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Museum spatial structure and sensory forms of knowledge:

Towards a syntactic understanding

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ABSTRACT

Museums are increasingly engaged with embodied and sensory forms of knowledge, and seeking to provide singular experiences that must be lived at that time and space, including through the use of digital technologies. Unlike the typical museum object, digitally mediated experiences invite visitors to 'look, listen and feel', amplifying their physical and sensory realities. This leads to the relatively underexplored questions: how do these new forms of knowledge interact with the spatial structure of the museum? And how does this interaction affect the informational (people to exhibits) and social (people to people) dimensions of visitor experience? These questions are explored though a novel media installation implemented in a landmark museum building, with an unconventional layout. The intervention, which fuses an archaeological object with the media projection to communicate the narrative compression of the relief scene on its front, constitutes the second phase of an ongoing, three-year funded research which takes a cross-disciplinary approach, combining architectural research, museology and interaction design. Methodologically, the research includes: a) the development and implementation of the installation, b) spatial analysis, and c) observation of spatial behaviour of visitors and d) gathering information about visitors' subjective experience and perception through questionnaires. The study reported in this paper mainly focuses on methods b and c. The results of the analysis suggest a duality: on the one hand, they emphasize the influence of spatial and visual configuration in producing different patterns of common presence between visitors; and on the other hand, they show the functional potential of the media installation as a lived experience to reorder space and create a sense of continuity though spaces.

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KEYWORDS

museum layout, spatial and visual configuration, projection-based spatial AR, spatial behaviour of visitors, informational and social function

1   INTRODUCTION AND RESEARCH QUESTION

Museums are increasingly engaged with embodied and sensory forms of knowledge, and seeking to provide singular experiences that must be lived at that time and space, including through the use of digital technologies. Unlike the typical museum object, digitally mediated experiences invite visitors to 'look, listen and feel' (Witcomb 2014), amplifying their physical and sensory realities. This leads to the relatively underexplored questions: how do these new forms of knowledge interact with the spatial structure of the museum? And how does this interaction affect the *informational* (people to exhibits) and *social* (people to people) dimensions of visitor experience?

These questions are explored though the development and implementation of a novel media installation fusing digital and physical space and the multi-dimensional, in-depth study of the role of the spatial layout in the way visitors view and engage with it. The media installation or intervention (a term used to emphasize its ephemeral character) is implemented in a landmark museum building, with an unconventional layout, the Archaeological Museum of Ioannina, Greece (see below). The media intervention is a digital augmentation of an archaeological object, using projection-based spatial AR,[1] of a Roman sarcophagus (or coffin), made of marble, dating from the second century CE, displayed in the Roman Gallery. The media installation is embedded in the display of the permanent collection of the museum as an another 'layer' of information to the archaeological object and as an integral part of the museum itinerary. This intervention constitutes the second phase of MUSEE, an ongoing, three-year research project, funded by the Hellenic Foundation for Research and Innovation (H.F.R.I.), which takes a cross-disciplinary approach, combining architectural research, museology and interaction design.

The paper is theoretically informed by earlier syntactic studies on museums[2] and an emerging body of media architecture literature concerned with the spatial dimension which is briefly reviewed in the first part. The installation positions itself among previous media installations exploring projections on archaeological objects and historic buildings (see for example Basballe and Halskov 2010, Dalsgaard and Halskov 2011, Nofal *et al.* 2018). The second part of the paper looks at the spatial structure of the building itself, and examines how, in conjunction with the spatial arrangement of objects, it affects visitors' behaviour patterns at the level of the museum as a whole. As we will see, this study is of interest not only in itself but also when set in the context of previous syntactic studies of museums.

Against this background, the paper then turns attention to the configuration of the sensory environment created through the media intervention and discusses visitors' patterns of viewing and engagement (*informational* dimension), and their emerging patterns of co-presence and co-awareness (*social* dimension). To this aim, the paper exploits the scientific tools of Space Syntax (Hillier 1996), and complements them with methodologies applied in HCI.[3] The results of the spatial and observation data analysis suggest that different space and display configurations shape different local behaviours, in particular different patterns of common presence between visitors. One of the contributions of this work, over and above the ideas and data generated by the research, is that it complements and enriches the study and evaluation of museum spatial design in ways that can lead to new insights into visitor behaviour when digital experiences are the 'exhibits'.

2   BACKGROUND AND METHOD

The background to the key questions of the paper is the increasing awareness in the interaction design literature that the spatial dimension has an essential role in the creation as well as the understanding of the relationship between people and the use of technology. For example, Brynskov, Dalsgaard and Halskov (2014) see *space* as one of five salient aspects of media architecture in public space, which, together with *aesthetics*, *interaction*, *meaning* and *participation*, plays a key part in the development, use and perception of public media architecture. Wouters *et al.* (2016) stress the importance of the spatial layout in creating the *honeypot effect* in HCI, while Fatah *et al*. (2008, 2013; see also Behrens *et al.* 2013) systematically explore 'the effect of spatial layout on mediated urban interactions. The latter stress that media installations create distinct interaction zones of display spaces, and others of a more transient nature and highlight the dynamic aspects of 'mediated' social interaction changing from for example a direct interaction to a passive one (interact, view, talk). Concerned with the fact that 'issues of scale and spatial organization, of context and environment are rarely considered' in the framework of Media Facades, Fischer and Hornecker (2012; see also Fisher *et al.* 2013; Vande Moere and Wouters 2012, Gehring and Wiethoff 2014, Afonso *et al.* 2019; Fredericks *et al.* 2023) proposed the Urban HCI Space Type Model which offers a conceptual framework as well as a terminology for the analysis of different settings for urban interventions. Analyzing the spatial configuration around interactive media façade installations in relation to the structuring of interactions, the authors identified seven types of space. This model could be usefully applied to our case and will be returned to in the next section.

While the problem of space is an explicit theme in the field of media architecture ('the design of physical spaces at an architectural scale incorporating materials with dynamic properties', as defined by Brynskov, Dalsgaard and Halskov 2013, p. 1), relatively little attention has been given to date, to the way digital interactions interweave with the design of space in museums (see for example Hornecker and Ciolfi 2019). However, research has demonstrated that certain spatial characteristics of accessibility and visibility are more likely to bring visitors into contact with the digital work, and

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perhaps engage them, more than others (Kortek and Grønbæk 2008, p. 616). In two recent papers (2017, 2023), we showed, through the in-depth study of examples of the museum work of two well-established creative studios which create interactive spaces and media installations, that aspects of the digital sensory environmids and their effects on visitors have a *relation of correspondence* with syntactic properties, such as *integration,* and *types of space*, and related these underlying correspondences to space syntax theory. Within this context, the paper will seek to contribute towards addressing the 'lack of a language for describing spatial phenomena and relations' (Fisher and Hornecker 2012, p. 307) in museum environments with media installations, by using analytical techniques which combine representations of space with methods of configurational analysis, in combination with observational data collection and analysis.

Specifically, we carried out an observation study of visitor behaviour, using established techniques.[4] First, the traces of the paths of 42 visitors (31 visitors before and 12 during the implementation of the digital project), randomly selected, were recorded for their whole visit to the gallery spaces – that is, from the moment they entered the exhibition (i.e. the permanent display) to the moment of exit. The precise location of their stopping points (*sum of stops*) and the total time they spent in the exhibition (*time spent*) were also recorded. Second, during the implementation of the digital projection, the all-day behavioural data at the local scale of the media space (that is, the morphology of visitors' local paths and trajectories, the location where they stand to view the digital projection, the number of times each visitor views the projection, the nature of interactions between visitors) were gathered by direct observation, over a period of four weeks. To complement the observation data, photographs and field notes were used to provide a more detailed picture of visitor activity, in particular during the implementation period of the media intervention.

3   THE SPATIAL STRUCTURE OF THE MUSEUM BUILDING

The Archaeological Museum of Ioannina, which opened in 1970, was designed by the well-known Greek architect Aris Konstantinidis, though later changes were carried out in 2008, in the context of the refurbishment of the museum and the redisplay of the collection.[5]

3.1   Axiality, grid organization and interplay between interior and exterior

The building, located on the edge of a park, and overlooking a lake is sensitive to the existing topography (Kenneth Frampton as cited in Giamarelos 2019, p. 86; see also Ryan 2020) The extrovert relation with the natural surroundings, which constitutes a distinctive feature of the museum, is made immediately felt by the axis of the entrance: it traverses the whole length of the building and is anchored at both ends by an element of the outside space, rendering the distant view of the lake (at

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the east end) the recurrent motif as visitors move around in the museum (Figure 1a-b). In a more obvious but no less striking way, the architect's intention to link together inside and outside in 'a pleasant functional unity' (Konstantinidis 1992) is also reflected in the transparent walls and door openings that overlook the three interior courtyards creating a dynamic relation between interior and exterior space, and light the galleries in a way that constantly changes throughout the day (1d).
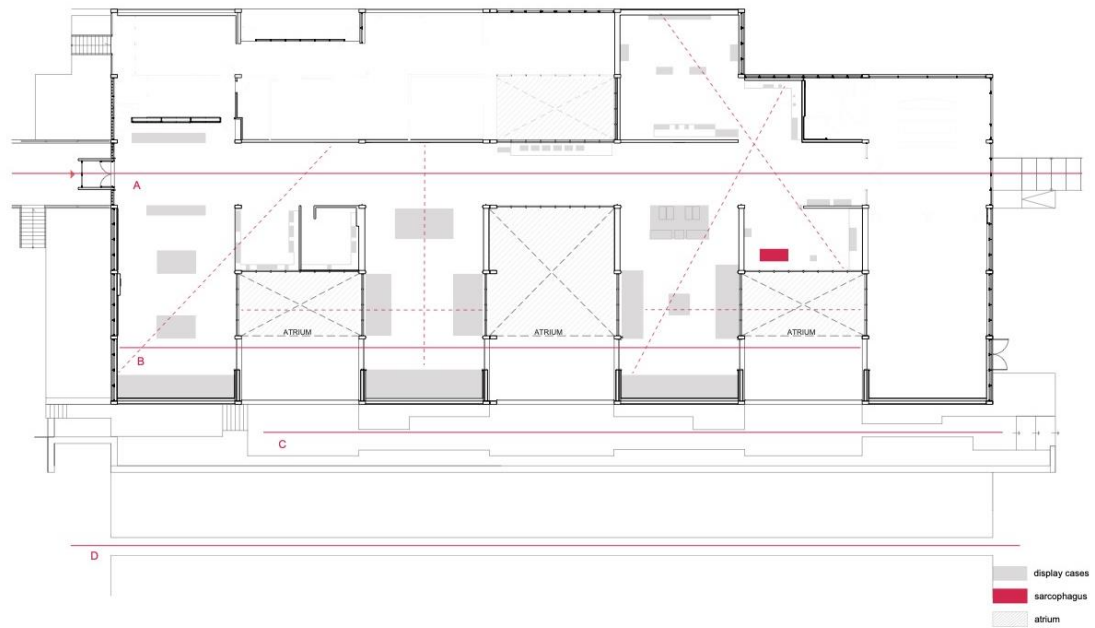

1 **Figure 1:** Views of the Archaeological Museum of Ioannina: the main axis is anchored at both ends by an element of the outside space (a-b); visual links between spaces through the atrium (c); the Roman Gallery (d)

The whole layout is organized around the main axis which gives access to the galleries mainly on one side, and is articulated on the basis of a modular grid (4.5X9m) (Figure 2). The modular rhythm of the plan is further reinforced by the simple and geometric relations of the constituent spaces and the alternation of closed and open spaces – galleries and interior courtyards – along the route, making the overall spatial pattern easy to read. As shown in Figure 2, three major axes seem to duplicate the main circulation core of the museum (A): an interior axis (punctuated by the aligned door-openings) which traverses galleries and courtyards, and makes visual links between and through them (B); the exterior paved path running the length of the south side of the building (C); and the linear path crossing the immediately adjacent park (D).

In spite of the repetitiveness of the spatial relations and the strong axial information given in the early stage of the visit, which make the overall spatial pattern easy to learn, the museum seems to be

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intended to be experienced gradually as the visitor moves in it. The spatial experiences that visitors discover as they go along are marked by visual links between and through spaces (Figure 2).


2 **Figure 2**: The layout of the Archaeological Museum of Ioannina, with spaces numbered. Three long axes of movement, in the interior and exterior of the museum (B-D), seem to duplicate its main circulation core (A). Additionally, visual links between and through spaces are represented by dotted lines.
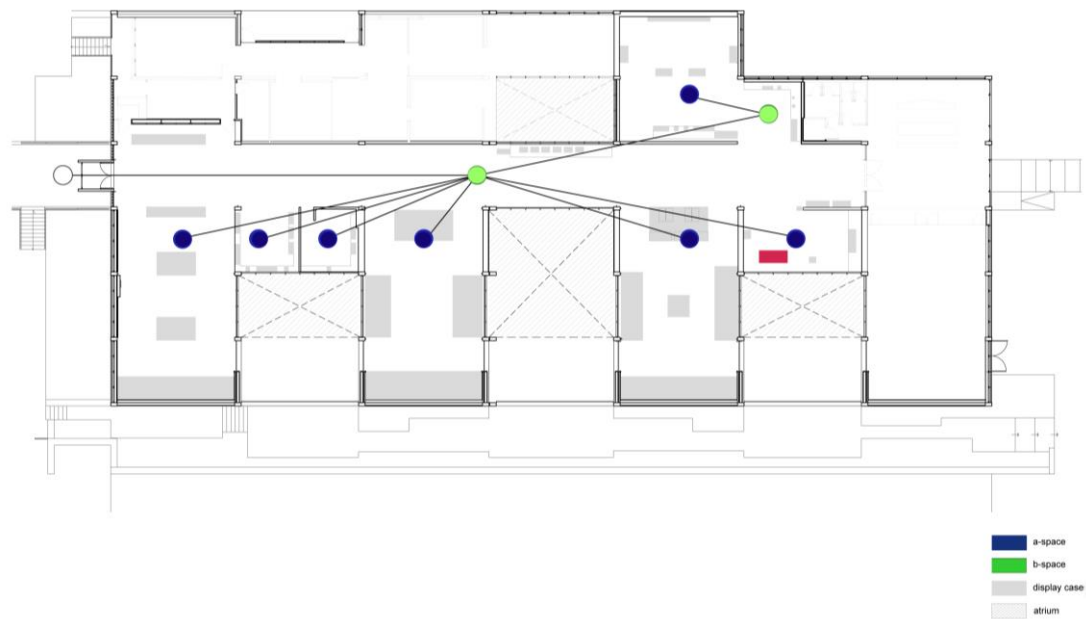
3 **Figure 3**: The plan of the Archaeological Museum of Ioannina with superimposed connectivity graph, showing space-types

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3.2 AB structure and complexity in local experience

A key feature of the organization of space is large spaces (with the exception of two small rooms, 3 and 4 in Figure 2, created in the context of the later changes discussed above), linked indirectly to each other. In space-type terms,[6] the layout is made up of *a-spaces* or *occupation* spaces (that is, dead-ends, which cannot be passed through), open to a *b-space or control* space (that is, a space that controls access to a-spaces, or other b-spaces, and so offers only the same way back) – in other words, the galleries and the axis (Figure 3). The configuration of space creates a non-hierarchical structure, while at the same time giving a strong controlling effect to the main axis. The pattern of *visual integration*, and *visual control* (the degree to which a space controls movement from its neighbours) make visually clear these key differences in the spatial structure (Figure 4). The axis constitutes the highly *integrated* and *controlling* space of the layout. The complex of syntactically homogeneous spaces lacks the hierarchical organization that is often used in museum design, for example with well-known works being placed in the more *integrated* spaces. Moreover, as the galleries are open to the axis but have no relations of direct accessibility between them, the visitor is not walking though spaces but in and out of them. This spatial discontinuity of the layout sets the pace of the visit. As noted by Filippidis (1997, p. 101), visitors (are invited to) constantly delay the spatial progression towards the end of the main axis so as to get to the galleries.
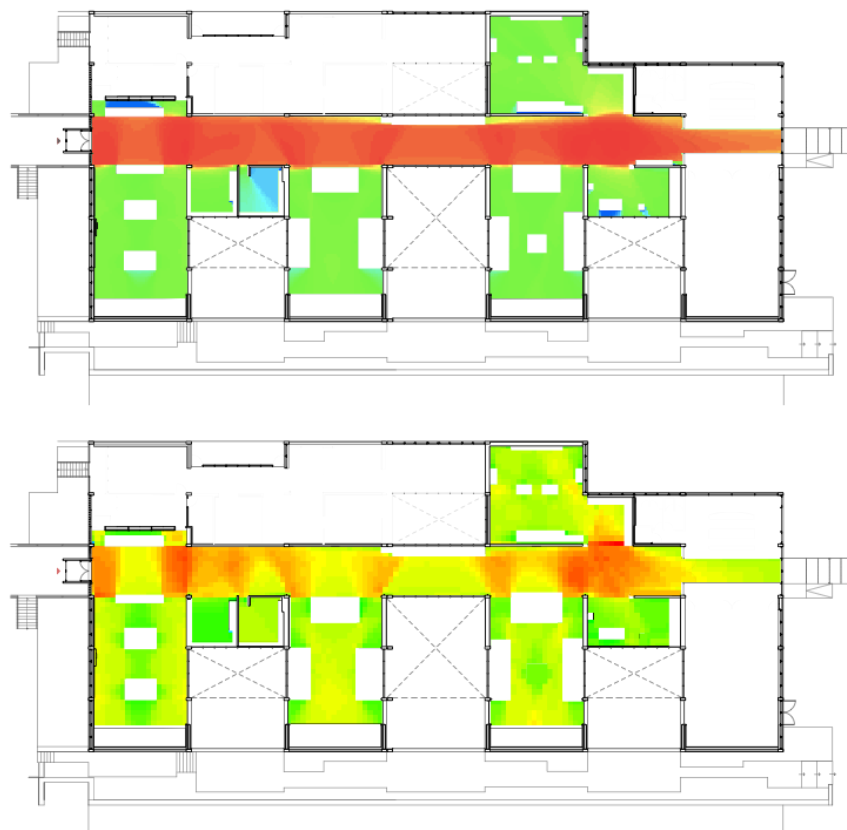
4 **Figure 4**: The pattern of *visual integration* (above) and *visual control* in the layout (below)

In terms of the visibility structure of the layout, the distant view from the museum entrance which seems to be 'informationally stable' (Peponis, 1997; Peponis et al., 1997) is coupled with changing and complex visual experiences at the local level as visitors move along the axis – as shown by the visual polygons or *isovists* drawn from the entrance and central points of the galleries in Figure 5. The complete openness of the galleries to the axis, the systematic use of glass walls and display cases, and the recurrent visual links between spaces though the glass atria (Figure 1d), which integrate the visual experience of the natural setting in the exhibition space, all contribute to creating overlapping planes at different depths and generating internally differentiated spaces. Thus, the organization of space combines coherence and intelligibility with an openness that allows for a measure of personal exploration and a degree of unpredictability.
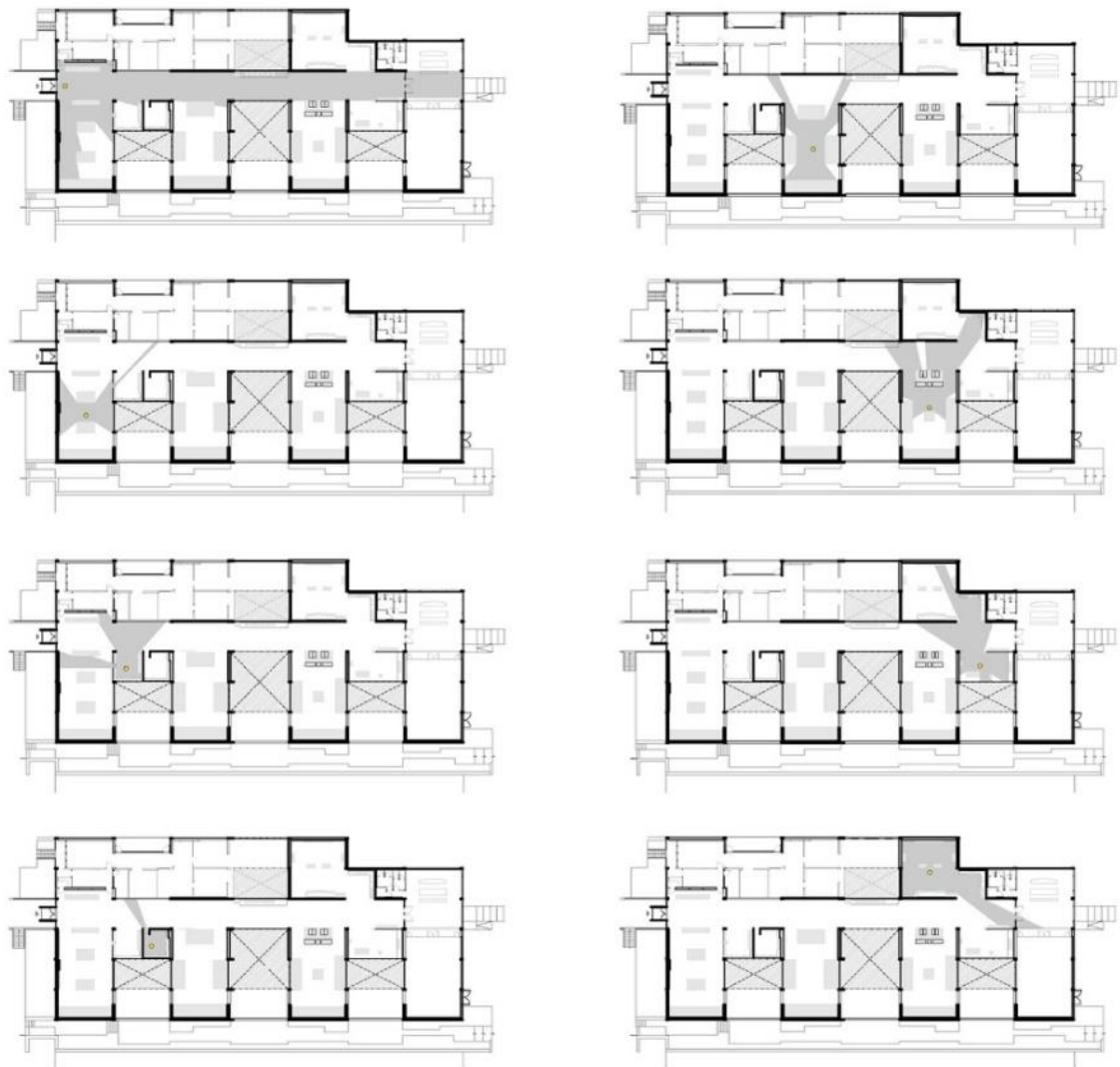
5 Figure 5: Archaeological Museum of Ioannina. Isovists drawn from the entrance (a) and central points of the galleries (b).

3.3   Relation to the spatial arrangement of objects

The spatial layout of individual rooms opening to the main axis supports the structure of the display: it comprises archaeological findings from the wider geographical region of Epirus that span a long period, from prehistory to roman times, and are arranged thematically in a broad chronological framework.

The main axis is intended to be read independently of the side galleries in the sense that it is mainly devoted to interpretive material, and the few archaeological objects displayed half way along visitors' itinerary and at its last part are dedicated to different themes.

As noted, within the galleries, spatial and visual variation is generated both by the spatial arrangement of the display cases, the spatial positing of objects, and the way framed views of the interior courtyards are used as the visual background of the displays (Figure 1c). This way of organizing space and objects prompts local exploration and, as suggested by the empirical study, seems likely to help the visitor to maintain attention.

3.4   The Roman gallery and the media intervention

Focusing attention on the Roman Gallery (Figure 1d; room 6 in Figure 2) displaying the marble sarcophagus and its digital augmentation, it should be noted that the space is 1-connected, located in the deepest part of the building, and opposite to the gallery (7) that accommodates the highlights of the collection, the lead tablets of the Dodona Oracle, inscribed on UNESCO's Memory of the World Register. Both galleries (6 and 7) are open to the main circulation axis, and more specifically to a highly *connected* location which brings together people moving in different directions (Figure 1). The Roman sarcophagus (L 2.20m X H 1.50m) is placed opposite the wide door opening, and against the background of the glass wall overlooking the interior courtyard. It is first perceived by visitors as they leave Gallery 5 and move along the axis. When visitors find themselves at the east end of the gallery, a multidirectional visual field invites them to choose one of the two side rooms (6 and 7). The long line of sight traversing the Roman Gallery, in combination with the view of the sarcophagus, which is large enough to be noticed from distance, makes visitors turn to the right side of the axis as the next stage of their route (see below).

The media intervention (entitled 'Sculpting Time') focuses on the relief on the front of the sarcophagus, depicting scenes of the Trojan War narrated in Homer's Iliad. It uses media projection in a loop of animations and graphics on the archaeological object, combined with music and sound effects, so as to invite visitors to look and hear in a purposeful way (Figure 6). The loop plays continuously for six minutes of projection duration, with a three-minute gap in-between. The aim is not to add meaning in the archaeological sense but to enhance and prolong the viewing experience and to reveal something relevant in the scene that visitors might otherwise have missed, either by accentuating what already exists, as the relief figure of Priam, King of Troy, on bended knee, begging

Achilles for the return of Hector's body, and kissing his hands – see Figure 6a), or by adding something to the object to extend the story of the scene carved in relief (as for example the fight between Patroclus and Hector, presented as a 'snapshot' and based on the iconography of ancient Greek pottery – see Figure 6b) (For the design rationale, see Tzortzi *et al.* 2023.) Through the digital projection, the *synchronic* understanding of the relief representation (that is, its 'cinematographic' dimension where the different episodes co-occur at the same time) is temporally transformed to a *diachronic* understanding (presenting the development of the mythological episodes in time). To these two 'objective' forms of time, of the relief representation and the digital narrative, is added a third one, *visitor lived time*.

6 **Figure 6**: Views of the media installation in the Roman Gallery of the Archaeological Museum of Ioannina

4   THE SPATIAL BEHAVIOUR OF VISITORS

Seeking to understand aspects of behaviour and functioning, we carried out the observation of patterns of visiting (Figure 7), particularly visitors' paths of exploration, their patterns of viewing and stopping points, and the emerging patterns of co-presence with other visitors, at the global level of the museum as a whole, as well as their patterns of behaviour and engagement in the media space.

4.1   Movement patterns through and within spaces

Entering the museum, visitors see a long axis and a series of galleries opening onto it (Figure 1a). What they see is a spatial pattern which offers an understandable global model. Looking at the map of 'directional splits' –the route choices made by percentages of visitors– from the entrance space, almost all visitors (95%) turn into the first space on the left (with the exception of visitors visiting specially to see the media intervention) (Figure 8). Visitors then use the relation between the main axis and the galleries as a general guide for their routes and integrate the viewing of exhibits arranged along the axis, at different points of their visit (mainly after having visited Gallery 4). This generates a meandering and interrupted morphology of movement at the global level, as visitors move in and out of the galleries, which is in complete contrast to the linear morphology of movement along the axis on their way back.

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In general, visitors move in a systematic way and go to an average of 94% of the spaces. Looking more closely, 64% get to all the spaces and the remaining 36% to three quarters of the spaces (they omit one or two galleries). It is worth noting that the spaces that tend to lie outside the search track of visitors are rooms 3 and 4 –two spaces shallow from the entrance and very different in scale, form, and character from the main galleries– which are visited by 76% and 88% of visitors respectively.

The single general direction of movement and the lack of choice spaces that would allow the layout to be explored in different ways are coupled with a considerable degree of non-linear movement locally, within the galleries. Visitors paths of exploration tend to be characterized by frequent changes of direction and cover all the sub-spaces of each large gallery, reaching its deepest parts (Figure 7). The positioning of objects in space, different in each gallery, and the emerging stopping opportunities within the galleries (as well as along the axis), create an unexpected variety and complexity in routes.

7 **Figure 7**: Archaeological Museum of Ioannina. The paths and stopping points of visitors observed - 31 visitors before (above) and 12 visitors during the media installation (below).

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8 **Figure 8**: Archaeological Museum of Ioannina. Percentage 'directional splits' of visitors from the spaces in grey, showing the initial routes from the entrance, before and during the digital intervention (in red).

It is clear then that in the case of the Archaeological Museum of Ioannina, space is a local determinant of movement, shaping exploration patterns within the spaces rather than a global determinant of movement flows – as we find in cases such as Tate Britain, characterized by the strong relation between integration in the layout and movement (Hillier *et al.* 1996; see also Tzortzi 2015).

As visitors are not aware of the media installation in the Roman Gallery prior to the exploitation of the museum, we cannot except effects on the pattern of circulation in the preceding galleries. But a key effect of the media intervention is the strong bias to the Roman Gallery for visitors leaving Gallery 5 and moving along the axis. As noted earlier, the spatial and visual configuration, in combination with the projection, makes 75% of visitors observed turn to the right side of the axis as the next stage of their route (as opposed to 50% before the media installation).

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4.2   Stopping patterns within exhibition spaces

Turning to the viewing pattern, we find an overall more or less uniform pattern. In general, there is no diversity in the viewing order of galleries (with the exception of the opposite rooms 6 and 7, as noted earlier) nor differences in the viewing intensity of individuals in different parts of the museum, as indicated by visitors' stopping points (both in absolute terms and in relation to the ratio *sum of stops over area)*.

We find *deeper* spaces having similar or sometimes higher number of stops than more swallow ones (as for instance in the case of the first and the last space in the route, that is, galleries 7 and 1). Before the media installation, the highest rate of stops (in absolute terms) is found in rooms 7 (featuring highlights of the collection), 5 and 4 (both displaying the highest number of objects), while the Roman Gallery (room 6) gets a lower rate, which can be partly explained by its size and the number of objects on display. As might be expected, the investigation during the media intervention reveals a different picture (discussed in detail in the next section).

Finally, the average time of stay in the museum is 43 minutes, which is high in relation to the floor area (853m^2), compared with the values in other museums (see Tzortzi 2015). Moreover, 44% of visitors observed stay longer than the average (up to a maximum of 85 minutes)

4.3   Interaction and engagement patterns

Let us now consider the way visitors group around, view and engage with the media intervention. We recall that the Roman Gallery is adjacent to the most highly *connected* location in the layout which brings together people coming from different parts of the museum. The position of the media intervention takes advantage of the network of connections and through movement to maximize the opportunities for initial awareness and engagement (as well as re-engagement as visitors' paths cross it again on the way to other spaces). More importantly, as shown by the observation study, it succeeds not only in attracting the attention of people moving in different directions, but also in holding it and progressively, over the course of time, increasing it. Once the projection becomes their focus of attention, visitors stay to view it at least once, often two or three times (see below).

Observing the all-day behaviour pattern of visitors and mapping the precise location of their stopping points allows us to distinguish two main *Viewing Zones* (1 and 2 in Figure 9a), one along the axis and the other within the gallery, about 3.7-4m and 2.5m distance from the media intervention respectively. In most cases, visitors tend to move from *Zone-1* to *Zone-2* to view the projection for a second round. What essentially differentiates the two zones is the observed visitor behaviour. The analysis and comparison of the collected material (observations, photographs, field notes) showed that the two viewing zones create two different kinds of spatial presence and co-presence. In *Viewing Zone-2* visitors tend to be more 'static' (in the sense that they tend not to move for a long time, sit on the floor, or make only short
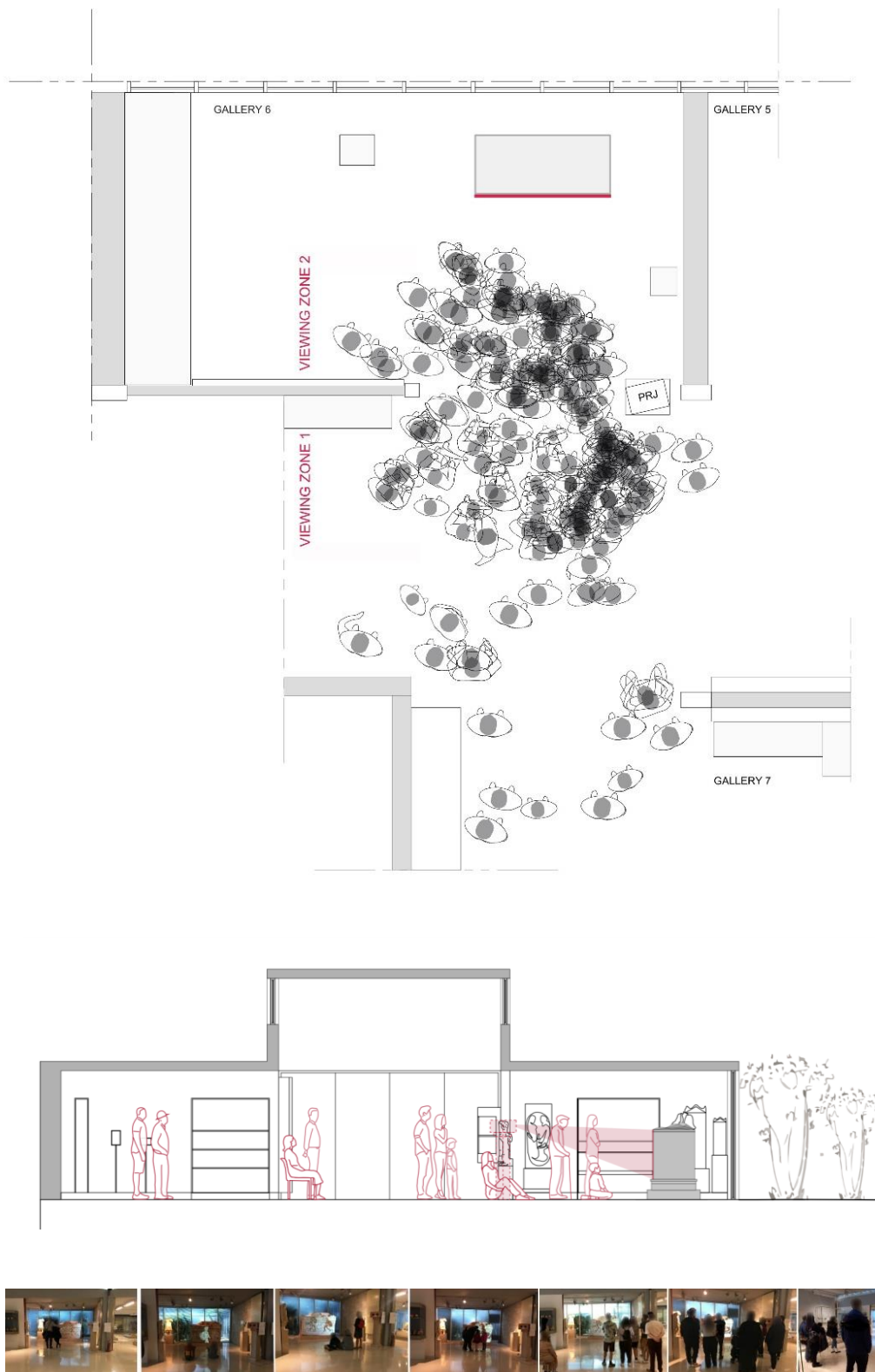
movements locally), while those in *Viewing Zone-1* they tend to shift positions and viewpoints, either in relation to the regularly changing configuration of other visitors, or independently (Figure 9a, c).

it seems that the spatial configuration of the museum acts on the pattern of common presence between visitors: *Viewing Zone-1*, by being part of the movement space of the museum, brings different groups of people together, allows for flexibility in the formation of viewers (for example, they can: position themselves along the whole length of the opening of the Roman Gallery; form small groups toward the edges of the opening, thus framing it; or stand in rows and view the projection from different distances and angles of sight) and diversity of activity (e.g. people watching the projection, reading the interpretative text on the media installation, taking pictures, or moving from/to a different direction), generating an *active* social co-presence. In contrast, *Viewing Zone-2*, located within the limits of the exhibition space (room 7), and most often occupied by people visiting together (couples, families, small groups of friends), shapes a *contemplative* co-presence, interrupted only by the recurrent commentary between viewers. People tend to interact, talking, watching films together, showing things to each other and discussing them. Affective postures and attitudes (for example, holding hands, leaning against each other) between members of couples of different age groups, or between family members are often observed. The opposite is the case in *Viewing Zone-1*. Although it encourages encounter density, social norms reduce the opportunities for conversations between members of groups.

On the whole, the media intervention generates local intensification of movement and engagement, and balances the differences between the average rate of stops (*sum of stops*) made in the two opposite side galleries (6 and 7) identified before the installation (see above). The high rate of stops in the media space and the amount of time spent interacting with the media intervention render the sarcophagus a very intensively viewed exhibit.

To these observations is also added visitors' tendency to engage with the three-dimensional inspection of the archaeological object at the end of the projection or in-between the end of one projection loop and the start of the next one, shaping jagged movement traces in front and on the sides of the sarcophagus, as they walk around and make short movements going forth and back and viewing again.

No less importantly, the physical co-presence and visual contact between visitors interacting with the sarcophagus in the media space is lengthened and so intensified, as compared to the brief encounters along the axis before the intervention, reinforcing the pattern of common presence. It could be said that the media intervention, in combination with the open spatial relationships between galleries 6 and 7, and the ample cross-visibility between axis and galleries make social interaction visible and maximize people's awareness of each other generated by visibility across boundaries (Figure 9b-c).

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9 **Figure 9:** The viewing zones for the media intervention (above). Section of the media space (middle). Illustrative examples of visitor engagement with the media intervention (below).

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4.4 Observed behaviour and types of spaces generated through the media intervention

The observation data has rendered explicit that the Display Space of the media intervention, that is the area from which it can be seen, extends beyond the Roman Gallery and encompasses part of the main axis as well as the introductory space of the opposite side room (7). Adopting Fisher and Hornecker' s *Urban HCI Space Type Model* discussed earlier, and based on the observed visitor behaviour, we could distinguish six types of interrelated space (Figure 10):
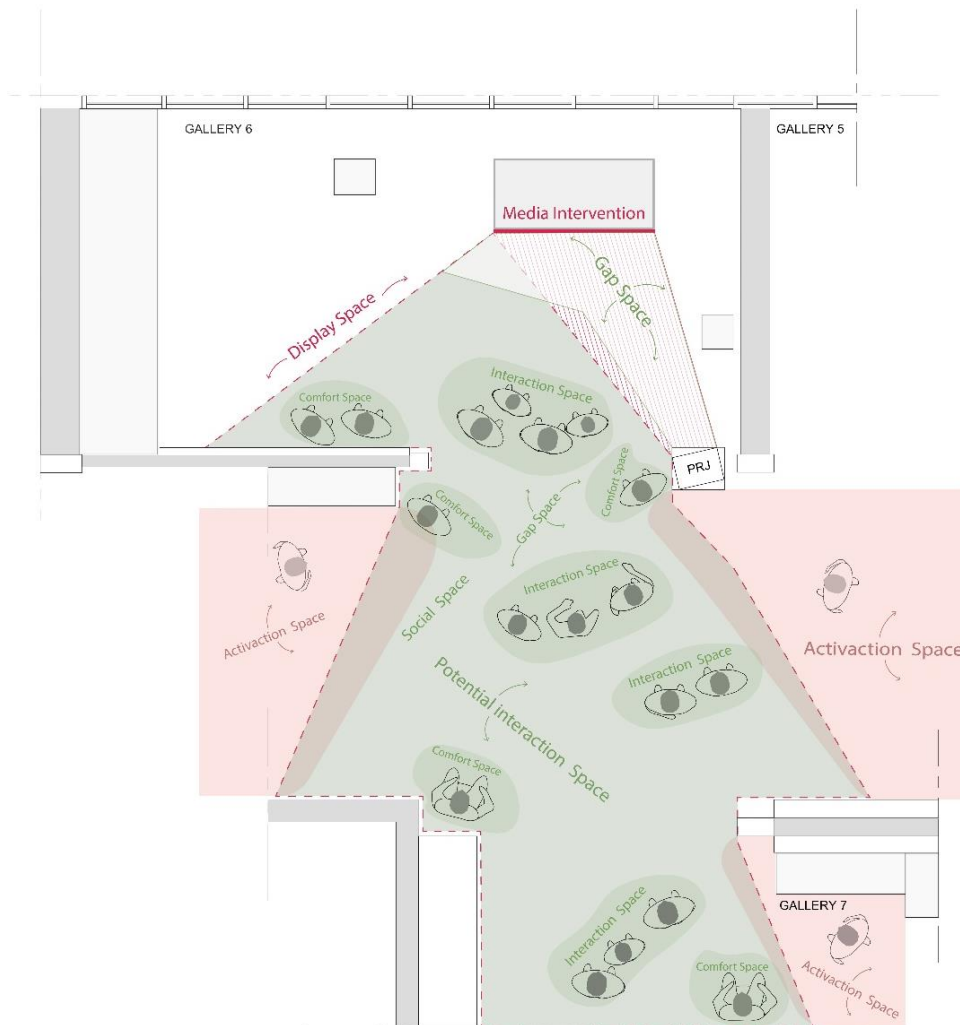
10 Figure 10: The media space: Types of spaces (based on Fisher and Hornecker's *Urban HCI Space Type Model*)

1, **Display Space:** the area from which the media intervention is visible and which includes parts of the layout with fundamentally different spatial properties.

2. **Interaction Space**: the space used at a specific moment in time, and the **Potential Interaction Space** which encompasses all the areas where a form of communication with the installation can occur.

3. **Gap Spaces**: spaces that create distances and gaps between visitors or between visitors and the media intervention.

4. **Social Interaction Space**: the area where people gather and can have shared experiences. It is mainly identified with the main axis where visitors' movements and encounters converge.

5. **Comfort Spaces:** spaces near architectural elements that provide a sense of physical and psychological ease, giving people the feeling of being 'out of the way'. It is observed that people tended to gravitate towards the projector tripod, the walls, and the few available seats close to the periphery of the Display Space.

6. **Activation Space:** the area from which the media intervention is partly visible, often triggering curiosity. Here visitors' physical rhythm seems to be temporarily suspended. Rather than immediately stepping into the gallery, visitors leaving room 5 tend to stand for a moment to make sense of an 'unusual' display and invite other members of their group to join them, before deciding to focus attention on the projection. This constitutes the main trajectory for visitors observed.

5   FROM A SYNTACTIC POINT OF VIEW: DISCUSSION AND CONCLUDING REMARKS

Synthesizing the above arguments, it could be said that, at a basic level, the research comes to enrich the syntactic studies of museums with a case of an unconventional layout that, by providing an intelligible environment, makes visitors feel confident to explore in a relaxed way. If we were to define the key feature of the pattern of visitor behaviour in the museum, we would argue that it is focused viewing and active engagement, as reflected in the ratio of *time spent over total display area*, the ratio of *sum of stops over total display area,* and the explorative aspect of visitors' movement within the exhibition spaces. Both are further intensified by media intervention (as shown earlier by the observation study).

At a more fundamental level, the paper illuminates the relation between the spatial structure of the building and the sensory environment and interaction space created by the media intervention, and its effects on dimensions of visitors' behaviour and experience. Using the two syntactic concepts of *synchrony* –which refers to the scale of a space– and *description* –which refers to the configurational embedding of the space in its context– we could argue that the Display Space of the media intervention, in comparison to the more conventional display space of the archaeological object, is strongly *synchronized* (since a larger amount of space –axial or convex– is invested in it) and highly *descriptive* (in that a larger number of spaces are related to it, either directly or indirectly).[7]

The spatial and observation data analysis also suggests that it is a strength in the layout as a whole and in the digital sensory environment in particular, that different spaces (axis, Roman Gallery) have different spatial and visual characteristics, and create a variability of visitor patterns and kinds of co-presence. It could be argued that the media intervention engages two polarities through the way it uses space to construct interaction and create engagement: between the most richly *connected* and highly *integrated* space in the layout where the diverging paths converge, and one of the deepest

dead-end spaces which focuses perception remote from movement; between the most visually open space that extends the whole length of the layout and a more enclosed and visually protected room that eliminates external information and isolates the embodied experience; and between the space that sustains an intensified awareness of the other people and renders viewing a shared, and so social, experience, and a space that encourages a comparatively more private contemplation and experience.

Concluding, it might be hoped that the ideas and data generated by the research could both inform the design of media interventions in new or existing museum settings, and complement and enrich the study and evaluation of museum spatial design in ways that can lead to new insights into visitor behaviour when digital experiences are the 'exhibits'.

NOTES

[1] Augments objects without the use of special displays (Meschini *et al*. 2017).

[2] For a review of syntactic studies of museums, see (Hillier and Tzortzi 2006) and (Tzortzi 2015). More recent studies include (Lazaridou and Psara 2021) and (Peponis 2023).

[3] It should be noted that the two methodologies are coupled with inquiries into visitor experience through questionnaires but the discussion of these findings is beyond the scope of this paper.

[4] The field study was carried out between January–December 2023. It should also be pointed out that the empirical data are based only on tracking records and not on flows across the thresholds of the rooms of the museum, as the number of visitors was too small. (According to the Hellenic Statistical Authority, the total number of visitors between January and September 2023 was about 9,800.)

[5] For a discussion on the museum, see Fillipidis 1997, 2013, Kotjabopoulou and Vasileiou 2009, Cofano 2012, Soueref 2013, Ryan 2020.

[6] Key topological properties of spaces are captured by the space syntax theory of *space types*, which defines spaces in terms of how they are connected to the layout of which they form part (Hillier 1996, ch.8).

[7] The distinction between synchrony and description is due to Professor John Peponis. See Hillier 1996, p.232.

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