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Domestic decryption

A longitudinal configurational analysis of social hierarchy in semi-detached houses

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ABSTRACT

The architecture of the dwelling is the closest representation of societal behaviours and ideals. An example of such behaviour is social hierarchy which this paper considers as an intrinsic value of the spatial configuration of the domestic space, responsible for mediating everyday interactions between inhabitants and between inhabitants and visitors. By adopting Hiller's and Hanson's configurational approach to space (1984), this paper examines the evolution of the English semi-detached housing typology to interpret and visualise changes in societal ideals as well as how these have manifested in the functioning and arrangement of interior spaces within this typology over the period of a century (1850-1950). While considering the wider political, technological and architectural context of the time, the study seeks to provide a deeper understanding of the social implications of historical architectural decisions. Such knowledge can be useful for architects and planners involved in the design of houses in order to accommodate changing family structures and living habits in the future.

The use of methods and tools from space syntax theory provides evidence of the effect of the configuration of a house plan and its individual spaces, their use and social meaning. Five case study plans, each representing a different historical moment in the evolution of semi-detached typology, are selected for the comparative analysis. The plans are used to produce scans which are examined from two perspectives - that of the occupant and of the visitor - in order to determine hierarchical patterns across different spaces and functions over time.

The main analytical tool used in this paper is Isovist_App (version 2.4) developed by McElhinney (2020). The software analyses the five plans, measuring their values of Integration, Visibility, Mean Metric Depth and Visual Control. The produced heat maps illustrate the probable experience of navigating through the building and can be compared both visually and numerically. Besides the

visual analysis, justified permeability graphs are also used to represent the separation and sequence of different spaces in the same plan.

The findings indicate a reduction over time in the importance of maintaining private and formal social spaces in favour of more open, informal social areas, and an increase in the permeability of the boundary between the house and the exterior space. The study draws particular attention to the social importance of individual spaces in relation to the whole plan, such as the importance of the front room as a buffer space between the central plan and the outside.

KEYWORDS

Development, social hierarchy, semi-detached, space syntax, Visibility Graph Analysis

1 INTRODUCTION

"*Buildings 'speak' to us. They tell us about the economic and social structures of the times in which they were built... ...all through the subtle use of architectural form*"
- Gorst. Introduction, 1995

Understanding the sociological relations between spaces is a critical part of designing for the future. It allows a comprehension of how the space can be used rather than just how it sits within its site. In that process, quantifying the affordances of existing domestic design interiors can create a foundation for understanding the development of space in relation to its architectural context over time which in turn forms a framework in which the critical thinking of contemporary domestic spaces can be realised on a more intimate level. Space syntax theory and methods enable a comprehensive understanding of the relations between spaces and consequently the potential social implications resulting from their design. Through use of a combination of Visual Graph Analysis and a contextual understanding of the desired occupant's status, numbers, and era of design, a cognitive understanding of a social characteristic can be determined (Koutsolampros et al, 2019) which cannot be derived from the VGA alone.

Previous attempts at identifying a coherence between sociological ideals and their manifestation within space, such as work by Hillier and Hanson (1984) with the social logic of space, provided a classification of different uses for space syntax ranging from the urban scale down to interior spaces, and identified the domestic space as the most indicative representation of sociality.

Increases in demand for housing, combined with an ever-decreasing amount of available and suitable space, means that the efficient use of space is a priority in new housing developments as well as the renovation of existing building stock to maintain their relevance. With little information regarding the causal factors leading to the variations in the configuration of domestic spaces over time, this paper attempts to develop a cognitive understanding of the reasons behind the changes in the arrangement

and layout of a domestic space in a semi-detached style building, and to develop a method which supports future design decisions with an understanding of the effect on the social values to both the occupant and visitor.

In this paper we will apply the space syntax techniques of visual and justified graphs to explore the development of a social hierarchy of functions and spaces within a sample of semi-detached houses built over a period of 100 years we will then attempt to extrapolate an understanding of the core design principles affecting the differing social experiences of domestic space as either an occupant or a visitor.

The paper is structured as follows. The ensuing chapters provide an extensive overview of previous literature and methodology as well as providing an explanation of space syntax and its relation to the topic question. We then present the chosen methodology and selected case studies for this paper whilst defining key terms. We present, compare and contrast the results of the analysis within the context of the case study design. The final section demonstrates socio-cultural changes over time and how these were reflected each time on the spatial hierarchy of the semi-detached house.

2 THEORY

The relation between the configuration of physical space and the social values that prevailed at the time has been researched from many different perspectives in the fields of space syntax and archaeology. Although the value of space is identifiable through the architecture of traditional homes of particular cultures in the pursuit of an 'ideal type' (Hanson, 1999), the complexity of the ordinary home as a hub representing the unique social expression of local culture has not been subjected to study.

The Social Logic of Space by Hillier and Hanson (1984) formed a foundation for the description and analysis of the kinds of spatial patterns produced by buildings and cities. Their theory established several comparative representations through study and provided a commentary on a collection of research techniques used to investigate spaces, networks of spaces and their relations - for example, looking at how a street connects to a city, or a room connects with the rest of a building. The primary aims of their study were to show how the organisation of space stems from social life and to highlight the ways in which the arrangement of space can already been seen to have been influenced (Hillier and Hanson, 1984).

Following suit, Hanson's *Decoding Homes and Houses* (1999) compiled the research of multiple professors and students on various traditional structures from different localised cultures around the world. The book identified aspects in which the sociological values of domestic spaces can be determined, other than simply by the configuration of the spaces themselves. For instance, the research investigated the relation between the functions of adjacent rooms as well as the physical human interactions that occur within the space on a daily basis. It is, however, also noted that the

sociological analysis of space through its occupants is, in most cases, impossible to achieve through either archaeological or historical studies as it would require a detailed understanding of the occupant's day to day use of the dwelling.

This study is primarily concerned with the occupant, by identifying a social class of person living in the housing type or considering the profile of the occupant for which the housing was built, in order to establish a contextual background from which various conclusions can be derived.

Despite the extensive research into the social significance of spatial configuration for a given culture, geographical location and era, little has been done so far to look at the development or change in social values over time for a particular category or type of housing.

Lofthouse's paper (2012) analyses the development of the English semi-detached dwelling from an archaeological point of view. It argues that, despite the lack of research interest in this ordinary and rather prevalent building type, the semi-detached house provides the most intimate social insights into the lives of the general public due to its rich history, spanning multiple centuries as the most built housing type. The paper goes into great depth describing the occupants' lifestyles and physical changes in response to the country's transition from a rural into an industrial economy. It does not, however, consider the relationship of the occupant with the interior space.

This study therefore also attempts to form a connection between the social theories identified by Hillier and Hanson and the development of the semi-detached residence represented through the work of Lofthouse in order to analyse the intricacies of the common dwelling and its complex expressions of the ordinary.

3 DATASETS AND METHODS

3.1 Issue of sample

The first issue that arises with an analysis of development relates to sample choice. Levi-Strauss (1967) identifies the difficulty of analysing a social culture through space for it requires common factors amongst a sample of people in order to draw meaningful conclusions from a study due to the large number of variances within the sample of people. "Among numerous peoples it would be extremely difficult to discover any such relations (social class, habitual behaviours, etc.)" (p292. 1967), indicating that with a random selection, there would be too many external variables to determine the reason behind a change in design. This was utilised in the study done by Hillier et al (1986) where the authors selected a sample that covered a specific location and function. Additionally, according to Levi-Strauss (1967), the sample must also represent an extended period of design and must therefore be a manifestation of the traditional values of the time.

Considering this, the case studies of this study were selected based on two criteria. Firstly, the houses had to belong to the same typology so as to reduce the discrepancy in the inclusion of rooms and luxury spaces. The typology could also provide a loose class identification to the inhabitants of the space, giving a general insight into the values and wider contextual issues held by the occupants. The English semi-detached house offered an interesting example to study due to it being the most common housing type in England, making up 32% of all dwellings (Lofthouse, 2012), whilst being subjected to relatively little research into its development. It also provided the most direct insight into the development of a social culture as it is most commonly inhabited by both the working and middle classes and was initially used to give the impression of a higher social status, the earlier symmetrical type appearing to be a single house and thus suggesting wealth (Lofthouse, 2012).

The second criterion was that the case studies had to share the same country in order to reduce the variance of national differences in social values and historical political and economic events. The initial sample itself covered a selection of housing plans collected through the works of Brown and Steadman (1990) dating from 1850 to 1950. The sample was then narrowed down to cover pivotal points within the development of the semi-detached type in the context of the UK highlighted in Lofthouse's paper. The five main events were the introduction of the semi-detached to the rural workers, the creation of council estates, the garden city, interwar semis and the universal semi. These events were utilised to derive a reasoning and context behind some of the identified disparities between the designs, allowing us to draw conclusions and create an understanding of the impact of the inhabitants' principles on the layout of the house and the use of the space.

The final case studies are: the Workman's cottages designed by Henry Roberts 1850; the Builder labourer's cottages 1860; the Brick cottages by Geoffrey Lucas 1905; Interwar semi-detached 1930, and the Universal design for semis 1950. They follow a period of transition for the semi-detached type as it transformed from a middle-class house to a more accessible dwelling for the lower class and desirable housing typology for the upper classes. The selection covers other pivotal events of the time beginning with the publication of Henry Roberts' *The Dwellings of the Labouring Classes* which created a foundation for the idea of healthy designs of the semi-detached for the working classes. The continuation of these ideas through the *Labourers' Friend Society's* competitions transmitted these ideals to the masses, leading up to the Letchworth Garden City competition which paved the way for innovative and affordable semi-detached housing designs. The interwar period saw changes in the preferred urban city housing to the semi-detached typology as it became more important that one's house reflected one's social status. Finally, a standardisation of the semi-detached typology through the design concepts by Frank Brown resulted in a more unified design strategy behind the innovative concepts developed at the beginning of the century.

3.2 Justified permeability graphs

In order to compare case studies from different eras on equal footing, convex maps are used to convert the floor plans into a set of convex spaces by transforming rooms and functions into the minimal set

of spaces which cover the whole system (Hillier and Hanson, 1984). Maps are then reduced to graphs where each convex space is represented by a node. Pairs of nodes are connected by a line if there is a physical connection between them. The graphs are converted to justified permeability graphs (Hanson 1998, p.27, 247), a method developed by Hillier and Hanson (1984), to visualise the depth of a system in the format of a simple diagram. These justified graphs have an allocated base node (often the outside world) acting as the 'root', wherein the nodes are arranged on a series of horizontal, consecutively numbered dotted lines, the lowest line being 0. Each dotted line represents a step into the building from one room to another connected directly to it. The nodes and solid lines representing the direct connections between them form a tree displaying the level of relative depth of a room with respect to the 'root' space.

By classifying the exterior as a single node, it is possible to determine a difference in the integration of a visitor to the system and as such establish, at least to a degree, a separation between social and private spaces. The justified permeability graph also allows the identification of *A*, *B*, *C* and *D* spaces (Hillier et al, 1987). *A*, *B*, *C* and *D* spaces allow for the definition of rooms based on their connection within the graph.

A spaces are spaces with only a single link and can be identified as dead end spaces. In a social sense these can be identified as the least accessible rooms and thus these with the least impact on the dwelling. A *B* type space is a space between spaces, defined as a point in which the number of connections is one less than the number of rooms and which is connected to at least one *A* space. Displaying a form of topological buffer between spaces can therefore be seen as a way of separating out private spaces. *C* and *D* spaces are attributed to ring formations as they are defined as spaces which form a part of a sub-system which contains no *A* or *B* type spaces, with the *D* space forming a connection between two of these sub-systems. The presence of either of these creates a more connected system of spaces and increases the value of the included spaces as core social spaces.

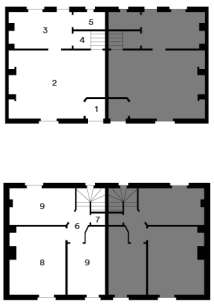
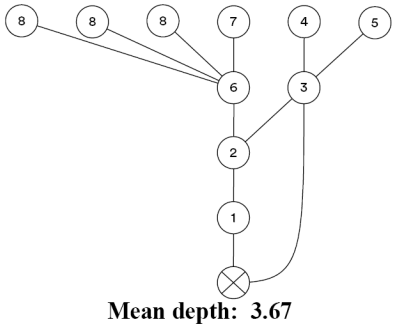
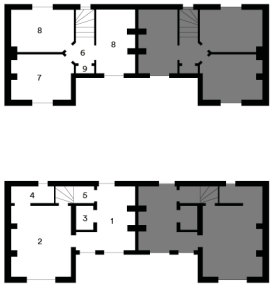
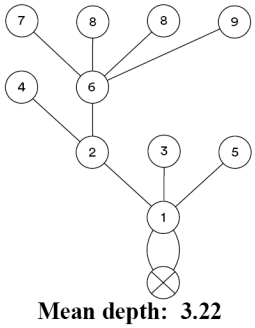
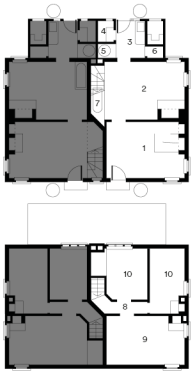
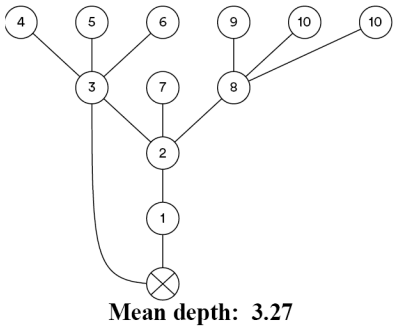
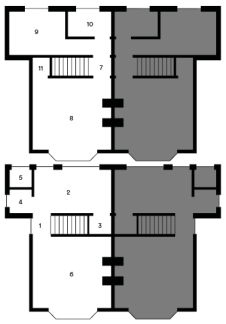
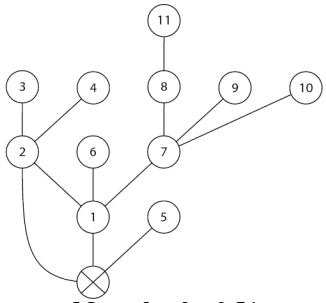
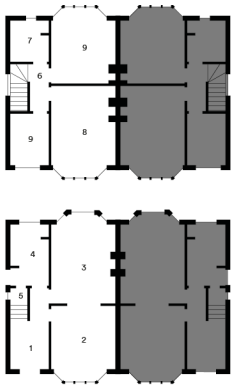
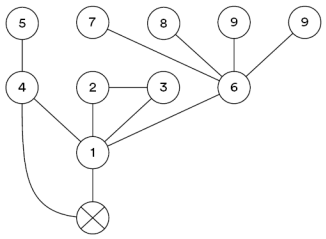
Henry Roberts Workman's cottages 1850		 Mean depth: 3.67	1 Front porch 2 Living room 3 Scullery 4 Coal store 5 Pantry 6 Landing 7 Linen 8 Master bedroom 9 Bedroom
The Builder labourer's cottages 1860		 Mean depth: 3.22	1 Scullery 2 Living room 3 Store 4 Pantry 5 Coal store 6 Landing 7 Master bedroom 8 Bedroom 9 Linen
Brick cottages exhibition 1905		 Mean depth: 3.27	1 Front room 2 Living space 3 Scullery 4 Larder 5 Copper & Cisterns 6 Coal store 7 Bath 8 Landing 9 Master bedroom 10 Bedrooms
Interwar semi-detatched 1930		 Mean depth: 2.54	1 Entrance hall 2 Scullery 3 Store 4 Pantry 5 Coal store 6 Living room 7 Landing 8 Master bedroom 9 Bedrooms 10 Bathroom 11 Store
Universal design for semis 1950		 Mean depth: 2.40	1 Entrance hall 2 Front room 3 Living room 4 Scullery 5 Pantry 6 Landing 7 Bathroom 8 Master bedroom 9 Bedroom

Figure 1. Table of selected case studies (2021)

3.3 Visibility Graph Analysis (Isovists_app v2.4)

After this, Visibility Graph Analysis software was used to further investigate any relations initially identified using the justified permeability graphs. In this method, the testing was used to determine a difference in the spatial patterns of the inhabitants and the visitors. The scans provide a more detailed analysis of the space as a geometric form (McElhinney, 2020). 'Hotspots' can be identified based on Visibility and accessibility which, when compared to the layout of room functions, provide an insight into the social functions of spaces, thereby developing an understanding of the role of the spaces within the system.

The key themes for the analysis of a social hierarchy of spaces are as follows: Connectivity - how connected the space is within the system determines its value as a space that is frequently traversed; Visually - the degree in which the space is within view as it provides a sense of visual accessibility and in turn the visual importance of the space, and finally Metrically - the distance which must be traversed in order to access it and its size relative to the system as a whole which determines its ability to hold multiple persons as a social space (McElhinney, 2020).

The key VGA metrics to identify examples for these themes are as listed (refer to Figure 2):

Integration HH: Integration or Relative Asymmetry (RA), as defined earlier, is the mean number of steps to every other node and can be used to determine the importance of a space within a system (Turner and Penn, 1999). This provides an understanding of how visually accessible a particular space is, and therefore how pivotal its function.

Visibility: Visibility is defined as how often a point is visible from a defined sample region (McElhinney, 2020). The results of this metric are typically comparable with those of the isovist area metric. Used in combination with each room's value of Integration, it can be used to determine the social value of the space.

Mean Metric Depth: Defined as the mean metric distance required to reach every other cell in the system (Koutsolampros et al, 2019, p5.), the Mean Metric Depth provides a visualisation of the effort required to move to certain functions. For example, an analysis from the entranceway may highlight private functions that are metrically furthest from the front door, thereby discouraging access either by guests or intruders.

Control: Use of the Control metric defines points which act as a visual link between space and highlights 'junctions' which are most likely to be traversed in order to access another space (Hillier and Hanson, 1984). This metric can be used to highlight a change in a social value as it can identify a boundary to a collection of spaces. The Control metric defines choke points within a configuration and in a retail context could be used for example to determine the ideal locations of security placements.

The final stage in analysis is the comparison of the samples against one another as a list of the different spaces by function. By allocating a set of values to each space for each metric, it is then possible to order the values from low to high and by doing so, determine any similarities or major differences between different dwellings. In this way, it is then possible to highlight average values for the semi-detached style of build and identify possible changes in social value for that function over time.

For testing the configuration of the samples with two or more floors, a spatial link tool can be utilised to connect the two floors by point of transition. This is also considered using the metric scans, providing a possibility for inter-floor relations.

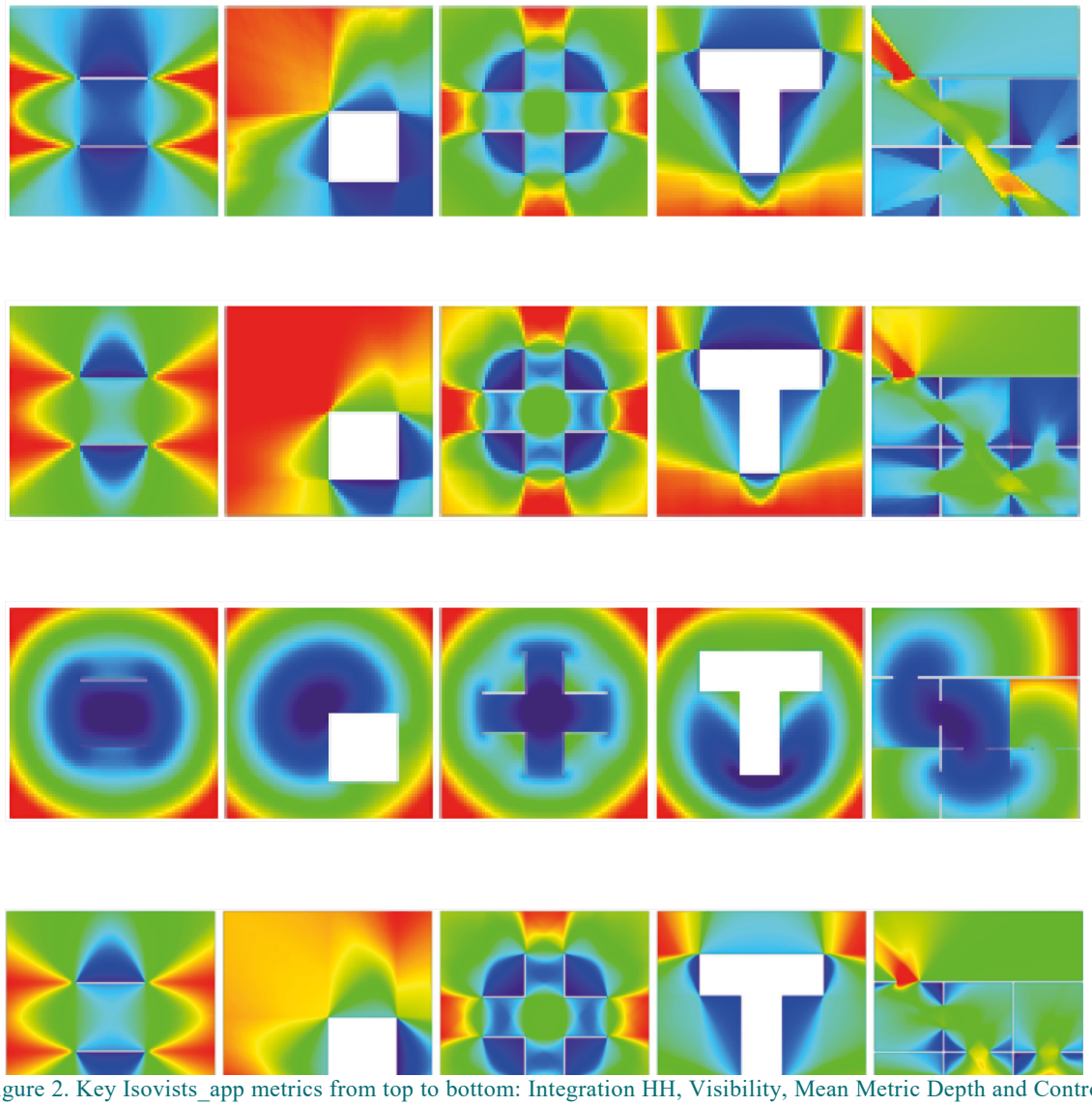


Figure 2. Key Isovists_app metrics from top to bottom: Integration HH, Visibility, Mean Metric Depth and Control
Sourced from: https://isovists.org/user_guide/

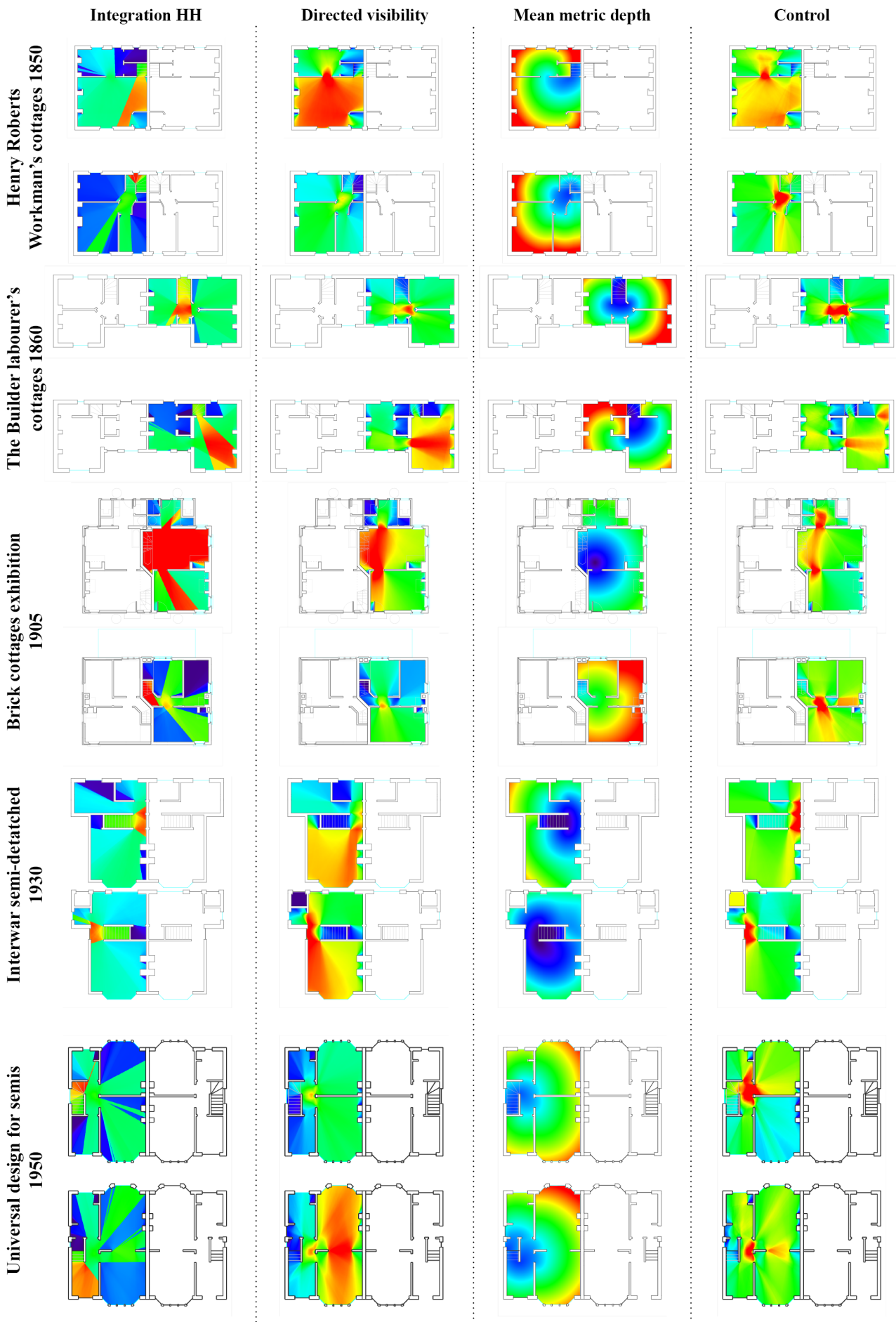


Figure 3. Metric scans of selected case studies (2021)

4 CASE STUDIES

4.1 Workman's cottages, Henry Roberts 1850

In 1850 Henry Roberts published *The Dwellings of the Labouring Classes*. The book addressed the benefits of a healthy dwelling with regards to the working-class population as well as Roberts' own designs for model houses for both the city and the agricultural districts. Contrary to the then current style of working-class housing e.g. terraces and large apartment blocks, Roberts' designs brought a new perspective to the semi-detached as a feasible typology for the working masses, receiving global acclaim and establishing the norm of three bedrooms in each house - a master bedroom and two further bedrooms for children of each gender (Lofthouse, 2012). This became a turning point for the class structure of the semi-detached as, prior to this, the majority of semi-detached dwellings were

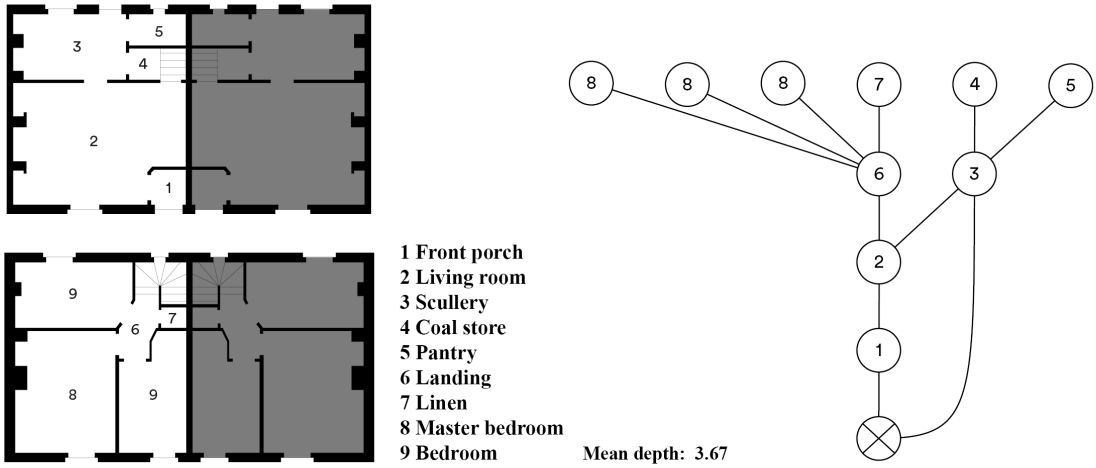


Figure 4. Workman's cottages, Henry Roberts. Floor plans and justified permeability graph. (1850)

aimed at middle- or upper-class occupants.

Comparing the floorplan of the Workman's cottages by Henri Roberts and its associated justified permeability graph, while assuming the exterior as the 'root' space, it is interesting to notice that the graph only splits after the living room (2). As the living room is a space in which the whole household might congregate, the provision of the front porch (1) creates a first step with a low value of Integration and a correspondingly reduced value as an intimate space to occupants.

Although the front porch (1) is typically used as a functional buffer to prevent the heat escaping when opening the front door, from the above it can be seen that the porch also has a social function. The front porch is a sacrificial space in the sense that a portion of the interior space is given up to prevent direct access to the core functions of the home by the visitor (e.g. living room, kitchen, bedroom), thereby maintaining the separation of the private space of the occupants. Furthermore, the justified graph displays a distinct separation of sub-functions within the cottage using the living space as a connecting space. Also, the graph only consists of *A* and *B* type spaces, mentioned earlier as spaces

which only lead to or are led to from one other space. This displays a simplification in terms of value of spaces as there is a linear structure to the functions.

Analysing first the Integration (HH) metric, the initial observation of the Visibility Graph further supports the observations made of the permeability graph that the space with the most integrated function is the living room (2). However, it is also interesting to note the particularly low values for the three bedrooms (8,9), signifying their privacy and the exclusion as core social functions of the system. Despite the scullery's (3) connection to four other functions, its Integration value is considerably lower, suggesting a segregation from the social spaces.

The Visibility analysis highlights the living room (2) as the space of highest Visibility meaning this is the space which is most visible from every point in the house. This is in keeping with the living room's function as it is usually the space in which the most interactions between both occupants and, in the absence of a front room, visitors. In direct contrast to the living room, the front porch (1), assumed to create a threshold between strangers and visitors, has a dramatically lower value of Visibility, creating a sense of visual privacy before entering the home. Notably, the other areas of high Visibility are the scullery (3) and master bedroom (8). It is interesting to note that the master bedroom has a significantly higher value of Visibility than the two other bedrooms (9) intended for children, displaying a visual hierarchy between the three bedrooms.

The Mean Metric Depth analysis highlights the staircase as the centre of the configuration. Geometrically this is unsurprising as the staircase sits in between the two levels and as such should be equidistant from both floors. However, in a social sense this creates a distinct division between the public and private realms as the distance between the two is the greatest.

An application of the Control metric reveals the areas of highest Control as the living room (2) with other hotspots located in the landing (6) and on the boundary to the scullery (3). This correlates with the analysis of the justified permeability graph as it highlights the existence of the subsystems mentioned earlier as the identified spaces are connections to dead end, *A* type, spaces i.e. spaces which don't lead further.

4.2 The Builder labourer's cottage 1860

Following on from Henry Roberts designs, the Labourer's Friend Society (1827) and many other societies that were created to improve the lives of the masses ceased to be, as their ambitious designs failed to materialise, largely due to cost. However, after the enclosure commission was established to ensure estate owners were providing cottages with specific minimum requirements, many of these groups held design competitions in an attempt to push the boundaries of these standards. In the majority of the cases the winning design would be that of the semi-detached, cementing it as a staple

typology which best emphasises the social values of the time through the rooms and their configurations.

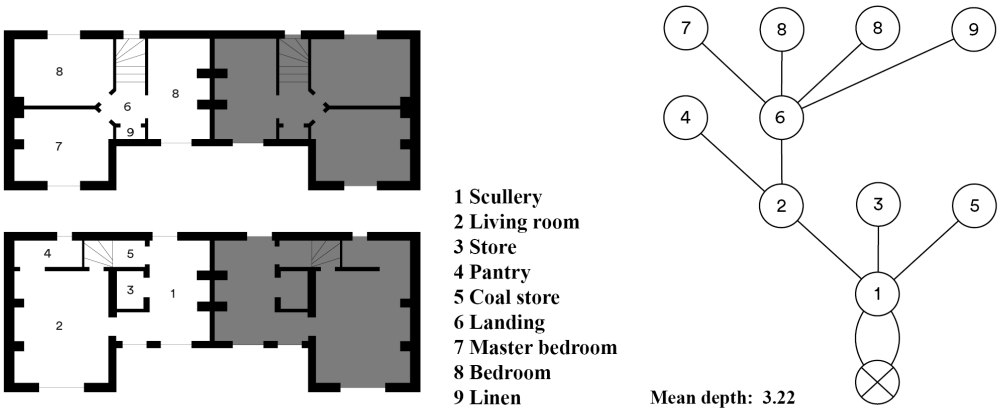


Figure 5. The Builder labourer's cottage. Floorplans and justified permeability graph. (1860)

The initial analysis of the floor plan (figure 5) displays an absence of the front porch seen in Henry Roberts designs and instead the main entrance directly accesses the scullery. This could be due to the nature of the design as it was primarily designed for use within an estate during the era of a "closed" village (Lofthouse, 2012). The need for a front room to buffer visitors before allowing access to the home was reduced due to the already private nature of the home.

Analysing the space as a justified permeability graph further supports this as the value of depth decreases from the previous study despite including the same number of spaces. In comparison the graph becomes shorter, reducing the number of steps a visitor must take to access the living space to just two, narrowing in turn the distance between the occupant and the visitor. Contrary to this however, the location of the pantry (4) which would normally be expected to be in the direct vicinity of the scullery (1), is located instead on the opposite side of the floor and in connection with the living room (2). The odd position of the pantry from a user perspective notwithstanding, the privacy level of the pantry remains comparable for a visitor, being three steps away from the main entrance. Even though the front entrance leads directly into the scullery, the rear entrance is still located in the scullery. Traditionally located in the scullery, the back door acts as an informal visitor reception as those who tend to access the dwelling from the rear are either occupants or friends.

Similar to Roberts' designs from 1850, the most integrated space is the living room (2) further supporting it as the central social space within the configuration. Notably, the area with the lowest Integration is the scullery (1) despite containing both entrances to the dwelling. This feeds into the idea, previously mentioned in relation the Workman's cottages, of a separation between the scullery and the living space (living room and the bedrooms).

Here, the Visibility analysis reveals the living room (2) to be the most visible space in the house, while the scullery (1) displays a significantly lower Visibility value despite both spaces being connected to three other spaces. The difference in value from the front entrance visually guides visitors to the dwelling through to the living room and further segregates the utility spaces from the living spaces.

Similar to the Workman's cottage, the Mean Metric Depth analysis highlights the staircase as the centre of the configuration. The scullery (1) is highlighted as the furthest, metrically, on average from any point in the configuration as visitors would have to first pass by the entrance in order to access it, creating a further segregation between the scullery and the rest of the living spaces.

The next metric reveals the living room (2) as the space with the highest visual Control point. Although this correlates with the Workman's cottages, in the absence of a front room, it is unusual that there isn't a value of high Control in the scullery (1) side of the dwelling as it has two exits, leaving it prone to intruders. However, this could explain the odd placement of the pantry (4) as it not only keeps the food stock within the more controllable part of the house but also places it the furthest away from the connecting wall assumed to be the warmest area of the house due to the location of the chimneys (Roberts, 1853).

4.3 Brick cottages, Geoffrey Lucas 1905

Designed as part of an exhibition in Letchworth to demonstrate an ability to design an affordable cottage home, the brick cottages are highlighted by Hilary French (2008) as one of the key domestic designs of the 20th century. Their introduction forms an interesting pivotal point in the development of semi-detached dwellings, dealing with a shortage of cottages in the rural areas. With the main class occupant of the semi-detached being the working and middle class, the exhibition tackled the issue of lack of attraction of the rural areas to the working classes who were unable to afford the rural costs of

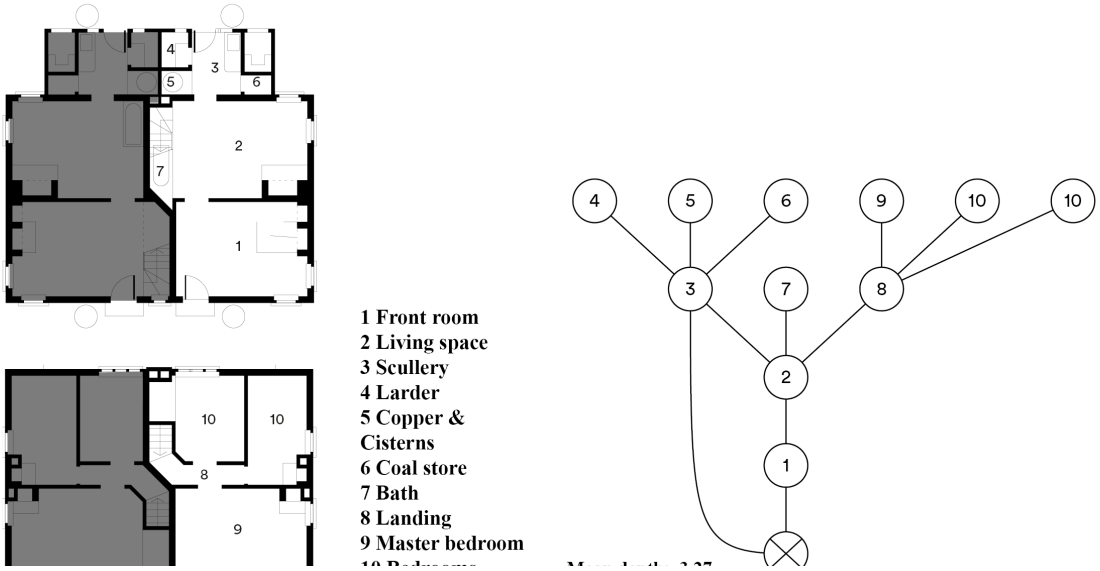


Figure 6. Brick cottages, Geoffrey Lucas. Floorplans and Justified permeability graph. (1905)

living (Lofthouse, 2012). The task led many architects to design using cheaper materials. A reduction in building costs required changes to the social configuration, prioritising the most critical social values and providing only those spaces deemed to be of base necessity. Geoffrey Lucas' Brick cottages are an example of this.
From just the floor plans (figure 6), it is interesting to note the division of functions between the ground and first floor, with most of the living functions being encompassed on the ground floor and only the sleeping arrangements on the upper floor.

Analysing the configuration as a justified permeability graph results in a graph similar to that of the previous two studies. However, it has significantly lower mean depth value than the previous two. Comparing this to the justified permeability graph, it's interesting to note that, despite the similarities to Henry Roberts Workman's cottages, the function that separates the living space from the exterior is different. The front room replaces the porch in this design, typically used as a reception room for welcoming guests as well as formal social events. It is odd that this space, despite its function, is still used in a similar way to the front porch by regulating the level of intimacy with visitors, acting as a buffer within the system and keeping the private space of the occupants separate. Furthermore, the justified graph displays a distinct separation of sub-functions within the cottage using the living space as a connecting space. The corridor on the first floor (8) only connects to the living space and the three designated bedrooms (9,10) while the scullery (4) similarly connects only to the living space and the three provision storages (4,5,6). This displays a level of value in the living space as a point of Control through the system and separates the functions into subsystems.

Similar to Henry Roberts Workman's cottage design, the Integration (HH) metric supports the observations made of the permeability graph with the function of highest Integration being the living room (2). However, it is also interesting to note the repetition of the low values for the three bedrooms (9,10), signifying their privacy and their exclusion as core social functions of the system.

The Visibility analysis on the other hand displays a strong visual channel through to the living room (2) from the main entrance. This is unusual as, from the justified graph, the front room's (1) purpose is to act as a social space for visitors, reducing access to the main core of the dwelling. However, the Visibility Graph displays a visual bypass of the front room directly into the living room which suggests a decrease in privacy of the living area and an increased social significance of the front room as a component of the private living space when compared to previously presented examples.

Similar to the first study, the Mean Metric Depth value further identifies the living room (2) as having the core social function of the configuration, with the central point being in the entrance of the living space. Unsurprisingly the functions which sit the furthest mean distance from any point in the system are the bedrooms (9,10), supporting their minimal social significance as part of the system.

Looking at the Control Metric, the existence of the sub-systems identified earlier are evident, with high Control values for the scullery (3) and landing (8) which each lead to end or *A* spaces. This can be seen as a grouping by social function that highlights a space's relation to others. In this case the spaces are grouped by function – utility, such as storage and culinary spaces, and living, such as the sleeping quarters.

4.4 Interwar semi-detached 1930

After the First World War, the United Kingdom was hit by an economic recession and with rent controls inflicted on the rental of interwar dwellings, there was no longer any investment into real estate as it was no longer profitable. Instead the interest was in owning rather than renting a home. Owning a home subsequently became a symbol of social status and combined with the new founded investments into the building sector (Barrett and Phillips, 1987), led to the development of many suburban-rural suburbs surrounding the towns and cities. As the semi-detached was cheaper to build but still held desirable characteristics in its appearance and in the spaces it usually incorporated, the semi-detached became the banner example of the interwar dwelling and made up over 85% of the 2.9 million developments built (Clapson, 2008). The interwar semi designs, mostly focused on the aesthetics of the exterior and ignored the modernist themes being promoted at the time, as the idea was to make them attractive to the middle and lower classes (Lofthouse 2012). From the initial analysis of the floorplan (figure 7), distinctions from the previous studies are evident. For instance, the location of the staircase as its own structure floating in the middle of the plan provides a direct access link to the first floor from the main entrance which reduces the usefulness of the buffer space to

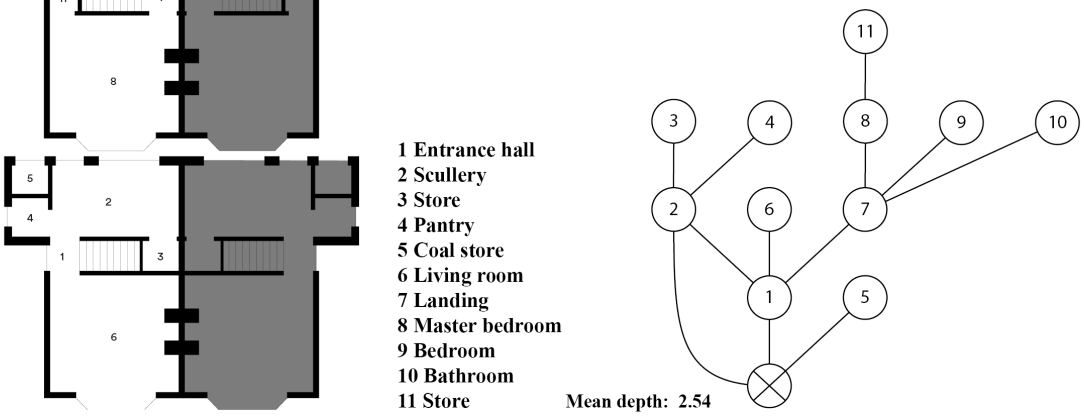


Figure 7. Interwar semi-detached. Floorplans and justified permeability graph. (1930)

prevent immediate access to the private spaces. Furthermore, the entrance to the home sits on the side of the building, prompting a more intimate relation to visitors as they must first pass by the length of the dwelling. In combination with the bay window displaying the intricacies of the living room, this suggests a diminishment of the barrier between occupant and visitor.

Converting the plan into the justified permeability graph (figure 7) reveals a complex tree-like shape. However, the average mean depth value is significantly lower at 2.54. This is due to the aforementioned lack of a front 'buffer' room and the value of depth shows the effects of this as a more accessible configuration. Alternatively, discounting the exterior space, there are no *C* or *D* spaces which are found in all the previous studies. This results in a lack of rings within the diagram and suggests a reduction in complexity and accessibility. It also illustrates the presence of the sub-systems – utility spaces, living and social areas, and sleeping rooms - identified throughout the previous studies.

The analysis of the Integration metric displays an interesting shift of value in relation to what was previously seen. The living room in this design is no longer the space of highest Integration. Instead, the highest values belong to the entrance (1) and landing (7). Every functional living space other than the secondary bedroom (9) are all equally integrated into the configuration which is different to the aforementioned sub-systems and results in a living space with fewer boundaries.

However, the Visibility metric identifies two spaces with higher Visibility: the living room (6) and the master bedroom (8). Despite both having relatively equal values, the connotations of these hotspots are different. The high value of Visibility within the living room correlates with the contextual idea at the time of the exterior of the home representing a social status and with the inclusion of a bay window, it can be assumed that the high Visibility value here represents the importance of the living room as a space to show off to guests. The master bedroom on the other hand represents a more internal value than theorised earlier in that it allows occupants of the child's bedroom an ease of accessibility to the parent's room in the case of an emergency.

The Mean Metric Depth predictably centres around the staircase. However it is interesting to note the surprisingly low values for the entirety of the ground floor. The only spaces with a relatively higher value are those of the bedrooms (8,9). Socially identified as the most intimate and private of the living spaces, it is notable that despite the rest of the spaces sharing an equal value, the bedrooms remain an exception to this.

Similar to the previous case studies, the Control metric has very few points of high Control due to the alignment of the staircase with the front entrance, the notable ones being located at the entrance (1) and on the landing (7). This is due to the connectivity between the spaces as every space, in order to access another, must pass through either the entrance or the landing. This is shown by the absence of rings in the permeability graph which would otherwise provide alternative routes. However, this arrangement does lead to an increase in *A* spaces which increases the chance of interactions on the landing and in the entrance as *D* spaces.

4.5 Universal design for semis 1950

The increasing demand for semi-detached housing during the interwar period led to the standardisation of the typology. The combination of the contemporary social context within the UK with the housing manual regulations required the grouping together of various parts of a cottage as well as facilitating maintenance and upkeep. The resulting concepts became the universal semi-detached house (Lofthouse, 2012). In 1990, Frank Brown wrote a paper in which he analysed interwar housing through a rectangular dissection, a form of spatial analysis. In which the components of the floorplan are converted into rectangles and disregarding their metric sizes. The aim was to understand the contextual influence on the shape of the dwellings. Upon applying the constraints, Brown discovered there were only two configurations which could accommodate three bedrooms, one of which was the typical design for the universal semi.

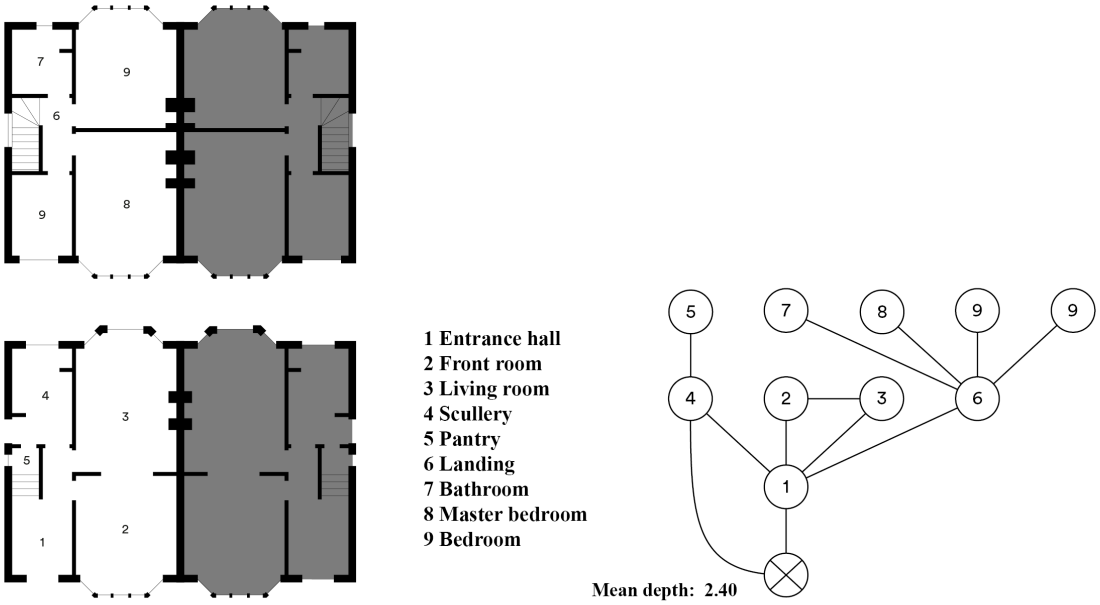


Figure 8. Universal design for semis. Floorplans and justified permeability graphs. (1950)

Upon the initial analysis of the floorplan (figure 8), there is an obvious relation to the interwar semis through the positioning of the staircase with regards to the front entrance. A similar reduction in value of a front room to create a buffer space to filter guests from occupants is also displayed. The floors both accommodate a similar layout of spaces which is not as evident in the earlier studies, representing a more balanced attribution of value between all the spaces. Comparing that to the justified permeability graph, the graph is at its shallowest with a mean depth value of 2.4. Every function is accessible from the entrance within two steps, prioritising accessibility over privacy. Interestingly, there is the first instance of a ring structure between the hall (1), sitting room (2) and living room (3). The sitting room, usually used as a space to entertain and interact with guests, sits at the forefront of the configuration making it the most accessible to visitors. This represents a degree of flexibility with the social ground floor functions as it removes the aspect of a clear determined route through the space.

The Integration metric displays a similar result to that of the interwar semis as the highest Integration values sit outside the living spaces. However, with the ring connection between the sitting room (2) and the living room (3), Integration is marginally higher in the social spaces intended for guests which shows a residual distinction between the public and the private spaces.

The Visibility metric further clarifies this with higher values throughout both the front room (2) and the living room (3). In social terms, this creates an overlap of the function of both spaces which only exists when the double doors are opened in the case of a large gathering or event, turning the living room from a private living space solely for occupants into an extension of the visitor's space.

The Mean Metric Depth predictably centres around the staircase with the entrance hall (1) and the landing (6) being the spaces with the lowest Mean Metric Depth to location and which separate the sub-spaces.

An application of the Control metric reveals similar results to that of the interwar semis with the hotspots being in the entrance hall (1) and on the first-floor landing (6). However, another relatively high value is visible on the threshold between the two social rooms - the living room (3) and the front room (2) - providing a 'bottleneck' point of interaction where guests and inhabitants alike will most likely bump into each other.

5 DISCUSSION

Despite the similarities between the results, a few notable themes can be derived from the analysis of the case studies (see generally figure 1 and 3). Firstly, the disappearance of a designated 'buffer' space, identified in the earlier studies of Henry Roberts' Workman's cottage up until Geoffrey Lucas' Brick cottages during the Garden City movement, used to separate the main body of the house from the entrance in the form of a front room or porch. Whilst this gradual disappearance can be understood as a way of maximising the living space for the occupants, it also signifies the loss of e.g. a front porch as a 'buffer', this was previously considered to be an essential function within the design of a home to filter uninvited guests from invited guests and occupants. This has a resounding effect on the rest of the configuration as it creates a more intimate relationship between the occupant and the visitor, giving immediate access to the main body of the house.

This is further supported by the second pattern identified through the different case studies. The Integration analysis reveals a distinct movement of the most integrated space from the living room to the staircase, displaying a balancing of the floors in terms of accessibility. This indicates a change in the social values of the era represented through the configuration of the domestic spaces. Notably this change occurs at the same time as the removal of the 'buffer' space i.e. after the first World War, during the design of the inter-war semi-detached dwelling. Several economic factors, including rent controls and building incentives as well as the development of better transport links, led to a rapid

development of the suburbs and rural areas in the years following the First World War. The desire of the middle classes to be part of a community (Lofthouse, 2012) could support this move towards a more open and accessible home. Despite this fundamental change, the presence of the previously mentioned subsystems, e.g. sleeping rooms, utility spaces (kitchen, scullery etc.) and living or social areas (living room, front room etc.) within a domestic space have remained and are recognisable in each of the cases studied, with the spaces grouped depending on their particular function. The presence of these groupings throughout the case studies displays an instinctively maintained value for thresholds between spaces of varying functions which is brought to light by the analysis. The presence of these thresholds in each of the examples is clearly identifiable through the Control metric where hotspots act as links between the various functional spaces. However it is interesting to note that, despite the segregation by function, when one looks at the Visibility metric upon entry into the dwelling, even if the entrance leads directly to more than one subsystem or grouping of rooms, the Visibility value is considerably higher for the social area, displaying a sustained social value of the social areas over the other spaces. The additional segregation of the utility spaces, with the exception of the pantry identified in the Builder Labourer's cottage, contributes to the definition of a clear hierarchy of the spaces at a subsystem level based on their functions in terms of social interaction: Living and social areas – Sleeping rooms – Utility spaces.

It is interesting to note that the segregation of subsystems remains prevalent even though the Mean Depth value is shown to have decreased significantly with the development iterations of the semi-detached style of dwelling over time. This appears to be largely as a result of relocating the staircase. In earlier building examples, the staircase would tend to be positioned towards the rear of the property and therefore away from the more formal space for receiving guests or visitors. In later examples however, the staircase is situated so as to be directly accessible from the main entrance. This modification has the effect of reducing the topological distance from any one point in the dwelling to any other. This suggests a change in the social classification of the guest and a lack of distinction between the formal and the informal visitor in the sense that, in the most recent housing designs, both guest and occupant are afforded access to what would have previously been considered as the private space, e.g. a living room. In real terms what has happened is a removal of the boundary (in the form of a front room) which previously divided the downstairs living space into formal and informal areas. The subsystem containing the sleeping areas, although accessible via the stairs immediately adjacent to the entrance, remains private by virtue of the fact it is located on a different floor. The space downstairs, however, becomes open to all visitors regardless of their genre which results in an introduction of the concept of accessibility utilising a 3D space as opposed to a layout of a single floor in two dimensions. The boundary is now created by the separation of floors rather than the inclusion of buffer room or space in the floor plan.

This would suggest a change in the social values attributed to the spaces themselves. If the social value of a space is defined by its horizontal and then vertical accessibility to both guest and inhabitant, then the living room in the later designs, being designated for use by both guests and inhabitants, can

be identified as the most valuable space within a dwelling as this is where the highest incidence of interaction takes place. This is because the living room now not only forms the social hub of the house for those that live in it, but also the space which showcases the dwelling to visitors, similar to the salle commune identified by Hiller et al (1987). Based on this theory, the *A* spaces or dead-end spaces, such as the bedrooms and pantries, would be regarded as the rooms of lower value as they contribute the least to the configuration as a whole. An example of such a hierarchy of the spaces at a room level based on their functions in terms of social interaction could be: Living room – Entrance Hall – Front room – Bedrooms - Scullery – Pantry – Coal store.

6 CONCLUSION

In conclusion, in this paper we combined a number of space syntax techniques from Hillier and Hanson (1984) and the isovist analysis by Turner et al (2001) using the isovist.org software by McElhinney (2020) to argue for the potential to identify both the presence and evolution of social hierarchy embedded in the design of seminal English semi-detached houses over the period of a century.

Through the analysis of the selected case studies representing pivotal eras of design for the semi-detached typology, it is evident that a social hierarchy of spaces within the configuration of a household can be defined, with the configuration of the spaces correlating to the historical context.

The emergence of subsystems separating the rooms into clusters by function including social, utility and private, represents a clear programmatic division between social spaces. The presence of the hierarchy based on the value of spaces as a place of interaction between occupants and visitors is a simple way of organising spaces. The hierarchy of spaces within a domestic space, however, is a lot more complex. Through this analysis we have identified a number of different ways of establishing a hierarchy of spatial levels within the semi-detached typology. Aside from the exterior/interior divide, these further include the use of floors as a way of separating groups of spaces and organising rooms and the use of subsystems in which spaces are grouped based on their value towards the occupants of the house. These, in combination with the additional presence of *A*/*B*/*C*/*D* spaces within each system, results in a social ordering of spaces based on their value to the household as a place of interaction between occupants or visitors.

The outcome of this study builds on the work of Hanson (1999) and highlights the more commonly built forms as subjects for understanding the social situations of the mass population. It further provides an insight into and an understanding of the modern development of housing which contributes towards a more specialised approach to the design of future homes. However, with the same approach in which the archaeological studies discussed by Hanson are limited by contextual information, this study is concerned only with the analysis of five variances of the same typology in a specific context using selected space syntax methods. In addition, the study does not consider a finer definition and demarcation of rooms and functions in terms of the interior layout of spaces due to the

absence of curated material surrounding the semi-detached dwellings of the period. To further understand and develop the results of this study, future investigations into this field could, for example, compare and discuss these findings with archival and historical testimonies of social interactions that occurred within these houses. Alternatively, the convex mapping could be refined and the surrounding local context (gardens, gates, streets etc.) could be studied in conjunction with the conclusions made here. Lastly, the relevance of these conclusions could further be compared to the design of modern-day housing.

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LIST OF IMAGERY

Figure 1, Burley, E. (2021) *Table of selected case studies* [Diagram] In possession of: Burley, E: Delft

Figure 2, McElhinney, S. (2020) *Key Isovists_app metrics from top to bottom: Integration HH, Visibility, Mean Metric Depth and Control* [Illustration] At: https://isovists.org/user_guide/ (Accessed on 02/01/2021)

Figure 3, Burley, E. (2021) *Metric scans of selected case studies* [Diagram] In possession of: Burley, E: Delft

Figure 4, Burley, E. (2021 *Workman's cottages, Henry Roberts. Floor plans and justified permeability graph.* [Drawing] In possession of: Burley, E: Delft

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