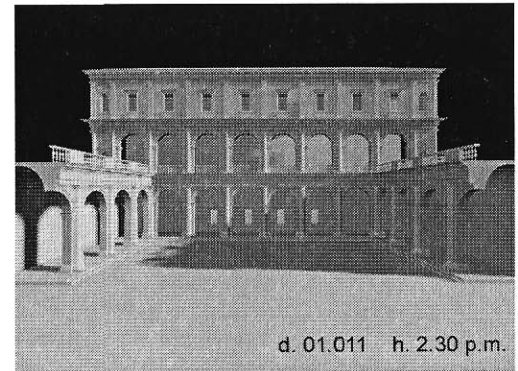
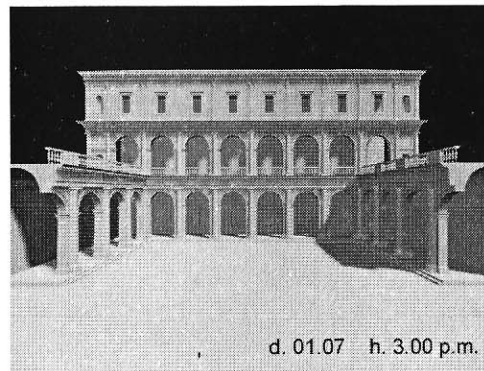
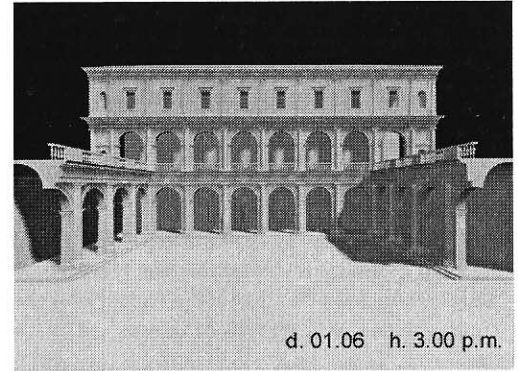
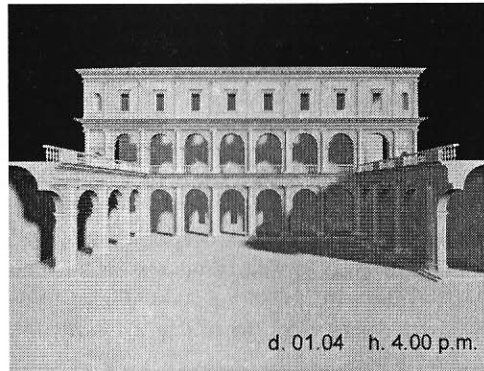


Figure 15  
The simulation of sunlight applied to the digital scene.

colours of the scene, are nevertheless true to afternoon sun exposure (the façade in fact is not illuminated in the antemeridian hours), and it is actually the analysis of the cast shadow, with an inclination with respect to the horizon line of 39,4 degrees, that can lead to the supposition that the scene had been “registered” a day of April at afternoon (maybe the 1st of April at 4:20 p.m.).

Therefore, the analysis of light is an additional confirmation that the variation hypothesised by Canaletto, beginning with the Palladian idea, is not without motivation. It had foreseen a terracing set against a façade on three levels on the right part of the courtyard, in place of a path of a singular level of lateral aisles. Canaletto, in fact, modifies Palladio’s intention with the intent to give more vertical slant to the work, but above all to provide his “virtual” scene with the correct light exposure that permits an optimum illumination of the architectural structure and of the people that, in 18th century dress, animate the ambience.

## Acknowledgements

The author wants to acknowledge Prof. Anna Sgrosso of the University of Neaples “Federico II” and Prof. Agostino De Rosa of the Faculty of Architecture of the University IUAV of Venice.

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