The Square as Threshold and Interstice: Representing the System of Squares in the Historic Centre of Genoa Between Survey, Memory, and Digital Perception

The historic centre of Genoa is a dense and layered urban fabric in which squares function as threshold spaces, capable of connecting, articulating, and transforming spatial experience within the narrow network of alleyways. This article presents an integrated analysis of Genoa's historic squares by combining digital surveying, 3D modelling, historical visual studies, and perceptual observations. Drone-based and photogrammetric surveys enable us to grasp the irregular shape of the squares and how buildings and open spaces relate to one another, revealing a network of interconnected places that structure the urban fabric. At the same time, the study of historical images, photographs, and narratives highlights the symbolic and identity-forming dimensions of these spaces, while the use of ephemeral and augmented technologies (light installations, projections, AR) reveals new ways to reanimate public space temporarily. The text wraps up by suggesting a multi-level method of representation that unites exact metrics, visual recall, and perception through digital means. Through this joining, the square, seen as a place of gap, becomes a special site for looking into, understanding, and rethinking the new city land.

Keywords: *Urban Thresholds, Digital Surveying, 3D Representation, Perceptual Analysis, Historic Urban Spaces*

Introduction

The research presented in this contribution is multidisciplinary and addresses the complex theme of analysing historic squares from multiple perspectives. The overarching objective is to achieve an articulated understanding of these spaces, obtained through investigations that, while adopting specific methodologies, converge in an integrated interpretation in the conclusions. In particular, the work is structured around three principal axes:

- Theories and representations of the square as threshold/interstice;
- Surveying and digital representation of the case studies: Piazza Giustiniani and Piazza San Bernardo;
- Augmented perceptions and ephemeral transformations of public space.

The historic centre of Genoa constitutes a privileged laboratory for investigating the relationship between urban form, memory, and perception. Its dense, fragmented structure, composed of glimpses, spatial backdrops, slopes, and sudden openings, defines a complex, stratified spatiality. Here, the square is more than just an area between the fronts of buildings; it is a threshold in its own right: a site where pace diminishes and then picks up again, where links and breaks happen at once, and where the town reveals itself through the dance of

1 light and dark, openness and closure, closeness, and shared living.
2   Interpreting the square as an interstice means shifting the focus from the
3 physical perimeter to relational space, where perception, rather than
4 measurement, becomes the criterion for understanding. The concept of liminality,
5 developed in anthropology and taken up in recent urban design studies (Hou,
6 2010; Thibaud, 2011), offers a key for analysing the transitional and ambiguous
7 nature of these spaces, suspended between continuity and discontinuity.
8   The article aims to investigate the squares of Genoa's historic centre as
9 spatial, perceptual, and cultural devices, interpreting them not as simple urban
10 voids but as threshold spaces capable of structuring relationships among the
11 different levels of the medieval urban fabric: architectural, urban, symbolic, and
12 perceptual. Through the integration of digital surveying, 3D modelling, and
13 visual memory analysis, the study seeks to:
14
15   - describe and understand the complex morphology of historic squares and
16   their relationships with the system of alleys;
17   - capture the perceptual dynamics through which these sudden openings are
18   experienced and interpreted by contemporary users;
19   - explore how ephemeral and augmented representations temporarily
20   transform the meaning of urban spaces;
21   - propose an integrated methodology for documenting and interpreting the
22   spatial and symbolic complexity of historic places.
23
24   In summary, the article aims to demonstrate how the square, understood as a
25 threshold and interstice, can be analysed and represented only through a
26 multidimensional approach that interweaves metric data, perceptions, memories,
27 and narratives.
28
29
30 **Theories and Representations of the Square as Threshold/Interstice**
31
32 *Theoretical Premise*
33
34   Since its origins, the square has been the quintessential urban space of
35 relation and transition. Far from being a simple geometric void within the built
36 fabric, it is configured as a threshold device, a place where passages, exchanges,
37 encounters, and perceptual shifts condense. Its liminal nature, suspended
38 between inside and outside, continuity and discontinuity, makes it a fundamental
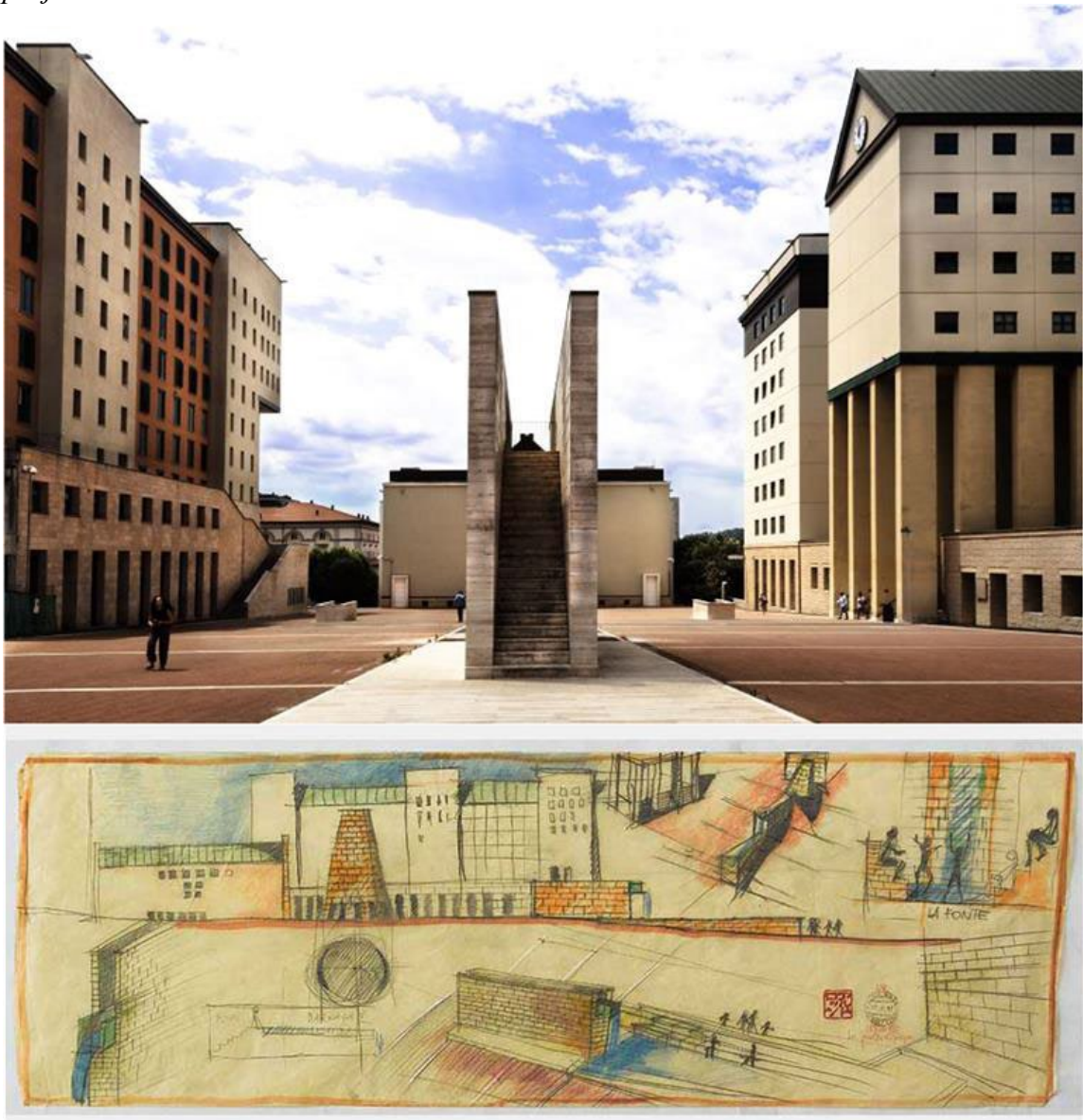39 element in the construction of urban experience.
40   In his essay Atmospheres (2006), Peter Zumthor identifies the sensorial
41 quality of architectural spaces as the key to understanding how they "act" upon
42 the body. Atmosphere emerges from the intertwining of light, material, sound,
43 and temperature, translating into an immediate, almost pre-reflective perceptual
44 form. Interpreted through this lens, the square becomes a field of environmental
45 forces: the point at which the body perceives distinct variations in luminosity,
46 visual openness, and acoustic resonance, transforming the passage from one

1 space to another into an intensified experience. Zumthor's idea that "an
2 atmosphere is the form in which space touches us" proves particularly effective
3 in reading what occurs when one emerges into sudden light after the darkness of
4 a Genoese alley.
5   In parallel, Marc Augé's distinction between places and non-places (Non-
6 Lieux, 1992) allows the square to be interpreted as a threshold connecting two
7 different spatial registers: on the one hand, the sedimented identity of the historic
8 fabric, with its enduring forms and social relations; on the other, the more fluid
9 dimension of contemporary movement, rapid circulation, and tourism. In this
10 sense, the square becomes a point of symbolic crossing between dwelling and
11 flow, recognisability and transience, memory and immediate experience.
12   A further interpretative layer is offered by Aldo Rossi's contribution in The
13 Architecture of the City (1966). For Rossi, the square is an "urban fact," a form
14 that resists functional transformations and expresses the continuity of the city
15 through its physical memory (see Figure 1). As a typology, the square carries
16 meaning: it is a palimpsest in which historical stratifications emerge not only in
17 architectural forms but also in collective habits, social rituals, and repeated uses.
18 This character of permanence, typical of Genoese squares, allows them to
19 continue generating urban identity while adapting to economic and social
20 change.
21
22

1 **Figure 1.** *Image of Piazza Nuova di Fontivegge and preparatory sketch of the*
2 *project*

3
4 *Source: © EREDI ALDO ROSSI, COURTESY FONDAZIONE ALDO ROSSI*
5

6   Lastly, the phenomenological interpretation suggested by Christian
7 Norberg-Schulz in Genius Loci (1979) introduces an existential aspect: the
8 square as the site where the essence of the city becomes apparent through the
9 connection between physical space and lived experience. From this viewpoint,
10 the threshold is not just a tangible limit but also a moment of insight. The passage
11 from the compressed intimacy of the caruggi[1] to the luminous openness of the
12 square stages what Norberg-Schulz defines as the "figure" of the place, its
13 capacity to be recognised and to welcome. The square thus becomes the

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[1]Typical name for the narrow streets of Genoa's historic centre.

1 symbolic horizon in which the Genoese Genius Loci is disclosed, in the
2 encounter between matter, light, and collective memory.
3
4 *Squares as Cultural Constructs and Sedimentations of Meaning*
5
6   Genoese squares were never designed as unified spaces; instead, they
7 emerged through processes of accumulation and transformation. The engravings
8 by Piranesi, the nineteenth-century views by Rubens and Alizeri, and early
9 twentieth-century historical photographs show how each square gradually
10 acquired symbolic meaning, often more narrative than strictly architectural.
11   Piazza Banchi, for example, is configured as an urban theatre in which the
12 verticality of the façades engages in dialogue with the depth of the arches of the
13 Loggiato; Piazza Soziglia, by contrast, functions as a node of crossings, where
14 perception is compressed, almost tactile; Piazza Campetto represents a social
15 microcosm, while San Lorenzo constitutes the monumental threshold between
16 the mercantile city and the liturgical city.
17   Alongside the historical reading, the research opens onto a perceptual and
18 affective dimension: how is the square experienced today? What is perceived in
19 the transition from the shadows of the caruggi to the luminous openness of public
20 space?
21   Through interviews, exploratory walks, and photo-elicitation techniques,
22 mental maps and visual narratives are collected that convey the diversity of
23 experiences. In these representations, the square emerges as a "perceptual
24 pause," a place of breathing and collective recognition, but also as a threshold of
25 passage, where time and memory condense.
26   The historic centre of Genoa constitutes an emblematic case of dense and
27 stratified spatiality. The morphology of the caruggi, a fabric of winding paths,
28 slopes, and sudden glimpses, produces a system of solids and voids in which the
29 square appears as an episode of discontinuity.
30   Unlike Renaissance squares, defined by regular proportions, Genoese
31 squares are generated through successive additions, as contingent outcomes of a
32 compact medieval fabric. This irregularity produces interrupted axes and partial
33 views: each opening becomes a perceptual event (see Figure 2).
34   From a historical perspective, the network of squares, from Banchi to San
35 Lorenzo, from Campetto to Soziglia, takes shape as a sequence of thresholds
36 between the mercantile, religious, and residential city. Since the Middle Ages,
37 squares have functioned as places of exchange and civic representation: the
38 Loggia of Banchi as a centre for negotiations, San Lorenzo as the symbolic core,
39 and Campetto and Soziglia as spaces of everyday life and minor commerce.
40   The building density and the material continuity of the urban fabric, slate,
41 brick, and painted plaster shape a tactile perception of space: the transition from
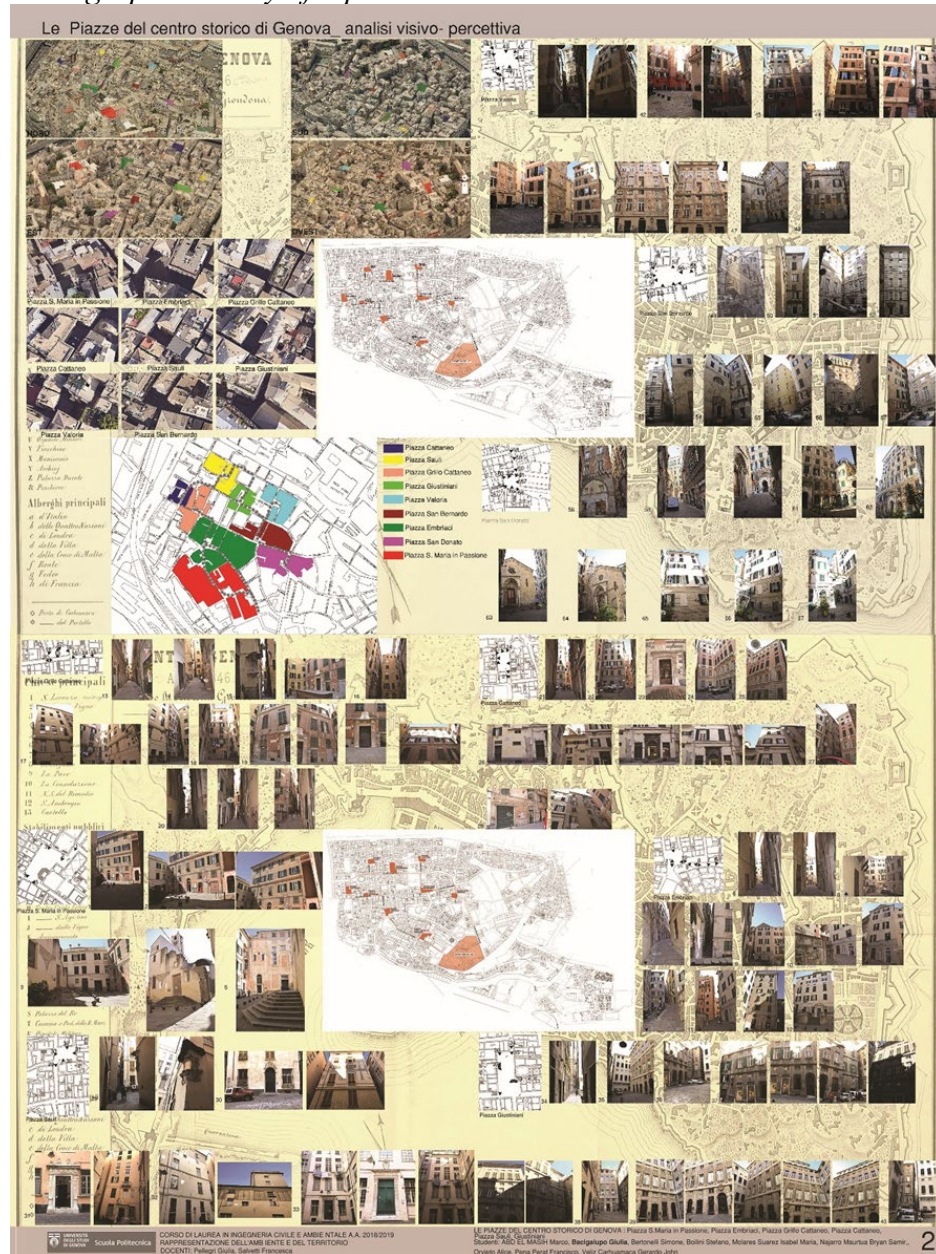42 the alleys' penumbra to the square's light constitutes a true sensory leap.
43   The Genoese square exists not only as a physical space but also as a shared
44 image. Since the eighteenth century, engravings, views, and photographs have
45 contributed to the construction of its collective imaginary.
46   The prints by Giacomo Domenico Ferretto and the nineteenth-century views

1 reproduced by Alizeri convey a dynamic urban landscape, in which squares
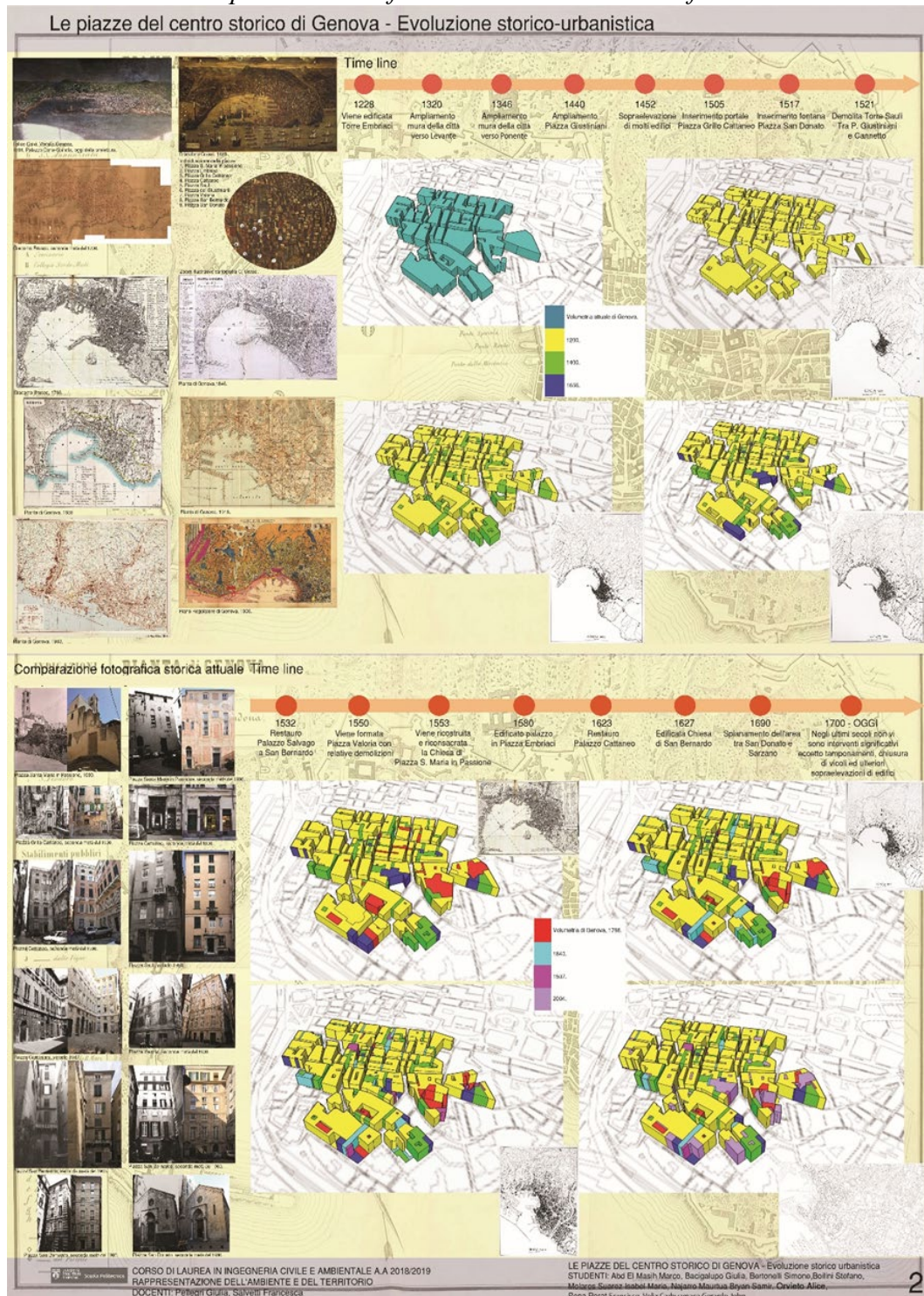2 appear as theatres of everyday and mercantile life.
3   Representation, in this sense, is not neutral: as Corboz observes (The
4 Territory as Palimpsest, 1983), every image is a rewriting that stratifies times
5 and meanings.
6
7 **Figure 2.** *Visual Perceptual Analysis of the Squares in the Historic Centre of Genoa.*
8 *Cartographic Framework. Satellite and Panoramic Views. Visual Perceptual*
9 *Photographic Survey of Square Accesses*

10
11 *Source: Author's image with materials produced during the Environment and Territory*
12 *Representation - Department of Civil, Chemical and Environmental Engineering UNIGE –*
13 *Teachers Prof. Giulia Pellegri, Prof. Francesca Salvetti*
14

1 **Figure 3.** *Analysis of the Historical–Urban Evolution of the Squares in the*
2 *Historic Centre of Genoa. Historical Cartographic and Iconographic*
3 *Framework – 3D Representation of the Historical Evolution of the Urban Fabric*

4
5 *Source: Author's image with materials produced during the Environment and Territory*
6 *Representation - Department of Civil, Chemical and Environmental Engineering UNIGE,*
7 *Teachers Prof. Giulia Pellegri, Prof. Francesca Salvetti*

1   Late nineteenth-century photographs, for example, those preserved in the
2 Photographic Archive of the Municipality of Genoa, document not only the
3 material state of places but also the gestures and uses that defined their meaning
4 (see Figure 3).
5   Alongside visual memory, the city keeps an oral and emotional memory:
6 popular stories, place names, and religious or commercial traditions tied to every
7 square make up mental maps. Such memories are part of a shared perception of
8 space in which daily life blends with history.
9
10 *Perceptual and Symbolic Interpretations*
11
12   The square makes itself known to the body through a series of changing
13 senses that set in motion an active perceptual process. The move from the narrow
14 passage to the bright space is a boundary where the body faces rapid shifts in
15 brightness, sound density, material qualities, and air temperature. These changes
16 in perception, differences in rhythm, sound pressure, and light bouncing off
17 surfaces, turn coming into the square into an event composed of tiny experiences
18 that overlap and connect.
19   In line with this perspective, the idea presented by Peter Zumthor
20 concerning atmosphere (Atmospheres, 2006) serves as a crucial interpretative
21 key: the square is not only defined by its measurements or shape but equally by
22 the ability of its physical parts to create a general feeling expressed as an
23 emotional "tone". Atmosphere thus becomes a perceptual field, an ensemble of
24 sensory qualities that do not reside in a single element, but emerge from the
25 relationship between body, light, matter, and sound.
26   Meanwhile, Jean-Paul Thibaud's theory on the sensory fabric of urban
27 ambience (2021) argues that seeing and feeling city space result from a synthesis
28 of the senses over time. The square is not merely a place on a map but rather a
29 medium for experience configuration through displacement, stoppage, audition,
30 and orientation. Ambience, understood as a sensory fabric, allows the square to
31 be grasped as a situation rather than as a static form: an environment in constant
32 transformation, influenced by human presence, activities, and climatic
33 conditions.
34   The idea of the palimpsest, proposed by André Corboz in his work Le
35 territoire comme palimpseste in 1983, fits very well with the Genoese context,
36 as every square shows imprints of use, function, and transformation layered over
37 time. Within the built fabric, markets and religious celebrations, along with
38 episodes of demolition and reconstruction, restorations, and contemporary
39 regeneration interventions, are sedimented to make every square a surface of
40 memory where the past does not vanish but re-emerges in new configurations
41 each time.
42   Henri Lefebvre tells us in The Production of Space that urban space is
43 socially produced: it is not a neutral backdrop for activities but rather the result
44 of all practices, representations, and symbols that society projects onto it.
45 Therefore, the square becomes a meeting place for conflicts and identities, as
46 well as for everyday rituals, local economies, and collective representations. In

1 this sense, the threshold cannot be reduced to a physical boundary between two
2 spaces, but must be interpreted as a field of social interaction: a space in which
3 perception is a cultural practice, and in which what happens, sounds, gestures,
4 encounters, waiting, contributes to the construction of meaning. The square thus
5 becomes one of the primary devices through which a city such as Genoa
6 produces and renews its identity.
7
8 *Synthesis*
9
10 The Genoese square, understood as a threshold and interstice, is configured
11 as an urban device capable of mediating between past and present, between
12 structural permanences and transformations of use. In the process of change, it
13 keeps the ability to produce a sense of place because of its twofold character: on
14 one side, a solid physical location; on the other, a changing platform for
15 community activities. This ongoing presence amid breaks in continuity keeps the
16 square one of those spots where the old town forever refreshes its significance,
17 even as it undergoes changes in shape, use, and how people see it.
18 In this context, representation plays a crucial role. Historical images, prints,
19 watercolours, perspective views, and photographs have, over the centuries,
20 contributed to the formation of a collective imaginary of the square, transforming
21 it into an icon of urban recognisability. Graphic and pictorial representations
22 have documented their formal transformations; photography, from the late
23 nineteenth century onward, has interpreted their luminous and material
24 relationships, revealing the social density and atmosphere of place. Today, these
25 materials constitute a true narrative heritage, through which it is possible to read
26 not only the physical history of squares, but also their perceptual history.
27 At the same time, contemporary techniques of survey and representation,
28 from digital photogrammetry to laser scanning, from 3D models to immersive
29 reconstructions in augmented reality, offer new possibilities for understanding
30 and interpretation. Digital surveying, in particular, makes it possible to analyse
31 squares as complex systems, highlighting spatial relationships that are difficult
32 to perceive with the naked eye: volumetric variations, light gradients, visual
33 fields, access thresholds, and dynamic perceptions linked to movement.
34 3D modelling enables the superimposition of different layers of information,
35 morphology, use, and perception, transforming the square into a dynamic
36 archive. Immersive experiences and the use of augmented reality further open
37 up the possibility of bringing to light narrative dimensions that no longer belong
38 solely to historical memory, but also to augmented memory: a memory
39 constructed through new languages, new technologies, and new modes of
40 fruition.
41 Through these practices, the square continues to function as a narrative
42 space, a place that is not only observed but also told. In its forms of
43 representation, ancient and contemporary alike, the city recognises itself,
44 rediscovers its stratifications, and constructs ever new interpretations.
45 Representation, therefore, does not merely reproduce what exists but
46 becomes a critical device capable of revealing latent potentials, tensions, and

1 meanings. In this way, the Genoese square, in its condition as threshold and
2 interstice, is confirmed as a privileged laboratory for understanding the
3 complexity of the urban landscape and for imagining its future transformations.
4
5

6 **Digital Survey and Representation of the Case Studies: Piazza Giustiniani**
7 **and Piazza San Bernardo**

8

9 *Methodological Introduction*

10

11 Architectural and urban surveying, understood in its broadest sense, is a
12 cognitive process that enables the translation of spatial experience into
13 measurable and representable knowledge. As stated by Docci and Maestri,
14 surveying is "a global cognitive operation" that encompasses observation,
15 selection, measurement, and representation, and is configured as a critical act
16 that interprets reality through drawing (Docci, Maestri, 1994; 2020). From this
17 perspective, surveying emerges as an indispensable and interdisciplinary tool for
18 understanding complex spatial systems, especially in densely stratified historical
19 contexts such as the historic centre of Genoa. In such settings, measurement does
20 not end with the objective recording of dimensional characteristics but instead
21 involves an interpretative process that selects, orders, and conveys settlement
22 logics, morphological permanence, and the dynamics that have shaped urban
23 form over time. Architectural surveying constitutes, according to Pellegri and
24 Salvetti, a "complex design act that integrates historical, perceptual, and
25 technical-metric competences, in which restitution is never a mere translation of
26 data but a critical interpretation of built space" (Pellegri, Salvetti 2019).
27 This approach is particularly relevant today, at a time when the tradition of
28 drawing from life is integrated with the potential of advanced digital techniques.
29 Surveying not only documents the existing condition, but also provides the
30 metric and informational basis for reconstructive and design-oriented operations.
31 These include the simulation or reprojection of decorative apparatuses that are
32 lost, degraded, or temporarily concealed by construction works. In this sense, the
33 digital representation of squares and their building fronts serves as an
34 experimental platform for controlled scenarios of the reintegration of painted
35 decorations, in continuity with previous experiences in the cataloguing and
36 digitalisation of historic façades in the centre of Genoa (Pellegri, Salvetti, 2020).
37 This approach aligns with the critical digital model theorised by Apollonio,
38 Fallavollita, and Foschi, in which the 3D model integrates data, sources, and
39 hypotheses and explicitly communicates the degree of uncertainty in
40 reconstructions (Apollonio et al., 2019; 2023).
41 Urban spaces, streets, intersections, widening points, and squares follow one
42 another without interruption and differ in form, scale, function, and
43 environmental character. Each urban space is the result of a stratification of signs
44 produced by human action to adapt the city to changing ways of life. The specific
45 configuration of the squares in Genoa's historic centre, characterised by small
46 dimensions, irregular layouts, and strong relationships with surrounding building

1 fronts, requires a context-specific, carefully calibrated methodological approach.

2 In the Genoese case, many small-scale squares originated as extensions of
3 noble palaces, true spaces of representation that over time have lost part of their
4 original function, undergoing processes of decline and transformation of use.
5 Piazza Giustiniani and Piazza San Bernardo belong to this category of urban
6 micro-spaces, generated by the widening of medieval caruggi and consolidated
7 by religious architecture and noble palaces. Their form results from incremental
8 processes, successive adaptations, and proportional relationships that do not
9 respond to preordained compositional criteria but rather to logics of growth and
10 progressive transformation.

11 These spaces, therefore, cannot be understood exclusively through a
12 planimetric reading. An analysis is required that can restore the relationship
13 between spatial form, the height of building fronts, the perceptual sequence of
14 access to the squares, the articulation of surfaces, variations in level, the interplay
15 between solids and voids, and contemporary uses. In the present study, this
16 analysis must also provide a sufficiently accurate digital basis to enable
17 operations of projection and "reactivation" of painted decorations, both when
18 they are still present but in a severe state of degradation, and when they have
19 been lost and can only be reconstructed through documentary sources or
20 typological analogy.

21 Within this framework, preliminary knowledge operations play a decisive
22 role. Even before instrumental measurement, surveying is grounded in an
23 exploratory phase that includes perceptual sketches of the square, façade
24 eidotypes, and historical, cartographic, and iconographic investigations to
25 critically guide the subsequent instrumental survey campaign[2]. As earlier studies
26 on the relationship between advanced surveying and knowledge for conservation
27 show, this phase represents the crucial starting point that guides the entire
28 process of measurement and representation (Pellegri & Salvetti, 2019). Only
29 through a careful and interpretative reading of space can the instrumental survey
30 be appropriately designed, relevant viewpoints selected, and the main
31 documentary priorities clearly identified (see Figure 4).

32 This cognitive dimension is integrated with advanced digital systems that
33 enable the acquisition and modelling of urban space complexity with a level of
34 precision unattainable by traditional techniques alone. The coordinated use of
35 terrestrial laser scanning (TLS), SLAM-based mobile mapping, high-resolution
36 terrestrial photogrammetry, and aerial photogrammetry makes it possible today
37 to address in a unified manner the documentation of narrow, irregular spaces
38 characterised by strong geometric discontinuities, overcoming the visual
39 limitations imposed by caruggi and high building fronts. The acquisition
40 techniques employed in digital surveying should not be interpreted as alternative
41 tools, but as components of a single cognitive process. Each technology, from
42 terrestrial and UAV photogrammetry to static laser scanning and SLAM

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[2]Perceptual sketches fix spatial relationships, lighting conditions, and regimes of visibility; eidotypes record proportions, anomalies, decorative details, and material–chromatic configurations; historical, cartographic, and iconographic investigations support the reconstruction of transformations and the identification of gaps or lost elements.

1   systems, produces a specific type of information, with different metric
2   resolution, radiometric density, and spatial readability. The integration of both
3   approaches allows us to surpass the inherent limitations of each technique,
4   particularly in challenging urban environments such as the historic centre of
5   Genoa. In such locations, with geometric discontinuities, high building façades,
6   and restricted visual openings, a strategy that utilises multiple sources is
7   essential. Recent literature confirms that the fusion of heterogeneous sensors is
8   now necessary to obtain complete and reliable 3D models. As emphasised by
9   Vosselman and Maas, the documentation of historic urban fabrics requires a
10   multilevel strategy in which data from heterogeneous sensors are fused within a
11   single coherent model[3] (Vosselman & Maas, 2010).

12   As noted by Remondino and confirmed by studies conducted on digital
13   representation through advanced surveying techniques[4] (Salvetti, 2024), the 3D
14   documentation of heritage requires the hybridisation of different methods, since
15   no single technology is sufficient to capture the complexity of historic
16   architecture and its surfaces (Remondino, 2011). In particular, recent
17   experiments in the documentation and restoration of frescoed surfaces show how
18   the integration of high-resolution photogrammetry and terrestrial laser scanning
19   (TLS) makes it possible to combine metric and radiometric accuracy, an
20   essential condition for degradation mapping, diagnostic analysis, and the
21   simulation of pictorial reintegration interventions (Bruno et al., 2022).
22
23

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[3]By multisensor integration we mean the alignment and co-registration of heterogeneous datasets (TLS/static point clouds, SLAM point clouds, dense photogrammetric clouds), with metric congruence checks performed through targets and/or control points, leading to the construction of a single, coherent geometric reference system.

[4]The observation is based on the results of the activities carried out during the research fellowship conducted in 2022/2023, titled "Digital representation through advanced surveying. Documentation, enhancement, and educational processes for heritage through digital innovation", at the Department of Architecture and Design, University of Genoa, under the scientific supervision of Prof. Giulia Pellegri.

Figure 4. *Knowledge-Based Investigations of Piazza Giustiniani. Cartographic Framework – Visual–Perceptual Survey of Square Accesses – Aerial Photogrammetry of the Roofscapes of the Buildings Facing the Square – Bottom-Up Analysis of the Square's Spatial Enclosure with Perspective Effects of Urban Space*

Source: Author's image with materials produced during Representation Laboratory 2 - Department of Architecture and Design UNIGE – Teachers Prof Giulia Pellegri, Prof Francesca Salvetti

The integrated and multilevel nature of digital surveying, based on the combination of heterogeneous data and on the need for a simultaneously metric and perceptual reading of urban space, is consistent with the most recent experiments conducted on the historic fabric of Genoa. In these studies, the interaction among photogrammetry, laser scanning, and chromatic analysis has demonstrated how surveying can function as both a cognitive and interpretive device and a documentary one (Pellegri, Eriche, Scaglione, Castaldi, Salvetti, 2022).

This methodological framework constitutes the implicit reference for the experiences carried out in Piazza Giustiniani and Piazza San Bernardo, in which digital surveying is conceived from the outset as a support for future scenarios of representation and re-projection of painted decorations (Eriche, Salvetti, Scaglione, 2019).

Methodology and Tools of Integrated Surveying

The methodological framework adopted for the survey of Piazza Giustiniani

and Piazza San Bernardo derives from a tradition of studies that places at its core the reading of urban spaces as a sequence of interconnected places, in which streets and squares alternate without interruption. Spaces are analysed as the outcome of a stratification of signs produced by human action in response to functional, social, and economic needs; surveying is therefore required to restitute both geometric characteristics and the perceptual and use-related aspects that define them.

In the present case, an additional objective is added to these aims: the construction of a reliable geometric and chromatic base on which to test, in digital form, hypotheses of reconstruction or reintegration of painted decorations on façades, both in cases of severe degradation and where historical sources allow the original configuration to be hypothesised with a reasonable degree of reliability. The 3D model thus becomes a platform for the controlled superimposition of reconstructed textures, light projections, or virtual environments, following an approach that, drawing on the concept of the critical digital model, aims to make sources, uncertainties, and possible variants always explicit (Apollonio et al., 2019; 2023).

The survey of the two squares was structured into three phases: survey design, instrumental survey, and data processing. A first framing phase involved the collection and analysis of historical, cartographic, and iconographic data, including consultation of historical and aerial cartography of the historic centre; examination of archival documents relating to the buildings facing the two squares; and the selection of iconographic materials (views, historical photographs) useful for reconstructing their transformations. This investigation made it possible to situate the case studies within the broader historical development of Genoese squares, highlighting the specific role of small noble squares, often linked to the trajectory of the families who generated them and to the subsequent decline following the relocation of residences towards the new nineteenth-century districts.

The second phase concerned the metric–geometric survey, articulated into a direct component and an instrumental component. Direct on-site surveying enabled the construction of an initial descriptive reading of the spaces through environmental sketches drawn on-site to fix the most significant viewpoints, preliminary planimetric and sectional schemes, and annotations on materials, colours, paving, lighting conditions, and state of conservation. This phase, already tested in other urban survey campaigns, proved decisive in selecting the portions of façades and decorative apparatuses on which to focus subsequent metric verification and pictorial reintegration simulations (Pellegri, Salvetti, 2019).
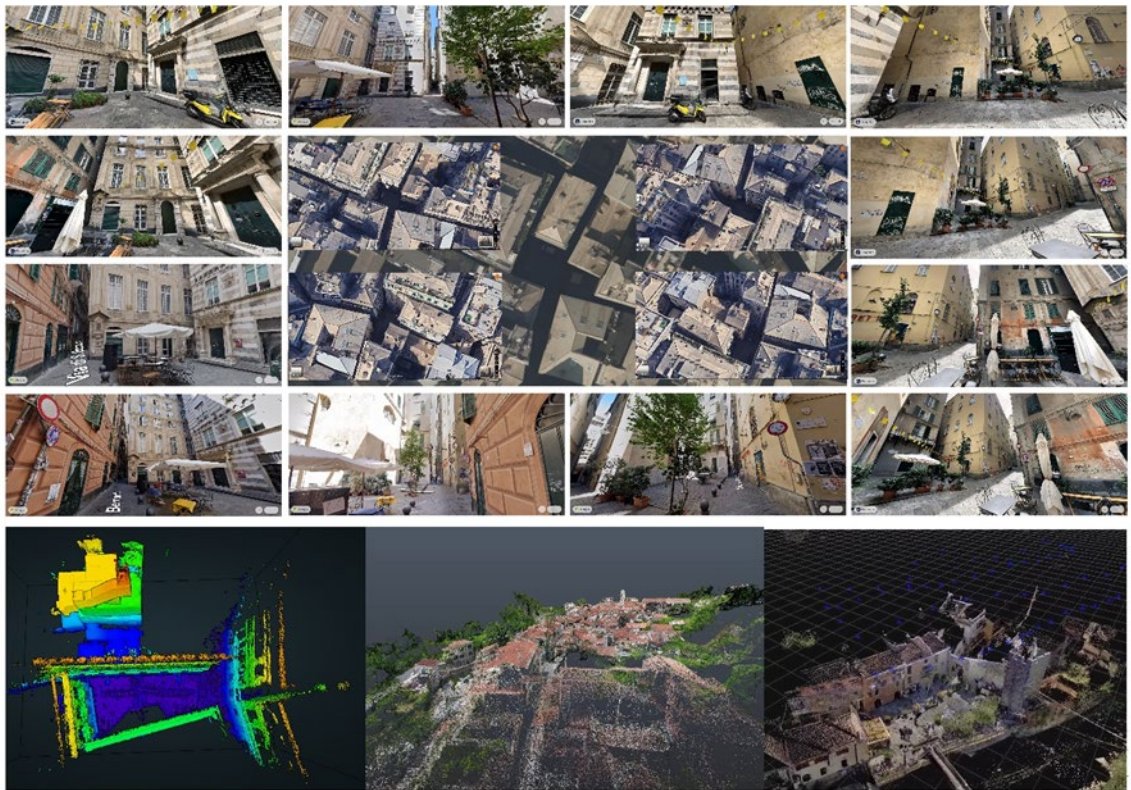
The instrumental component was structured around three integrated acquisition lines. UAV aerial photogrammetry was applied to both squares, supplying high-resolution planimetric bases for defining block outlines, roof configurations, and the overall geometry of urban voids, as well as for the restitution of façades and still-visible decorative elements. Flights were carried out using a multirotor drone at altitudes between 18 and 20 metres for roofs and at a maximum distance of 5 metres from façades, with serpentine trajectories and

1 adequate image overlap to ensure correct SfM processing.
2   Terrestrial laser scanning (TLS) was adopted in particular for the fronts
3 facing the squares, which produced high-density point clouds of the surrounding
4 building fronts, with specific attention to painted façades, mouldings, openings,
5 and masonry textures at higher elevations, which are difficult to read from
6 ground level without optical aids. Scan stations were positioned to cover the
7 entire perimeter of the urban space, minimising shadow zones and ensuring
8 surface continuity.
9   Mobile SLAM surveying, conducted along the access routes from the
10 caruggi to the squares, allowed the continuous acquisition of the volumetric
11 sequence of spaces according to the logic of a "survey in motion" that records
12 variations in cross-sections and façade heights along the path. This type of
13 survey proved particularly effective in capturing the transition from the linear
14 space of the alley to the widening of the square, a key element for the
15 interpretation of visual thresholds. (see Figure 5)
16
17 **Figure 5.** *Survey of Roofscapes through Aerial Photogrammetry; Photographic*
18 *Investigation of Pedestrian Access Routes to the Square with Identification of*
19 *Users' Actual Perception; Examples of Point Clouds Generated by Terrestrial*
20 *Laser Scanning and Mobile SLAM Surveying.*

21
22 *Source: Author's image*
23
24   All acquisitions were georeferenced using control points measured with
25 GNSS instrumentation and verified through a network of topographic targets.
26 The datasets were integrated in dedicated software environments (3DF Zephyr

1 Aerial, RealityCapture) using alignment, cleaning, and point-cloud fusion
2 procedures to construct a single 3D model for each square. These models form
3 the basis for subsequent morphological analyses and for the creation of a
4 comprehensive documentary framework to be explored in later spatial
5 perceptual investigations and in experimental digital reconstructions of painted
6 decorations, in continuity with other applications of advanced surveying to the
7 conservation and restoration of frescoed surfaces (Bruno et al., 2022).
8
9 *Photogrammetric and Aerial Photogrammetric Surveys of the Case Studies*
10
11 Piazza Giustiniani is a small open space of an almost rectangular shape, with
12 approximate dimensions of 12 × 26 metres, generated by the widening of an
13 ancient street layout in the heart of the historic centre. The space is dominated
14 by the Palazzo Marcantonio Giustiniani's frontage, which defines its character
15 as an almost "private" square, albeit one open to urban flows. The paving
16 preserves portions of historic brickwork, while the façades testify to a
17 stratification of interventions ranging from the amalgamation of medieval
18 buildings to seventeenth and nineteenth-century additions, in continuity with
19 what can be observed in other small patrician squares of the historic centre.
20 For this case study, a UAV survey campaign was conducted to document
21 both the configuration of the roofscapes and the volumetric relationship between
22 the square and the surrounding blocks. The instrumental component involved
23 three integrated acquisition lines. The first consisted of an aerial
24 photogrammetric survey using a DJI Mavic Pro Platinum[5], employed both to
25 document the roofs and to acquire metric and chromatic data of the painted
26 façades.
27 For the roofscapes, nadir images were acquired with the camera oriented
28 vertically towards the ground at altitudes between 18 and 20 metres to maximise
29 metric resolution and achieve a ground sampling distance (GSD) of 0.7-1.0
30 cm/pixel[6]. Oblique images complemented these acquisitions, providing valuable
31 data for improved modelling of roof planes, dormers, and geometric
32 discontinuities, while maintaining a general flight altitude of 18 to 20 metres to
33 ensure full planimetric coverage of the area. Flight trajectories were planned in
34 a serpentine pattern, with 80% longitudinal overlap and 70–80% transversal
35 overlap, ensuring reliable reconstruction through Structure from Motion (SfM)
36 techniques.
37 For the painted façades, the drone camera was oriented frontally,
38 maintaining a maximum distance of approximately 5 metres from the surface, a
39 necessary condition for acquiring high-definition textures that allow pictorial
40 details to be read, decorative patterns, and chromatic variations. These frontal
41 takes were combined with other slanted pictures at different angles (about 25-

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[5]The drone is equipped with an FC220 camera (1/2.3″ CMOS sensor, 12 MP, 28 mm equivalent lens, f/2.2 aperture), with a resolution of 4000 × 3000 px.
[6]The GSD is estimated as a function of flight altitude, focal length/sensor characteristics, and image size; here, the value is used as an operational indicator of the metric resolution achievable on the roof surfaces.

35°) to reduce shadowed areas, enhance photogrammetric link, and show protruding or non-flat parts of the façades.

Overall, the high-up photogrammetric task collected over 700 images per square, including top-down and slanted roof views, as well as close-up shots of the façades. The whole picture set went through the steps of internal checking, matching up, and bundle fixing to produce clear, thick 3D models.

The images were processed using Structure from Motion methods to obtain a digital surface model of the area, a high-quality orthophoto of the square and building fronts, and an updated planimetric base for the control and validation of direct measurements. At the same time, a close-range photogrammetric survey of the façades and a set of laser scanner acquisitions produced a dense point cloud of the building fronts, which helped to analyse façade geometries, alignments, projections, openings, and decorative apparatuses. The combination of aerial photogrammetric data and terrestrial survey enabled us to overcome the perspective limitations imposed by the narrow caruggi and to document even the upper portions of the façades, following procedures already tested in other case studies of built heritage digitisation (Pellegri, Salvetti, 2019).

On this basis, it was possible to produce orthophotographic restitutions of the façades suitable not only for documentation purposes, but also for the digital reintegration of lost or degraded painted decorations, through the superimposition of reconstructed textures derived from historical sources, typological comparisons with other contemporary palaces, and stylistic analogies. At an urban scale, this procedure replicates approaches tested in recent studies on the restoration of frescoed environments, in which the integration of photogrammetry and TLS underpins the simulation of intervention scenarios (Bruno et al., 2022).

Piazza San Bernardo presents an even more compact configuration, taking the form of an interstitial widening along the axis of Via di San Bernardo. The space is defined by the presence of eighteenth-century oratories and noble palaces, including Palazzo Salvaghi, characterised by the typical Genoese masonry texture and the alternating use of white and black stone in the façades. The height of the buildings and the reduced width of the space accentuate a visual "compression" effect, which the digital survey is required to make explicit.

In this case, the aerial photogrammetric survey was complemented by a more extensive use of mobile SLAM surveying to capture the perceptual progression from the caruggio to the square. Continuous acquisition along the access route recorded variations in cross-sections and façade heights, allowing the reconstruction of a sort of "spatial profile" of the entire itinerary. The combination of point clouds derived from terrestrial laser scanning and SLAM enabled the production of complete 3D models of the spaces and surrounding building fronts, on which sectional analyses and altimetric comparisons between the two squares could be carried out.

The digital model obtained through almost automatic procedures from raw data acquired from real sources (photogrammetry, laser scanning) and the information model enriched with data elaborated and interpreted by the authors are distinguished according to the paradigm of the Critical Digital Model, which

1 emphasises transparency of sources and the conjectural nature of integrations
2 (Apollonio et al., 2019; 2023). In the present case studies, the information
3 concerns partial reconstructions of degraded or lost painted decorations, derived
4 from iconographic and documentary sources or compared with existing
5 decorations of other palaces from the same historical period. This reconstruction
6 procedure aims to rationalise and systematise the process using the most
7 objective data possible, thereby limiting the author's subjectivity.

8   The parameters adopted were: the reliability and credibility of sources; the
9 accuracy of the details restored; the typological and stylistic coherence with the
10 context; and the verifiability of hypotheses in light of other documented case
11 studies. The combination of these variables makes it possible to define
12 differentiated levels of confidence for the various portions of reconstructed
13 decoration, providing a transparent basis both for potential ephemeral
14 projections onto façades and for applications in augmented and virtual reality, in
15 line with the most recent experiments on the use of immersive technologies for
16 cultural heritage (Eriche, Salvetti, Scaglione, 2019).

17

18 *Morphological and Spatial Analysis*

19

20   The 3D models obtained from the survey campaigns form the basis for a
21 detailed morphological analysis, carried out by extracting plans, sections,
22 altimetric profiles, and axonometric views. The city, understood as a continuous
23 fabric of spaces, is here investigated starting from its voids, considered
24 structuring elements on a par with built solids. In this sense, the square is not a
25 simple "interval" between buildings, but a geometric form endowed with its own
26 proportions, dimensional relationships, and hierarchical relations with the
27 surrounding building fronts.

28   For Piazza Giustiniani, planimetric analysis highlights the close
29 correspondence between the dimensions of the square and the main façade of the
30 palace, confirming that "right measure" between void and solid that characterises
31 many historic Genoese squares. Longitudinal and transverse sections derived
32 from the 3D model reveal how the heights of the building fronts, which exceed
33 the width of the space, contribute to defining a contained environment in which
34 light penetrates selectively and traces complex trajectories across the surfaces.
35 The configuration of the roofscapes, made legible by the aerial photogrammetric
36 model, reveals further stratifications and alignments that are only partially
37 perceptible at the pedestrian level.

38   In the case of Piazza San Bernardo, digital sections show even more
39 accentuated ratios between the height of the surrounding fronts and the width of
40 the space, producing perceptual effects that translate into a sense of verticality
41 and enclosure. The combined reading of plans and sections makes it possible to
42 identify the visual thresholds that accompany the transition from the caruggio to
43 the square's widening, highlighting the sequence of "compressions" and
44 "expansions" that characterise the place's experience. The altimetric profiles of
45 pavements and building entrances also allow an evaluation of the relationship
46 between the levels of public space and interiors. This aspect is particularly

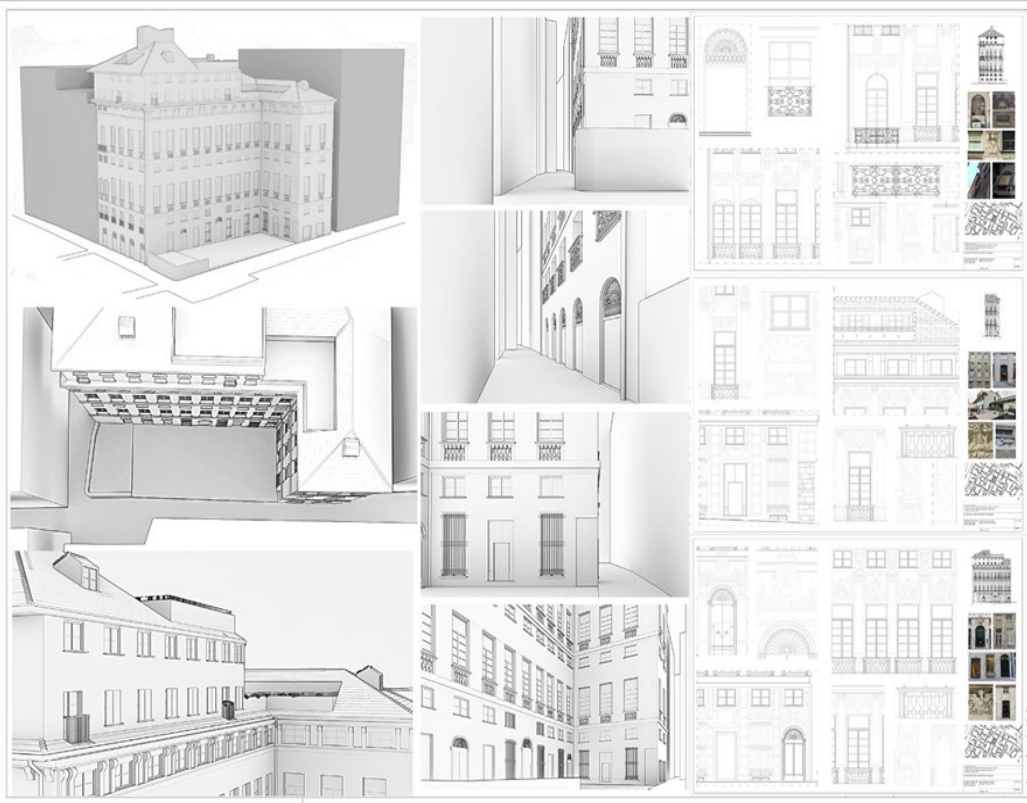relevant in view of future conservation and functional adaptation interventions.

This quantitative analysis is complemented by a qualitative reading of the elements that define the environmental image: pavements, façades, materials, and colour. The survey has shown, for example, how stone and brick paving, bichrome or frescoed façades, and the presence of minimal furnishings (steps, thresholds, openings) work together to shape the perception of the squares. This confirms the insights of townscape culture regarding the role of paving and small-scale elements in the design and experience of urban space.

3D Restitution and Sectional / Synoptic Readings

The phase of graphic restitution does not merely translate survey data into conventional drawings; however, it aims to construct a coordinated set of representations capable of making the different components of urban space legible. Alongside plans and orthogonal sections, axonometric drawings and perspective views derived directly from the digital models are produced, allowing a 360° reading of the relationship between the square and the surrounding building fronts. In this way, the 3D model becomes an essential tool for simultaneously visualising altimetric trends, volumetric stereometry, and spatial relationships with the broader context (see Figure 6).

Synoptic sections play a particularly significant role, conceived as selective cuts that bring together, within a single framework, the two squares and their respective building fronts. Through the juxtaposition of profiles and silhouettes, it becomes possible to compare proportions, heights, light gradients, and paving configurations, highlighting typological analogies and differences. These representations are developed in continuity with experiments previously conducted on other Genoese squares and on urban case studies treated as panel drawings, in which drawing takes the form of a panel capable of integrating metric survey data, morphological interpretation, and critical annotations (Salvetti, 2020).

1 **Figure 6.** *Restitution of Façades, Painted Decorations, and the 3D Model*

2
5

6   The synoptic dimension does not serve a purely comparative function but
7 also enables the construction of a graphic narrative of space. Access routes,
8 prevailing views, and relationships between architectural elements and urban
9 furnishings are organised through figurative devices that convey the place's
10 complexity without sacrificing clarity. The combined use of drawings at the
11 urban scale and enlarged details (cornices, portals, paving textures) allows a
12 continuous shift from the general to the specific while maintaining a constant
13 reference to the square's overall structure.
14   In this study, these representations also serve as a support for visual
15 verification of hypotheses regarding the reconstruction of painted decorations.
16 The controlled insertion of reconstructed pictorial apparatuses into sections,
17 axonometric views, and panel drawings makes it possible to assess, first within
18 a digital environment and potentially later through in situ light projections, the
19 perceptual and morphological compatibility of the proposals. This approach
20 reduces arbitrariness and fosters an informed dialogue between research, design,
21 and heritage conservation.
22
23

1 **Figure 7.** *Restoration of the 3D Model and of Degraded and Partially Lost*
2 *Painted Decorations.*

3
4 *Source: Author's image with materials produced during Representation Laboratory 2 -*
5 *Department of Architecture and Design UNIGE – Teachers Prof Giulia Pellegri, Prof Francesca*
6 *Salvetti*
7

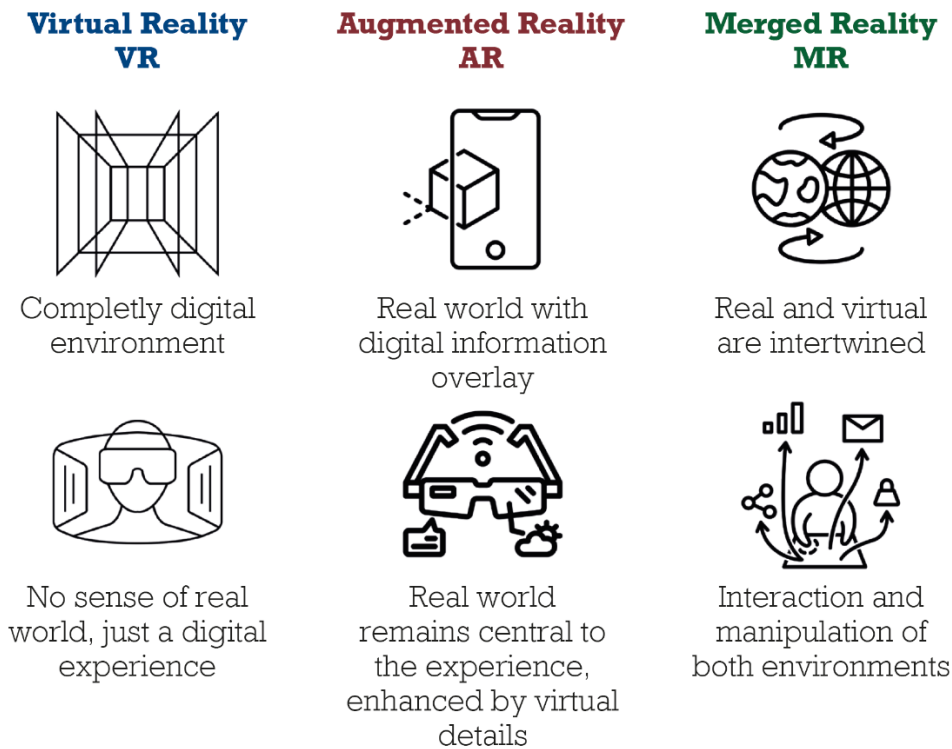8 **Augmented Perceptions and Ephemeral Transformations of Public Space**
9
10 *Premise*
11

12   In continuity with what was discussed in Part I (Scaglione) regarding the
13 square as a threshold space and a perceptual device, this section explores how
14 digital technologies can amplify, through ephemeral and non-invasive means,
15 the legibility of historic urban places. The square, conceived as a convergence
16 of paths, visual axes, and social relationships, emerges as a privileged setting for
17 experimenting with forms of augmented perception that do not modify the built
18 fabric, but instead temporarily bring to light aspects that are hidden, lost, or not
19 immediately recognisable.
20   The accurate digital base obtained through the survey operations (Part II,
21 Salvetti) represents the technical prerequisite for activating performative and
22 interpretative processes in which augmented reality (AR), virtual reality (VR), and
23 mapped light projections can restore or interpret historical, decorative, and narrative
24 information associated with building fronts. These technologies do not produce a
25 physical transformation of space, but introduce additional layers of information that,
26 when superimposed onto reality, temporarily modify its perception.

1   Within this perspective, the historic square is configured as a sensitive urban
2   stage, capable of hosting ephemeral digital interventions that enhance its
3   stratifications and renew the public experience, while maintaining a firm
4   grounding in the critical knowledge produced through surveying. This premise
5   makes it possible to introduce, in the following sections, a reflection on the
6   potential of AR/VR technologies and projection mapping[7] for the reading,
7   communication, and reactivation of built heritage, with specific attention to
8   Piazza San Bernardo and Piazza Giustiniani.
9
10   **Figure 8**. *Differences between VR, AR, and MR*

Virtual Reality VR — Completly digital environment — No sense of real world, just a digital experience

Augmented Reality AR — Real world with digital information overlay — Real world remains central to the experience, enhanced by virtual details

Merged Reality MR — Real and virtual are intertwined — Interaction and manipulation of both environments

11
12   *Source: Picture retrieved from https://marketingtechnology.it/15-miglioriapp-realta-*
13   *aumentata*
14
15   *Digital Technologies for the Augmented Perception of Urban Space*
16
17   The use of immersive technologies in historic urban contexts does not arise
18   as a merely spectacular practice, but responds to the need to restore informational
19   layers that are not immediately perceptible, reconnecting the material dimension
20   of buildings with their historical memory. Augmented Reality (AR), in
21   particular, enables the overlay of digital content onto the real world, expanding
22   its legibility without replacing it. In recent studies (Castaldi, 2024), AR is
23   defined as a non-invasive enhancement tool capable of revealing historical
24   traces, decorative stratifications, and contextual information through commonly

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[7]Projection mapping is a form of projected augmented reality that requires precise geometric calibration and alignment in order to "map" digital content onto real surfaces, drawing on technical studies in projected augmented reality.

1 used devices such as smartphones and tablets. This accessibility makes AR
2 especially suitable for activating participatory processes in public spaces.
3 Virtual Reality (VR), operating within a fully reconstructed environment, is
4 practical when the aim is not to intervene directly in urban space but to
5 reconstruct scenarios that no longer exist, allowing users to experience historical
6 and architectural conditions that have been lost. Recent literature (Castaldi,
7 2024) describes VR as an interpretative tool well suited to museum
8 communication and educational activities, thanks to its ability to restore
9 volumes, colours, and atmospheres with a degree of immersion that is difficult
10 to achieve through drawing or photography alone.
11 Mixed Reality (MR), although less widespread in urban contexts than AR,
12 shows growing potential for design simulation activities, as it allows users to
13 interact simultaneously with real space and virtual objects anchored to the
14 geometry of the built environment. In this case as well, the quality of survey data
15 is crucial, as it ensures that the augmented experience respects the geometric
16 coherence of physical space.
17 The entire technological framework converges towards a shared objective:
18 extending the visible by making perceptible what is no longer so, lost
19 decorations, historical phases, volumetric relationships, and original colour
20 schemes, through temporary, reversible, and materially respectful modes of
21 intervention in the urban environment.
22
23 *Projection Mapping as an Ephemeral Transformation of Public Space*
24
25 Projection mapping today represents one of the most effective techniques
26 for activating temporary transformations in urban space without physically
27 intervening on architectural structures. Through carefully calibrated light
28 projections, building surfaces become supports for visual narratives that
29 reconstruct lost decorative apparatuses, reinterpreting historical colour schemes,
30 or highlighting morphological and symbolic aspects that are often imperceptible
31 to the naked eye.
32 Thanks to survey data produced through integrated techniques, terrestrial
33 laser scanning, SfM photogrammetry, and SLAM-based surveys, it is possible
34 to obtain accurate 3D models on which to base the perspective registration of
35 projections (Remondino, 2011). This geometric correspondence between the
36 digital model and the real surface enables us to avoid distortions and ensures that
37 the projection respects the original proportions, alignments, and volumetric
38 configurations.
39 Recent studies in the field of digital restoration (Bruno et al., 2022) have
40 shown how light can assume an operational role analogous to that of traditional
41 pictorial reintegration, while maintaining a fully reversible and non-invasive
42 character. Mapping techniques, in fact, allow reconstructive hypotheses to be
43 visualised without interfering with historic material, introducing a controlled
44 temporality that returns a renewed image of heritage to the community.
45 This approach aligns with the principles of Spatial Augmented Reality
46 (SAR) defined by Raskar and collaborators (Raskar et al., 1998; Bimber, Raskar,

1   2005), according to which calibrated projection enables digital content to be
2   integrated directly onto physical surfaces, without the use of wearable devices.
3   Further studies have investigated the geometric and radiometric calibration
4   processes required to compensate for irregularities, curvatures, and material
5   properties of architectural surfaces (Grundhöfer, Iwai, 2018), thereby providing
6   a solid technical foundation for applications in urban enhancement.
7   In the urban context, projection mapping does not merely recreate original
8   aesthetic conditions. However, it activates perceptual processes that renew the
9   relationship between observer and architecture, transforming the square into a
10   dynamic and participatory scene. This approach is particularly coherent with the
11   compact spaces of Genoa's historic centre, where the presence of continuous
12   vertical building fronts favours the definition of highly integrated luminous
13   scenographies.
14

15   *Literature Review. European and Italian Case Studies*

16

17   The international scientific literature on the use of augmentative
18   technologies in cultural heritage highlights a progressive maturation of
19   methodologies integrating metric data and digital representation. In several
20   European contexts, including Barcelona, Athens, Lyon, Bruges, and Mantua,
21   AR, VR, and mapped projections have been employed to make construction
22   phases that are no longer visible legible, to restore external decorative
23   apparatuses, or to reconstruct historical stratifications through temporary and
24   non-invasive interventions.
25   Particularly significant are studies focused on the digital reintegration of
26   frescoed surfaces, in which the integration of TLS and high-resolution
27   photogrammetry enables the generation of 3D models suitable for hosting
28   calibrated projections and virtual reconstructions (Bruno et al., 2022). In cities
29   such as Mantua and Florence, for example, experimental AR interventions have
30   enabled the virtual restoration of portions of severely deteriorated external
31   pictorial apparatuses, demonstrating how digital overlays can selectively render
32   visible lacunae, original colours, and decorative patterns that are no longer
33   legible today. These experiences show that metric precision is an indispensable
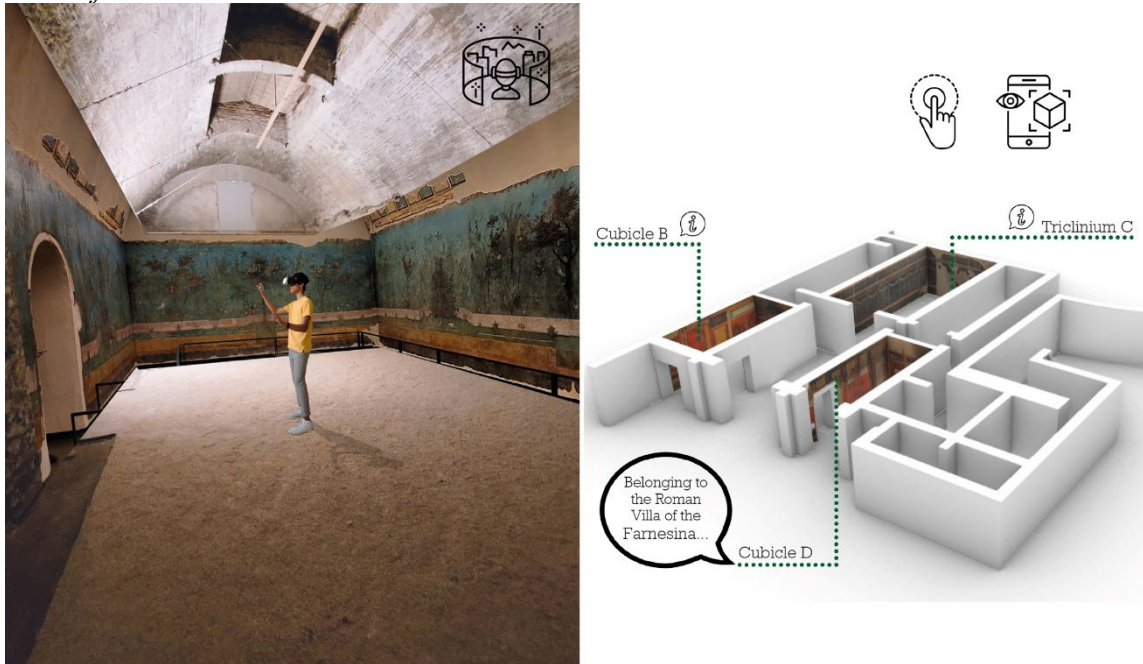34   requirement for any digital restitution applied to historic architecture.
35
36

Figure 8. *Examples of 3D modelling of Triclinium C of the Villa of Livia at Prima Porta and Cubicle B of the Roman Villa of Farnesina*

Source: Author's elaboration

Similarly, European experiments in urban AR have shown how superimposing digital content onto real space can facilitate understanding of elements that no longer exist or are difficult to read. Athens has tested AR applications to visualise archaeological stratifications in situ; Barcelona has developed systems for the augmented reading of Modernist façades; Lyon has adopted AR tools to make nocturnal urban transformations and vanished decorative cycles visible, integrating historical data, 3D models, and informational content accessible through mobile devices. These examples demonstrate how AR can function as a dynamic interpretive device, capable of revealing the complexity of the built environment even in dense, articulated urban spaces (Castaldi, 2024). (see Figure 9)

1 **Figure 9**. *On the right, Explanatory diagram of the VR view of the frescoes and*
2 *architectural layout of the Roman Villa of xFarnesina.On the left is an*
3 *explanatory render of the AR view of the frescoes and the Triclinium Hall of the*
4 *Villa of Livia at Prima Porta.*

5
6 *Source: Author's elaboration*
7

8   A further body of studies concerns historical reconstruction in VR,
9 particularly developed in Northern European contexts. In the historic centres of
10 Bruges and Ghent, for instance, VR has been used to reconstruct entire blocks
11 that no longer exist, allowing users to explore disappeared urban phases virtually
12 and to restore external decorative cycles that have been lost.
13   The literature on the ephemeral enhancement of public spaces highlights the
14 growing role of projection mapping, adopted at numerous international festivals,
15 including the Fête des Lumières in Lyon[8], the Amsterdam Light Festival[9], and
16 Roma Light Mapping. In these contexts, light is used to temporarily convert
17 building fronts into narrative surfaces, where videomapping and luminous
18 projections, conceived as ephemeral artistic installations, reinterpret streets and
19 squares, demonstrating the capacity of lighting technologies to activate the urban
20 fabric narratively. This type of intervention is based on the principles of Spatial
21 Augmented Reality (SAR), theorised by Raskar and collaborators (Raskar et al.,
22 1998; Bimber, Raskar, 2005), according to which calibrated digital projection
23 can integrate virtual content directly onto physical surfaces without the need for
24 head-mounted displays or screens.

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[8]Fête des Lumières (Lyon). An international festival that illuminates squares and historic façades with artistic light installations, transforming the city into a large-scale light art environment in which architectural surfaces become dynamic supports for visual storytelling.
[9]The Amsterdam Light Festival is an annual event that transforms Amsterdam's canals and historic façades into immersive and audiovisual light installations, using projections and light to create a layered spatial experience.

1   More recent studies have addressed the geometric and radiometric
2 calibration required to ensure that projections accommodate the irregularities of
3 the built environment, thereby guaranteeing visual and perceptual coherence
4 even in complex contexts (Grundhöfer, Iwai, 2018). In the field of cultural
5 heritage, applications of projected AR have demonstrated the possibility of
6 making lost decorative apparatuses legible through light, with significant
7 experiments carried out in both museum and urban contexts (Fiorentino et al.,
8 2012).

9   Alongside these experiences, Italian initiatives, specifically Genoese, have
10 also emerged. The Municipality of Genoa has recently launched projects of
11 scenographic and monumental lighting, such as the 2023 intervention dedicated
12 to the Cathedral of San Lorenzo, where new architectural lighting enhances
13 volumes, textures, and hierarchical relationships of the historic façade
14 (Municipality of Genoa 2023; City Green Light 2023). In parallel, the event
15 Genova Flower Power Lights (Visit Genoa, 2024) has experimented with light
16 as a diffuse narrative tool, transforming façades and urban routes through
17 ephemeral lighting installations.

18   Although these interventions do not strictly constitute projection mapping
19 in a technical sense, they clearly demonstrate how light can function as a device
20 for urban activation, prefiguring more advanced application scenarios, including
21 those based on digital survey data, in Piazza San Bernardo and Piazza
22 Giustiniani.

23   This convergence between European experiences and local experiments
24 confirms the transferability of augmentative technologies to the Genoese
25 context, where the density of building fronts, the intimate scale of spaces, and
26 the presence of lost decorative elements create particularly favourable conditions
27 for ephemeral and non-invasive enhancement interventions.

28   In this sense, the use of light, AR, and VR makes it possible to enhance the
29 intimate and contained character of these micro-spaces, offering new
30 interpretative keys to their complexity and enabling the virtual reconstruction of
31 the lost painted decorations of Piazza San Bernardo and Piazza Giustiniani.

32

33 *Applications to Piazza San Bernardo and Piazza Giustiniani*

34

35   Piazza San Bernardo and Piazza Giustiniani, which were the focus of the
36 integrated survey campaign described in Part II, constitute ideal case studies for
37 the application of AR, VR, and light-based mapping technologies. Their compact
38 morphology, the presence of historic façades characterised by largely lost
39 decorative apparatuses, and the limited scale of the spaces favour calibrated and
40 controllable interventions.

41   AR can be employed to virtually re-integrate painted decorations, using
42 orthophotos and 3D models as reference surfaces for anchoring digital content
43 (Castaldi, 2024). This approach makes it possible to restore original colour
44 schemes, iconographic layouts, and decorative phases to public perception
45 without physically intervening on the buildings, while clearly communicating
46 the reconstructive nature of the operation.

1   Projection mapping, applied in nocturnal contexts, allows façades to be
2 temporarily transformed into narrative surfaces. Thanks to the accuracy of TLS
3 and SfM data, light projections can closely follow real world geometries,
4 allowing lost pictorial elements to be re-evoked with high visual coherence. This
5 ephemeral transformation does not modify the architectural structure, but
6 enriches its perception by making historical traces visible that would otherwise
7 remain intangible.

8   Experience gained in Genoa's historic centre, such as the new scenographic
9 lighting of the Cathedral of San Lorenzo (Municipality of Genoa, 2023; City
10 Green Light 2023), shows how light can strengthen the figurative reading of
11 complex historic façades, paving the way for more advanced applications
12 grounded in digital survey data. In a similar vein, initiatives such as Genova
13 Flower Power Lights (Visit Genoa, 2024) confirm the potential of light as a tool
14 for urban storytelling, capable of activating historic micro-spaces and renewing
15 the perception of building fronts.

16   These local precedents make the use of digital mapping particularly
17 appropriate in Piazza San Bernardo and Piazza Giustiniani, where the relatively
18 uniform surfaces and limited scale allow for accurate and well-controlled
19 projection calibration.

20   Virtual reality, finally, provides an immersive environment for exploring
21 comprehensive reconstructions of the historic configurations of the squares,
22 enabling a deeper understanding of volumetric sequences, original colour
23 schemes, and lost decorative elements. In this case, historical reconstruction
24 functions as an interpretative and educational tool, aimed at understanding urban
25 transformations and enhancing heritage value (Castaldi, 2024).

26   Across all three approaches, the quality of the survey constitutes the
27 foundation of the entire process: the 3D models produced in Part II ensure the
28 geometric accuracy required to avoid visual distortions and to guarantee
29 complete coherence between digital representation and the physical
30 configuration of urban space.

31   AR, VR, and projection mapping thus provide practical tools for interpreting
32 and enhancing public space through temporary transformations that renew
33 perception without compromising historic material. In dialogue with the
34 theoretical reading of the square as a threshold and interstice (Part I) and with
35 the metric knowledge produced by digital surveying (Part II), these technologies
36 make it possible to render lost elements visible again, interpret complex
37 stratifications, and reconstruct decorative apparatuses by integrating scientific
38 rigour with public engagement.

39   Thanks to their urban configuration and accurate 3D documentation, Piazza
40 San Bernardo and Piazza Giustiniani constitute privileged contexts for
41 experimenting with ephemeral interventions based on light and digital
42 augmentation. Recent experiences carried out in Genoa, from the monumental
43 lighting of the Cathedral of San Lorenzo to the distributed installations of the
44 Flower Power Lights project, show how light can become a contemporary device
45 for activating public space, anticipating the potential of more sophisticated
46 interventions grounded in 3D models and advanced processes of augmented

1 reality or calibrated projection.
2   Reversibility, methodological transparency, and the absence of impact on
3 the built fabric consolidate these technologies role as instruments for the
4 contemporary enhancement of urban heritage, capable of integrating research,
5 design, and cultural dissemination. From this perspective, Genoese historic
6 squares not only accommodate such practices but also become privileged
7 laboratories for experimenting with new forms of urban narration through light
8 and digital media (see Figure 10).
9

10 **Figure 10**. *Hypothesis of light projection as a non-invasive enhancement tool:*
11 *in the case of the Church of San Bernardo, the simulation is stylistic, due to the*
12 *absence of surviving fresco traces; in Piazza Giustiniani, the projection is based*
13 *on preliminary research on the pictorial traces still visible on the façade. Top*
14 *left: photograph of the current state of the Church of San Bernardo, 3D model*
15 *of the square, and light-mapping design hypothesis. Bottom right: photograph*
16 *of the current state of Palazzo Gio Battista Saluzzo in Piazza Giustiniani, partial*
17 *reconstruction of the frescoes based on façade traces, and light-mapping design*
18 *hypothesis.*

19
20 *Source: Author's elaboration*
21
22

1 **Conclusions**
2
3   The research highlights several key conclusions:
4   The squares of Genoa's historic centre form an interconnected system.
5   Three-dimensional analysis and photogrammetric surveying show that,
6 despite their morphological irregularity, these squares function as nodes within
7 a complex network of open spaces and alleys, contributing to the perceptual
8 organisation of the urban fabric.
9   The square acts as a threshold space.
10   Squares are not mere voids, but transitional devices mediating between
11 different scales and conditions: between minute and urban scales, between
12 compressed paths and sudden openings, and between historical memory and
13 contemporary transformations. From a perceptual standpoint, they reconfigure
14 spatial experience through variations in light, shifts in perspective, and
15 articulated visual sequences.
16   Historical and visual representations reveal a symbolic and identity-based
17 dimension.
18   The analysis of engravings, photographs, and narratives demonstrates that
19 each square is also a cultural construct, shaped by historical stratifications and
20 shared interpretations that contribute to Genoa's urban identity.
21   Emerging technologies expand interpretative possibilities.
22   Light installations, projections, and augmented reality applications
23 introduce ephemeral dimensions that temporarily modify the reading of space,
24 offering new interpretative keys and suggesting design potentials capable of
25 activating or re-signifying public space.
26   An integrated methodology is essential to address complexity.
27   The research shows that only an approach combining metric survey (for
28 spatial accuracy), 3D modelling (for morphological analysis), perceptual studies
29 (for the experiential dimension), and historical–visual reconstruction (for the
30 symbolic dimension) is adequate to represent the complexity of squares as
31 dynamic, stratified, and plural places. Squares as contemporary urban
32 laboratories.
33   Interpreted as thresholds and interstices, the squares of Genoa's historic
34 centre are confirmed as paradigmatic sites for understanding the evolution of
35 historic urban landscapes and for experimenting with innovative forms of
36 representation and design[10].
37

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[10] In Sharing the positions expressed in the article, the result of common theoretical approaches and elaborations, the themes: "Introduction," "Theories and Representations of the Square as a Threshold/Interstice," and "Conclusions" are attributed to Michela Scaglione; "The Survey and Digital Representation of Case Studies: Piazza Giustiniani and Piazza San Bernardo" is attributed to Francesca Salvetti; "Augmented Perceptions and Ephemeral Transformations of Public Space" is attributed to Martina Castaldi. The article was translated with the assistance of software based on artificial intelligence.

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