

Space Syntax

Analyzing the design of exhibition space and display

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Introduction

A key issue in museology, theoretical as well as practical, is how visitor experience is shaped by the interaction between building and display. Both the design of the building and the design of the display have in common the creation of some kind of spatial order. Space, in this sense, is the common language of both building and display and so forms a key link between architecture and museology, between the architect and the curator.

The importance of space in museums and its effects on the way in which we approach and perceive displays has been increasingly acknowledged by museum studies (Duncan and Wallach 1978, Falk and Dierking 1992, Mason, Robinson and Coffield 2018, Whitehead 2009, Witcomb 2003) and architectural (Basso Peressut 2014, Brawne 1982, Markus 1993, Pallaasma 2014) literatures. Within architecture, and more specifically in the theory and methodology known as *space syntax*, there has been a more analytic approach to museums through space, which is the focus of this chapter. This approach facilitates the empirical study of museums, enables us to bridge between the two layers of organization – of space and objects – and allows the spatial properties of museum layouts to be systematically related to observed aspects of space use, so linking our knowledge of the functioning of museums to their morphology.

Since the first published syntactic studies on museums (Hillier, Peponis, and Simpson 1982, Peponis and Hedin 1982), a body of studies of museums has accumulated which use space syntax concepts and techniques to explore, amongst other themes, the relation between the layout of space and the communication of knowledge, the role of movement in the exploration of the content of the museum and the production of meaning, and museum space as a symbolic system.¹ More recent

1 For a review of syntactic studies of museums, see Tzortzi (2015). Recent studies include Lazari-dou and Psarra (2021), Li and Psarra (2022), Lu and Peponis (2014), Tzortzi (2017, 2022), Tzortzi and Hillier (2016), Peponis et al. (2021), Peponis (2024). For a wide selection of papers us-

studies explore how the experiential and ‘sensory turn’ in museum displays and exhibitions affect museum space (Tzortzi 2017, Tzortzi and Hillier 2016). This research approach and methodology is seen as a key perspective on museums, as reflected in the especially dedicated chapters in key books in museum studies (Macdonald 2006, Mason 2020).

Aim of the method

Space syntax is a theory of space and a set of analytical, quantitative and descriptive tools for analyzing the layout of space in buildings and cities (Hillier 1996, Hillier and Hanson 1984). Space syntax is a way of trying to answer the question: Does spatial layout make a difference? And if so, what kind of difference? One of the fields to which it has been applied is the museum. For museums and galleries, it asks: What dimensions of our experience of museums are affected by the way galleries and objects are organized spatially? Does spatial design influence how people move through the layout? Does it make any difference to how a gallery works as a social space? How does it relate to curatorial intent? Can curators use spatial layout to enhance the experience of exhibits?

The fundamental idea of space syntax is that the way museum buildings are used and function is not only about the properties of individual spaces but about the complex relations between spaces and how they affect each other by co-existing simultaneously – defined as *configuration* in syntax (Hillier 1996, Hillier and Hanson 1984). In contrast to the metric or geometric properties of space which can be perceived directly (for example, the size or shape), the *configurational* properties (for instance, the overall location of a space in the layout) are more abstractly comprehended. This is the reason why we need techniques of configurational analysis that allow us to analyze buildings as systems of relations, that is, in terms of the relationships between each space in a layout and all others.

In space syntax, relational concepts, such as *integration* (which is a measure of spatial accessibility – see below), are applied to representations of space, such as rooms, axes and fields of view, and this allows us to describe and quantify the *spatial* and *visual configuration* of the museum as experienced by the visitor in a more analytic way and to make comparisons with its observed function. In this chapter, I outline some key syntactic concepts and techniques for the analysis of space² and use the analysis of the layout of the *National Museum of Modern Art, Centre Pompidou*,

ing Space Syntax, see the Space Syntax Symposia at <https://www.spacesyntax.net/symposia/> (05.08.2024).

2 For a detailed discussion on the theory and method of space syntax, see Tzortzi (2015) and Hillier and Tzortzi (2006).

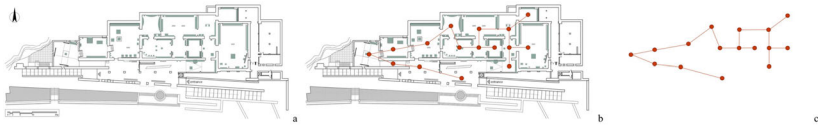
Paris, to show how the way the architectural layout is *configured* has a crucial effect on the visitor's experience of the museum and its exhibitions.

Step-by-step-guideline

1. The graph and justified graph representation

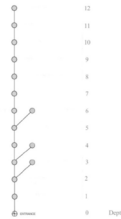
The overall spatial organization of the museum can be first clarified by representing the plan as a *graph* of connections, in which the spatial elements (that is, rooms or spaces) are the nodes and the spatial links between them the lines (Fig. 1). To draw the graph of the layout we can use a 'layer' overlaid on the museum plan and draw a circle (node) in the centre of each room. If two rooms are adjacent and it is possible to walk unhindered from one room to the other, then we join the two nodes, representing those spaces with a single unbroken line (link). This brings to the fore the way the museum is designed to structure the visitor's journey.

Fig. 1: Plan of the Archaeological Museum of Delphi (a), with the graph superimposed (b) and the graph (c), © Kali Tzortzi.



Once we have the graph, we can do two things which bring to light the *structure* of the layout. We can justify the graph from a particular space (the museum entrance in Fig. 2) – that is, treat the space under consideration as a root and align all the other spaces above that in layers according to how many spaces deep they are from the root space (for the concept of depth see below). Comparing the *justified graphs* of different museums/exhibitions can clarify their different spatial structures.

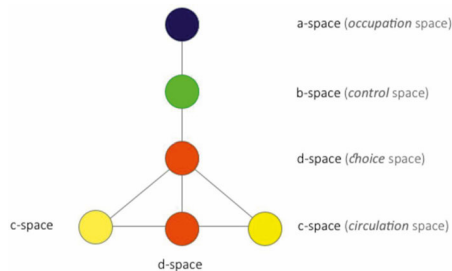
Fig. 2: The “justified graph” of the Archaeological Museum of Delphi, showing the “depth” of spaces from the museum entrance, © Kali Tzortzi.



2. The analysis of ‘space types’

We can also identify each space as a type *a*, *b*, *c* or *d* in terms of how it is embedded in the graph and so in the layout of the museum (for their definitions see Fig. 3.1 and 3.2). While some museum layouts make use of *a*- (or occupation) *spaces*³ (*b*- or control spaces are rare), most museum layouts are made up of *c*- (or circulation) *spaces* and *d*- (or choice) *spaces*. It is the ratio between this pair of space types and the way they are arranged that critically affects the experience of the visitor. The more *c*-*spaces*, the more constrained the visitor will be to particular sequences, while the more *d*-*spaces*, the more there is choice and potential for exploration.

Fig. 3.1: Visual representation of the space type definitions, © Kali Tzortzi.



3 See for example cases analyzed in Tzortzi and Hillier (2016) and Tzortzi (2017) where *a*-*spaces* are seen as the experiential type of space par excellence for the ‘sensory turn’ in contemporary museums.

Fig. 3.2: Detailed table of the space type definitions, © Kali Tzortzi.

SPACE TYPE		DEFINITION
a	occupation space	a-spaces are dead-ends, so cannot be passed through
b	control space	b-spaces control access to a-spaces (or other b-spaces) and so offer only the same way back
c	circulation space	c-spaces form rings, so offer one alternative way back
d	choice space	d-spaces offer more than one alternative way back, so present route choices

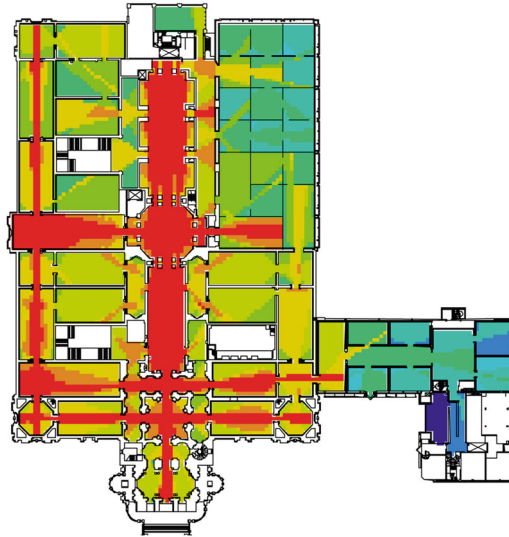
3. The concept of ‘depth’ and the related property of ‘integration’

Looking at the graph, a key configurational concept can be defined, that of *depth* (Fig. 2). It is a function of how many spaces must be passed through to go from each space to all others and so characterizes the relationship of each node to the graph as a whole. It can be thought of as the syntactic measure of distance, which is accordingly topological rather than metric. Here, depth is used conceptually rather than numerically. But it should be noted that the lower the total depth of a space, the more *integrated* (or easily accessible) the space is in the spatial system, that is, the closer to all the other spaces. The higher the total depth, the more *segregated* the space. The justified graph representation itself shows very clearly the pattern of depth and so of *integration*.

Integration can also be made clear visually by assigning colours to spaces according to their depth from all others – from red for most integrated through to blue for least. The colours allow us to see at a glance the pattern of integration values in the system (Fig. 4). For all but the simplest systems, these calculations require the use of the open access space syntax software called *Depthmap*.⁴ Computer-based configurational analysis allows us to bring the *integration core* of the building to the surface, meaning the syntactically central spaces of the museum, in the sense that they are more directly accessible to all the spaces in the layout. As suggested by syntactic studies, for instance the study of Tate Britain (Hillier et al. 1996, Tzortzi 2015), the syntactically central spaces of the museum tend to be those to which visitors’ movements converge.

4 The computer software, accompanied by a ‘building spatial analysis’ tutorial, is freely available at <https://www.spacesyntax.online/software-and-manuals/depthmap/> (05.08.2024), see also Turner (2001).

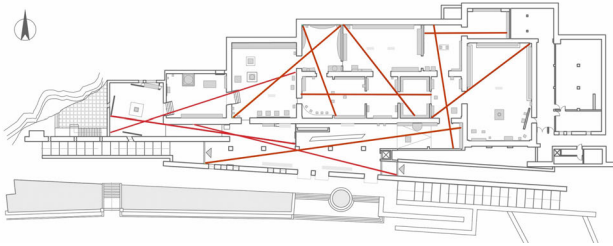
Fig. 4: The red pattern or “integration core” of Tate Britain. The distribution of the integration core along its main axis and the way it is linked to other parts of the museum affects key dimensions of experience, for example the way visitors become co-present and aware of each other, © Kali Tzortzi.



4. The techniques of ‘axes’ (or lines of sight) and ‘isovists’ (or visual polygons)

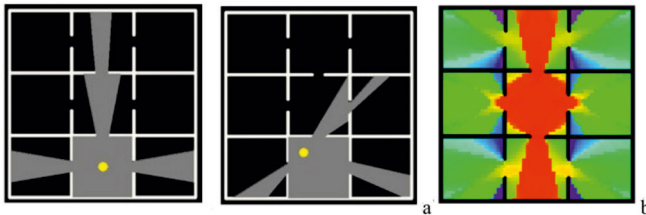
The museum layout can also be represented as an *axial map*, that is, as the simplest network of lines that characterize the possibilities of linear movement that we see when moving around (Fig. 5). Axes show how the visitor can move from one space to the other and so help us understand the layout as a whole, as in the conventional museum layout that consists of linear sequences of rooms, with strong visual and permeable interconnections.

Fig. 5: "Axial map" (lines of potential movement) of the Archaeological Museum of Delphi, © Kali Tzortzi.



In contrast, to describe the limits of visibility which are formed by the building around the located visitor and change as she:he moves, we use the *visual polygon* or *isovist* (Benedict 1979). The isovist defines the area that is visible around a point in the layout and offers us a way to study plans in terms of visual fields (Fig. 6a). We can use the succession of isovists to describe how the spatial perception of the visitor changes as she:he moves about in the layout. The isovists from all points (that are drawn and analyzed using *Depthmap*) can be used to calculate *visual integration* in the layout in the same way we use the rooms to calculate *spatial integration* (Fig. 6b).

Fig. 6: Visual fields (in grey) from two different points in space (a); the pattern of "visual integration" in the layout (from red for most integrated though to blue for least) (b), © Kali Tzortzi.



The above concepts and methods bring coherence and rigour to the study of museums and exhibitions and allow us both to differentiate one space from another within the same layout and to formulate clear distinctions between one kind of spatial layout and another. Being able to describe spaces according to their position in the layout in a systematic way also allows us to analyze exhibition designs: are the key works of the collection placed in integrated or segregated spaces? At the end of the axis or along it? And what are the consequences for the experience of the visitor and the way they perceive them? How do patterns of movement interact with pat-

terns of viewing, and do we find strategic differences between different cases? How does their interaction contribute to constructing meanings complementing the exhibition narrative?

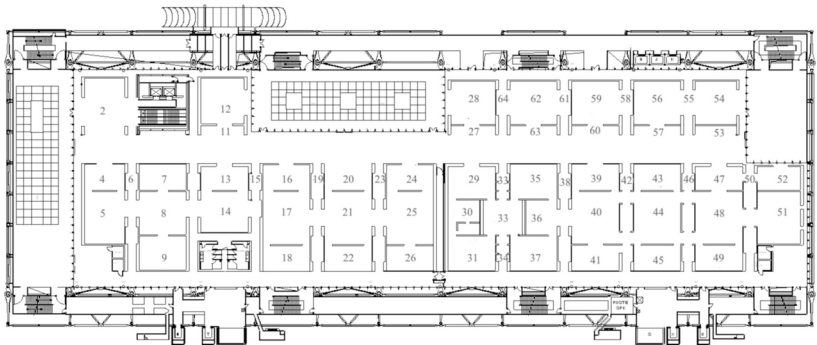
Case study

Moving to our illustrative example, the National Museum of Modern Art, Centre Pompidou, is a big-scale museum, extending over two floors, with a long history and influential evolution that made it a landmark in the history of architecture in general and in museum design in particular.

Morphology of space

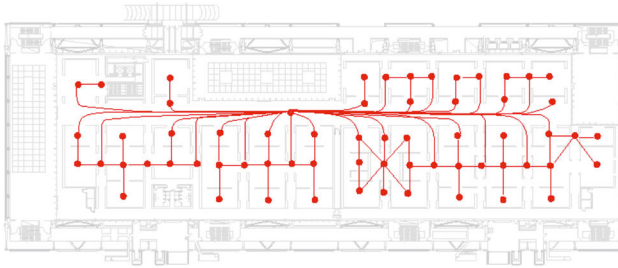
The layout of the museum (specifically the fifth floor which interests us in this chapter) is organized around a long axis, often referred to as the ‘grande avenue’, running the length of the building, giving physical and visual access to the galleries on both sides (Fig. 7).

Fig. 7: The layout of Pompidou (fifth floor), with spaces numbered, © Kali Tzortzi.



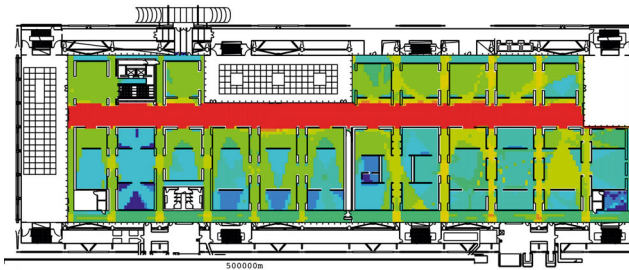
If we represent the layout as a graph (Fig. 8), we see that there is a consistent pattern: spaces are organized in small *rings* (circuits) along the axis with many points of route choice so that visitors can make choices and change direction.

Fig. 8: The graph of the layout of Pompidou (fifth floor), making visually clear the rings of movement linked to the main axis, © Kali Tzortzi.



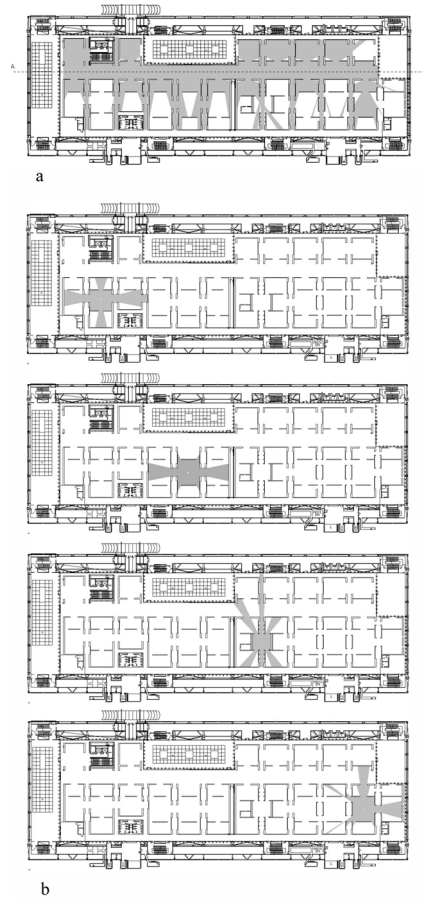
By using computer-based configurational analysis to examine the layout, we find that the axis constitutes its integration core (Fig. 9). It interrelates the gallery spaces with frequent visual and spatial links into the complex and links them to the entrance, meaning that the visitor can grasp the global structure of the building by moving about in it.

Fig. 9: The main axis in Pompidou which constitutes the "integration core" of the layout, © Kali Tzortzi.



If we draw the visual fields that can be seen as one moves along the axis (in grey in Figure 10a), we see that it enhances *information stability* (Peponis 1997), that is, visual information that remains relatively stable. But as the viewer goes deeper into the gallery, axes become more fragmented and views shortened, which imposes a different rhythm of progression, slows down the viewer's physical rhythm and creates a 'process' of discovery. As shown in Figure 10b, the variety in the disposition of openings forms isovists of extremely heterogeneous shapes. The characteristic of the Pompidou Centre is rich visibility: the dense links between spaces in different directions create for the visitor constantly changing visual relations and emphasize a dynamic sense of space.

Fig. 10: Line isovist drawn from the main axis of Pompidou that constantly gives clues about its global structure (a) and isovists taken at central points of the galleries, showing the dense and multi-directional spatial connections between them (b), © Kali Tzortzi.



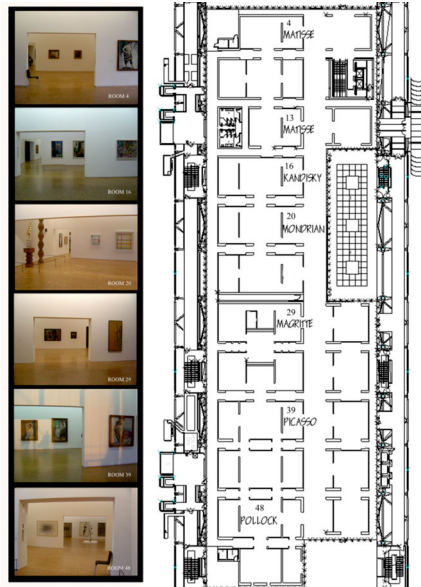
Morphology of display

How does the spatial design of the museum relate to the presentation of its collections? The display is devoted to the period from the early twentieth century to the 1960s, and its general organization follows the art-historical scheme of hanging by movements and artists in a chronological framework.⁵ One of its defining features is that the arrangement of the collection consistently makes use of configurational properties of the layout and spatial decisions are systematically related to the positioning and categorization of objects. Key works which attract visitors' attention (Fig. 11) are hung in the most accessible spaces – in the galleries opening onto the central circulation space or those structuring the continuous interior axis – and placed in strategic locations in relation to door openings or on the axes of the viewer's passage, while the deeper and more secluded spaces are devoted to monographic displays or parts of the collection of a more specialized interest. It could be argued that over and above the content of the objects, the articulation of space and spatial hierarchy (realized according to how the structure of space privileges certain galleries over others, through direct accessibility, ample or distant visibility, rich network of connections) convey meaning and serve a display that aims at emphasizing “the major movements and artists from that period” (Centre Pompidou 2022).

But the arrangement is neither prescriptive nor hermetic. The axial dispositions of rooms and the proliferation of openings which allow works to be seen from a variety of distances and angles of sight engage visitors both physically and intellectually. Looking at a specific object means discovering new relationships, seeing the same work in different combinations and perceiving simultaneously surrounding visual realities. It could therefore be argued that space is systematically used as a narrative device and mediates additional relationships between exhibits. The connection network seems to suggest that modern art is a composition of individual achievements, the product of the mutual influence between artists, movements and styles.

5 It should be noted that though the analysis of the fifth floor of Pompidou is based on an earlier arrangement of space, the underlying organizing principles and spatial themes discussed here still remain the same.

Fig. 11: The arrangement of the collection along the main axis in Pompidou, showing the location of works of key artists. The numbered views on the left correspond to rooms in the plan. Source: K. Tzortzi, courtesy of Centre Pompidou, © Kali Tzortzi.



Paths of exploration and patterns of co-presence

So the question that arises next is: What are the implications to be drawn from the particular ways of organizing space and objects for the visitor experience, as manifested in observable patterns of visiting in each museum?⁶ Recording visitors' routes during their whole visit (Fig. 12) showed that each followed a different path, taking advantage of the dense network of connections and exploring the variety of possible combinations – with half of the people tracked skipping half of the galleries. So their routes tend to be individual and exploratory. But, despite the heterogeneity of their itineraries, there is a strong tendency for visitors to get to the 'pre-determined' key spaces that structure the main route. The higher rates – with the exception of

6 Visitor behaviour was analyzed using established techniques (traces of paths of visitors recorded for their whole visit to the gallery, 'gate counts' of flows across the thresholds of spaces and 'snapshots' in which the observer records on a plan the location of people in each space viewing exhibits). For the full study of Pompidou, see Tzortzi (2015), Chapter 6.

the central axis where all the diverging paths necessarily converge – are found in the right complex and, more specifically, the central spaces which structure the first and the last part of the internal circulation path, while the spaces with low movement are consistently located at the end of the sequence or in the *deepest* spaces of the gallery that are visually segregated and not directly accessible from the main axis (Fig. 13).

Fig. 12: The routes and stopping points of visitors observed at Pompidou, making visually clear the heterogeneity of their paths and the strong bias of space use towards the main axis and the galleries located at the beginning of the itinerary, © Kali Tzortzi.

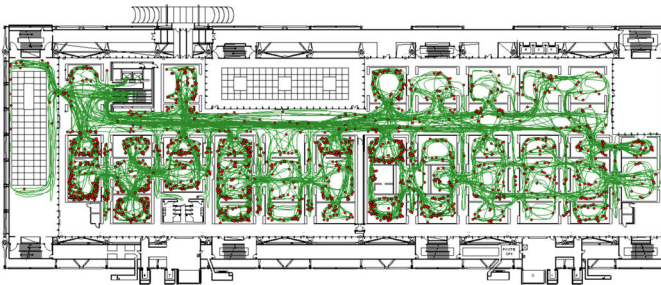
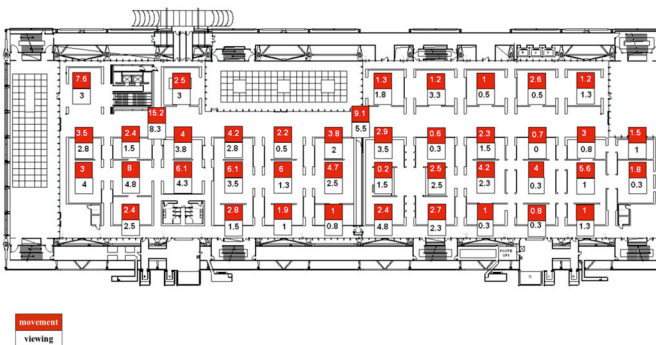


Fig. 13: The rates of movement (in red) and viewing (in white) on the fifth floor of Pompidou, © Kali Tzortzi.



At the same time, it is clear that the spaces with high viewing are also those with the key attractors (Fig. 13). These parallel effects clearly reflect a curatorial strategy to place the highlights of the collection in striking positions, in the spaces that have

more movement than others, so rendering them the most intensively occupied galleries of the museum.

But there is also a by-product effect of the way people move and explore museum space, and that is a social effect created by the spatial design. Visitors that split in different directions, re-encounter each other in the axis at different points of their visit. The urban-like spatial design of the museum (many spaces can work as both starting points and points of aim that are diffused in the layout) maximizes opportunities for encounter and intensifies the sense of being together with other people, which is central to our experience of museums.

Method reflection

As the preceding sections suggest, this analytic approach allows us to show that space affects our experience of exhibitions by the way it organizes three kinds of spatial relationships: among *galleries*, determining the way they are explored and used, among *objects*, affecting the way they are perceived and appreciated, and among *visitors*, through the possibilities for co-presence and encounter created by the first two acting together.

It could be said in conclusion that this way of seeing exhibitions can bring to the surface things we understand intuitively when we design an exhibition but find difficult to describe and represent (for example, how the informal educational role of the exhibition can be structured through movement in space and how patterns of visibility interact with ways of seeing and understanding), give some account of the experiential differences between exhibitions and explain why each has its own distinctive spatial, intellectual, and social character.

In this sense, it might be hoped that the theoretical ideas and research findings set out here could be useful in the design of exhibitions, not by offering design guidance, but by suggesting a deeper understanding of the likely consequences of strategic design decisions. This understanding could both inform design choices and facilitate evaluation of alternative solutions in relation to specific requirements and intentions. More importantly perhaps, it could also lead to the generation of ideas and open up new ways of handling spatial and display considerations.

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