

2D/3D Producing Illusion

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Landscapes Coleção
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2D/3D . PRODUCING ILLUSION

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The inconsistent images of Piranesi's *Carceri*: filling the gap between 2D and 3D representation

ABSTRACT

Many artists over the centuries have used inconsistent images, and G.B. Piranesi is one of them. The research proposes a method to investigate the ambiguous spaces of the *Carceri*, based on the integration of architectural, perspective, and perceptual interpretations, which allows the three-dimensional reconstruction of these spaces. Piranesi's mastery in the art of perspective allowed him to insert impossible figures and hide them simultaneously, alternate rationality and incoherence in a balanced way, and leave the observer the task of putting together the fragments of an insoluble puzzle.

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Introduction

Inconsistent images, also known as impossible figures, are ambiguous representations that can be imagined and drawn but cannot have a concrete, tangible form. Impossible figures relate to space in a *dialetheical* manner (Priest and Berto 2018) since they can be simultaneously true and false, depending on whether they are considered in 2D or 3D, respectively. They exist because visual signals and spatial clues provide contradictory information. Bruno Ernst proposes a classification that divides them according to the three main signals most commonly used: the covering and joining of planes, their continuity, and their orientation (Ernst 1986: 36–38).

Many artists have made more or less overt use of inconsistent images over the centuries, and Giovanni Battista Piranesi is one of them. In his *Carceri*, both in the first edition (1749/50) and in its reworking (1761), the Venetian engraver plays with space and perspective, contextualising a series of impossible figures¹.

Due to the perspective and spatial peculiarities of Piranesi's representations, perspective restitution is not feasible to achieve the goal of 3D space modelling.

The present research intends to propose an investigation method of the ambiguous spaces of the *Carceri*, based on the integration of architectural, perspective, and perceptual interpretations, which allows the three-dimensional reconstruction of these scenes.

Plate VIII, which did not undergo any architectural changes between the first and second editions, is examined among the various plates with spatial ambiguities. The group of two pillars (one of which with the portal) seems to have the side faces on the same plane if observed in the upper part. If observed in the lower portion (including the staircase), the pillars appear to be at different depths: the one on the right with the portal seems to be further forward than the other. The impossible figure “hidden” in plate VIII shows a plane that appears to be simultaneously placed at two different distances without having geometric discontinuities. This effect is obtained through the interposition of an element with determined volume and depth (in this case, the staircase), which cancels the flatness of the previously flat face [Figure 1].

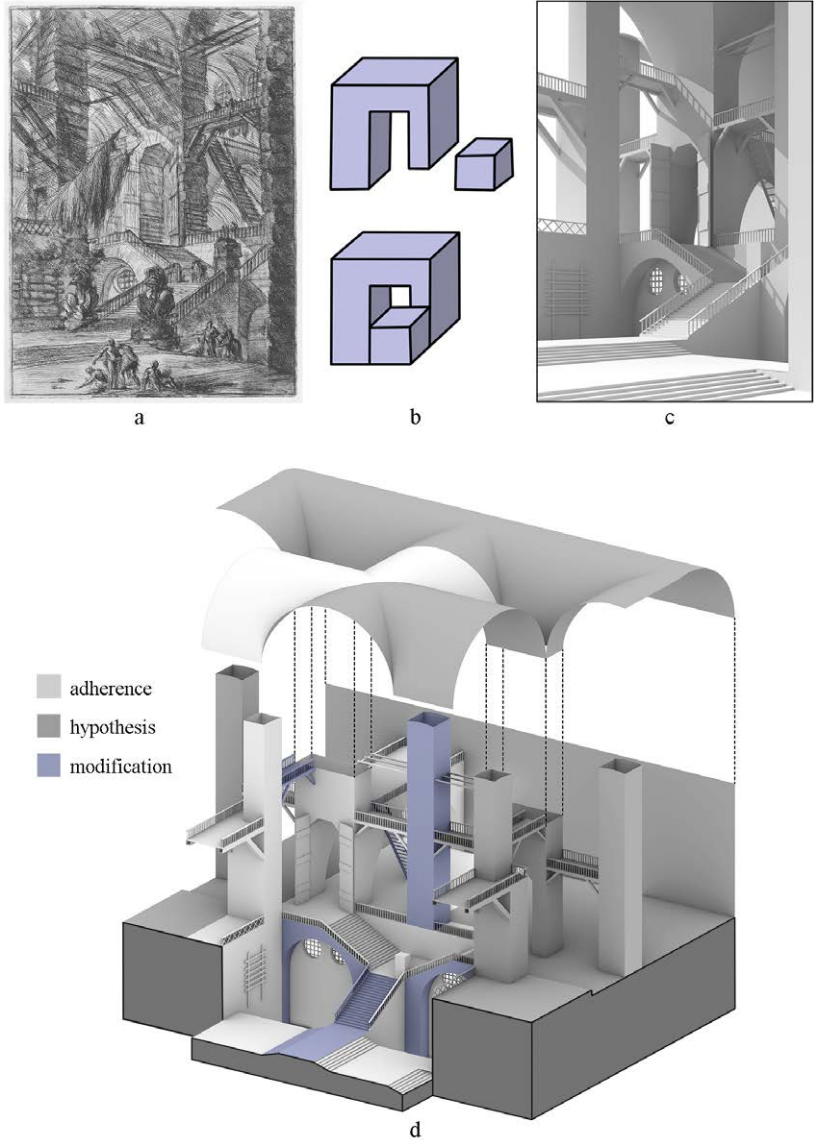
Methodological aspects and their application

The proposed method exploits the integration of knowledge from different areas of study (architecture, perspective, and perception), which, thanks to their interrelation, allows the reconstruction of the

Figure 1

From the etching to the 3D reconstruction:

- a Plate VIII of Piranesi's *Carceri*;
- b Schematisation of the inconsistent image introduced by the engraver;
- c Rendered view of the 3D model from the projection centre;
- d Axonometry of the reconstructive 3D model, highlighting the parts that show adherence to Piranesi's drawing, the hypothesised parts, and the modified ones.



space represented in the plate VIII of the *Carceri*. The aim is to fill the gap between the 2D and 3D representation of inconsistent images.

Architectural interpretation. Perspective images can only evoke configurations known to the observer, so knowledge of architecture is essential when choosing functional elements to base the restitution (e.g. triorthogonal elements) (Baglioni *et al.* 2016: 1029–1030).

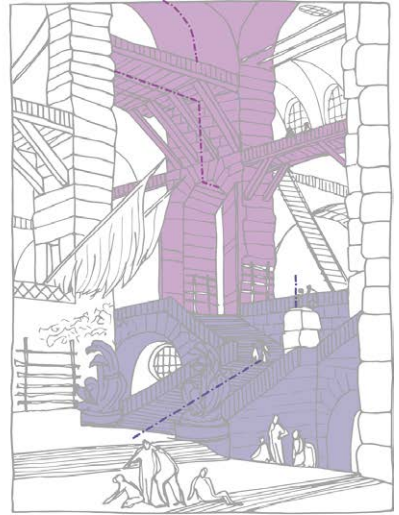
Inspired by the method of graphic analysis of architecture, consolidated in the Roman School since the 1950s (Fasolo n.d.), the architectural values traced in the perspective image are selected. The drawing of architecture is the medium through which the analyses are conducted. In this case, the drawing

Figure 2
Architectural interpretation of plate VIII. Some examples of drawings for graphic analysis:

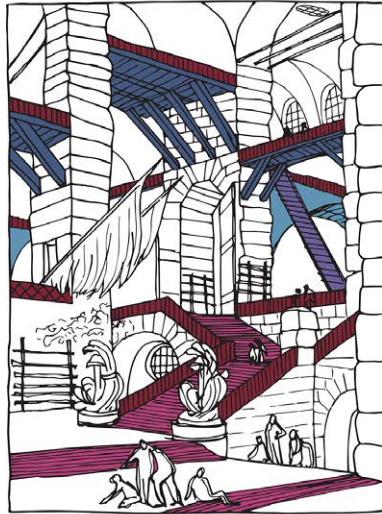
- a Mass analysis,
- b Symmetry analysis,
- c Connections for the systematic analysis of recurring elements,
- d Openings for the systematic analysis of recurring elements.



a

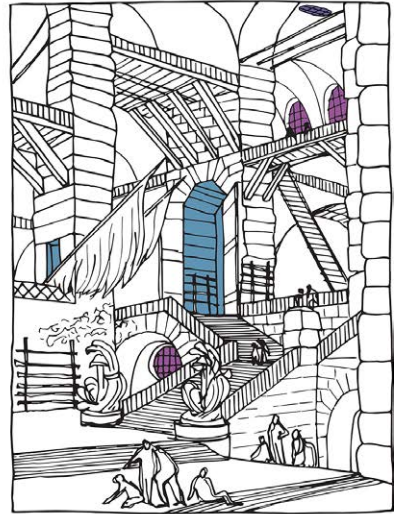


b



● balustrades ● staircase ● ladders ● walkways ● bridges

c



● circular windows ● lacunars ● doors

d

allows observations not on concrete architecture, as is the practice in typical graphic analysis, but on fantastic and immaterial architecture.

Following the principles of structuralism, which considers the work (literary texts, paintings, architectures) as an organic whole that can be broken down into elements and units, different levels of analysis are identified, whose functional value is determined by the set of relationships between each level and all the others. The decomposition of a complex space into more easily readable representations allows the modelling of the phenomenon.

The graphic analysis involves eight different types of investigation [Figure 2]:

- Re-drawing of the work
- Analysis of masses
- Analysis of the full/empty relationship
- Analysis of symmetries
- Analysis of proportional ratios
- Analysis of structures (arches/beams, floors, pillars, masonry, trusses, vaults)
- Analysis of materials (stone, rope, metal, brick, wood)
- Systematic analysis of recurring elements (connections, openings, architectural furniture, anthropic environment, prison furniture).

The critical synthesis of the various levels of investigation lets to recompose the unity of space through its three-dimensional interpretation, as will be seen later.

The architectural interpretation of plate VIII suggests which elements are to model, excluding all those not participating in the spatial configuration. It also suggests the composition triorthogonality, the recognition of architectural elements and symmetries. The last two help present a hypothesis of the development of space that is not directly visible in the etching.

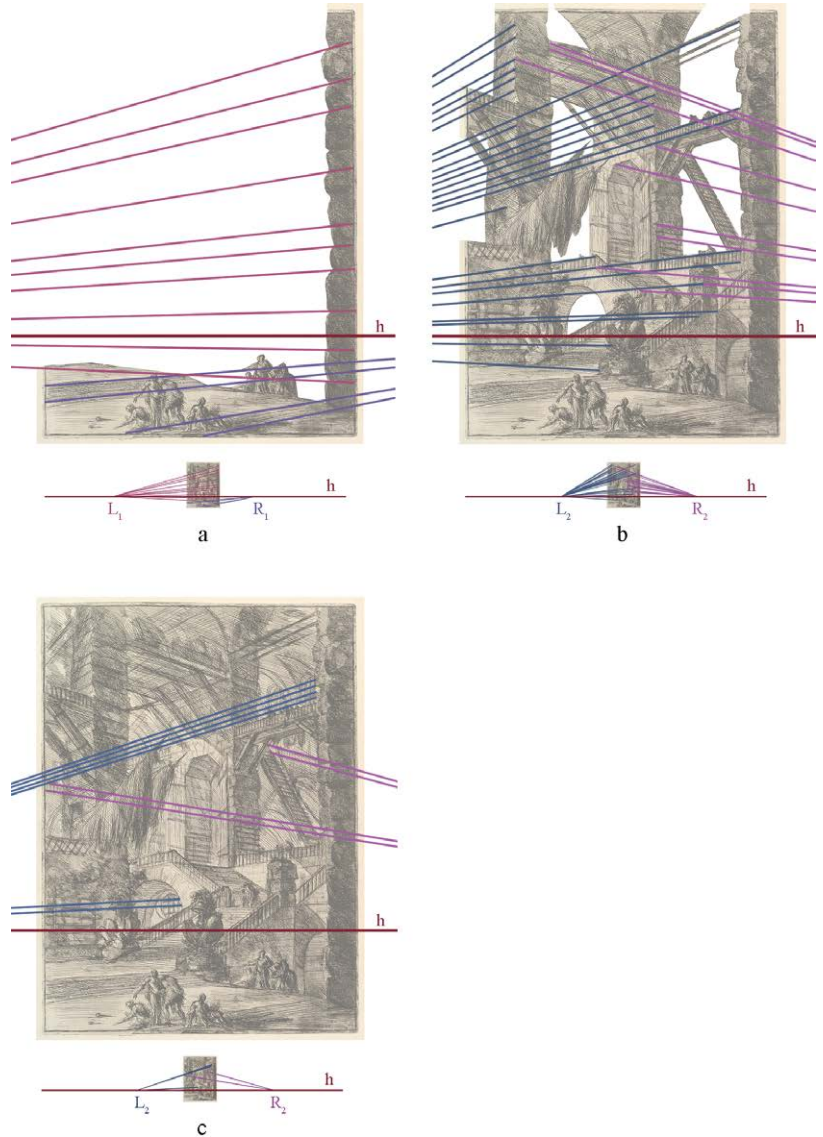
Perspective interpretation. After analysing and interpreting the space from an architectural point of view, we try to understand the spatial relationship of the represented objects, using, as far as possible, the tools of perspective restitution and the principles of stage design. The first one only allows to obtain general information on the perspective setting that the author chose for his work, which informs his communicative intentions. The idea of breaking down the plates into various planes at different depths, as if they were backdrops or stage flats, derives from stage design. In this way, it is possible to indicate the spatial relationship between the represented elements, at least in relative terms. This operation is carried out by searching for elements that define limits in the representation and identify space sectors at different distances from the observer. These segments of the representation can be characterised by different graphical and tonal treatments, through which the author creates the illusion of depth.

Therefore, perspective interpretation is based on the interrelationship between the decomposition of the image into depth planes and the perspective analysis of these individual planes, aiming to identify as much information as possible about the objects' point of view and spatial arrangement. In particular, what can be sought are the vanishing points of horizontal lines, through which the horizon line passes defining the height of the observer.

The plate VIII can be broken down into three depth planes [Figure 3]: the element framing the right margin in the foreground; the central architectural complex cannot be broken down into other planes as there are no visible continuity solutions between the elements; and the background.

Figure 3

Perspective interpretation of plate VIII. Analysis of the perspective setting of the three depth planes. For each depth plane (a, b, c), a construction detail (top) and the miniature of the complete construction (bottom) are shown. All lines running to the same vanishing point have the same colour.



According to the analysis of the perspective setting, these three depth planes share the same horizon h (that is not common in all the plates of the series). What varies are the vanishing points, both left (L_1, L_2) and right (R_1, R_2), of the elements in the first depth plane (L_1, R_1) compared to the other two (L_2, R_2). The non-coincidence of the vanishing points suggests a different orientation of the right margin wall in the foreground compared to the following architectural complex.

Perceptual interpretation. Assuming that the aim of the three-dimensional reconstruction of the perspective representations is to arrive at a space configuration closest to the one perceived by the observer, the third and final component of the proposed method is the perceptual interpretation of space.

The experimental method of perceptual interpretation proposed by this study is based on the processes of image decoding, which occur in the human visual system continuously and unconsciously, recorded through eye movements with the eye-tracking technique. Since the human maximum visual acuity is in the central region of the retina (*fovea centralis*), eye movements allow us to select what we are looking at clearly, and their recording is significant for perceptual purposes. An important study conducted at the end of the 1960s shows that the elements of largest fixation are those that the observer considers most useful for perception and understanding of the scene (Yarbus 1967).

Since looking at an artwork is influenced by the cultural variability of the observers, the experiment was conducted upon a reasonable sample of individuals (29) from different age and cultural backgrounds. Each of them was asked to look freely at the plate for 20 seconds before a webcam monitor, and eye-tracking was recorded through a software-based system. The free view let us understand whether, without any instructions, the areas that include spatial ambiguities are considered more than the others, as one would expect according to literature, or whether Piranesi managed to include ambiguities and to “hide” them in the composition at the same time. This information is important for the three-dimensional reconstruction, as it directs the modelling to pay more attention to those areas where fixations are most frequently focused. The test results includes an eye-tracking map in which warm tones are associated with the most observed areas of the plate [Figure 4].

The perceptual interpretation of plate VIII shows a pattern concentrated on the portal and the monumental staircase in the centre. Since the eye-tracking map shows few fixations in the upper part of the two pillars, it seems reasonable to assume that most observers did not notice the impossible figure introduced by Piranesi.

A reconstructive model of the space was obtained by combining the results of the architectural, perspective and perceptual interpretations. This model shows the same perspective as the etching when observed from the same projection centre. Clearly, the model and the etching are not perfectly coincident.

The 3D model shows different colours according to the elements directly taken from the Piranesian engraving (light grey), the elements modified for reasons of architectural and structural coherence (violet), and the elements hypothesised because they are not visible in the boundaries of the plate (dark grey) [Figure 1].

In order to solve the inconsistent image three-dimensionally, it was decided to follow the non-planarity of the side faces of the pillars suggested by the areas most observed during the perception test. Consequently, the width of the walkway connecting the two pillars, which is smaller than the engraved one, is modified, so it takes the width of the left pillar.

Figure 4

Perceptual interpretation of plate VIII. Eye-tracking map showing the pattern recordings of 29 individuals who freely observed the plate for 20 seconds.



Other changes were necessary for architectural and compositional reasons: on the first flight of the staircase, whose left balustrade diverges to make it wider and more imposing in the etching, on the arch supporting the second flight, which is not centred in the etching, and on the pillar in the centre of the right span, which was not on axis with the staircase.

Conclusions

The present research allows us to draw up a valid method in all cases in which the three-dimensional modelling of non-rigorous perspectives is to be achieved. The proposed method entrusts architectural interpretation with the understanding of the

represented architecture, perspective interpretation with the investigation of the spatial relationships of the architectural elements, and perceptual interpretation with the identifying of spatial relationship in the most ambiguous cases. None of these three fields, on its own, provides sufficient information for reconstruction, but together they allow to synthesise knowledge that supports the three-dimensional modelling and reconstruction process, basing it on data that is as objective and shared as possible. The outcome of the modelling represents one of the infinite possible reconstructions of plate VIII. It is not *the* reconstruction but *a* reconstruction because many variables come into play, and the biunivocity between the representation and the represented space is lost.

The application of the method on the plates of Piranesi's *Carceri* allows tracing a reasoned path of space reconstruction, pointing out in the 3D model the areas of greater and lesser adherence to Piranesi's drawing.

The study highlights the extent to which the *Carceri* are visions, images. They are not the result of a project, of the rational space prefiguration. They still and forever belong to the embryonic phase of the idea, which, brought to maturity through a spatial project, becomes architecture.

Therefore, the work that this research undertakes belongs to that phase of the prefiguration process that transforms Piranesi's images into architecture based on the clues that the engraver left in his works.

Piranesi's mastery in the art of perspective allowed him to insert impossible figures and hide them in the composition at the same time, to alternate rationality and incoherence in a balanced way, so that the observer is left with the appearance of a logic regulating the total scheme: "*piecing together the fragments of an insoluble puzzle*" (Sekler 1962, 335).

Notes

1. Ulya Vogt-Göknil is the first to have analysed graphically what she considers “the most daring structures” of the *Carceri* (plates VII, XIV and XV) [Vogt-Göknil 1958].

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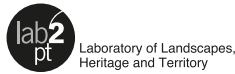
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On the 27th and 28th of May 2021, in the midst of pandemic restrictions, a group of artists and researchers managed to meet in Porto. For two days, under the initiative of mala voadora and Lab2PT, they enjoyed discussing illusion: linear perspective since its invention until its entailment under new technologies, and a wide variety of representation systems, practices and epistemological positioning that somehow converge within the production of visual illusion. This book bears witness to what happened there.

The Landscapes, Heritage & Territory Collection promotes the publication of texts in the Research, Essay and Catalog lines, under the seal of Lab2PT with the aim of promoting the circulation and dissemination of their scientific production within the main areas of the R&D unit—Archeology, Architecture & Urbanism, Design, Geography, Geology, History and Visual Arts.