

Morphologies of Co-presence in Interior Public Space in Places of Performance

The Royal Festival Hall and the Royal National Theatre of London

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Abstract

When visiting places of performance to experience collectively a cultural event occurring in the theatre or auditorium, we also make use of foyers to see, meet and potentially informally interact with others. In large contemporary cultural buildings, main foyer spaces are freely accessible through the day, usually combining various facilities in open-plan arrangements. This paper attempts to analyse morphological characteristics of such public interiors and their relation to patterns of visitors' space use and co-presence. The main foyer spaces of London's Royal Festival Hall and Royal National Theatre are analysed comparatively. The study employs a new method, based on fields of visibility and access, at a fine-grain scale, enabling spatial descriptions of continuous 'free plan' layouts. It also analyses quantitatively modes of interface, using visibility graphs constructed from visitors' actual observed locations, proposing a user-centred methodological approach to the analysis of the character of public space.

Spatial Integration is shown to correlate with visitors' average degree of co-presence. The integration or segregation of entrances in the overall layout is found to impact on relative perceived levels of co-presence upon entry, creating a formal or informal first interface.

The analysis provides evidence suggesting that spatial layout and distribution of facilities modulate patterns of use, co-awareness, co-presence and potential for interaction among visitors, generating different modes of socialisation and transmission of culture.

1. Introduction

In recent times, as arts are becoming more accessible to a wider public, buildings of performance undergo a process of re-evaluation and change to their cultural agenda, aiming for larger numbers and diverse groups of visitors. Rather than transitional spaces between the city and auditorium or meeting places used exclusively by art-goers in the evenings, foyers become informal spaces, freely accessible throughout the day. Much like museums, libraries or recently bookshops, they integrate retail, catering and information facilities, music and seating in a conditioned environment, often with cultural events, such as exhibitions, informal performances and workshops. As public interior places, they embody characteristics of urban settings like co-presence with strangers and randomness of encounter. Their use as places to meet, rest, see, learn and potentially interact with others becomes in itself a mode of transmission of public culture.

In this sense, a socio-cultural experience does not solely depend on the arts programme and management of facilities. The character of interior public space can perhaps be shaped by the way visitors make use of it and may change at different times of the day, depending on co-presence, space use, diversity, interface with other visitors or members of staff. Are these

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Co-presence, encounter, public interior, visibility analysis, free-plan layouts, visitor behavior

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variables affected by the spatial layout? Is there a relation between spatial configuration and patterns of visitors' movement and public space use? How does space and the location of functions affect the perceived character of buildings of performance?

Previous research on various building types has provided evidence of the relation between movement and encounter patterns to spatial configuration, measured by syntactic variables based on axial and convex spatial descriptions (Choi 1996, Hillier & Penn 1991, Penn et al. 1999, Peponis et al. 1990). In museums, visitors' exposure to art objects when exploring art collections is complemented by visual awareness of one another (Choi 1996), which may acquire a formal or informal character, influenced by spatial configuration (Hillier, Peponis & Simpson 1983). Consistent analysis of museum settings shows a significant relation between spatial integration and visitors' movement, with deterministic viewing sequences found to tend to a formal co-awareness, and probabilistic layouts offering more choice and informal co-awareness (Choi 1996). The same study shows a correlation between visual encounter among people and convex integration. Analysis of Tate Gallery, Millbank shows strong relations between visitors' room occupancy and spatial integration combined with configurational depth from the entrance (Hillier et al, UAS, 1991).

Unlike museums, where the interface with artwork and with other people is synchronous, cultural buildingsⁱ of performing arts may generate different kinds of interface, depending on programmed events in space and time. For example, a collective experience in the auditorium usually assumes a pre-ordered interface (spatially and chronically) shared by audience and performers, generating a formal type of co-awareness among spectators. Still, an empty auditorium contributes to a different experience from a full one; a spontaneous performance in the street has different character to a programmed event in the theatre. Space and visitors' awareness of each other and spatial relation to the performers may impact on the way a cultural event is experienced.

Studies of history and social culture in places of performance have drawn upon theatre location, decoration and architectural style. In Carlson's analysis of the semiotics of theatre architecture it is noted that 'in addition to providing a space for the performance of a dramatic text, a theatre building has taken on a wide variety of social meanings over the centuries - as a cultural monument (...) and 'can signify a great deal about the way users relate to society as a whole both immediately and historically' (Carlson, 1989 pp 8). The analysis of modes of co-presence among users and of the role of spatial configuration in cultural buildings presented here aims to contribute to a better understanding of the character of interior public spaces with respect to how people experience them.

2. Visiting Interior Public Space: two Buildings of Performing Arts on the South Bank, London

The role of the layout in modulating spatial relations among visitors during intervals of performances is evident in certain traditional arrangements of vertically layered foyers. Although space use becomes informal rather than ordered, the potential for interface among visitors is to some extent controlled by the building through accessibility and visibility relations between layered parts.

Similarly, inside the auditorium, seating at the upper circle, boxes or stalls offer each a different relation of the viewer to, not just the stage, but also the rest of the audience, shaping accordingly the character of the collective experience. But what about the character of public

spaces accessed directly from the street? How does it differ in cultural buildings offering the same range of activities? How does their spatial layout affect the densities and distribution of users within?

In order to approach such questions the study analyses comparatively the public parts of two buildings of performing arts, focusing on their main foyer levels. The ground level of the Royal National Theatre (RNT) and the upper entrance level of the Royal Festival Hall (RFH) present interesting differences in their patterns of use.

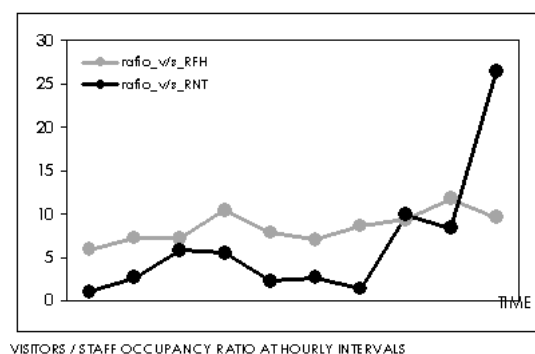
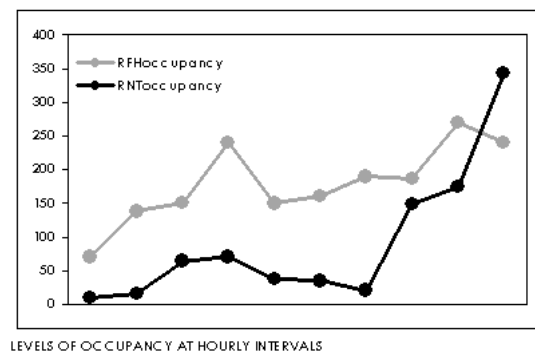
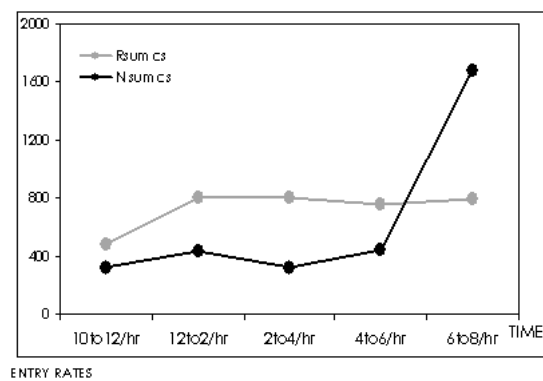
Direct observations of visitors' entry ratesⁱⁱ showed high levels of movement into the Royal Festival Hall consistently throughout the day, despite the fact that there were no performances in its auditorium. A children's exhibition at part of the foyer and open rehearsals in the ballroom were taking place on the days observed. By contrast, the Royal National Theatre has low entry rates through the morning, with a small peak at lunchtime, but comes to life after 6pm, when visitors start arriving for the performancesⁱⁱⁱ. (figure 1a-b).

Movement and static activity are spread throughout the main foyer level of the RFH, with comparatively high densities at the caft to the east river-side space in the morning and the central foyer in the evening. In the RNT levels of occupancy closely resemble the pattern of entry, with most of evening activity - as well as afternoon activity on days of matinee performances - feeding into the theatres (figure 1b). At times not associated with programmed events movement and static use are sparse and focussed at the two opposite sides of the building. Evenly distributed dense activity throughout characterises the times before theatre performances. The ratio of visitors to staff is higher in the RFH, attained in the RNT only at times of mass arrival for the programmed events (figure 1c).

Both buildings' main foyer levels are free plan layouts, directly accessible from urban space. Located at close distance to each other on the South Bank of the Thames, London, they both offer a similar range of facilities, including catering, seating, bookshop, information and bookings in their public spaces, providing access to upper level smaller foyers and the auditoriums. However, the differentiation between them in terms of entry rates, densities and patterns of use is evident.

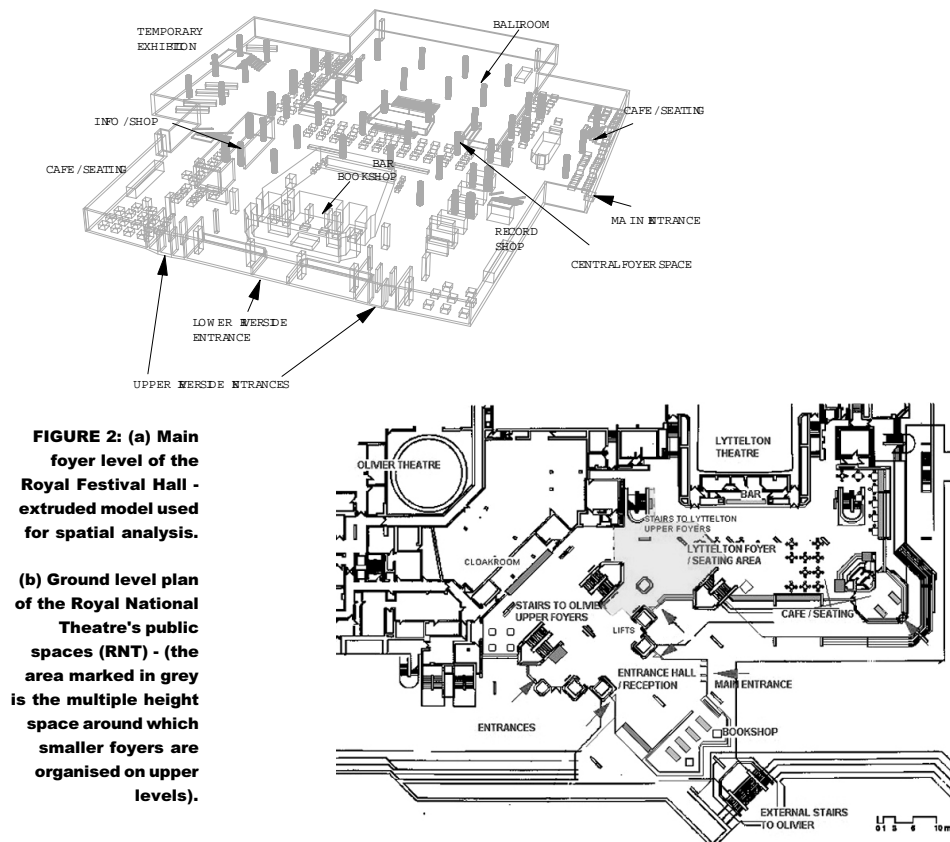
Designed by London County Council, Leslie Martin and Peter Moro, the Royal Festival Hall was the only permanent building of the 1951 Festival and the first public building of Britain after the war. During the design process, emphasis was placed on the general planning and circulation for the building to work as a whole, aiming specifically to allow visitors to spend

FIGURE 1: Comparative hourly visitors' entry rates (a), occupancy levels (b) and ratio of visitors to staff (c) in the RFH and the RNT.



long hours in the main foyer. The auditorium is enclosed within and above the public spaces and suspended over the main foyer and ballroom at entrance level, where informal events take place (figure 2a).

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The Royal National Theatre (RNT)), designed by Sir Denys Lasdun, opened in 1976, accommodates three theatres - the Olivier, the Lyttelton and the Cottesloe. The latter has its own entrance and foyer, and has been omitted from the study. At ground level the current spatial arrangement resembles an L-shape, with the entrance hall and bookshop on one side, below the Olivier foyers, and the seating areas on the longer side of the L-shape with Lyttelton's upper foyers extending above. The design concept for the public spaces was to be experienced as a forth theatre, where people are both the audience and the participants, with the city at the background^{iv}. This is realised in section by the strata or horizontal layers of upper foyers, extending from the two theatres, overlooking the central part of the ground level public spaces. While upper level foyers establish visual connections between the two parts of the L-shape, within the overall configuration, the ground level acts as their only accessible link through. With the complexity of the buildings in three dimensions taken into account, spatial analysis in this study is confined to the ground floor (figure 2b).

The study analyses the morphological characteristics of the spatial layout in each building and compares them to observed patterns of movement and static activity. Detailed analysis of networks of people at observed locations provides the framework within which the

spatial organisation of activities reveals patterns of co-awareness, co-presence and potential interaction. By examining differences and similarities in these aspects of visitors' experience, conclusions are drawn on the character of public spaces.

3. Spatial Analysis: methodology and findings

The fact that both buildings' main foyer levels are continuous 'free plan' layouts addresses methodological questions. Unlike linear urban networks and cellular building plans, in this case, syntactic axial and convex spatial descriptions can neither uniquely divide space into parts, nor capture spatial variations among adjacent locations. Therefore the method used is based on Visibility Graphs (VGA) constructed for all locations (nodes) specified on an evenly spaced grid of approximately 1m, covering publicly visible and accessible areas. A planar isovist - visibility or accessibility field - is generated from each grid point to produce a network of all direct connections between nodes and, from that, a visibility graph, analysed to obtain patterns of configurational and local properties (Benedikt 1979, Turner et al 2001).

The RFH has been analysed for both visibility and accessibility, excluding any moveable furniture. The RNT has been analysed once, since there are no differences between the visibility and accessibility graphs that significantly affect configuration. In order to account for the relation between interior and urban surroundings, both layouts have been re-analysed, including exterior spaces visible from their entrances.

The resulting syntactic measures used for the analysis are connectivity, spatial integration, point depth from the entrances, clustering coefficient and clique size.

Connectivity of each node in the system is the number of all other nodes directly linked to it (seen or accessed with no change of direction). Since the analysis is on a regular grid connectivity values indicate the size of the field of direct visibility (isovist) or access.

Point depth from a specified location indicates the least number of changes of direction in visitors' movement necessary to get from this to any other location in the system.

Spatial Integration of a node, derived from mean depth, is an index of the mean number of changes of direction required to get to every other node in the system (Hillier, Hanson, 1984).

Clustering coefficient of a given location measures the degree of convexity (or conversely multi-directionality) of the isovist generated from this location. It derives from the ratio of actual direct connections of nodes within the isovist to the maximum possible connections of the same number of nodes, if they were in a convex arrangement (Watts & Strogatz, 1998, Turner et al. 2001).

Clique size of a location quantifies the number of nodes forming the largest possible convex arrangement, i.e. completely inter-connected set of the visibility graph of which the location is part^v.

Configurational depth of the integration core from the entrance is derived by comparing patterns of spatial integration to each other and to point depth from the entrances. Specifically for the RFH, the relation between visibility and accessibility is investigated. The focus is on the underlying structure of the public foyer spaces and the way the parts associated with the various facilities or activities relate to each other and to the whole.

Integration analysis (VGA) of the Royal Festival Hall's main level highlights, in terms of visibility, the ballroom, the space where most informal events take place and spreads to the surrounding seating area of the central foyer (figure 3a). In terms of access, the integration core of the interior shifts to the two junctions at either side of the central foyer, between the

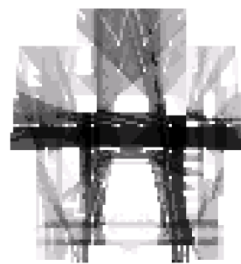
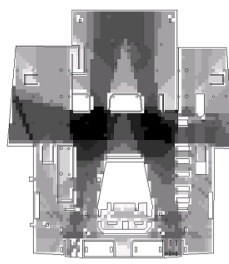
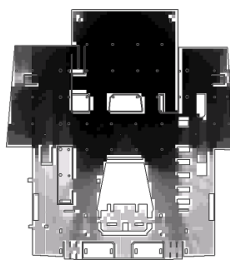


FIGURE 3: RFH:
Spatial Integration
core and structure of
the RFH analysed for
visibility (a), for
accessibility (b) and
for accessibility
including visual
fields from the
entrances to the
exterior(c).

FIGURE 4: Isovists
from the entrances
to the RFH main
foyer level.

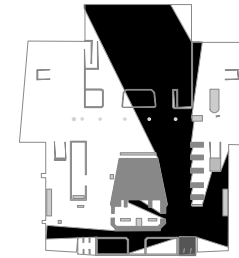
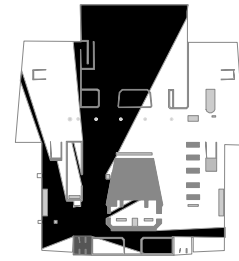
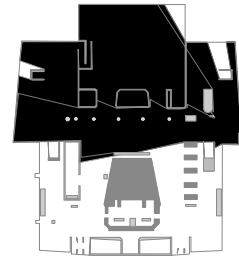


Table 1: Average
point depth from the
entrances to the RFH

RFH	Mean Point Depth
Main entrance	1.885
Riverside entrance (L)	1.79
Riverside entrance (R)	1.765

ballroom and bar. The ballroom itself becomes less integrated, with only its deepest part highlighted (figure 3b). By embedding the accessibility model in the exterior area defined by the visual fields from each of the entrances, the integration core extends from the central foyer and reaches the main entrance. The pattern of integration picks up the structure of the space, including the routes leading from the two symmetrical riverside entrances to the central foyer space (figure 3c). The interior -to-exterior relations through the entrances enhance the perceived spatial structure, following the same integration patterns but further differentiating among locations.

The visual fields from each entrance reach the central foyer and allow views to the ballroom (figure 4). Most spaces are accessible within the first change of direction after entering the building (table 1). The RFH has a shallow integration core directly visible from all entrances (at this level, and within one-two changes of direction from the lower level entrances).

The pattern of clustering coefficient of the interior differentiates between locations with almost convex isovists (values close to one, in white) and those with multi-directional isovists (close to 0, in black, figure 5a). All main level entrances to the RFH as well as the two junctions on either side of the central foyer space offer multi-directional views and options towards the various facilities. Spatial clique size analysis shows that the largest convex areas are formed in the ballroom and central foyer around it (figure 5b).

Visibility graph analysis of the Royal National Theatre's ground level public spaces suggests different spatial morphology. The integration core of the interior lies at the hinge of the L-shape, between the single story Olivier foyer and the part of the Lyttelton foyer exposed to views from upper levels. A well-integrated alignment links this space to the seating areas. The



FIGURE 5: Patterns of Clustering coefficient (a) and clique size (b) in the RFH (high values in white, low values in black).

entrance hall, reception and bookshop appear spatially segregated. When embedded in the external space visible from the entrances, the RNT's integration core shifts to the main entrance hall away from the Lyttelton foyers (figure 6).

Taking into account access from the exterior, the seating areas and centre of activity appear segregated, whereas internally the entrances seem segregated.

Two to three changes of direction are required from the main entrance to the integration core adjacent to the seating area. The main entrance hall and the cafi entrance on the opposite side of the building are highly clustered. The largest convex spaces are formed at the Lyttelton foyer (figure 7).

Comparison of average values of spatial measures in the two buildings' interiors shows that, the layout of the RNT locally enables larger fields of direct accessibility while the RFH achieves greater integration levels and locally larger size of convex areas (Table 2).

4. Way-finding and activities

How do the spatial characteristics of the above analysis relate to the patterns of movement and the development of activities in the public spaces of these buildings?

Movement traces recorded for the first three minutes of entry to the RFH (Figure 8a), show good use of the circulation spaces linking the riverside entrances to the central foyer. The riverside entrances accommodate approximately 30% each of all movement into the building, the main entrance being less used with almost 20%. Visitors' routes meet at the junctions on either side of the foyer, form rings of circulation through it, and are distributed towards various facilities. Although there are fine scale differences in the distribution and densities of movement through each space across the day relating to particular activities, the

FIGURE 6: Spatial Integration pattern of the RNT's interior layout (a) and including visual fields to the exterior from the entrances (b). High spatial integration values in black, low integration in white).

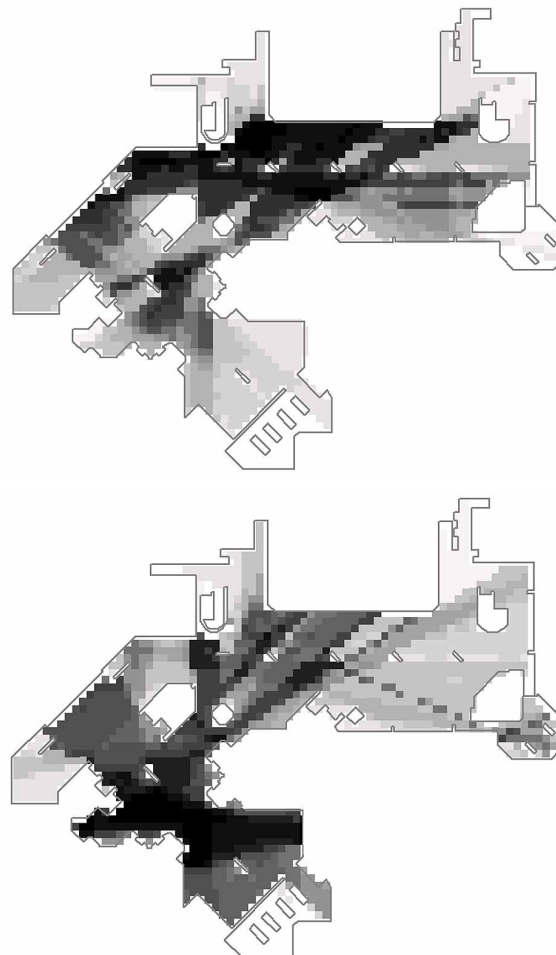
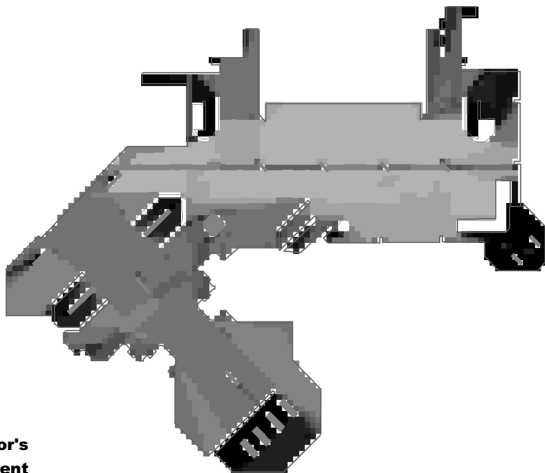
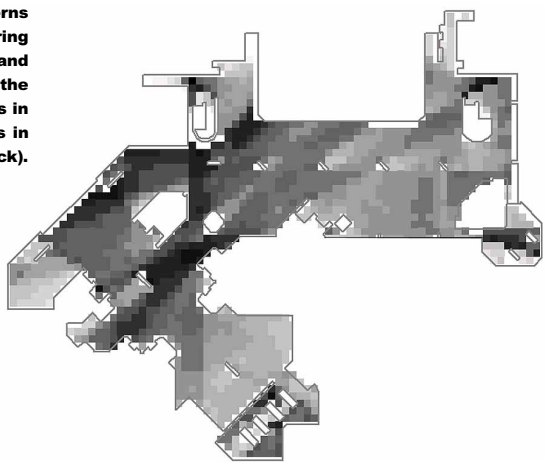
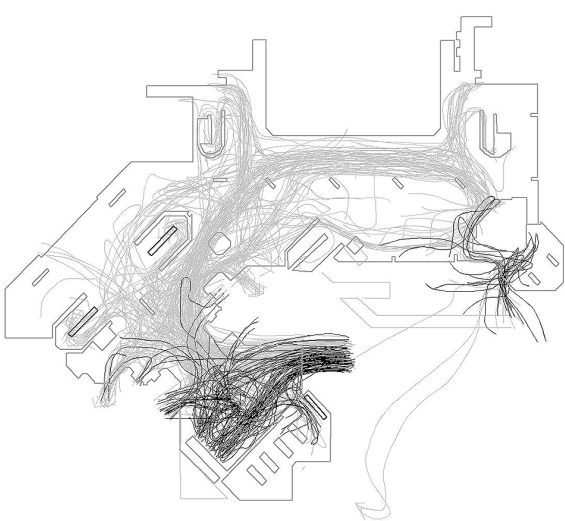
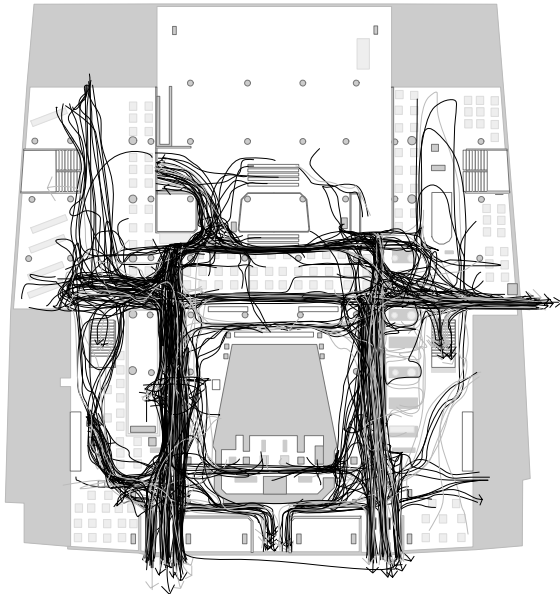


FIGURE 7: Patterns of Clustering coefficient (a) and clique size (b) in the RNT (high values in white, low values in black).



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FIGURE 8: Visitor's 3-minute movement traces from the entrances -total across the day for the RFH (a) and RNT (b) local movement in the entry areas in black, through or to-movement in grey)



overall pattern visually responds to the spatial integration pattern for accessibility, suggesting that visitors explore the public spaces according to the configurational structure.

The majority of visitors to the RNT come through the main entrance. A separation is evident between movement local to the entrance hall and through-movement to the deeper foyer spaces and upper levels, which occurs mostly at lunchtime and at times before the start of performances (figure 8b). The spatial layout's lack of potential for forming non-trivial rings of circulation encourages backtracking in visitors' path. The difference in the configurational structure perceived from the outside to that of the interior space results in a weak relation between the structure of exploration and the configuration of the layout.

Table 2: Daily average, for the days observed, of visitors' ratio of co-awareness, co-presence and convexity to occupancy for each of the two buildings.

(Ratios to occupancy)	Co-awareness	Co-presence	Convexity
RFH	3of7	1of5	1of7
RNT	2of7	2of7	1of7

5. Networks of people in interior public space

The spatial distribution of activities creates distinct patterns of visibility and accessibility among people^{vi}. The networks of visibility relations among users generate the perception of co-awareness - of seeing and being seen by others - specific to each location. Since visibility relations among users, and therefore patterns of co-awareness, change continuously with movement, so does visitors' experience of public space over time.

With the aid of visibility graph analysis and GIS, the locations of users observed by snapshots are analysed to attribute numerically to each occupied location local properties based on visibility and accessibility among users. This analysis generates patterns of visual co-awareness, co-presence and convexity relations among people in continuous interior space, as characteristics of the way the building functions at a time^{vii}.

Co-awareness is defined here as the amount of visual relations formed among people at a time. In this study it does not include visual links across different levels of the buildings, nor through glass partitions.

Co-presence as a measure is obtained by the number of people directly accessible to the person at the observed location.

Convexity relations are expressed quantitatively by another set of calculations for maximum clique size. This attributes to each visitor's location the maximal set of people who are all visible from that location and inter-visible to each other, i.e. in a convex relationship^{viii}. It has been used to indicate potential interaction in groups/clusters of visitors, a characteristic not immediately visible by the pattern of distribution of people in a free plan layout. Figure 9 represents graphically a sample of the network of visual and accessible connections, which give rise to each of the three types of relations^{ix}.

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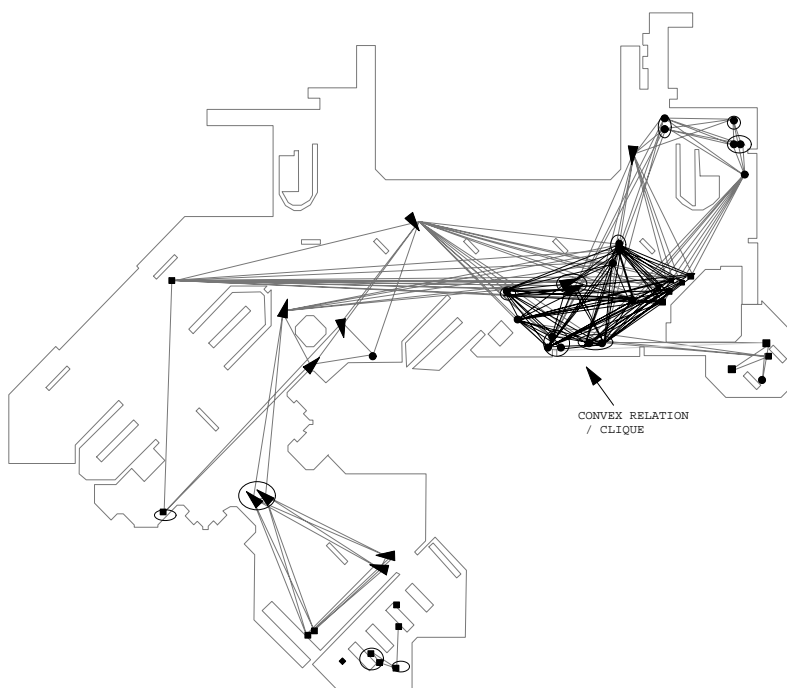


FIGURE 9: Sample graph of visibility and accessibility connections among users of the RNT' public spaces, determining co-presence and convexity relations.

Comparative average levels of occupancy, co-awareness, co-presence and clique size through time in each of the public venues indicate clearly that visitors perception of one another increases with absolute occupancy levels. In both buildings, only lunchtime levels are significantly lower than expected, suggesting that increased occupancy at that time is not transformed to co-presence. This may be associated with use of particular facilities locally, rather than affecting significantly a more global sense of inter-visibility. Further, on average throughout the day, given the same number of occupants, the spatial distribution and use patterns produce higher potential for co-presence in the RNT than in the RFH, but higher co-awareness potentials in the RFH (Table 3).

The differentiation of these properties by location, characteristic for different times of the day, requires more detailed analysis. In figure 10 the spatial distribution of perceived co-presence and maximal clique size - the potential for collective experience by forming large convex groups, is mapped, superimposing analyses from all times observed. In both buildings the perception of interface with others and of maximal convex relations are highest in the main foyer areas - the centre of activity where informal events take place and minimum in the bookshops, despite their high density of occupancy.

FIGURE 10:
Superimposed
snapshots of visitors
to the RFH (a) and
the RNT (b) across
the day analysed and
colour-coded
according to patterns
of co-presence

**Table 3: Daily
average, for the days
observed, of visitors'
ratio of co-aware-
ness, co-presence
and convexity to
occupancy for each of
the two buildings.**

R2 values (Rn vs co-presence by time	RFH	RNT
10:00 AM	0.037	-0.92
11:00 AM	0.029	-0.98
12:00	0.451	0.27
1:00 PM	-0.075	0.64
2:00 PM	0.39	0.64
3:00 PM	0.35	0.71
4:00 PM	0.75	0.34
5:00 PM	0.7	0.7
6:00 PM	0.54	0.44
7:00 PM	0.66	0.71
8:00 PM	0.6	(no data)
Daily average	0.408	0.445



There is a distinct difference however between the two buildings' public places in the degree of co-presence perceived upon arrival. In order to analyse this levels of co-presence are calculated locally at each snapshot of time observed for an imaginary visitor standing at each entrance to the RFH and at the main entrance, as well as in front of the information desk, at the RNT's entrance hall (figure 11).

In the RFH co-presence from each entrance is consistently higher than average perceived levels of co-presence at the same time for the whole layout. By contrast, in the RNT co-presence perceived from both the main entrance and the reception area is at all times lower than the average levels in the public spaces as a whole. The lack of visual access from the entrances to the centre of activity, its convexity and the segregation of the entrance hall in the overall configuration of the RNT's public spaces result in a person entering forming a first impression of the building being less used than it actually is.

6. Co-presence as a function of space

This last finding indicates a link between co-presence and spatial characteristics. To a certain degree the relation between visual access among people and the spatial layout is self evident, since every building structures visibility and access potential in space. However, since levels and patterns of users' movement and occupation are differentiated rather than of uniform density at all parts of the layout, visibility among people is not determined by the size of visual field at a location. What is the relation between configuration and observed patterns of space use, namely occupancy (absolute and density), co-awareness, co-presence and convexity in these public spaces?

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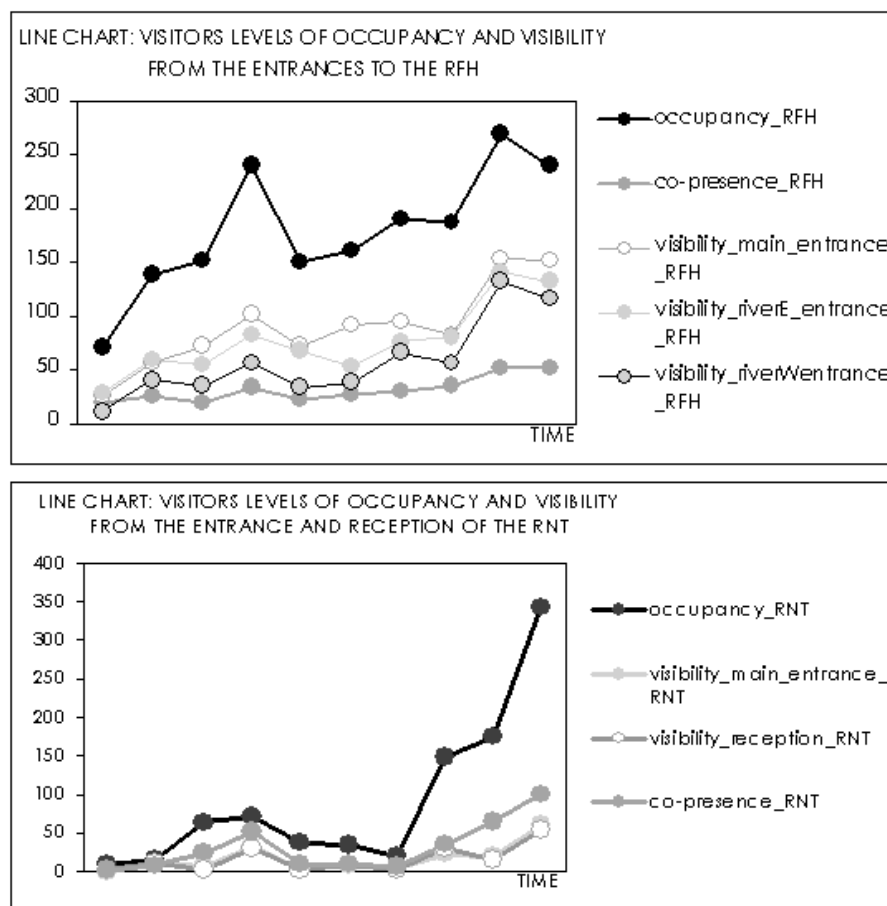
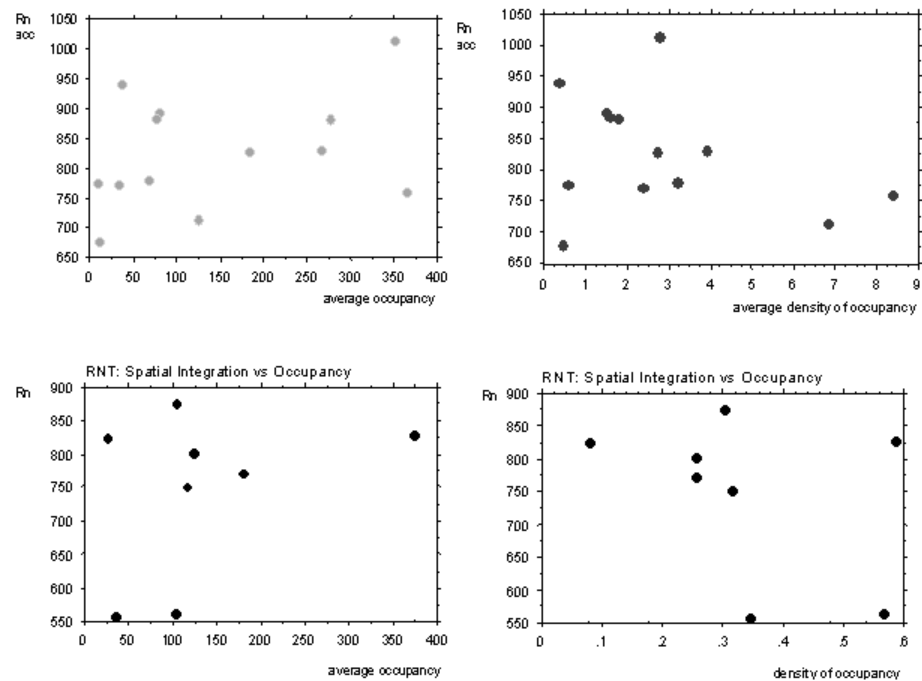


FIGURE 11:
Comparative line
chart of co-presence
from the entrances
and average levels of
co-presence and
occupancy in the
whole layout of the
RFH (a) and RNT
(b) across the day.

FIGURE 12: Scatter of Spatial Integration vs average occupancy (a) or density of occupancy for the Royal Festival Hall (b) and the Royal National Theatre (c,d)



16.12

Two ways of investigating this relation are examined. First, the layout of each building is conventionally divided into parts, based on functional and spatial evidence and the average values are correlated. The results show that, although spatial integration does not relate neither with absolute occupancy nor density of occupancy throughout the day (figure 12), there is a significant correlation between spatial integration and the average degree of visitors' co-presence (figure 13). This finding is in accordance with that of the analysis of museum settings mentioned in the beginning (Choi, 1996) and shows that the degree to which visitors perceive occupancy locally, by being co-present with others, is a function of the degree of spatial integration.

Further, the average size of maximum convex area from individual locations in the public parts of both buildings of performance correlates strongly with the average size of fully inter-visible cluster of users in them, and therefore with the potential for group interaction and collective experience (figure 13c-d).

At the level of large areas these are promising result. However, the division of space into parts is convenient, but methodologically unstable, since both buildings are continuous open-plan layouts. With the exception of cellular spaces, such as the bookshops, where a convex break-up might give a unique way of partitioning, there is no clear boundary to the various functions in the public spaces, except for signage and furniture. On the other hand, correlations between spatial characteristics for individual locations and observed levels of space use are practically impossible for the whole layout otherwise, since, in order to attribute a value of occupancy or co-presence to each grid location analysed by visibility graphs, repeated observations would have to be carried out to ensure a statistically significant sample. For this reason another method for detailed analysis is applied, whereby integration values (VGA) according to accessibility of the spatial layout at each observed location are attributed and correlated with the local degree of co-presence at the particular observed time.

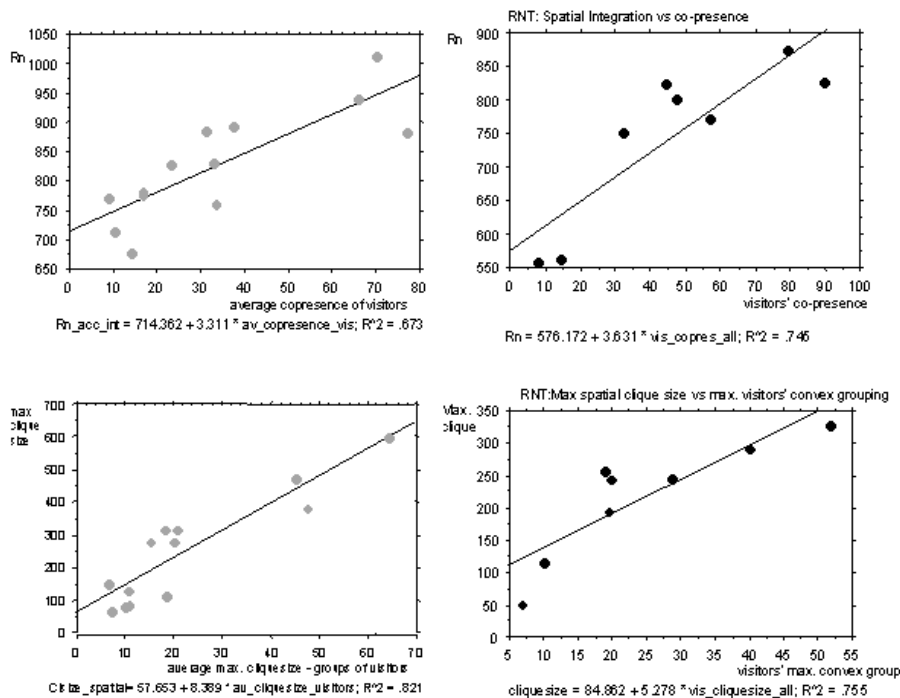


FIGURE 13: Scatters of Spatial Integration to co-presence in the RFH (a) and the RNT (b).

Scatters between maximum clique size of space and maximum convex group size of visitors in the RFH (c) and the RNT (d).

16.13

At this micro-level of individual locations of users at each time observed correlations do not confirm the previous findings. Since the degree of co-presence of visitors occupying the same place changes depending on the pattern of space use by others at the time, whereas spatial characteristics remain constant, the degree of correlation between spatial integration and co-presence varies (table 4).

Spatial integration correlates better with the degree of co-presence in the case of the Royal National Theatre, although the variation in R^2 values suggests that the degree of correlation is not predictable. In addition the low levels of absolute occupancy restrict the fine variations in degree of co-presence among users at times not related to programmed events. In the case of the RFH the correlation is weaker in the morning and increases towards the evening when there are informal performances in the ballroom. With the exception of lunchtime, the correlation between co-presence and spatial integration increases in the Royal Festival Hall together with increasing levels of occupancy towards the end of the day (figure 14).

R2 values (Rn vs co-presence by time)	RFH	RNT
10:00 AM	0.037	-0.92
11:00 AM	0.029	-0.98
12:00	0.451	0.27
1:00 PM	-0.075	0.64
2:00 PM	0.39	0.64
3:00 PM	0.35	0.71
4:00 PM	0.75	0.34
5:00 PM	0.7	0.7
6:00 PM	0.54	0.44
7:00 PM	0.66	0.71
8:00 PM	0.6 (no data)	
Daily average	0.408	0.445

Table 4. R2 values of the correlation between spatial Integration (VGA for accessibility of interior) and visitors' co-presence across the day.

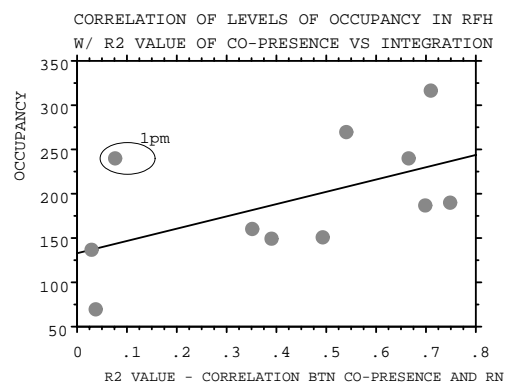


FIGURE 14: Scatter of average occupancy in the RFH through the day and R2 values of the correlation between spatial integration and levels of co-presence of individual observed locations at all times.

7. Spatial configuration and networks of people in public interior space

The study has investigated morphological characteristics of interior public spaces of the Royal Festival Hall and Royal National Theatre, in relation to visitors' space use, attempting to understand the role of the spatial layout in the creation of formal and informal modes of socialisation.

The term public space, embodies the potential for random encounter among diverse groups or individuals engaged in different activities. The degree of co-presence perceived locally, but changing with movement, becomes characteristic of a space, more so than its overall occupancy. Perceived diversity, multi-functionality, and therefore choice, contribute to its informal character.

Despite the buildings' similarities in range of facilities and sense of continuity of parts, patterns of co-awareness, co-presence and potential for interaction among visitors, generated by space use, are modulated in distinct ways in each building.

The main foyer of the RFH, below the raised auditorium, acts as the centre of activity, to attract movement towards it and re-distribute it to various facilities or directions. The shallow integration core, visible from all entrances, results in visitors' degree of co-presence perceived on entry being invariantly higher than average co-presence in the building at the time. Visibility and accessibility relations are regulated to ensure visual continuity as well as spatial differentiation. The inter-visibility of parts generates a sense of co-awareness of visitors engaged in different activities, characteristic of informal public space.

The RNT's spatial organisation employs the morphological properties of depth and convexity to distinguish entrance spaces, where a more formal interface with staff takes place, from the Lyttelton foyer which is the center of activity. The deep core structure results in levels of co-presence perceived by visitors entering being lower than average in the building, even when occupancy levels are at their highest. The visual isolation of points of arrival, coupled with limited permeability between activities, constructs a more formal experience.

Further study would be required to reveal the complex relations of visibility across levels and analyse co-awareness in three dimensions. However, even at this level, analysis of morphological characteristics combined with investigation of spatial relations among people suggests an approach of understanding how public spaces work with respect to their users. Spatial cliques have been introduced and tested to describe properties of inter-connectivity in groups of visitors, relating to potential interaction and the perception of forming part of a collective experience. Mapping of relations among people in interior space and analysis of immersing patterns of co-presence and potential interaction can contribute to a deeper understanding of modes of interface among users created by the layout, as an integral part of design. This method can add to an understanding of environments where function and location of users are to some extent designed within, such as offices or factory layouts, and of spatial layouts where these are completely unprogrammed, generated by the space itself.

Endnotes

- i The term culture is broadly used here to describe ideas, activities and institutions of social groups, whereas cultural buildings are regarded as those whose primary function is to house manifestations of aspects of human civilization and knowledge, including arts, sciences and humanities, as individual, group, or general expressions in time or of a particular place in time.
- ii Direct observations were realised in hourly time periods on weekdays, from 10 in the morning to 8 in the evening and included entry rates, three-minute movement traces from entrances and snapshots of static and moving activities. They were repeated in the RNT on a day with an additional matinee at the Olivier.
- iii Hourly numbers before the performances (6-8 pm) are indicative of high flows in the RNT, since they were recorded for 4 minutes but change frequently within the hour.

- iv "The strata seem to capture the fundamental sense of theatre as a place of gathering and provide a framework for the experience of visiting the theatre, which takes the city itself as backdrop'...'Space, structure and surface made manifest by the nature of concrete. People and events will be the decoration' (Lasdun, interview AR 1977).
- v This property is based on spatial cliques, i.e. a maximal set of nodes approximating a continuous area attributed to each node of the visibility graph within which all nodes are inter-connected and therefore at a convex arrangement. (On-going research Doxa & Turner, 1999-).
- vi Visitors' activities - sitting, standing and moving, reading and talking - were recorded once every hour. A distinction between staff, casuals, children, teenagers and Londoners working in the area was originally made; however, with the exception of staff-visitors, it was not found significant in the analysis and has been omitted.
- vii Only direct connections are taken into account; no relation is registered between visitors at one change of direction of movement or visibility line apart; no experiments with integration of visitor locations have been performed.
- viii On-going research on the method and application of convex descriptions generated from visibility graphs (Doxa & Turner, 1999-).
- ix Measures are based on the convention of visibility and access through 360 degrees, rather than 180 or 110 degrees of a person's visual field. A better terminology would rather be for 'potential of co-presence, awareness of others etc. A more detailed observation study and spatial analysis would be taking into account directional relations, which are not necessarily two-way. In addition, the obstruction of a person's visual field as a result of the presence of others in space is not taken into account.

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