

# Logic of Traditional Korean Settlements

## Nakan, Hahoe and Yangdong villages

Chang, Dongkuk\*

Park, Kangchul\*\*

### Abstract

Little research has been done regarding the explicit and objective analysis and explanation of the spatial logic of traditional Korean settlement patterns, in spite of many archeological and socio-historical studies. In this paper we present research into spatial mechanisms and their social meanings in three traditional villages in the southern province of Korea. Conventional space-syntax analysis of spatial configuration has been used to analysis and investigate the morphological forms and functions of the traditional villages. The research results show that the traditional Korean villages are spatially deeper and syntactically less connected than other comparable urban forms, such as old European cities. Configurational analysis of the three villages reveals that their spatial structures are configured to have their own spatial logic, not a geometric order but a spatial structure. What is however noteworthy is the way they embrace their own environmental context and factors and implement them into the process of urban growth or spatial construction.

### 1. Introduction

Much of the research about the relationship between spatial forms and functions of traditional housing settlements is still limited within archeological and socio-historical studies. It is sometimes extremely difficult to unveil such a relationship of form and function by mainly relying on abstract historical facts or hypotheses. Therefore this often leads to a discursive and exploratory explanation. The Korean villages of Nakan, Hahoe and Yangdong in the southern province of Korea, are such cases, which have been extensively studied and archaeologically researched but still require more in-depth knowledge focusing on their spatial and social characteristics.

It is, in fact, hard to find analytical studies which attempt to reveal the working mechanisms which seem to be hidden behind spatial organizations. Little research

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\* Senior Project Consultant, OAD Architectural and Urban Design Consultant Ltd. in London.

\*\* Professor, Dept. of Architecture, Chosun University

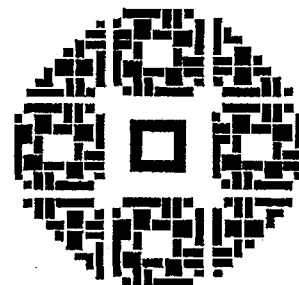
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has answered such questions as: is there any spatial or social logic behind the spatial structure and form?; how does the spatial configuration respond to social concepts or functions and what is the consequence?; is it possible to find a morphological genotype?; and so on. This research therefore aims to answer these questions by investigating spatial forms and functions of those three traditional settlements with the assistance of descriptive methodological tools of spatial configuration, generally known as space syntax?

The configurational analysis of settlement forms will deepen our knowledge of how the organic or master-minded settlement structures are working. There is no doubt that the research results will provide valuable lessons on today's designers and planners regarding the designing frameworks of spatial organization in both small scale of housing block and urban or city scale.

## 2. Order & structure: local parts & global whole

It is only recently that urban designers have tried to understand the complex form of a city as a physical and spatial object transmitting the true nature and dynamics of urban solidarity. Batty and Longley<sup>2)</sup> argue these movements lead to a deeper understanding of the form of cities, in which "the physical form of cities is the ultimate result of a multitude of social and economic processes, constrained and shaped by the geometry of the natural and man-made world." The form of cities and towns whose structure we try to capture is generally classified into two different spatial forms, known as 'ideal' or 'Planned' and 'organic' or 'natural' in which configurational differences between them have been debated so far.<sup>3)</sup> However, as Batty and Longley argue<sup>4)</sup>, it is most likely that "most towns and cities



(a) R. Bofill's 'New Socialist Village' in Algeria



(b) Traditional town of Apt in France

Figure 1. Geometric order & spatial structure

2) Batty, M. and Longley, P. *Fractal Cities: A Geometry of Form and Function*, Academic press, 1994, p.1.

3) Hillier, B., Penn, A., Hanson, J., Grajewski, T. and Xu, J. "natural Movement: or, Configuration And Attraction in Urban Pedestrian Movement", *Environment and Planning B: Planning and Design*, 20, 1993, p.35. Hillier, B. "Against Enclosure", in N. Teymur, T. Markus and T. Wooley (eds.) *Rehumanising Housing*, Butterworth, 1988, pp.69 ~ 70. Hillier, B., Hanson, J., Peponis, J., Hudson, J., and Burdett, R. "Space Syntax: A Different Urban Perspective", *The Architects' Journal*, 1983, p.59

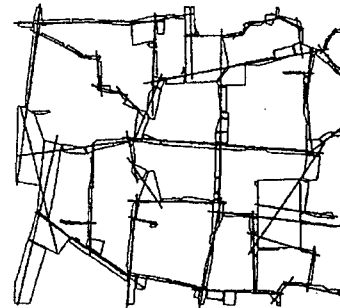
provide a blend of both, usually containing elements of the planned within a backcloth of organic growth?

To represent these different forms of cities as physical and spatial object, we need to understand what kind of properties make them really different, properties which seem to be beyond the instantly recognisable visual differences in their geometric forms. By looking at the two town plans in figure 1, we can immediately distinguish them by their apparently different geometrical order. It seems that the clearly ordered plan of R. Bofill's 'New Socialist Village' in Algeria gives a clear bird's eye view of the village to the people who are looking at the plan, however it is believed that its ordered plan disorientates people who experience the 'structure' of the village on the ground.

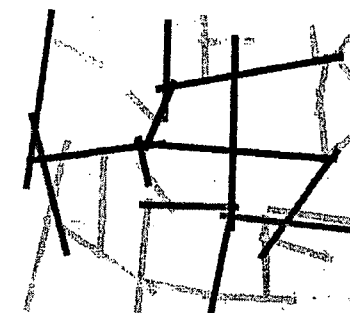
Then, how can we describe the true realities of the two different forms of cities? Hanson provides a clue to the answer with the suggestion of two concepts, 'order' and 'structure'<sup>5)</sup> It has been presumed that order simultaneously produces structure in the reality of urban buildings and places. But Hanson made it clear that order is quite different from structure, describing it as "... principles based on some generally accepted notion of sameness, repetition, geometry, grid, rhythm, symmetry, harmony and the like".<sup>6)</sup> On the other hand, she defined structure as existing: "... in the sense of making places intelligible through creating local differences which give both a sense of identity and a grasp of the relation between the parts and the whole, such that we are able reliably to infer the global form from any



(a) Figure-ground map of Apt in detail



(b) Axial lines on convex map



(c) Integration (global)

Figure 2. An example of axial modelling

4) Batty, M. and Longley, P. 1994, p.9.

5) Hanson, J. "Order and Structure in Urban Space: A Morphological History of London", PhD thesis, University College London, 1990. Hanson, J. "Order and Structure in urban Design: The Plans for the Rebuilding of London after the Great Fire of 1666", *Ekistics*, 1989, pp.334~335.

6) Hanson, J. 1990, p.16; 1989, p.22.

position within it".<sup>7)</sup> Therefore, it is possible that "an apparently disorderly layout may turn out to be well-structured and intelligible to its users, whereas a highly-ordered architectural composition may in fact be unstructured when we experience it as a built form".<sup>8)</sup>

It is this relationship between order and structure in cities, representing deeply structured physical and spatial forms of urban realities, that is believed to be the issue that designers should concentrate on, as Hillier and Penn argue.<sup>9)</sup> To understand the structure of spatial layout not as a series of geometric forms but through the relation of spaces, Hillier and Penn<sup>10)</sup> suggest that we need to look at cities and towns as a relation of 'local parts' and 'global whole' in syntactic terms.

Hillier et al.<sup>11)</sup> argue that it is this relationship of local parts to the global whole which makes cities and towns successful places, as well as allowing people to distinguish one city from another. More specifically speaking, what makes people distinguish one place from another is 'a sense of local place', that is local information about the space directly surrounding us. What makes us feel a city as an 'urban whole' is obtained through the interrelationship of its well formed local parts.

### 3. Space syntax as analytic methods of spatial configuration

The 'space syntax' modeling methods, which is used in the configurational analysis of the three traditional Korean settlements, were first developed in the 1970s by Professor Bill Hillier and his team at the Bartlett School of Architecture, UCL. They regard the city as a continuity of space in which social knowledge is embedded through its spatial configuration. Therefore the first thing to do in the configurational analysis is to produce the explicit and objective description of spatial configurations and urban movement patterns that are predominantly influenced by the urban grid structure. These concepts are the most distinguishing features of the configurational analysis known as 'space syntax'.

What is common in the ideal and organic cities is that they are both grids, which are made up of publicly accessible open spaces, and thus form a continuous system of space interconnected with each other. It is believed that the grid structure "has an interior spatial and functional logic to it which can be retrieved by what we call configurational computer analysis, and tested by direct functional observation of

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7) Hanson, J. 1989, p.22.

8) Op. cit.

9) Hillier, B. and Penn A. "Dense Civilisations: the Shape of Cities in the 21st Century", *Applied Energy*, 43, 1992, p.45

10) Hillier, B. and Penn A. "Virtuous Circles, Building Science and the Science of Buildings: Using Computer to Integrate Product and Process in the Built Environment", *The International Journal of Construction Information Technology*, 1.4, p.71.

11) Hillier, B., Penn, A. and Dalton, N. "Milton Keynes: Look back to London", *The Architects' Journal*, 15 Apr. 1992, pp.42~43

the urban system at work".<sup>12)</sup>

Figure 2 shows an axial mapping of the centre of Apt in the south of France, created by drawing the fewest and longest straight lines of directly visible and publicly accessible space covering all the possible convex spaces in the configuration. Each axial line represents a pathway of the longest line of sight and accessibility along the line. The local sense of place and the sense of the urban whole are formalised and quantified with these two syntactic properties: the convex organisation 'we are in' and the axial organization 'we might go'.

The concept of 'depth' is a key relational property in space syntax. It means the minimum number of axial lines on an axial map in order to reach a space. When a pathway between one space and another is more direct (and thus has a minimum number of direction changes), it is defined as 'shallow' in depth. On the other hand, when there are many intervening 'steps' between them (and therefore frequent direction changes), it is said to be 'deep' in depth. Every movement on an axial line has a certain number of depth from every other line, which makes every space relatively different in its depth value. This depth structure is the basis for a measure of 'integration' which describes the degree of complexity of a spatial structure.

The most important syntactic property is the distribution of integration values in the urban grid structure, which are now automatically computed by the 'Axman' programme developed in UCL and shown graphically by shading the axial lines in black (the most integrated) and white (the least integrated, i.e. for which means the most segregated). Figure 2 (c) shows the computation result of integration (global) of the central Apt. What is noteworthy about integration is that it is not a 'metric distance' but a 'syntactic depth' which is measured in terms of Real Relative Asymmetry(RRA) values.<sup>13)</sup>

The syntactic term of 'intelligibility' is the most fundamental of the elementary syntactic measures. This is defined as a correlation (here Pearson's correlation coefficient) between the connectivity and integration values of each line. This relationship between local and global syntactic properties means that the structure of the whole of a system is intelligible to the people who receive information about the spaces they are in from its directly visible and accessible local connections or parts of a system.

Three traditional Korean villages were selected for the configurational analysis: a fortified village Nakan, in the south-west of Korea and two well preserved villages, Hahoe and Yangdong, in the south-east. The former was a planned village encircled

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12) Hillier, B. and Penn A. 1992, p.47.

13) Other syntactic properties definitions as well as this computation process are explained in detail in the following references: Hillier, B. and Hanson, J. *Social Logic of Space*, Cambridge University Press, 1984, pp.97~114; Chang, D. *Integrated Multi-level Circulation System in Dense Urban Area: the effect of complex spatial designs on multi-level pedestrian movement*, PhD thesis, The Bartlett School of Architecture, UCL, 1998, pp.112~116

with walls and three gates, and the latter were organically developed through time. There is a topographical difference between the latter two: Hahoe village is placed on a plain site surrounded by the Nakdong River, but Yangdong village is surrounded by many hillsides. These typological as well as topographical differences will provide a basis for the study of each settlement type as well as a comparative analysis of the two different village forms, the planned and organic patterns.

#### 4. Syntactic measurements of settlements

The syntactic investigation of spatial organization starts by exploring the measurements produced from axial analysis. Mean values of syntactic measurements are used to make it easy to compare syntactically different forms and sizes of systems (table 1). Three notions are noteworthy in the table 1: firstly, there is relatively little difference in the syntactic values of local factors (such as, connectivity and RRA3) in spite of the three villages' significantly different system size; secondly, the syntactic value itself decreases from the more local measurements to the more global measurements, such as connectivity and RRA integration respectively; finally a close relationship between the maximum value of global integration (Max. RRA) and the mean depth of system from the most integrated line (Md. Int.) is found.

The first result of the low connectivity in all of the three cases implies an extreme difference between small number of highly connected major spaces and large number of disconnected spaces from their whole villages. This is supported

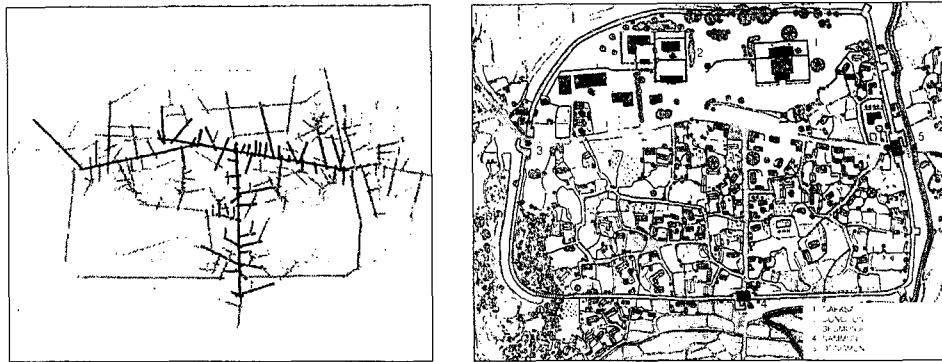
Table 1. A comparison of syntactic measurements from the axial maps

Village	No.of AL	M. Conn	M.RRA3	M.RRAr	M.RRA	Max.Dep.	Max.Conn	Max.RRA	Min.RRA	Md. Int.
Nakan	403	2.493	1.566	1.316	0.94	14	30	1.756	0.426	5.459
Hahoe	249	2.787	1.689	1.118	0.809	12	11	1.128	0.569	6.775
Yangdong	726	2.628	1.514	0.792	0.554	21	15	0.908	0.32	9.627
Mean	459	2.636	1.59	1.075	0.768	15.7	18.7	1.264	0.438	7.287

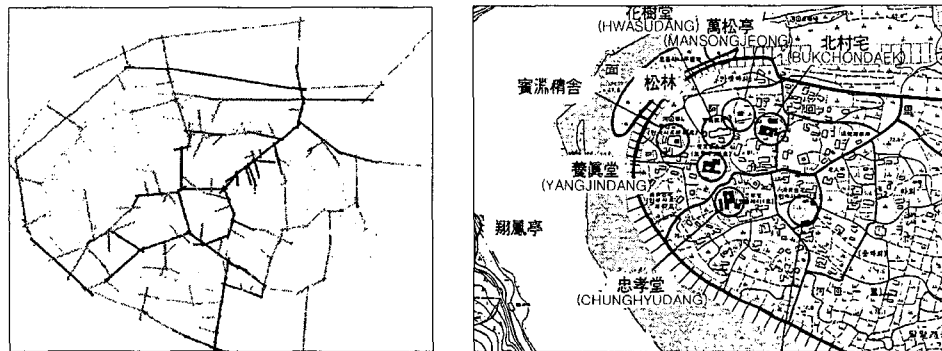
M.=mean, No of AL=number of axial in a system, Conn.=connectivity, Max.=maximum, Dep.=depth, Min.=minimum, Md. Int.= mean depth from the most integrated line in a system

by the fact that the integration values are also relatively lower than other case studies, such as the Barbican and the South Bank area in London, and old English cities.<sup>14)</sup> This means that the traditional Korean villages are spatially deeper and syntactically less connected than the two local areas in London and the old English cities as well. Regarding the second result, much research, such as that in England and Iran<sup>15)</sup>, has also shown the same tendency of decreasing values from the more

14) Chang,D. 1998, p.135, 146, Karimi,K. "The spatial Logic of Organic Cities in Iran and the United Kingdom", The proceedings of space syntax first international symposium, UCL, 1997, p.06.4. There is however little difference in the integration values between the three korean villages and six Iranian cities The integration cores of both villages and cities are, in general, linearly extended in the centre with a high integration value



(a) Nakan village



(b) Hahoe village



(c) Yangdong village

Figure 3. The global integration (RRAn) maps of the three traditional Korean villages in their present forms.

local factors to the more global factors. This means, as K. Karimi<sup>16)</sup> suggests, that "the cities of the same urban genotype share more common characteristics at local level, whereas when they grow to larger scales they tend to show more global

15) Karimi, K, 1997, p.06.4.

16) Op.cit.

variations." This might be regarded as a generic consequence of the syntactic process of the system, which needs further study. A good correlation between the maximum value of global integration and the mean depth from its most integrated line illustrates a morphological characteristic of the settlements: a high maximum integration with shallow mean depth, means a simpler space structure of a system as a whole (such as Nakan village) and a low integration with deep mean depth a more complex one (such as Yangdong village).

These syntactic differences represent the three villages' particular patterns of spatial structure: Nakan village, in general, is more globally configured than the other villages, whereas Yangdong village is not only spatially deeper than other villages but also syntactically less integrated both locally and globally; Hahoe village lies somewhere between the two but it is more locally integrated than others with shallower spatial depth. The results of syntactic measurements are clearly related to their topological, as well as sociological, differences among them. This however needs to be clearly defined with in-depth investigations of their spatial configurations.

#### 5. Configurational analysis

The global integration maps of the three villages (fig. 3) show an extreme difference in their integration values between the highly integrated core in the centre and the rest of the village, shown in the dark and grey lines respectively. The most integrated lines in the villages of Nakan and Yangdong are linearly extended with many lumps of spatially segregated lines, whereas the shape of the integration core of Hahoe village forms a 'deformed wheel' in the centre which connects the encircled lines in the most outside of the village. Much research<sup>17)</sup> in the syntactic analyses of urban layouts has found that the integration core usually corresponds with the most accessible streets in an urban centre (thus having the potential to be very crowded), such as a highstreet. Such research suggests that the integration core reveals the most important, morphological deep structure of a town and urban layout. It is this deformed wheel core that generates different types of movement pattern within the configuration. In other words, the configuration of a deformed wheel core creates a movement interface between inhabitants who are living or are familiar with the area and strangers who are just passing through, i.e. "a strong natural probabilistic interface" referred by Hillier<sup>18)</sup>.

There are two main routes or 'thoroughfares' in Nakan village (fig.3 (a)): one is the route connecting the east and west gate and the other starts from the gate in the south and meet the east-west route in the market place in front of the main government office block in the north. The former route, which is believed to be used as a main 'through-route' shows the highest integration value, whereas the latter route, the second most integrated route, is said to be used mainly for

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17) Hillier et al., 1993, p.35, Hillier, 1988, pp.69~70, Hillier et al., 1983, P.59.

18) Hillier, 1988, p.70.



ceremonial purposes.<sup>19)</sup> Considering that the main route in a traditional town and city layout is the north-south route, in terms of both functional and symbolic use, the spatial configuration of Nakan village can be understood to satisfy both social and functional needs: following the Confucian principles of urban layout by setting out the symbolic north-south route and connecting the east and west of the village by one significant thoroughfare.

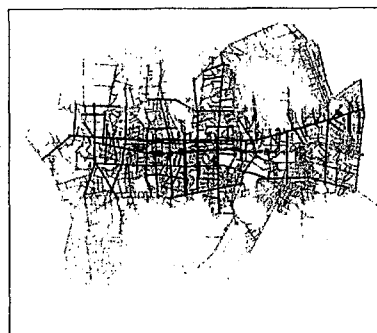


Figure 4. The global integration (RRAn) map of the old city centre of Seoul in its present form.

It is, however, noteworthy that the mean depth from the most integrated line of the east-west route shows the lowest value among the three villages (table 1). This means that it is relatively easy to access the rest of the village from the main thoroughfare. In other words, it is an efficient form of spatial structure which makes it easy to control space and thus to show power.

Table 2. The correlation coefficients (*r*-squared) of global integration against other measures

Village	RRAn vs Conn	RRAn vs RRA3	RRAn vsRRAr
Nakan	0.098	0.335	0.784
Hahoe	0.218	0.33	0.754
Yangdong	0.12	0.192	0.842
Mean	0.145	0.286	0.793

As a fortified village which is believed to place more emphasis on the efficiency of the administrative control rather than on the economic activities, the spatial configuration of Nakan village shows the very 'traditional' Confucian urban patterns, having a small number of extremely symbolic and functional axial lines which do not penetrate into the inside of the system. This, in consequence, produces many lumps of segregated spaces throughout the village, which makes the spatial system the least intelligible as a whole (0.098).

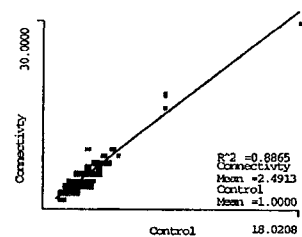
The Confucian concept of planned urban layout is still visible today in the global integration map of the old city centre of Seoul (fig. 4). The axial map picks up Chong-ro street in the centre as the most integrated line. The street is directly linked with other major axial lines of horizontally and vertically layered 'super-grids' that connect the integration core of the city centre with the outside, such as

19) Seungjoo District Council, Detailed Archaeological Report of Traditional Nakan Village No. 1, 1985, p.133.

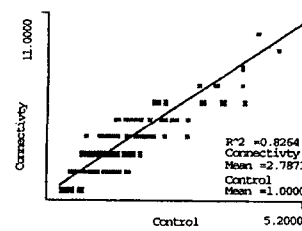
Dongdaemun-ro, Chunggaechon-ro and Toegae-ro, and Sejong-ro, Changkyungkung-ro and Daehak-ro as horizontally and vertically layered axial lines respectively. Its intelligibility is extremely low with a value of 0.124 which is lower than European cities, such as London (0.290) or the six English cities (mean: 0.264) studied by Karimi.<sup>20</sup>

The intelligibility of Yangdong village (0.12) is also lower than the European cities with its short and broken up axial lines. The shape of the integration core is also linear and it separates the hilly village into two, the north and the south. Due to the hilly nature of the terrain, the second group of integrated axial lines extends from the thoroughfare into the northern part of the village through the three valleys. However, they do not penetrate into the inside of the village but are immediately broken up with short axial lines, which, in consequence, reduces the degree of intelligibility of the system. Yangdong village shows the deepest spatial system among the three with the highest maximum depth and the lowest global integration. Many of the axial lines terminate at the large houses of the village elite that are located at the hilltop end of the cul-de-sac.

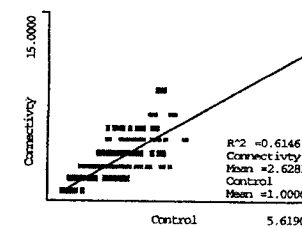
The interactive relation between the local parts and the global whole system can be measured as a correlation coefficient of global against local integration. Where the correlations between the local integration (RRA3) and the global integration (RRAn) for Nakan and Hahoe villages are high, that for the Yangdong village is still poor (0.192). However, the correlation between the radius-radius integration of the integration core (RRAr)<sup>21</sup> and the global integration rises significantly in all three



(a) Nakan village



(b) Hahoe village



(c) Yangdong village

Figure 5. The relationship between two local state (connectivity) and dynamic (control) measurement.

20) Chang, D., 1998, p.135 and Karimi, K., 1997, p.06.8. The north Seoul's intelligibility is approximately same as the old Iranian cities (mean: 0.116)

21) The radius is set to the mean depth of the whole system from the most globally integrated line. This radius-radius analysis method is used to eliminate the 'edge effect' which is a system effect having a tendency for the edges of spatial systems to be different from the interior. The exterior appears more segregated than they are in reality.

22) Hillier, 1996, p.361.

22) Hillier, 1996, p.340; Richardson, D., 'Random growth in a tessellation', Journal of the Cambridge Philosophical Society, 74, 1973, pp.515-528.

cases. This means that a higher degree of integration radii can identify the local structures of the old three villages more successfully. The degree of the integration radius, which is a mean depth from the most integrated line, is very likely to be determined by the overall complexity of a system, such as the degree of maximum depth, and the shape of an integration core.

Unlike the Nakan and Hahoe villages where the most integrated lines are located in the centre of the system, the most integrated line in the Yangdong village is located at the bottom of it, where it can be directly linked with the surrounding villages. This centrality of the most integrated line verifies Hillier's remarks on 'The laws of settlement growth' in which he argues that "the lines that are prioritised tend to be among those that link the settlement to its exterior"<sup>22)</sup> However, the main street is still being used just as a route to connect to its surrounding villages without any market place or public facilities on it.

Hahoe village has grown organically with relatively fewer environmental obstacles to be tackled, such as the fortified walls and the hilly terrain in Nakan and Yangdong villages respectively, but with an adjacency to the Nakdong River. Hahoe village's circular form of integration core clearly shows the result of a fundamental process of urban settlements as they grow into an aggregated whole. According to Hillier and Richardson<sup>22)</sup>, the circular pattern of settlements, that is the most frequent type of settlements as they aggregate through time, is the most integrated shape. This minimises the complexity of all trips within the area, thus contributes to the intelligibility of the system.

Hahoe's intelligibility (0.218 in table 2) is the highest of the three. The integrated lines in the core penetrate into the inside of sub-groups and link many of the important large houses of the elite, such as Choonghyodang, Yangjindang, Bookchondaek and Namchondaek. The location of these houses in the village is noteworthy, in that they are not directly accessed from the integration core but two or three steps away from it. With the elaborate layout of these large houses, they could achieve two important roles as the houses of the elite. Firstly, they were able to successfully realise the Confucian idea of 'Self-effacement', as a residence, meaning that the layout of the house was carefully arranged to avoid excessive symbolic emphasis, i.e. by not facing an axial line at right angles. Secondly, despite this selective arrangement of axial lines, they were not segregated from the rest of the village nor gathered together at a specific location, but were arranged in strategically important locations around the integration core.

It may be the relationship between the two local syntactic measurements of connectivity and control values, which shows the most distinctive social, as well as

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effect' which is a system effect having a tendency for the edges of spatial systems to be different from the interior. The exterior appears more segregated than they are in reality.

<sup>22)</sup> Hillier, 1996, p.361.

<sup>22)</sup> Hillier, 1996, p.340; Richardson, D., 'Random growth in a tessellation', Journal of the Cambridge Philosophical Society, 74, 1973, pp.515-528.

spatial characteristics among the three villages (fig. 5). As seen in the lowest mean depth from the most integrated line (table 1), Nakan village, as a planned settlement, is characterised by its exceptionally strong administrative power of spatial control by a few major axial lines as shown in figure 5 (a). Yangdong village (fig. 5 (c)), as an organically grown settlement in hilly terrain, is also strongly affected by a major integrated axial line but it is not significant as Nakan's. Hahoe village (fig. 5 (b)) shows the most well correlated structure, which suggests that its system is reasonably well structured in terms of spatial hierarchy. This could be regarded as the most functionally structured as well as socially hierarchised system.

## 6. Conclusion

It has been found that the three traditional Korean settlements are not only spatially deeper but also syntactically less connected with their surroundings than the current and old English cities considered. In general, their spatially deep morphological structure and extremely low intelligibility are much the same as those of Iranian old cities, which are made up of a few of highly integrated thoroughfares, with the rest of the axial lines extremely short and broken-up (thus forming many segregated local parts). These morphological differences certainly represent the distinctive cultures and social ideas that have been embedded into their spatial configuration. The main ideology underlying the spatial configuration of the three old Korean villages was a Confucianism which emphasized social hierarchy (thus spatial differentiation).

In fact, this social hierarchy between different classes was expressed into the three settlements with each village having different spatial and functional configurations of their own. Nakan village is more globally configured than the other villages, so its spatial system is structured to be more controllable than the others. This spatial characteristic certainly fulfils the main priority of the village? development as a fortified settlement, constructed with regard to effective defense and administration.

Yangdong village shows the most typical structure of spatial configuration of traditional Korean settlements. Due to the hilly terrain, most of the houses of the elite are located on a hilltop to have a good view of the area, which makes the village spatially deeper and less accessible as a whole. A few of the linearly extended lines of high integration were used for just bypassing the village, verifying 'the laws of settlement growth', proposed by Bill Hillier.<sup>23)</sup> The integrated lines that extend from the major integration core do not penetrate into the sub-structures, but break up with short axial lines. This suggests that the planners who were the upper strata of society at that time chose hilltops to gain aesthetic as well as social superiority rather than for functional as well as economic reasons.

Hahoe village can be said to be more locally integrated than the others. Its

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23) Hillier, 1996, p.361.

※ See the notes for the definitions of syntactic properties.

circular patterned integration core makes the village spatially shallow, and thus functional in its operation. The layout of the large houses of the elite satisfies a Confucian idea of 'self-effacement' by positioning themselves around strategically important locations that are neither directly accessible nor segregated from the rest of the system.

It is now clear that the three villages are configurationally structured according to their own spatial order, although their spatial forms look irregular and disorganised. A distinctive configurational difference can be read between the planned structure of Nakan village and the organically grown villages of Hahoe and Yangdong. However, it is very likely that it is the environmental context and factors that have given shape to the configurational structures of the villages. This might be the reason why the three traditional settlements have their own particular configurational characteristics. This research result certainly gives a lesson to the current architects and planners in view of the way that the environmental context and factors have been incorporated into the process of urban growth.

Notes:

Axial map: A map of the least set of the fewest and longest straight lines of sight and access that pass through all convex spaces and make all rings.

Connectivity: It measures how many other lines are immediately connected to each line, and thus it shows a local measurement of urban systems.

Control: It is measured by giving a value of 1 to each line, then summing the reciprocal of each immediate neighbours, which gives values over 1 for spaces with strong control than their neighbours and values less than 1 for weak control.

Mean depth (MD): It represents how deep or shallow a chosen space could be from the other spaces within the system.

Integration: it measures how many other axial lines connected to each line within a given depth from it. High value indicates 'integrated' line which means that the whole system is shallow from that specific space, and low value indicate 'segregated' line which means that the whole system is deep from the line.

Global integration (or radius n; RRA<sub>n</sub>): This is measured from all spaces in a given system, thus representing a syntactic property of global structure of the system as a whole.

Local integration (e.g. radius 3; RRA<sub>3</sub>): This is measured up to three lines away from each line, thus representing a local measure of shallowness. Pedestrian densities in local areas have been found to be best predicted by radius 3.

Intelligibility: The structure of the whole of a system is 'intelligible' to the people who receive information about the spaces they are in from its directly visible and accessible local connections or parts of a system, that allow them to predict where

they are globally.

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