

HOW DO WE READ NARRATIVES WITHIN GEOMETRIC ORDER OF SPACE? Morphologies of museum intertwining or dissociating navigation and exhibit viewing

AUTHOR: İpek Kaynar ROHLOFF
Department of Art History, Architectural Studies, Mount Holyoke College and Five College Inc.,
United States
e-mail: kaynar.ipek@gmail.com

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Abstract

This paper discusses how museum design presents exhibition content and shapes visitors' encounters with displays. We focus on museum design characterized with atria-and-gallery configurations, and with variations in space network, local connections and geometrical order. In three case study museums, we compare these design properties with exhibition organizations and visitors' space-use patterns concerning navigation and exhibit viewing. Through these comparisons we look at how design within such variations underscores exhibition narratives and predicts visitors' encounters with displays. Findings show that museum design with continuous promenade and frequent vistas encourage a reading of content on the surface, while engaging visitors with navigation and pausing at displays synergistically. Whereas museum design that provide more restricted sequence and fewer vistas to beyond the visited galleries highlight a more didactic and in-depth presentation of content while motivating visitors' focused interactions with displays. The fundamental difference in presenting content and shaping visitor experience is engendered by gallery geometric orders and local connections. This can be registered in visual fields analysis in addition to understanding network of spaces.

1. INTRODUCTION

A key issue of art museum design is how to orchestrate visitors' spatial experience between navigation in galleries and pauses at displays. Museums design should facilitate comfortable navigation while motivating encounters with works of art. Museums' institutional goals may prioritize spatial experiences to offer surprising encounters, or more focused interactions with works of art following a more didactic approach. In either case, museum design should work in concert with these goals. Among many possible design configurations, museums configured within galleries around an atrium provide a spatial structure for collections to be exhibited in a promenade sequencing conceptually related groups and motivate visitors' explorations displays along this promenade. Yet, this widely seen museum configuration may encompass design variations that can prioritize exhaustive explorations over focused interactions with art, or the contrary.

In atria and gallery configurations, design variations can be defined by networks of spaces as well as geometric order and local connections among galleries. In each museum, these spatial variables provide a unique spatial logic for exhibition installations. This spatial logic underscores exhibition narratives and encourages visitors' interactions with works of art in various ways. In this paper, we investigate the effect of design variations in atria-and-gallery configurations on exhibition narratives and visitors' encounters with those narratives. In particular, this paper explores the following questions. 1) How are exhibition narratives constructed within the gallery geometric orders and spatial properties? 2) How are visitors guided by gallery spatial properties as well as narratives? 3) How might the narratives be perceived within visitors' guided space-use?

We address these research questions by examining the main gallery layouts of three case study museums: the Yale Center for British Art in New Haven (YCBA), the Museum of Modern Art in New York (MoMA) and the High Museum of Art in Atlanta (HMA). Our examination focuses on the main gallery layouts of these museums that capture architectural design characteristics of the building through atria spaces. These museums are chosen for their similarly formed gallery spaces arranged around atria, yet each of these museums shows variations in local connections among spaces and in the geometric order of galleries (Figs. 1 and 2). Focusing on these three layouts helps us understand how these design variations formulate exhibition message and motivate different kinds of encounters with displays.

The research questions are explored in each of those museums by comparing design properties, exhibition narrative organization, and visitors' data of space-use. We understand exhibition narratives by examining display groups and their spatial relations in galleries. We analyze visitors' space-use in the data of their movement and pauses at displays collected through observation studies. We examine design properties of the museum layouts within spatial accessibility and visibility network relations obtained from convex map and visibility graph analyses. A spatial accessibility network demonstrates the spatial structure provided for exhibit organization and visitors' explorations. A visibility network can influence visitors' spatial experience in relation to displays. In global networks of visibility, visually integrated spaces are those that can be reached within the fewest numbers of changes in perceivable visual information. Thus, displays in visually integrated galleries are viewed by involving least number of other displays in sight. This capacity renders a more prioritized encounter. Visual connectivity captures the amount of direct and mutually visible spaces, thus visually connected spaces provide heightened co-awareness and more frequent encounters with the exhibited works. In addition to examining design properties with these syntactical properties, we correlate visitors' movement patterns and pauses at exhibits with visual fields in each museum gallery layout to understand how visual information released by local connections may shape experiences with displays. The

results of these investigations are comparatively examined throughout the three museums to identify the differences design.

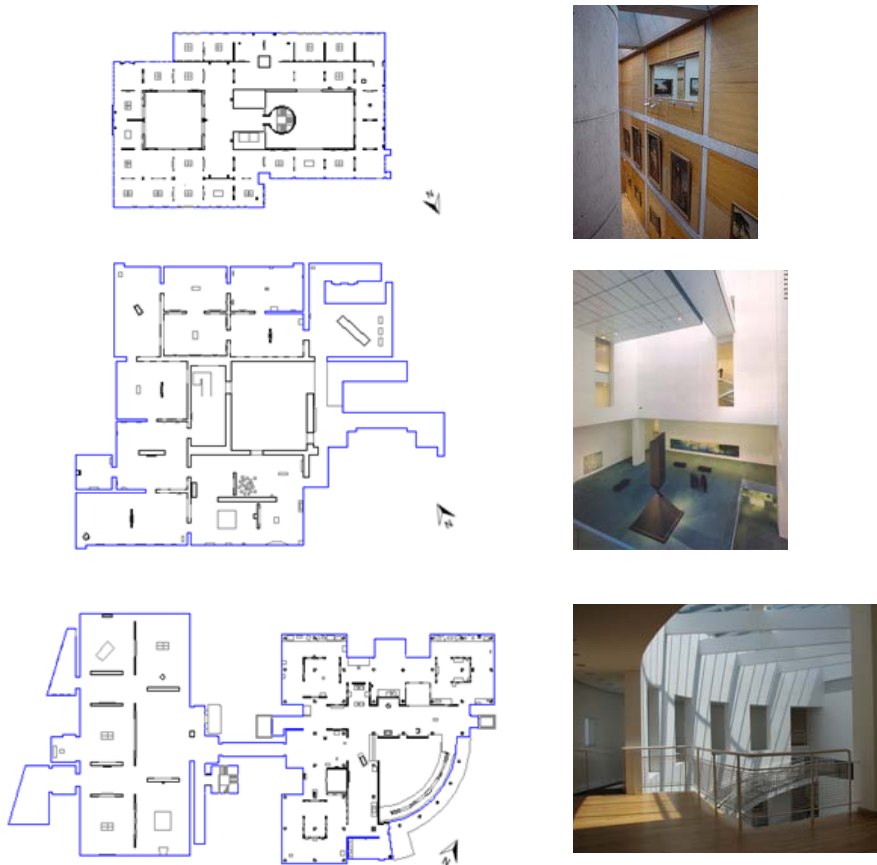


FIGURE 1 Floor plans of the three museums the to scale and view from their atria spaces, the Yale Center for British Art; fourth floor (top), the Museum of Modern Art; fourth floor (middle), the High Museum of Art (bottom).

This article is organized as follows. In the section immediately following we provide a brief review of previous studies. Section 3 analyzes design properties of the three museums and identifies what display strategies are motivated by their design. Section 4 examines the exhibition organizations in the three layouts and details how exhibition narratives are constructed with the effects of layout properties. Section 5 analyzes to what extent visitors' movement and pauses at displays are predicted by design, along with the potential effects of exhibition organization. We conclude in Section 6 with comparative discussion of the effects of design properties on exhibition narratives and visitors' encounters with them.

2. PREVIOUS STUDIES DISCUSSING SPATIAL LOGIC OF EXHIBITION NARRATIVES

Previous studies of greatest relevance can be reviewed in two groups based on different approaches in reading the relations between design and exhibitions. The first group examines design in terms of space

network relations and compare these relations with the conceptual structures of the content presented (Peponis & Hedin, 1982; Pradinuk, 1986; Psarra, 2005; Psarra, Wineman, Xu, & Kaynar, 2007; Tzortzi, 2005, 2007; Zamani & Peponis, 2010). In this group, Tzortzi's analysis (2007) is of particular insight through its identification of three models in which museum layouts and exhibition organization interact with each other, in reference to Hillier's expressive and generative layouts discussion (Hillier, 1996). Here, Tzortzi notes that generative layouts have greater morphological diversity facilitating visitors' encounters with exhibitions in various and interesting ways. A few others from this group explore the capacity of layouts to be pedagogical tool for institutions presenting knowledge (Peponis & Hedin, 1982; Pradinuk, 1986; Psarra, et al., 2007; Zamani & Peponis, 2010). The second group investigates the way in which visibility networks particularly present exhibition narratives and discuss how movement is also shaped with the effect of layout and exhibition organization at the same time (Psarra, 2005; Psarra & Grajewski, 2000; Tzortzi, 2003, 2004, 2005, 2007). Psarra and Grajewski (2000) examine how atrium space establishes relationships with farther gallery surfaces and unfold displays to peripatetic observer. Of particular note, Tzortzi (2007) and Psarra (2005) observe that movement is more evenly distributed in visually integrated layouts, whereas in segregated layouts unfolds exhibition step-by-step and through directed sequence, and such layouts narrowly guide exploration. Analyzing MoMA's modern art galleries, Psarra et al (2007) discusses that less integrated and less intelligible layouts distribute the movement less uniformly, thus motivates interactions with few possible viewing sequences within all available ones, which restricts the narrative presentation.

Previous studies cited here provide extensive investigations on the ways in which museum layouts construct and express exhibition narratives while also guiding visitors' explorations of exhibits and space (Hillier, 1996; Peponis & Hedin, 1982; Pradinuk, 1986; Psarra, 2005; Psarra & Grajewski, 2000; Psarra, et al., 2007; Tzortzi, 2003, 2004, 2005, 2007; Zamani & Peponis, 2010). Only a few studies have looked at what particular design properties determine layouts' capacity to shape narratives and predict space use patterns. Our analysis below demonstrates how museum layouts shape narratives and visitors explorations due to particular design properties.

3. NETWORK RELATIONS AND GEOMETRIC ORDER IN THE YCBA, MOMA AND HMA

In this section, we examine design properties of the three museum layouts that provide spatial structure for exhibit organization. As demonstrated in the diagram in Figure 2, the three museum layouts differ in terms of the location of atria spaces, their relationship with galleries and the gallery arrangement. In the YCBA and the MoMA, the central location of the atria forms gallery sequences and accessibility networks within large rings. In the HMA the off-centered atrium does not play role in shaping gallery sequences that continue toward the extension wing. As shown in the convex maps of the three layouts (Fig. 3 part a), the most integrated galleries in the YCBA are near between the two atria, in the MoMA are those more towards the south of the layout and in the HMA are galleries close to the extension wing (on the relative west side of the diagram).

Figure 2 also demonstrates the local connections among the galleries of each museum. In the YCBA, the partitions are positioned at the center of the gallery span and thus open up gallery rooms at the corners. This arrangement maintains an uninterrupted permeability around the atria core and parallel to rectilinear shape of that layout. In the MoMA, however, the rooms are connected through doorways situated at the central parts of the partitions in opposing or staggering positions to one another. Thus, potential movement is allowed through the central parts of the gallery rooms, and visitors can move uninterruptedly through a

few rooms and in straight or shifting directions through others. The HMA's layout has a composite room configuration resulting from the different organization principles in the two gallery wings. In the (original) Stent wing situated on the east side, movement take place in two parallel sequences, one in the galleries on the inner side of the L-shape layout and the other in the series of fluidly connected pavilion type galleries at the outer edge of the L-shape layout. While movement along the inner side of the L-shape is less restricted, the pavilion type galleries in the room-within-a room arrangement allow for a meandering movement through cyclically situated partitions. In the (extension) Wieland wing, the rooms are connected on the basis of a matrix organization within a rectilinear volume and spatial accessibility is maintained through doorways connecting the rooms at their corners. Movement is likely to be meandering within choices provided at the corners of the galleries (Figs. 1 and 2).

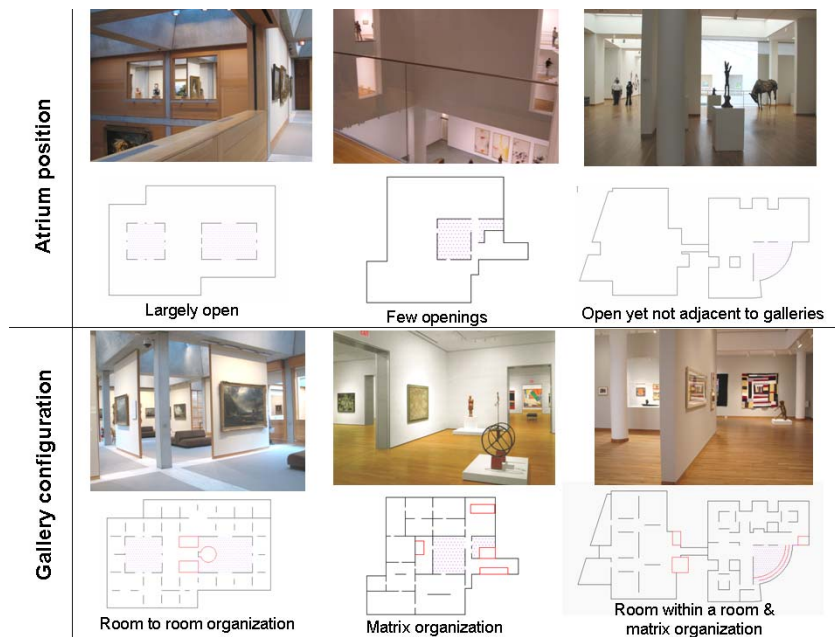


FIGURE 2 Three museum layouts (YCBA, MoMA and HMA) and analysis of their design properties

As for visibility network relations, in the YCBA the gallery doorways and the atria openings create visually highly integrated regions extending in longitudinal and diagonal directions. The gallery located between two atria spaces and the space extending from this gallery diagonally towards the southern promenade (upper part of the floor plans in Fig.1 and 2) are visually the most integrated. Due to the dense network of visibility through the atria voids as well as aligned gallery doorways, promenades in longitudinal direction are also quite integrated. Connectivity values are higher only for the galleries adjacent to the atria openings, so visitors can be aware of works of art at the distant galleries and other visitors mostly at the atria openings.

In the MoMA, the opposing and staggering doorways and few atria openings render a few galleries towards the south part of the layout visually integrated. The atrium openings minimally contribute to the interconnectivity among the spaces, and doorways allow only a few rooms farther ahead to be seen. Thus,

the MoMA galleries have low levels of visual connectivity which is maintained through the viewing sequences. When we examine visual connectivity property in detail, we see that gallery threshold spaces extending towards the central parts of each gallery are relatively more (visually) connected than spaces by the walls. Thus, visitors' awareness of the displays in adjacent galleries is improved at the gallery doorway thresholds.

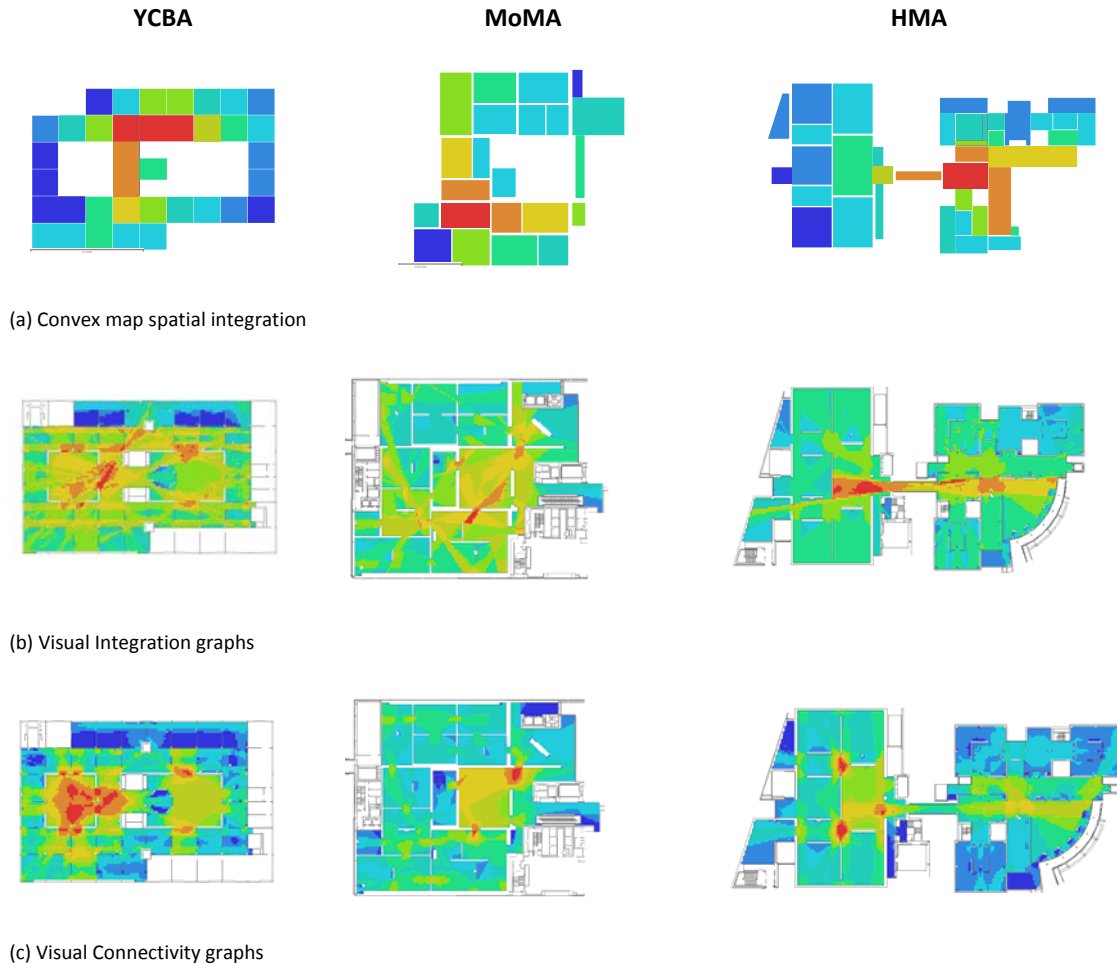


FIGURE 3 Comparison of Gallery Layout in terms of their Spatial Layout Properties.

In the HMA, due to composite room configuration and its open atrium situated at the west end (the Stent wing), the longitudinally situated core space remains visually close to all other galleries. The central core is one step away from most galleries at the peripheral locations, and so this core is visually quite well connected. In the Wieland wing, corners of the large welcoming gallery are where visitors can capture the direct and mutual visibility of greatest amount of surrounding spaces, and be able to see displays in adjacent rooms in comparison.

A comparison of the three layouts in terms of spatial intelligibility (Table 1) shows that in the YCBA and the MoMA local connections give good guides to the position of that space in the configuration as a whole (Hillier, 1996, p. 129). This capacity is weaker in the HMA. The spatial intelligible capacities in the YCBA and

MoMA may make it easier for visitors to develop an understanding of the narrative as they move through galleries. In the HMA narratives may be grasped more in fragments.

TABLE 1. Spatial Intelligibility measures of three layouts, along with scatter graphs illustrating those correlations

	YCBA	MoMA	HMA	
Correlation between connectivity and integration measures	0.70	0.73	0.41	<i>r</i>
	0.000	0.000	0.014	<i>p</i> -
	0.49	0.53	0.17	<i>R</i> ²

4. SPATIAL CONSTRUCTION OF EXHIBITION NARRATIVES IN THE YCBA, THE MOMA AND HMA

This section analyzes the ways in which each of the three museum layouts support displays for their art collections. This analysis discusses the extent to which layout properties help museums maintain a contemporary understanding of telling the story of art, which is through experiential and aesthetic qualities of works of art beyond their scholarly meaning (Elderfield, 2004; Serota, 1997).

4.1 YCBA: Visual Narratives of Sixteenth to Nineteenth Century British Painting

The YCBA's fourth floor layout displays British paintings and sculpture from the sixteenth to mid-nineteenth centuries. The exhibit (installed in 2005) offers multiple viewing sequences and places an emphasis on various themes associated with artistic endeavor, unlike previous exhibits with a prescribed route and merely chronological account (Trumble, 2005; Trumble & Albinson, 2005). The 2005 exhibit focuses on the works of British portraiture and British landscape painting. In both British portraiture and landscape, display groups have various conceptual foci, ranging from subject matter (works depicting people or natural landscapes) to art in certain political periods, to the styles of individual artists.

In contrast to this complexity of exhibit content, the museum layout has a strict geometry and spatial organization, characterized by square- or rectangular-shaped rooms arranged on a structural grid. Galleries that form parallel room sequences are utilized to present the British portraiture and landscape painting in promenades. Three gallery room promenades parallel to each other in the longitudinal direction reflect a chronological progression from south to north (from upper to bottom part of the layout, Figs. 1 and 4a). While the first promenade on the south focuses on British portraiture emerged in the sixteenth century, the second promenade (on the southern side of the atrium) presents more specific categories of British portraiture, namely the "conversation pieces"¹ and other genre depicting British middle class in the early eighteenth century. The third promenade (bottom part of floor plan in Figs.1 and 4a) exclusively presents British landscape painting that had appeared latest in history, portraying outdoors as well as imaginary natural settings. These sequences of portraits and landscapes are divided into shorter (western and eastern) sections delineated by the location of an introductory gallery between the two atria (the first exhibit space to be visited on the fourth floor). The eastern portions (left side of the floor plan) of both the landscape and portrait sequences are devoted to works influenced by Romanticism. The western portions (right side of the floor plan) focus on emerging and evolving categories in British art, such as landscapes featuring animals or

¹ The "conversation piece" is a genre of painting originated by British artists. The word "conversation" is used to characterize informal group portraits showing families and friends engaged in everyday activities such as hunts, meals, or music parties.

the portrait genre, conversation pieces. The introductory gallery (space between the two atria) provides highlights of the exhibit and a synoptic statement of development of art in Britain with reference to the political context that influenced artistic production between 17th and 19th centuries. The exhibit viewing sequences originate from the introductory gallery and proceed into four possible directions toward the eastern or the western portions. These four sequences present the collections from the lens of different influences and development patterns of landscape or portraiture paintings, and thus allow various ways to grasp the narrative.

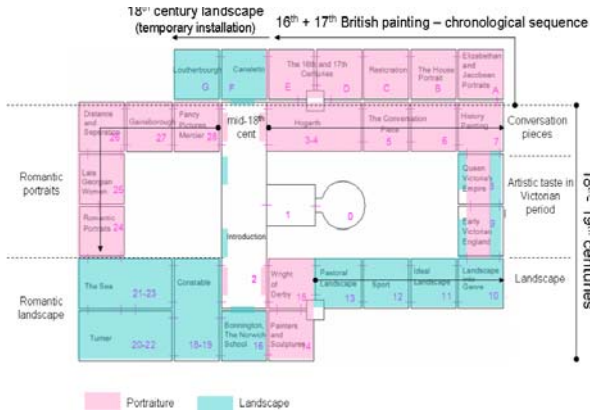


FIGURE 4a Exhibition organization on the YCBA's fourth floor (diagram prepared by the author).

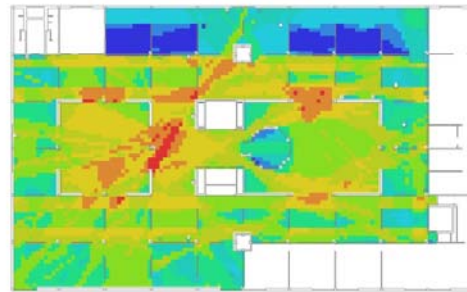


FIGURE 4b Global level visibility distribution (eye-level) on the YCBA's fourth floor.

This variety in reading the narrative is enriched even further by the YCBA's visibility network. Visibility through local visual connections among galleries and atria in multiple directions allow glances at exhibits at distant parts while placing emphasis on certain groups of displays that can be easily viewed from most spaces. In the global visibility network, visual integration concentrated in introductory gallery and the space towards the southern promenade highlights emergence of uniquely British portraiture genres (conversation pieces and others) within their influences from historic developments. Both the portraiture and landscape painting sequences along the atria core are visually integrated, thus each of these sequences can be related to other display groups with a few changes of visual fields. Yet, the sequence on the southern edge presenting the earliest historical developments and political period that influenced the emergence of portraiture remains visually and physically more isolated from the rest. Additionally, local visual connections through gallery gateways and atrium openings motivate visual comparisons among some display groups and thus help appreciating the works of art within their comparable aesthetic qualities accentuated with architecture of the building. Most notably, the galleries displaying art from the Victorian era look out on a panoramic view of the main atrium, offering a view of the displays positioned in other galleries in diagonal directions, and thus reflects the importance of the Victorian era in British art.

Therefore, the architectural design of YCBA underscores the narratives in its galleries in two ways. First, the design promotes displays depicting the emergence of British portraiture genres like "conversation pieces" and their ties with key political developments within a wide array of other displays in the layout. Second, the architectural design creates an aesthetic presentation of the collection, utilizing the atria openings to create opportunities to view the pieces at a glance, in juxtaposition to others. Therefore, design sharpens the

curatorial message to present British-ness of the art invested in artistic endeavor and relaxes the structured organization of the displays and enrich visitor experiences within main promenades.

4.2 Tracing the Complex Story of Late Modern and Pre-Contemporary Art (1940s-1980s)

The fourth floor of the MoMA building exhibits painting and sculpture from the 1940s through 1980s representing the late Modern art movements in complex patterns of evolutions, transformations and derivations. In the MoMA's new building, the design intent was to present these Modern art movements and styles with their richness and complexity by acknowledging contrasting and reactionary artistic moments. The fourth floor layout provides a semi-directed gallery sequence with few choices in itineraries. The physical connections among the galleries in multiple directions and a few vistas across the atrium express the trajectory of the Late Modern art movements within their complexity (Elderfield, 2004; Lowry, 1998).

Each gallery (so-called "chapter room"²) is devoted to a single art movement, or the style and works of an individual artist, while subdivisions within each room corresponded to subtle differentiations within the same movement or style. Physical and visual connections between these chapter rooms express how the various art movements emerged and evolved within a genealogical trajectory including oppositions, reactions, derivations and other complexities. The two galleries at the very beginning of the itinerary (the northern side galleries) exhibit works from the post-war era (1940-50s) and commence a sequence to narrate the emergence of Abstract Expressionism (i.e works of Jackson Pollock and his contemporaries). The galleries following immediately after capture the evolution of Abstract Expressionism into different styles by proceeding to either the gallery on "Painterly Abstraction" or to the post-Cubist and late Surrealist movements. The galleries displaying later derivations of Abstract Expressionism are reached through gateways situated in staggered positions. This positioning creates changing directions in the viewing sequence, which is intended to refer to the unsteady and multi-directional developments of Abstract Expressionism in post-war period art. The "Reinventing Abstraction, ca. 1960" gallery opens onto several other galleries in various directions, exhibiting Pop Art, Conceptual Art, Minimalism and post-Minimalism to express the complex, reactionary, and multi-directional developments which produced these more individualized styles from the Abstraction.

The visibility graphs of MoMA's fourth floor (Fig.3 parts b and c; Fig. 5b) shows that the galleries that are visually close to all other spaces were the "Reinventing Abstraction, ca. 1960" gallery, displaying the cross currents of the 1960s, and the "Minimalism" and "Post-Minimalism" galleries, representing the styles emerging out of these crosscurrents. Visual integration in those galleries places emphasis on the art of the 1960s and those reactionary or contrasting movements which developed afterwards, and implies that the complex and diverse post-1960s movements are significant for an understanding of late Modern art trajectory. On the level of local visibility, the visual isolation of the northern side galleries displaying post-Cubism and late Surrealism undermines the relative importance of these movements. This weak spatial emphasis implies that these movements need to be understood individually as the precursors to the complexity of post-1960s movements. From the beginning to the end of the fourth floor galleries, the visitor is able to see only a few rooms ahead. This arrangement facilitates viewing the works in the upcoming or

² "Chapter room" refers to rectangular gallery rooms representing each artistic style at a domestic scale. These rectangular rooms provide a laboratory-like setting for visitors to study and appreciate art and walls with minimal contextual information (Noordegraaf, 2004).

just recently visited rooms in conjunction with the gallery a viewer occupies, emphasizing the “kinship” between adjacent rooms and their related art movements. Masterpieces are thus placed at the end of visual axes which can be seen from the adjacent rooms. This placement utilizes gallery room entrances to frame the masterpieces and emphasize their unique qualities.

These strategies of displaying art establish a spatial structure parallel to the conceptual structure of the exhibit content, characterizing MoMA’s approach to understanding the story of Modern art as still relatively close to that complexity level of originally developed by the museum. MoMA’s fourth floor exhibit can therefore be considered quite didactic, utilizing the space to express scholarly or academic interpretations of art. However, the extent to which visibility relationships place greater emphasis on the increasing complexity of late Modern art after the 1960s and allow the visitor to appreciate also experiential qualities of art.

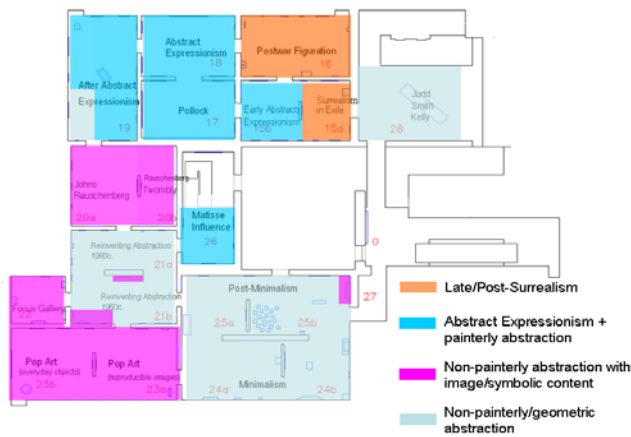


FIGURE 5a Exhibition organization on the MoMA’s fourth floor.

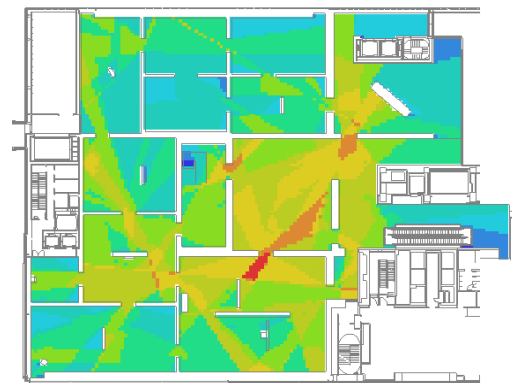


FIGURE 5b. Global visibility network (eye-level) in the MoMA’s fourth floor.

4.3 HMA: Hybrid Narratives of the Twentieth Century American art

The High Museum of Art’s fourth floor galleries exhibit works from three genres of twentieth century North American art: modern, contemporary and self-taught art. The exhibition is organized by utilizing the various geometry and spatial features to express the content presented by the works of modern, contemporary and self-taught art. Within this diversity of the works exhibited, the curatorial intent was to highlight affinities and connections among the works that came with artistic techniques and explorations, in addition to presenting these different genre works in their unique context and properties (Brenneman, 2006; Cove, 2006).

The exhibit of modern art in the HMA makes references to key developments in North American social and political history, thus presents the works in implicitly chronologic sequence at the outer edge of the Stent wing’s L-shape. At the beginning and end of this sequence, the pavilion type galleries with a room-within-a-room arrangement create a circular organization allowing a focused representation of key periods such as pre-World War 1 and post-war. The works of self-taught art are installed in a similar room sequence in the other “arm” of the L-shape, and the same room-within-a-room organization is utilized to create a focused

presentation of memory paintings. The third genre of the exhibit, contemporary art, illustrated the progressive and avant-garde movement emerged from modern art and increasingly diversified styles and individual explorations of later artists. The earlier contemporary works, therefore, are grouped into art movements and styles and assigned to galleries in the Wieland wing. This installation offers an implicitly chronological sequence of the art movements, minimalism, late abstract expressionism, pop art and other styles in matrix organization of Wieland galleries. The latest works in the collection represent increasing individualization and therefore are freely placed in large gallery in the Stent wing independent of any categorization. Despite the placement of these genre works in separate parts of the layout, the corner of the L-shape Stent wing is where the display sequences intersect, and thus the different genre works could be read in comparison (Fig.6a).

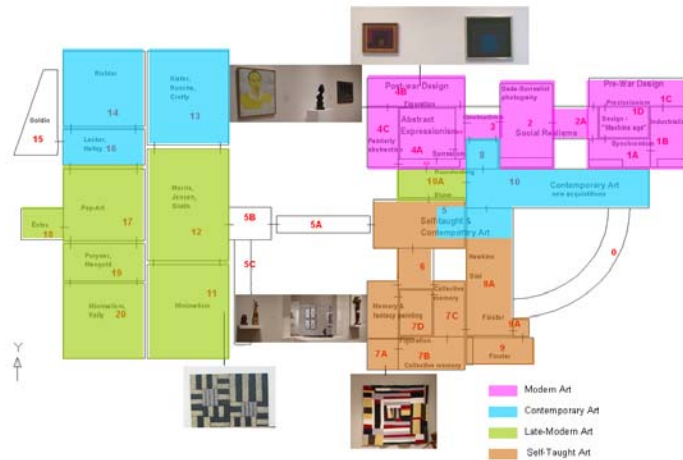


FIGURE 6a. Exhibition organization on the HMA's fourth floor (diagram prepared by author)

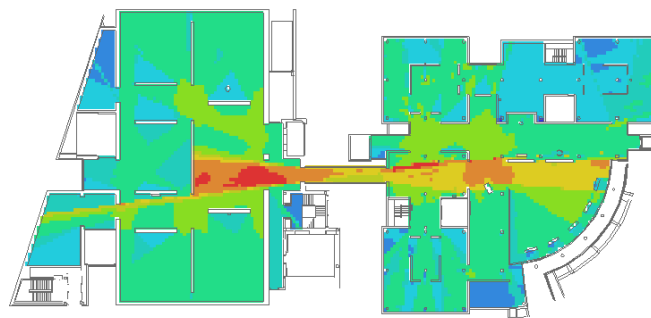


FIGURE 6b Global visibility network (eye-level) on the HMA's fourth floor.

The intent to present displays in individual parts and in comparison is further accentuated by visibility network. The composite spatial organization of the layout engenders varied levels of visibility and thus placed different emphases on the displays (Fig.6b). Due to the visual isolation of the outer edge Stent wing galleries, the works of Modern art are more likely to be grasped separately from all the other displays. The works of self-taught art in the other side of the Stent wing are similarly affected due to their inconvenient location as well as the visually isolated position of the galleries. Some display groups representing pre-

contemporary art periods in the Wieland wing are also in a relatively detached location. This hinders a seamless narrative flow in the entire layout and instead presents the narrative within distinct chapters or parts. Only at the gallery scale, the fluid space organization and gallery openings bring opportunities to “read” the works within numerous visual combinations in each of these exhibit sections. On the other hand, high degrees of visual integration at the bend of the large gallery hall next to the atrium (the inner corner of the L-shaped Stent wing) place emphasis on the intersection of different sequences. Thus, both contemporary and self-taught art can be viewed in conjunction. This capacity highlights the two collections’ similar artistic languages—utilizing scrap material, found objects and figures representing subconscious thoughts and motivations. A few modern works that anticipate the emergence of contemporary styles are also visible from this location. Displaying these works of modern, contemporary and self-taught art in visual juxtapositions reveal possible dialogues between/among these art genres.

By providing many opportunities for these displays to be visually compared to those in other sequences or spaces HMA’s skyway level layout emphasize coalescence of different art genres. This emphasis indicates the museum’s much less conventional approach to presenting and reading art, creating the potential to appeal to broad groups of visitors regardless of knowledge.

5. VISITORS’ MOVEMENT AND PAUSES AT EXHIBITS PREDICTED BY LAYOUT AND NARRATIVES

This section examines the effect of spatial layout on visitors’ space use patterns. We investigate the link between spatial properties and visitors’ space-use patterns through an analysis correlating spatial accessibility and visibility properties of galleries with key measures of the space-use patterns (movement paths and pauses at exhibits). A comparative discussion of the results obtained from each museum indicates where in the museum layouts visitors are engaged in navigation and exhibit viewing and how these patterns are linked to spatial properties.

Correlations investigated in each museum between spatial accessibility properties and movement paths crossing galleries indicate that spatial accessibility property has an influence on movement distributions. Visitors are likely to visit the galleries that can be reached by intervening least number of spaces (Table 2). In the HMA this effect of integration is rather weak and less significant than in other two museums, and this can be explained by the weak spatial intelligibility of the layout which makes it more difficult for visitors to grasp the entire configuration based on local connections. When we correlated movement paths with visibility properties of galleries in each museum, the analysis shows that in all three gallery layouts visitors are most strongly guided by visibility property that is strongest in each layout; visual integration in YCBA, and visual connectivity in MoMA and HMA (Table 2). This result suggests that in the YCBA being visually close to a wide range of spaces, and in MoMA and HMA the capacity to directly see neighboring locations motivate visitors’ movement.

TABLE 2. Correlations of movement paths with spatial accessibility and visibility graph measures

Space-Use measure	Museum	Integration (HH)	Connectivity	Visual Integration (HH)	Visual Connectivity	
Number of movement lines crossing each gallery	YCBA	0.72	0.74	0.76	0.60	<i>r</i>
		0.000	0.000	0.000	0.000	<i>p-value</i>
		0.50	0.53	0.58	0.36	<i>R</i> ²
	MoMA	0.60	0.75	0.43	0.68	<i>r</i>
		0.003	0.000	0.047	0.000	<i>p-value</i>
		0.36	0.56	0.18	0.46	<i>R</i> ²
	HMA	0.41	0.70	0.57	0.64	<i>r</i>
		0.014	0.000	0.014	0.000	<i>p-value</i>
		0.17	0.49	0.32	0.41	<i>R</i> ²

To investigate how layouts may impact visitors' contact with displays, we correlated key measures of stopping to view displays with spatial accessibility and visibility. When we correlate the visitors' pauses at exhibits with spatial properties, we see that exhibit viewing patterns are less consistently predicted by the layouts. Correlating the normalized counts of pauses obtained from each gallery with spatial accessibility properties yields no significant result. Yet, we find that the normalized stop counts are linked to the syntactic and non-syntactic visibility properties at various degrees. The results obtained from stop counts normalized by number of displays demonstrate that in the YCBA, visitors appear to stop at integrated spaces to view exhibits more than other spaces, irrespective of the number of displays available (Table 3). On the other hand, in the MoMA, visual integration and counts of pauses at displays (normalized by number of displays) are inversely related; visitors tend to stop less often to view displays at visually integrated spaces (Table 4). When this investigation is re-performed with the counts normalized by room areas, we see that again in the MoMA and HMA stopping to view exhibits appears more often at the spaces with low connectivity and low integration, irrespective of the room size. These results suggest that except for in the YCBA, in the MoMA and the HMA visitors' exhibit viewing patterns co-vary inversely with global level visibility, and in the HMA there is also an inverse relationship with local visibility (Table 5).

TABLE 3. Correlations of space-use patterns (movement and pauses at displays) with syntactic and non-syntactic visibility measures in the YCBA's fourth floor.

YCBA	V. Integration	V. Connectivity	Iso. Max Radial	Iso. Area	
Movement lines crossing each gallery	0.76	0.60	0.38	0.64	<i>r</i>
	0.000	0.000	0.033	0.000	<i>p-value</i>
	0.58	0.36	0.14	0.41	<i>R</i> ²
Pauses at displays (norm. by n. of displays)	0.45	-	0.52	-	<i>r</i>
	0.012	-	0.003	-	<i>p-value</i>
	0.20	-	0.27	-	<i>R</i> ²
Pauses at displays (norm. by room areas)	-	-	-	-	<i>r</i>
	-	-	-	-	<i>p-value</i>
	-	-	-	-	<i>R</i> ²

TABLE 4. Correlations of space-use patterns (movement and pauses at displays) with syntactic and non-syntactic visibility measures in the MoMA's fourth floor.

MoMA	V. Integration	V. Connectivity	Iso. Max Radial	Iso. Area	
Movement lines crossing each gallery	0.76	0.60	-	0.68	<i>r</i>
	0.000	0.000	-	0.001	<i>p-value</i>
	0.58	0.36	-	0.46	<i>R</i> ²
Pauses at displays (norm. by n. of displays)	-0.51	-	-	-	<i>r</i>
	0.019	-	-	-	<i>p-value</i>
	0.26	-	-	-	<i>R</i> ²
Pauses at displays (norm. by room areas)	-0.51	-	-	-	<i>r</i>
	0.019	-	-	-	<i>p-value</i>
	0.26	-	-	-	<i>R</i> ²

TABLE 5. Correlations of space-use patterns (movement and pauses at displays) with syntactic and non-syntactic visibility measures in the HMA's fourth floor.

HMA	V. Integration	V. Connectivity	Iso. Max Radial	Iso. Area	
Movement lines crossing each gallery	0.57	0.64	0.40	0.65	<i>r</i>
	0.014	0.000	0.014	0.000	<i>p-value</i>
	0.32	0.41	0.16	0.42	<i>R</i> ²
Pauses at displays (norm. by n. of displays)	-	-	-	-	<i>r</i>
	-	-	-	-	<i>p-value</i>
	-	-	-	-	<i>R</i> ²
Pauses at displays (normalized by room areas)	-0.57	-0.50	-	-0.55	<i>r</i>
	0.000	0.002	-	0.001	<i>p-value</i>
	0.32	0.25	-	0.30	<i>R</i> ²

When we examine these results in each museum in comparison with correlation results between movement paths and visibility, we obtain some interesting findings. In the YCBA, visual integration guides visitors' both navigation and exhibition viewing patterns, though at different strengths and significance. This result implies visitors engage in exhibit viewing in more or less in the places they move through. However, this is not the case for the MoMA and HMA. We see that high degrees of global and local visibility in both MoMA and HMA motivate frequent visits to galleries, which means spatial layout seems to have a guiding effect on navigation through the availability of visual information at local and global levels. However, the same properties discourage exhibit viewing; visitors tend to pause at displays more often in visually isolated locations. This means, with the effect of visibility network in the YCBA, visitors' navigation is synergized by their exhibit viewing, yet in the MoMA and HMA navigation is dissociated with exhibit viewing.

These inconsistent effects of visibility on movement and pauses in three museums can be explained by a number of factors other than network relations among spaces, based on further analysis of visitors' pauses with respect to exhibit organization and local visual cues in galleries. When we compare the visitors' pauses with exhibition organization in each layouts, we see in MoMA the popular paintings (in Pop-art and Abstract Expressionism groups) are placed in visually isolated galleries. In HMA, exhibits that are sequenced by chronological development of art offering clearer content structure are in segregated galleries. In both museums, popularity of the works of art and their clear conceptual structure may work as attractor motivating visitors' focused viewing despite their less frequent visits. In YCBA, there is no association with visual segregation and high rates of exhibit viewing, yet some of the display groups (i.e. works presenting the Victorian period, and Romantic landscapes of Turner and Constable) attract visitors' attention

independently of spatial factors. This shows that in addition to the influence of spatial layout, the works of art within their placement in the layout may have a quite strong effect on exhibit viewing patterns.

When we correlated visitors' space-use against (non-syntactic) visual field (isovist) properties, we are able to explain to what extent movement and exhibit viewing patterns might be related to visual cues released by local connections and geometric order of galleries. In the YCBA, significant correlations between normalized counts of visitors' pauses and visible area as well as isovist maximum radial suggests that visitors stop to view displays more often in locations that offer larger visible areas and deeper vistas. In YCBA, isovist maximum radial is found linked with movement paths crossing galleries as well, which means availability of deep vistas into space also motivates frequent visits to galleries. These correlations of isovist maximum radial with both movement and pauses at exhibits suggest that deeper vistas in space both guides navigation and focus attention to exhibits (Table 3). On the contrary, in the HMA the analysis indicates a negative association between visitors' patterns and visible area, suggesting that visitors prefer contained spaces to view exhibits. Yet, visible area and isovist maximum radial properties are linked to movement paths in galleries. While this discrepancy between the factors predicting movement and pauses confirms that visitors' navigation and exhibit viewing are dissociated, the different effects of visible area on exhibit viewing in two museums might be related to gallery geometric order. Smaller galleries offered in YCBA motivate visitor to maintain visual information extending beyond the confines of each gallery, whereas in larger galleries in HMA and MoMA visitors prefer contained spaces to view exhibits.

These effects of local connections confirm that the YCBA's capacity to visually connecting displays in far corners indeed makes an effect on the way in which displays are read by visitors. In the MoMA there is no evidence on to what extent local visual connections in particular influence exhibit viewing, yet the attraction towards popular paintings seem prominent. In the HMA, despite the museum's capacity to create many visual comparisons among the displays in gallery scale, this property does not necessarily encourage visitors' pauses to view exhibits in visual comparisons; on the contrary visitors seem focused on exhibit viewing when there is no distraction of local visual information.

6. DISCUSSION OF FINDINGS AND CONCLUSIONS

All the findings discussed in this manuscript portray how the design of the three museums (YCBA, MoMA and HMA) may influence the ways in which the exhibits are read. In the YCBA, through an attraction towards spaces that are visually close to a wide array of spaces, visitors are likely read the highlight of the exhibit, (the emergence of uniquely British portraiture genres as well as natural scenery painting). In the MoMA, visitors' interactions with displays are dissociated from their navigation; despite visitors' guidance by local level visibility, which also improves their awareness with exhibits in the neighborhood, visitors' focused interaction with exhibits take place in visually segregated spaces. This suggests that exhibits presenting the crosscurrents in the late modern period that are displayed in the most integrated galleries are not necessarily visitors' focus of attention. Instead, visitors seem to engage in viewing the works that are quite popular yet less of the centerpiece of the exhibition narrative. Similarly, in the HMA, visitors engage in navigation and exhibit viewing in quite different parts of the layout; despite moving through spaces that are visually close and directly accessible to wide array of spaces, visitors pay more attention to exhibits in the sequences visually isolated from the rest of the layout. As a result, dialogues among the works of modern, contemporary and self-taught art are probably not recognized by visitors. Instead, narratives in each exhibit section (development of modern art and self-taught artists explorations, or specific styles of contemporary

art) are more likely to be grasped by visitors through their focused viewing in visually isolated spaces that offering contained views.

We identify design properties that facilitate visitors' various encounters with displays. As illustrated by the architecture of the YCBA, museum design with continuous promenade, smaller size and more open galleries offering frequent vistas encourage a reading of content on the surface, while engaging visitors with exhibit viewing and navigation at the same instances. In contrast, as demonstrated by the MoMA's and HMA's layouts, museum design that provide more restricted sequence, less open and larger galleries with fewer vistas to beyond the visited spaces highlight a more didactic and in-depth presentation of content. Such layouts motivate visitors' focused interactions with displays. The fundamental difference in presenting content and shaping visitor experience is engendered by gallery geometric orders and local connections. As demonstrated by the effect of local visual information through gallery openings, these contrasting effects of layouts on visitor experiences can be explained by differences in gallery geometric order as a result of spatial vocabularies, such as YCBA's galleries punctuated with openings at the corners of galleries, MoMA's well-defined chapter rooms, or HMA's galleries in variety of size and configurations.

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