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Measuring the Cognitive Dimension of Space

Integrating the user's perception in the syntactic analysis of a house

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ABSTRACT

Space syntax analysis postulates that a spatial system reveals its social meaning through its configuration. In the building analysis, defining the discreteness of each unit of space is the first step to measure its connectedness. In doing so, walls and partitions are the most reliable physical entities to demarcate convex spaces. This paper proposes that reality is more fine-grained than the partitioned space, and there are possible ways to incorporate this unexplored cognitive dimension in the spatial analysis. We took an urban vernacular house in Seoul built in 1930s as a case to experiment how a sequence of going into the house can be analysed in a higher resolution. Walking through the house, what fascinates visitors is the richness of perceptual sensation that can never be captured by merely looking at its floor plan. It will be explained how a journey through 6 partitioned spaces are experienced as 16 different spatial arrangements, each of which evokes changing mode of human behaviour. What generates this denser perception is the continuous change in floor levels and ceiling heights, a rhythmic pattern of ups and downs with varying degrees of pitches and lengths, resembling a musical score. By precisely measuring the intensity of each subdivided unit of space, this research shows how cognitive properties in space can be incorporated in the syntactic analysis.

KEYWORDS

Space Syntax, Cognitive dimension, Spatial intensity, human behaviour, Korean vernacular houses

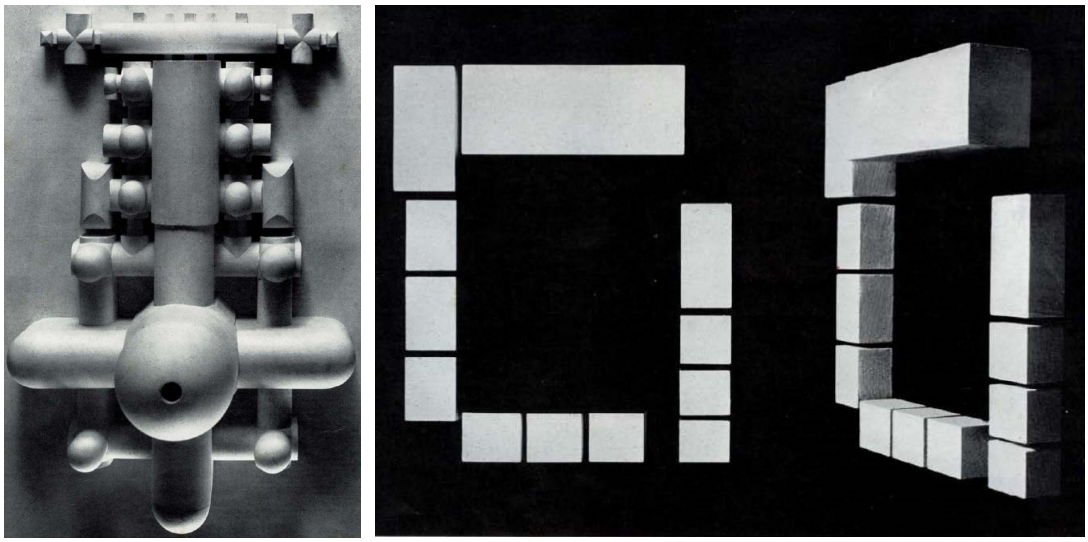
1 BOUNDARIES IN DWELLING AND PERCEPTION IN TRANSITION

A house requires its territory demarcated by a noticeable boundary, whether it be physical or notional (Hillier and Hanson 1984, p72). A house becomes a domain of control by a certain ordering of boundaries which is used to interface with the rest of the social world (ibid, p146). The transition from the outside world to the domestic space inside has an important social meaning. Levi-Strauss (1987), from his semantic description of American Hopi Indians' myth, derives the following sequence of territorial retreat:
(bush : fallow land) :: (fallow land : garden) :: (garden : house) :: (Nature : Culture)
It shows the gradual territorial retreat from the untamed wild nature to the dwelling; at each stage, the binary scheme of 'nature/culture' is recurring as a system of equivalence. Each set of domains represents two heterogeneous fields abutting on each other, creating a certain amount of conflict and anxiety. A positional shift of the social boundary between the house and the outside world reflects the changing cultural norm of a given society. Ian Hodder (1990) defined three concepts, i.e. domus, agrios, and foris, that represent the house domain, the cleared outside field, and the untamed forest respectively. He showed how the central stage of living has been shifted between them through the European Neolithic period. Arnold van Gennep posits three phases of rites in passing the social boundary, i.e. separation, transition and incorporation, that are not always equally treated with the same importance (van Gennep 1960). According to Edmund Leach (1976), the transitional zone of boundary is 'abnormal, timeless, ambiguous, at the edge, and sacred' and thus going through this zone requires a ceremony to separate the actor from the previous stage and incorporate him to the next.

The boundary between the inside and the outside is not always explicit. For example, although the entrance hall is regarded as the most dramatic transitional point between the outside world and the domestic world (Lawrence 1987; Rosselin 1999), it cannot be fixed on a particular spot if there are multiple boundaries and gates within the premises. In this case, the whole passage from the main gate to the reception room, can be arranged as a ritual journey to provide 'social boundary communication' to represent the house owner's social status and taste (Blanton 1994). Here the main gate is not a single fixed marker of the borderline but constantly negotiated through 'meaningful, psychologically effective transitions' to mediate the connection between the city and the house as advocated by Team 10 (Jaschke 2008). Equipped with a series of boundaries, they reconcile what Aldo van Eyck termed 'spatial polarities' of the inside and the outside in a gradual manner (Teyssot 2011).

In his article 'Structures and Sequences of Spaces' in the magazine, Spazio written in 1952, Luigi Moretti argued that the internal hollow space is essential in the experience of moving through an architectural space and thus is central in evaluating its quality (Moretti 2002). He defined four parameters of empty space, i.e. geometric shape, volume, density (by light), pressure (by proximity of masses), that interplay to give emotion and experience during a user's sequential movement. Using plaster cast models, the Italian architect contrasted two different design

approaches in offering a sequential journey: first, juxtaposition of spatial events where transition from one space to another is clearly perceived by distinct shapes and volumes as in Basilica of Saint Peter [figure 1(a)]; second, continuous spatial journey which is rather homogeneous as in Palazzo Ducale in Urbino [figure 1(b)]. While the Basilica juxtaposes clearly distinguishable spatial events, this type of religious buildings tend to have wide open connections between them. In sharp contrast to this, although the spatial events in the Palazzo are all similar in their rectangular block shapes, a partition with a narrow door strongly intervene between two connected spaces, exerting high spatial 'pressure'.



(a) (b)

Figure 1. Luigi Moretti's plaster cast models of internal hollow spaces from the Basilica of Saint Peter (a) and Palazzo Ducale in Urbino.

This paper will look into a possible way to analyse interior spaces by adopting Moretti's parametric approach. Whereas he suggested a conceptual level of thoughts on the interpretation of space, we will propose a simple method to quantify the perceptual dimension in space. Modern houses tend to have the spatial pattern of Palazzo Ducale in that their rooms have no noticeable variations in shape, volume, density and pressure in Moretti's term. When analysing their spatial values, therefore, it is acceptable that each room divided by walls and partitions is treated equally as a single node in the network of convex spaces. Unquestionably, physical barriers such as walls are clear manifestation of human intention to separate the otherwise continuous field of space. This concept works perfectly well in most cases of modern building analyses, especially when we focus mainly on their connectedness. There are other cases however where the cognitive dimension of the space makes a huge difference on how each unit of space is perceived. One such case is the Korean vernacular house of which the building form and their layout are radically different from modern houses, not only in its construction technology but its conceptualisation of space.

2 HONG HOUSE IN EARLY 20TH CENTURY SEOUL

The Korean upper-class house consists of several building blocks arranged within its premises. Each building is typically one room deep and grows linearly by adding more rooms lengthwise. Although each building block is thus shallow and linear, the whole compound generates a complex alternating pattern of 'inside-outside' by combining a multiple number of building blocks and yards as in figure 2. This spatial complexity also occurs at the facade of each building block. With the changing profile of eaves stretched out from the building wall, combined with the changing levels of the podium, a passage from the exterior to the interior provides a cognitively rich ritual of transition. These two aspects, i.e. the recurring inside-outside relations and the elaborated facade, make the lived experience of the Korean house very different from what can be understood from a conventional space syntax analysis which is based on its planar information.

Hong house was built in 1934 in Pirun-dong, the old town in central Seoul. It was built by Geonik Hong, the house owner, in the style of the modern Korean vernacular house that adopted the early 20th century style while maintaining the vernacular Gyeonggi province style. Hong was a government official working for foreign language translation, belonging to the new emerging upper-class in the early twentieth century. The house went through a restoration immediately after it became a listed building of Seoul in 2013 (Tohyung Corporation 2015). It has the total floor area of 154.63 m^2 on a 740.5 m^2 site.

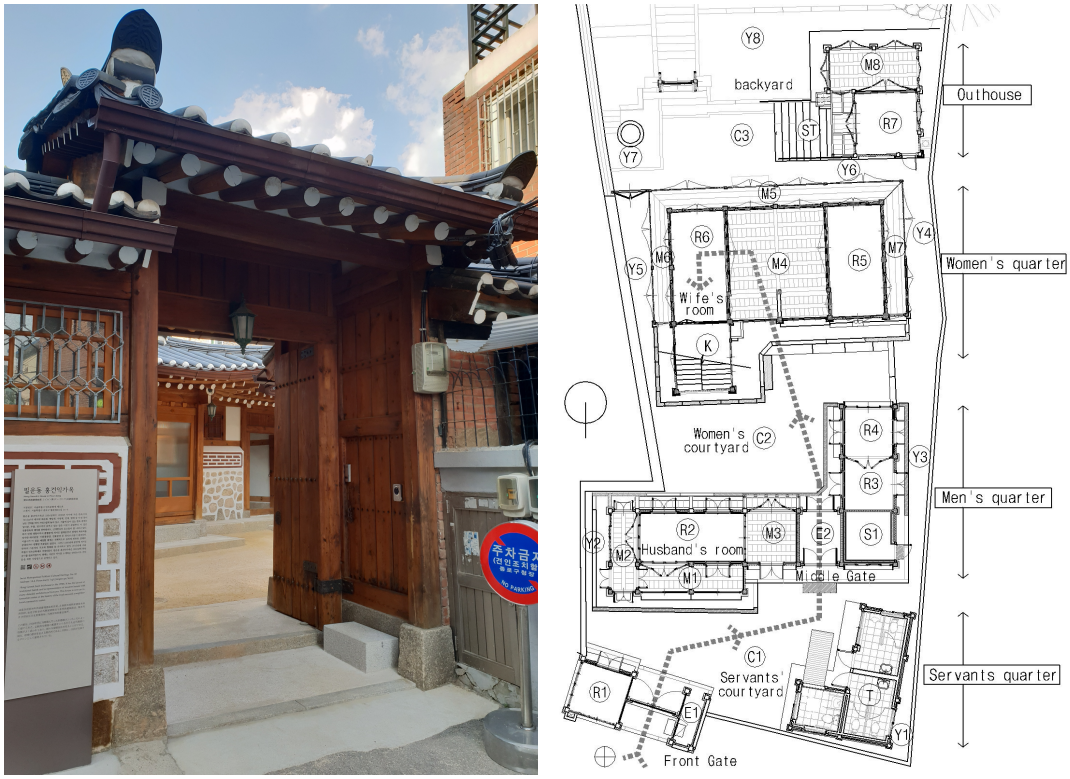


Figure 2. Photo of the main gate from the street and the site plan with floor plans of the five building blocks.

Figure 2 shows the main gate and the site plan. The dotted line on the site plan indicates the journey from the entrance to the wife's room, the most important room in the house not only for the housewife but for the whole family and special guests. Hong house preserves many typical characteristics of the Korean vernacular upper-class house that prevailed for centuries thorough Choseon dynasty (1392-1910). At the same time, it has some features of the time, e.g long corridors on the periphery of building blocks, which has been influenced by the Japanese colonial style (1910-45). It is composed of 5 building blocks on a narrow plot stretched to the north-south direction. From the street, a well-structured gateway is visible within the gate building. This makes the entry point perceived as a discrete enclosed area, surrounded by the roof and four columns around it. From the entrance, an interesting spatial journey unfolds that leads to the wife's room. Passing through the servants' courtyard (C1), the middle gate (E2) appears which is also a void space within the men's quarter (figure 3 left). After the middle gate lies the women's courtyard (C2), the most central outdoor space enclosed by the women's quarter and the men's quarter (figure 3 right). To go inside the women's quarter, one has to remove shoes and step up to maru (M4) which is the elevated wooden floor. Walking across maru, there are sliding doors on the left to the wife's room. It is the typical pattern in Seoul that the wife's room is at the pivotal point in the L-shaped block, flanked by maru (M4) and the kitchen (K).

Figure 3. Middle gate (left) and the women's courtyard (right).

Overlooking the whole journey, this transition from the outside public domain to the most important family space seems quite different from those in modern houses. First of all, there is a rhythmic alternation of building blocks and yards. The building blocks have void gateways within and this allows continuous movement without having to go around them. This recurring

dialectic dialogue between the inside and the outside makes the cognitive distance of the route much longer than reality, because the route loaded with more imageable physical features and noticeable changes tends to be experienced much longer (Lee 1970, Kaplan 1973, Sadalla & Magal 1980, Sadalla & Staplin 1980, Nasar 1983).

3 ANALYSIS

3.1 Standard Space Syntax Analysis

Figure 4 shows in a graphical way where this journey of going into the wife's room is located within the whole organisation of the compound. The node at the bottom is the outside and the route to the wife's room (R6) is highlighted by thick lines. The route is a powerful penetration through the premises, but it only passes through a line of 6 spaces that is a small subset of the whole configuration made of overwhelming 33 spaces.

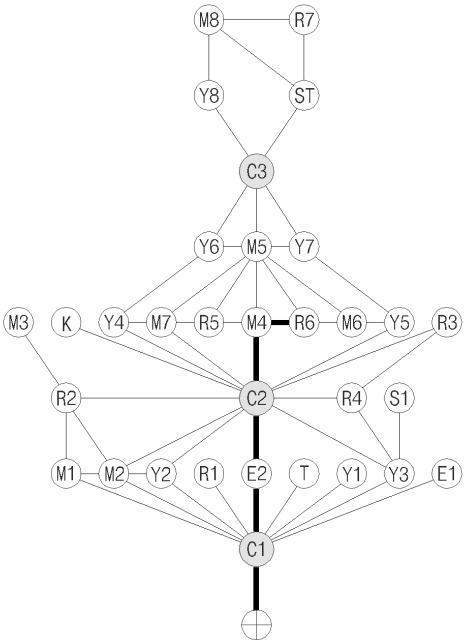
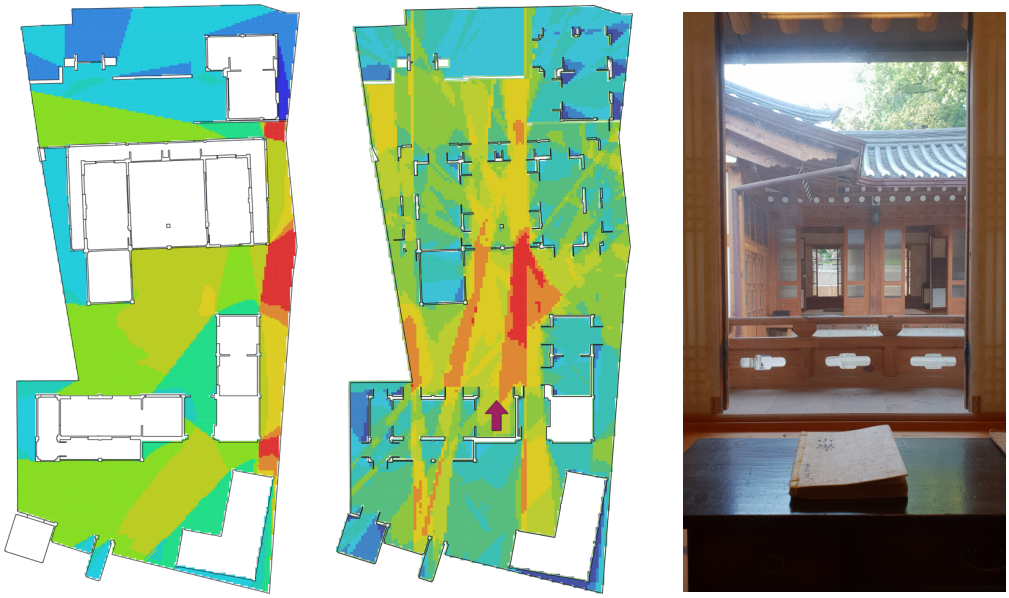


Figure 4. Justified graph of Hong house (grey nodes are courtyards and thick lines are the route to the wife's room).

What looks most striking in the j-graph is that the three courtyards (grey circles) are taking a critical role in integrating the whole system together. The servants' courtyard (C1) connects 10 different spaces, the women's courtyard (C2) 11 spaces, and the backyard (C3) 5 spaces. Without having to calculate integration values, it looks obvious that the women's courtyard (C2) is the most integrated space of all. Positioned between the other two courtyards and surrounded by the two main living quarters, it is a central hub for the whole household activities. Taking the whole graph structure, it is evident that the courtyards and building blocks are making an interesting spatial shift between inside and outside. Following the route to the wife's room, the house has a

sequence of 'building – yard – building – yard – building'. This naturally sets a series of nested boundaries as we go deeper into the house.

While drawing a justified graph can be relatively simple by following the intuitive rule of finding a 'largest and fattest convex space', measuring visual permeability of the house requires a cultural interpretation. Since the buildings are made of the post-lintel structure and the void spaces between spans are mainly fitted with doors and windows, the house can display a higher level of permeability when the doors and windows are open. This allows the unique penetrating view through a building and a courtyard. Depending on how they are open and closed, the visual experience of the house changes radically. For example, when doors and windows are all closed during winter (except for the middle gate), the outdoor spaces are rather visually fragmented [figure 5(a)].



(a) (b) (c)

Figure 5. Visual integration in winter (a) and summer (b) by VGA analyses; and visual connection between the men's and women's quarters (c).

The colour spectrum reveals that the main courtyards have lower integration values except for the narrow side path on the right edge of the side. The analysis for summer however shows a completely opposite result. The graph (b) shows that the red to yellow range of colour is spreading out wider and farther across the premises. With windows and doors mostly open, all outdoor spaces are visually interconnected through the voids in buildings. Standing at some points [the arrow in Figure 5(b)], it is even possible to experience a long axial line of 'interior-exterior-interior-exterior' as in figure 5(c).

In fact, it is not just this visual permeability that changes by seasons and occasions. The physical permeability can be also changing in a variety of ways depending on which doors and windows

are open or closed. This high level of flexibility of movement causes a significant problem in measuring integration values as there is no fixed scenario of how residents move around. Thus, the justified graph in figure 4 can be understood as a possible case when all openings are open and used for physical movements.

3.2 Incorporating the Cognitive Dimension

Figure 6 shows the section drawing of three building blocks and two courtyards between them, cut through the sequence of going into the house from left to right, to arrive at the women's quarter. Under the drawing are six different ways of setting boundaries based on six elements that are written on the left: roof, ceiling height, walls & doors, columns, shoes removal, and levels & thresholds. Along the grey horizontal bar, the boundary lines set by each element is drawn as thick vertical lines, aligned with their respective position in the section drawing. While the third element of walls and doors is a conventional guide in setting boundaries, the other five offer an opportunity to calibrate the fine-grained resolution of building features or behavioural patterns. Those spans between boundary lines that are roofed or enclosed are indicated by arrows and annotation to indicate they belong to the interior domain.

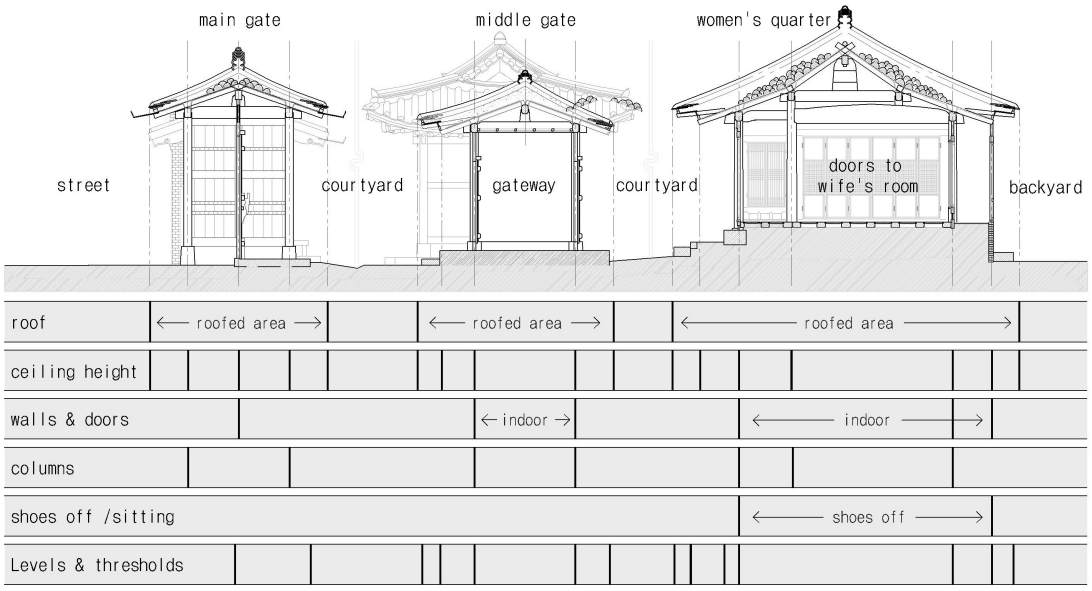


Figure 6. Site section of Hong house and six different ways of setting boundaries.

the first element of roof sets 6 boundary lines aligned to the edges of three roofs. The second element of ceiling height sets the boundaries aligned with the variations in the ceiling, mainly decided by its change in height but when there is a materialistic change or an interruption in its continuity by walls, partitions or columns, it was also regarded as a threshold of perceptual change. This entails 17 boundary lines set against the critical points in ceiling variation. The third element relates the boundary to the position of walls and doors, hence six boundary lines. The fourth element deals with columns. Like many other Asian architecture, Korean vernacular houses are based on the post-lintel construction using timbers. Once columns are placed by a

predetermined interval, the span between them are filled in by doors, windows or mud walls. In any case, columns are visually exposed, showing their regular rhythm and generate a certain territorial sensation by forming layers of perceptual boundaries. In Hong house, 7 boundary lines of columns are experienced during the journey. The fifth element is not associated with physical features of the house but with human behaviour of removing shoes. It is one of the distinct characteristics of the South-East and East Asian houses that the whole structure is elevated from the ground and people remove shoes before they step up to the raised living area (Seo 2012, 2015, 2021). As the women's quarter is our final destination, it is this space where visitors and residents leave their shoes on the steppingstone before they go up to the elevated floor. Finally, the last element for setting boundaries is floor levels and thresholds. At the beginning of the journey, the ground level rises one step at the point of the main gate as in the section drawing in figure 6. This must have reinforced the ritual feeling of going into the house, combined with the spatiality of the whole main gate structure. Just as the action of shoes removal, the change in level also entails behavioural involvement and thus adds to the feeling of transition from one space to another. This level change occurs at 14 points, causing a series of up-down movement of the moving body.

In space syntax analyses, walls are regarded as the most, if not only, reliable entity to decide the discontinuity of a spatial system. This discretisation is a crucial first step to quantify the whole syntactic network. In our example, however, it is hard to settle on a particular point to set a boundary. The main gate in figure 2, for instance, can be seen as a separate internal space when judged by the covered area by the roof, but its area diminishes when judged by the position of columns that are set back from the edge of the roof. To make things more complicated, the two swing doors in the main gate, which is the actual physical barrier, lie neither of these two boundaries but on the centre line of the roof. The level of complexity increases even further when other features such as floor levels and ceiling variations are factored in.

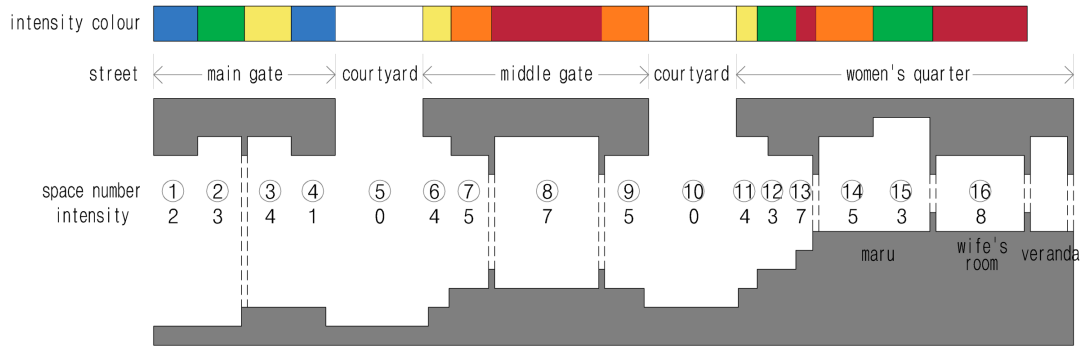
Figure 7. Changing profile of the eaves and the podium, elaborating the transitional boundary.

One unique characteristic of the vernacular Korean house is that architectural elements are corresponding each other. A clear example can be seen from the relationship between eaves and podiums. The eaves are supported by rafters that overhang from the outer columns to protect the space underneath from the sun and rain (figure 7). Various daily activities are performed here including shoes removal on the steppingstone before entering the building, and delivering meals from the kitchen to maru and the wife's room. For important building blocks such as the women's quarter, which is bigger than others, the eaves tend to extend farther from the column for functional and aesthetic reasons, and accordingly the podium underneath tends to become more elaborated with an increased depth and height. Figure 7 shows the relation between the eaves and the podium in the women's quarter. It is the main building in the premises and thus its floor has been elevated higher than others. To provide gradual rise to arrive at the height of its floor, the podium is split into three steps. Accordingly, the eaves are also stretched out longer by means of double rafters – outer rafters sitting on top of the inner rafters. As the top and bottom elements of the building are constructed in a corresponding way, this space provides a three-dimensional experience of transition, mediating the inside and the outside in a more powerful way.

3.3 Quantification of Spatial Quality

From the side perspective in figure 7, it is visually clear that this buffer zone between the inside and outside can be further sub-divided into two sections by the ceiling variation, or three by the

floor level change. If the whole journey from the street to the wife's room is sub-divided by all possible boundaries illustrated in figure 6, it can be segmentalised into 16 discrete phases (figure 8).



	main gate	middle gate	women's quarter
ceiling height change	2	3	4
door/window layers	1	2	4
floor levels	2	3	5
enclosure	non enclosure	single enclosure	double enclosure
behavioural features	door, levels	doors, levels, thresholds	doors, levels, thresholds, shoes stone

Figure 8. Intensity of 16 segmentalised spaces (section drawing) and the architectural elaboration in three buildings (table below).

This spatial division in finer resolution allows different ways of looking at the meaning of depth in architectural analyses. It can be said that those 6 spaces in the conventional space syntax analysis are zoomed in to reveal 16 spatial segments each of which carry a different set of perceptual moment, thus creating different degree of spatiality. This section drawing has been simplified and modified from figure 6 to render the gradual changes in the ceiling and the floor more prominent. The numbers in the circles are the ordinal numbers to indicate the sequence of 16 spaces from the main gate to the wife's room. The table under the section shows the degree of spatial elaboration in each building blocks.

In the main gate, the ceiling height has 2 possible variations while the middle gate has 3 and the women's quarter has 4, showing the increased degree of variation. The second row in the table shows how many layers of doors or windows are installed in each block. Again, it shows gradual increase from 1 to 2 and then to 4; the deeper a space, the more barriers it has. Floor levels show the same pattern; the change in floor levels are 2, 3 and 5 as one goes deeper. The fourth row is about the degree of enclosure in each building. The main gate is not enclosed space although sheltered by the roof, but the middle gate can be enclosed by closing doors on each side. In comparison, the women's quarter provides double enclosure; the wife's room is inside the twofold enclosure.

Finally, it is possible to count the number of features in each building that cause behavioural engagement. Walking in from the main gate, a person has to open the gate and step up; therefore

there are two features, i.e. doors and levels, that cause physical behaviour. In the middle gate, thresholds are installed between space 7 and 8 and also 8 and 9, providing 3 features, i.e. doors, levels and thresholds. Arriving at the women's quarter, shoes must be removed at the steppingstone in space 13. Thus, there are now 4 building features associated with behaviour. All these five indices attest that the density of elaboration, or intensity of perception, increases along with the depth of the building from the main entrance. This intensifying architectural detail by depth must have provided an amplifying ritual sensation especially to the visitors. Obviously, this is something that cannot be captured by a justified graph or a plan-based analysis.

It is difficult to measure the intensity of spatial sensation which is subjective in its nature, but using the aforementioned indices as an objective tool, it is possible to quantify the perceptive dimension of space. A simple measurement of spatial intensity can be defined in the following rules:

- Rule 1: When there is a change in ceiling height, add 1; if it is abrupt change such as the transition from the outside to the inside, add 2.
- Rule 2: When opening or closing a door, which is an active physical action, add 2 on each side of the door.
- Rule 3: When there is a threshold or a change in floor level, which necessarily involves a physical action, add 2.
- Rule 4: When a space demands a stationary physical action, such as shoe removal, add 3.
- Rule 5: Outdoor spaces and courtyards have no spatial intensity – hence 0.

By applying these five rules to the spatial sequence in figure 8, we can get the intensity – the numbers under the space numbers. It is a combined cognitive measurement for each segmentalised space, showing an interesting variation ranging from 0 to 8. Following Rule 5, the courtyards between the building blocks were given 0 since it is the space where spatial intensity, or 'pressure' in Moretti's term, dissolves. To make this numerical variation more readable, they were colour coded: red (intensity above 6), orange (intensity 5), yellow (intensity 4), green (intensity 3), blue (intensity 2 and 1), and white (intensity 0). This generates the colour spectrum of intensity as shown at the top in figure 8. It is now easily recognisable that the most intense space in the house is space 16, the wife's room. It is scored 8 because of the ceiling change (1), door closing behind (2), threshold (2), and the stationary action of floor-sitting (3): 1+2+2+3=8.

The second most intense spaces are the inside space of the middle gate (space 8) and the steppingstone (space 13). It all makes sense that these two spaces have second highest intensity, because the former is surrounded by two doors and two thresholds, all of which cause physical actions, while the latter demands one's removal of shoes and opening the door ahead.
The intensity measure explored so far is not something that can be proved since it belongs to the realm of subjective perception. However, by limiting the rules to the measurable minimum and

excluding ambiguity in measuring judgement, it shows a possible method of converting quality into quantity. Thus, it is an attempt to find a way of integrating the two dimensions, i.e. built environment and human perception, of which the latter has been almost repressed to non-existence while the former gained legitimacy to embody social meaning.

4 CONCLUSION

The spatial analysis in space syntax has pioneered a new way of looking at the built environment around us by making it possible to find the social dimension through the careful investigation of spatial connectedness. This inevitably necessitated the process of discretisation to convert a given spatial system into a network of distinguishable parts. It is undeniable that this approach enabled us to explore and discover the hidden meanings in our cities, towns, and buildings for better understanding of the world we live in. There is, however, an innate ambiguity and inconsistency in quantifying a spatial configuration which seems to be an unavoidable aspect in the realm of social science as pointed out by many researchers (Brown 1990, Batty 2000, Ratti 2004).

This research has investigated Hong house in Seoul as a case that challenges the existing syntactic methods of quantifying spatial configuration. Built with the vernacular construction method and layout pattern, the house is comprised of five building blocks and courtyards, generating a complex pattern of a spatial interweave. Unlike modern houses, each building block has many doors and windows that can be used for physical access as well as visual permeation. A justified graph was drawn to show the connectedness of the house, but the actual spatial links can be always changing by choosing which door or window to open, depending on the users' preference and seasonal requirements. Likewise, two contrasting seasonal variations in visual permeability were displayed through VGA analyses.

Having the typical characteristics of the traditional Korean house, Hong house exhibits an interesting building-yard interactions and multiple layers of boundaries across the premises. By focusing on a visitor's movement from the outside to the innermost space, the wife's room, it has been shown how different boundary lines can be perceived during the journey. A new method of measuring the cognitive dimension was proposed by adopting the measure of intensity which has been influeced by Moretti's spatial parameters. The ritual passage has been segmentalised based on the variations in architectural features that cause behavioural and perceptual changes during the movement. The resulting spectrum of intensity showed a highly rhythmic pattern of ups and downs along the route. In addition, it was found that Hong house pertains an interesting pattern of increasing degree of elaboration in details as one goes through three building blocks, from the outside towards the deeper inside.

Measuring the social dimension in built environment has been long practieced in space syntax research. While urban analyses have gained a certain level of objectivity in the technique of discretising road networks, building analyses have often relied on subjective judgement of the

researcher in deciding boundaries of spatial units. What this paper has suggested is not a solution to this ambiguity of interpreting space. Rather, it is to question the normative way we abided by for so long. Atmospheric ambiguity and spatial overlap are often conceived as an innate beauty of architecture. Then it would be futile to try to single out a method to generate a meaningful conclusion. For the analysis of buildings such as the Korean vernacular house, no single interpretation can gain authority over others.

REFERENCES

Aldo van Eyck, A (2008) 'Vincent Ligtelijin and Francis Strauven', *Collected articles and other writings, 1947-1998*, SUN Amsterdam.

Batty, M. (2000) 'Exploring isovist fields: space and shape in architectural and urban morphology', *Environment and planning B: Planning and Design*, vol.28, pp.123-150.

Blanton, E. R. (1994) *Houses and Households: A Comparative Study*, Plenum Press, New York.

Brown, F. (1990) 'Comment on Chapman: some cautionary notes on the application of spatial measures to prehistoric settlements', in *The Social Archaeology of House*, ed. Ross Samson, Edinburgh University Press, Edinburgh.

Hillier, B. & Hanson, J. (1984) *Social Logic of Space*, Cambridge University Press.

Hodder, I. (1990) *Domestication of Europe: Structure and Contingency in Neolithic Societies*. Blackwell.

Kaplan, S. (1973) 'Cognitive Maps in Perception and Thought', In R. M. Downs, & D. Stea (Eds.) *Image and Environment*. Chicago: Aldine Publishing Company.

Jaschke, K. (2008) 'City is House and House is City: Aldo van Eyck, Piet Blom and the Architecture of Homecoming', in *Intimate Metropolis: Urban Subjects in the Modern City*, ed. Vittoria Di Palma, Diana Periton and Marina Lathouri, Routledge, London and New York.

Laurence, R. (1987) *Housing, Dwelling and Homes: design theory, research and practice*, John Wiley & Sons, New York.

Leach, E. (1976) *Culture and Communication*, Cambridge University Press.

Lee, T. (1970) 'Perceived distance as a function of direction in the city', *Environment and Behavior*, 2, 40-51.

Levi-Strauss, C. (1987) *Anthropology and Myth: Lectures 1951-1982*, Basil Blackwell.

Moretti, L. (2002) Structures and Sequences of Spaces', in Luigi Moretti: Works and Writings, Ed. Federico Bucci and Marco Mulazzani, New York: Princeton Architecture Press; Originally published in Spazio, 7 (Dec 1952 – Apr 1953).

Nasar, J. L. (1983) 'Environmental factors, perceived distance and spatial behaviour', *Environment and Planning B*, 10, 275-281.

Ratti, C. (2004) 'Space Syntax: Some Inconsistencies', *Environment and Planning B: Urban Analysis and City Science*, Vol.31, issue 4, pp.487-499.

Rosselin, C. (1999) 'The Ins and Outs of the Hall: A Parisian Example', in Cieraad, I. (ed) *At Home: An Anthropology of Domestic Space*, Syracuse University Press.

Sadalla, E. K. & Magel, S. G. (1980) 'The perception of traversed distance', *Environment and Behavior*, 12, 65-79.

Sadalla, E. K. & Staplin, L. J. (1980) 'The perception of traversed distance: Intersections', *Environment and Behavior,* 12, 167-182.

Seo, K. W. (2012) 'DNA of the House: A Hidden Dimension in the Evolution of the Domestic Space in Seoul', *Journal of Home Cultures*, Vol.9, Issue 1

Seo, K. W. (2015) 'Making a Home: Architectural Features', In S. R. Quah (Ed.), *Routledge Handbook of Families in Asia*, London: Routledge.

Seo, K. W. (2021) 'Relocating Home Activities: Spatial Experiments in Malaysian Apartment Houses to Accommodate the Vernacular Lifestyle', *Journal of Asian Architecture and Building Engineering,* 13 Jan 2021.

Teyssot, G. (2011) 'Aldo van Eyck and the rise of an ethnographic paradigm in the 1960s', *Joelho: Revista de Cultura Arquitectonica*, No. 02.

Tohyung Corporation (2015) *Hong Geonik House Restoration Report*, Seoul Housing & Communities Corporation.

Van Gennep, A. (1960) *The Rites of Passage*, Routledge & Kegan Paul Ltd. London.