

# Overlapping and permeability: Research on the pattern hierarchy of communication space and design strategy based on environmental behavior

Sun Leilei<sup>1,a</sup>, Zhang Liang<sup>1,b\*</sup>, Chen Bing<sup>2,c</sup> and Xi Hong<sup>3,d</sup>

<sup>1</sup>School of Architecture, Soochow University, Suzhou, Jiangsu, China

<sup>2</sup>Department of Urban Planning and Design, Xi'an Jiao Tong-Liverpool University, SIP, Suzhou, China

<sup>3</sup>Xi'an University of Technology, Xi'an, Shanxi, China

<sup>a</sup>s0902@163.com, <sup>b</sup>zl27zzg@126.com, <sup>c</sup>Bing.Chen@xjtlu.edu.cn

<sup>d</sup>bihaiqingniao@163.com

**Abstract.** This thesis is to analyze the basic pattern hierarchy of communication space by using the theory of environmental psychology and behavior combined with relevant principles in architecture, to evaluate the design and improvement of communication space in specific meaning, and to bring new observation ideas and innovation in design methods to the system of space, environment and behavior.

## 1. Foreword

In recent years, the theory of environmental behavior has been studied in depth and been expanded and extended in the process of multi-dimensional transformation. Environment, space, behavior, and place are not just within the scope of social science research, but also within the scope of architectural research which is based on comprehensive science.

The academic field of architecture has been involved in research based on the theory of environmental behavior from macroscopic city to micro-space. For instance, in the field of urban planning, there are studies about the behavior patterns of urban public space and spatial relations (Xu Ning & Wang Jianguo .2008) <sup>[1]</sup>, (Wu Hui & Dong Ya.2012) <sup>[2]</sup>, and the renewal researches of residential exterior space and waterfront space(Wang Juan.2012) <sup>[3]</sup>. At architectural complex design level, people have studied the vitality of commercial streets and consumptions (Zhu Wei & Wang De.2010) <sup>[4]</sup>, and the suitability of campus building space(Sun Leilei & Jiang Hui 2006) <sup>[5]</sup>. And in the field of single building and interior design, there are also studies about the behavior and spatial scales, degree of comfort and material use as well as ergonomics and space construction (Xu Leiqing.2006) <sup>[6]</sup>. This paper, based on previous studies, will be focused on the basic pattern of communication space, generalizing effective levels of communication, analyzing and reviewing the design of communication space of specific significance and then bringing new ideas of innovation in design methods to the system composed of space, environment and behavior.

Human is the subject of behavior, the environment is where the behavior exists; communication is one of the human's instincts, the space is where the communication takes place. Communication-Space is exactly what behavior-environment reflects in the sense of architecture. Therefore, based on the environmental behavior theory combining the analysis of building mode, this thesis attempts to obtain design strategy for this kind of architectural space. The communication space is playing a role



in guiding the following: hint the way of activities, create an atmosphere and feeling, and reveal the attitude of the building. This guidance is usually given by means of the power of habits or subconscious. Researches on the universality of people's mental habits or awareness of communication space mainly concentrate on the field of environmental psychology and environmental behavior science.

## **2. Three Aspects of Environmental Behavior**

Environment is an external thing that encircles individuals or groups, which can be perceived psychologically and has limitations on behaviors. Environmental psychology is mainly concerned with environmental visual, environmental assessment, personality and other environmental aspects. The study of environmental ethology focuses on the relationship between human and the objective place where they stay, as well as how the environment is used as a means of communication, or how the environment affects human behavior and their communication. The following are aspects that environmental behavior contains and important concepts that need to be explained.

### *2.1 Personal space and geographical space*

E.T. Hall, an American anthropologist, mentioned a space pattern in his *The Hidden Dimension*: a distance acts as an invisible bubble that surrounds the organism. Outside the bubble, two organisms are not as intimately involved with each other as when the bubbles overlap. The bubble is the demesne of space surrounding people. (E.T.Hall.1988)<sup>[7]</sup> In contrast, geographical space is a territory where individuals or collectives stay and that will repeatedly be occupied and used. Geographical space is formed by defined borders and regional differences which will remind occupants the territory of their own.

With the understanding of the concept of personal space and geographical space as well as through what aspects the personal characteristics of those occupants can be explored, we could pay more attention to these occupants in our design of communication space, and appropriately grasp the sense of the field, interpersonal distance, privacy, and openness.

### *2.2 Individual behavior and psychology in public space*

Such situation is equivalent to the status of individual "bubble" when it moves in public space, and the individual needs to experience public life when keeping a sense of the field and privacy and to establish contact with the public space. The behavior of observation and self-expression in public places is a representation of human character, attitude, and self-awareness. Seeing and being seen is a wide range of free exchange with unrestricted objects, and psychologically it's a "performance" in the eyes of others and consequently people can find satisfaction in the approval of self-worth as well as in curiosity when observing others. With regards to the self-protection required by some people, it should be made by designing the "save points", hidden and available for observation, by means of sheltering and converting with multi-level space.

Individual psychological hints in public places are closely linked with "boundary effects". Christopher Alexander said in his *A Pattern Language* that if the "boundary" no longer exists, the space will definitely not be vivid. (C.Alexander.2002)<sup>[8]</sup> In cities, people moves quickly on clear roads and slowly on obstructed ones, and tortuous borders are the places where people often stay. Psychological support can be obtained when people stay on the boundary.

### *2.3 Features of Small Groups' Behavior*

Those who have common patterns of behavior, especially in the universities, often form small groups with ecological characteristics. Small group behavior is a combination of individual behavior, and the basic "modulus" of complex group behavior which is of great significance as a link. Size is the most important issue when individuals group together. For instance, a group of 3 persons has three possibilities for the relationship between 2 people and ten possibilities for a group of 5 and so on. However, the group will become too complicated when there are over 27 possibilities (around eight

persons), requiring a certain organization or a theme that everyone concerns seriously. Otherwise it will be broken down into many smaller groups to establish relationships in an easier way. Take student group as an example: a group of 2 to 4 persons will communicate and study more deeply featuring a close relationship and long-term stability, and that of 5 to 9 persons is suitable for ordinary cooperation and conservation which is relative at will and busy. A group of 10 to 15 persons fits well-organized symposium and small groups. And a larger group is for gathering and social activities. The diversity and selectivity should be considered in the design of communication space according to various use and different scales in university.

### 3. Relevant Theories in Architecture

Discussions on the spatial patterns of communication will finally be on this fundamental issue of space. Among the environmental psychology, environmental behavior and specific design of communication space, there is a level which not only focuses on human activities macroscopically but also studies the category of urban and architecture. Studies belonging to this level often focus on some of the daily activities and space subjects that are universally appropriate, which describe the rules and general principles of spatial relations. Books of this aspect are usually linked with urban planning and design.







#### 3.1 Communication and space

People's daily outdoor activities can be summarized into three simplified types: necessary activity, spontaneous activity, and social activity. [Figure1]Jan Gehl stated that criteria for evaluating the city and its buildings remain closely whether the three above-mentioned basic types of activities can be exciting. The classification of communicative behavior has referred to the criteria, moreover, two other patterns are proposed on account of the particularity in a campus's life. One is the purpose communication that can be understood as closely related to regulation of the learning activities and training exchanges, the other is the occasional communication, which comes from the people's original psychological needs of free participation and communication.

Perception, communication, and scale are the main factors affecting the interaction space. The design of various outdoor space is preconditioned by the manner and scope of human's perception. The organs of human perception are mainly adaptable to horizontal walking. If the eyes, ears, and nose are defined as distance-type sense organs (skin and muscle as direct-type), the distance (scale) determines the effect of human perception. Additional factors also include time (or speed) for people to experience as well as the space methods.

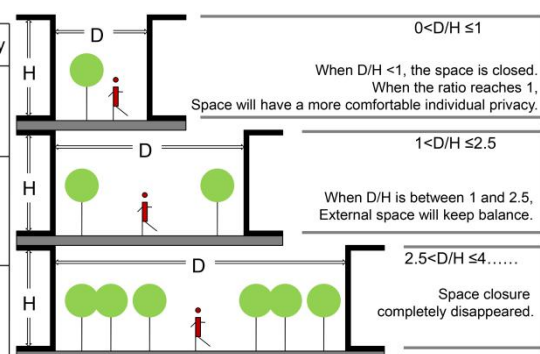
#### 3.2 Exterior space design

External space, the external environment created by people, is defined from the beginning of nature and more meaningful than the natural space. Due to being demarcated by physical boundaries, the

Physical environment quality			
	Bad quality	Good quality	Selective tendency
<b>Necessary</b> activity			Equalization
<b>Spontaneous</b> activity			Good quality salient
<b>Social</b> activity			Good quality modest

**Figure1.**Simplified types of outdoor space

Picture from: Drawing. Picture from: Life Between Buildings, Jan Gehl, Denmark,2002.



**Figure2.**D/H Model

exterior space establishes centripetal order towards the core of space, creating active space that meets people's intentions and capabilities. In contrast, nature is centrifugal space which extends infinitely, and it can be seen as negative space. The features of both mentioned spaces are penetrated and integrated. Exterior space, as the "negative" interior space or called the "roofless" building space, is determined by two factors, namely, the wall (enclosure elements) and floor (including elevation). The design of the two factors should first be a numerical relationship then texture. For instance, the wall can be higher or lower than people's eyes; the proportion of the wall height (H) to distance (D/H), etc. [Figure2]

#### 4. The Pattern Hierarchy of Communication Space—case study of university building space

In this paper, the communication spaces in universities (or colleges) are typical samples which need to be discussed. Student's groups play an important role in social contacts and communication culture. From this point, we can clearly explore the physical attributes and levels of communication space. Reviewing the history of the development of higher education, it has developed from single "teaching" in its early stage to knowledge conservation, knowledge impartation and talent training, and then to contemporary higher education featuring a further development in its quantity, quality, scale, and form. Similarly, the space environment in a university has also experienced the change of "closed" to "open" then to "organic growth" with corresponding spatial patterns at different stages. College communication space, corresponding to the overall space environment, showing a form which is in compliance with certain historical conditions and social development can be called college communication space pattern. According to the theory of geographical space, individual behavior and groups' behavior mentioned above, the college communication space pattern can be divided into three major hierarchy categories.

##### *Hierarchy 1: External communication space belonging to a specific building*

Specific space design and the creation of environment are really important when shaping effective communication spaces at campus. Interior communication space of a building and public open space have always been the concern of architects. However, those external communication spaces belonging to a particular building has been easily overlooked. External communication space belonging to specific buildings is the most frequently used by those who are usually fixed, staying, passing, resting or entering the building. If the purpose communication or behavior related to teaching probably occurs inside the building, external space belonging to specific building will usually cause communication accidentally, which is currently the most natural and the most worthy of advocating ways. Such communication space comprises: near the entrance, front yard, inner court, backyard, terrace and roof garden, etc.

Exterior space enclosed by main teaching buildings of School of Architecture, Soochow University has formed an important part of such communication environment.[Figure3] The layout of buildings, trapezoidal plaza and landscaped facilities, on one hand, guide the direction for pedestrians; on the other hand, provide people with outdoor space for rest and talk. Such design will have a positive impact on the campus communication space.

##### *Hierarchy 2: Communication-featured building interior*



**Figure3.** Main teaching buildings of School of Architecture, Soochow University.  
Picture from: scan/photo.

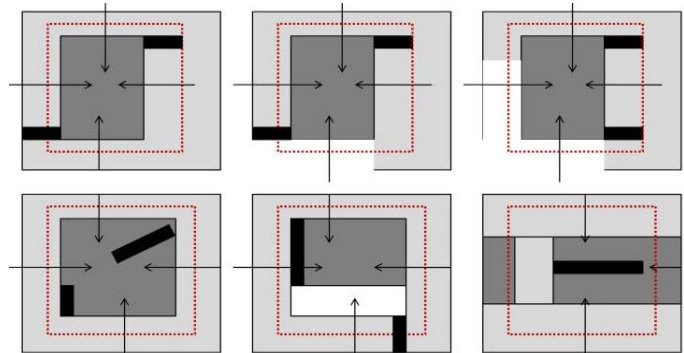
As internal space of the building, the communication-featured interior is defined by the basic architectural elements with flexible spatial modeling methods. Such communication space is very important in campus communication space pattern. First, the quality of communication space will affect the use of the building as they are integrated mass and closely associated with each other; secondly, users, relatively fixed, have the most convenient access to the inner communication space. Such communication space includes sharing space, vertical connection, and aisle which facilitate communication.

Sharing, elevation and aisle, the three space elements, are to be combined to make a spatial pattern that is overlapped and penetrative and capable of actively generating and encouraging human communications; The concept of “Overlapping and Permeability” will be developed to emphasize the importance of this pattern. This concept is based on the combination of various factors above, in turn, summarizing corresponding principles and methods for these design elements, which are the operating strategy aimed at communication space in the architectural design. [Figure4] The space within the orders, but beyond the functions is an important archetype of modern architectural design. (Sun & Huang.2015)<sup>[9]</sup>

The combination of sharing and elevated space connected with access helps to blend the interior and exterior and promote dialogue between human and the nature. The purpose is to increase the vitality of space which is based on human’s activities. The characteristic of communications among people determining communication space should be flexible and variable in function, be permeable in vision and be overlapping in use. Thus, the overlapped and penetrative communication space achieves leading the communication functionally and visually. The communication space in School of Architecture, Soochow University was exactly designed to provide more free communication and more social intercourse through overlapped variation in space. [Figure5]

### Hierarchy 3: Public open space

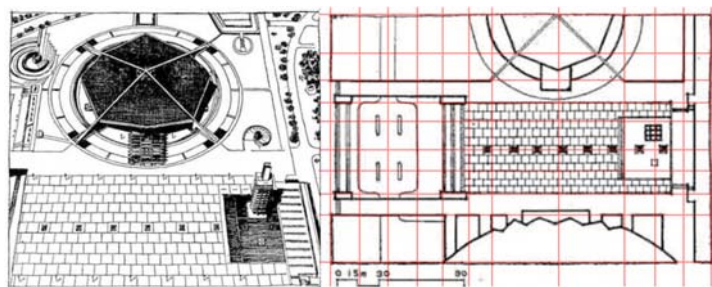
Public open space is usually an important node in campus’ space frame, forming interesting features on campus. It is a symbolic physical environment in the spirit of campus, and also an indispensable part of communication space. The following is the main types: the central plaza, the green space and water-front space. (C.C. Marcus. 2010)<sup>[10]</sup>



**Figure4.**Archetypes for atrium with three space elements.( sharing, elevation, and aisle) Picture from: Drawing.



**Figure5.**Varied interior communication space in School of Architecture, Soochow University. Picture from: photos.



**Figure6.** External modulus theory. Picture from: External Space Design. Yoshinobu Ashihara.1985

In general, the central plaza is located on the node where main traffic passes and that is connected with the entrances and exits of important buildings to attract people to stay and participate. The plaza should be open, south oriented with ample sunlight, and avoid high rises to block the view and light. The scale of central plaza should bring comfort to people with proper building volume and the ratio of length and width of the plaza. Secondly, redividing the central plaza can help to improve the feeling of drabness and hollowness owing to its large scale, and also can help to strengthen the sense of domain field by defining greening, paving, water, parapet and other elements, etc. The specific methods of a secondary division can follow a modulus by referring to the "External modulus theory" mentioned in "External Space Design" (Yoshinobu Ashihara.1985) <sup>[11]</sup>, namely, the external space may use the modulus of a distance of 20-25 meters. Spaces are repeated or have elevation changes every 20-25 meters to break the drabness even in a large space. [Figure6]

## 5. Conclusions: Design Strategy

The pattern of communication space will constantly be updated with times. Similarly, like a process of metabolism, the creation of communication space is an organic system which needs to be maintained and updated to keep it in balance and coordination. According to investigations at different times on a routine day, quantifications for behavioral vitalities in different hierarchies of spaces present interesting distributions. The density and vitality of different behaviors can imply the characteristics of communication space. [Figure7] Principles and design strategies to improve and optimize the above-mentioned communication space are mainly reflected as follows:

LIST0	LIST1	LIST2	LIST3	LIST4	LIST5	LIST6	LIST7	LIST8
		08:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00
Hierarchy 1	Talk	•	•	•	•	•	•	
	Stay		•	•	•	•	•	
	Read	•	•	•	•	•	•	
	Walk	•				•	•	
Hierarchy 2	Talk	•	•	•	•	•	•	•
	Stay	•	•	•	•	•	•	•
	Read			•		•		
	Walk	•	•	•	•	•	•	•
Hierarchy 3	Talk	•	•	•	•	•	•	•
	Stay	•	•	•	•	•	•	•
	Read	•		•	•			
	Walk	•	•	•	•	•	•	•

LIST0	LIST1	LIST2	LIST3	LIST4	LIST5	LIST6	LIST7	LIST8	LIST9
Hierarchy		corridor	atrium	porch	staircase	courtyard	platform	square	corner
1) External communication space belonging to a specific building	Conversation								
	Entertainment								
	Reading								
	Discussion								
	Rest								
2) Communication-featured building interior	Conversation								
	Entertainment								
	Reading								
	Discussion								
	Rest								
3) Public open space	Conversation								
	Entertainment								
	Reading								
	Discussion								
	Rest								

**Figure7.**Quantifications for behavioral vitalities in different hierarchies of spaces on a routine day  
Picture from: Drawing.

(1) Change the remaining space into a positive space.

(2) "Reserving space, arranging space and creating space" is the key point not just dealing with the relationship among building groups, but also creating communication space with rich layers, especially for organizing those external ones subordinate to particular buildings at new universities: such as inner courtyard and elevated ground floor; and organizing similar communication space where building relations are complicated to provide spaces for people coming in different directions; such as front yard and backyard in a building group.

(3) The principle of "overlapped and penetrated" is an organic order, which is not only mixing the space mixed, not simply listing the space but to meet the overall logic of penetration with the possibility of human activities fully considered in the design. The approach of "overlapped and penetrated" is to control the transition of space purposefully, furthermore, is the suitable and organic variations and combinations of spaces of different types.

In conclusion, this thesis focuses on the hierarchical structure of communication space by using the theory of environmental psychology and behavior combined with relevant design principles in architecture to bring new observation ideas for "Pattern Hierarchy" and develop the design strategy based on the concept of "Overlapping and Permeability". Not only that, but it is also a part of the

architectural language exploration in hope of getting more academic exploration and theoretical perspective.

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### Reference

- [1] Xu Ning, Wang Jianguo. Study of Urban Public Space Based on Civic Daily Life:Case Study of Three Kinds of Public Space in Nanjing Old City. *Architectural Journal*.2008.(08):45-48.
- [2] Wu Hui, Dong Ya. Reseach on Urban Open Public Space Design and Environmental Behavior: The Case of Beijing Ditan Park Outside Park. *Architectural Journal*.2012.S2(08):130-133.
- [3] Wang Juan. The Design of Sanhe Waterfront Open Space Base on the User Environment-behavior Patterns[D].*Beijin:Tsinghua University*.2012:33-37
- [4] Zhu Wei,Wang De. A Review on the Models in Research of Consumer Behavior in Commercial Space. *Progress in Geography*.2010.(12):1470-1478.
- [5] Jiang Hui, Sun Leilei, et al.2006.Colony in Campus. Nanjing: *Southeast University Press*:24-37
- [6] Xu Leiqing.2006. Human Engineering and Environmental Behavior. Beijing: *China Building Industry Press*:50-60
- [7] E.T.Hall. 1988. The Hidden Dimension. Chicago.USA: Anchor Books:10-12
- [8] C.Alexander, et al (Wang & Zhou). 2002. A Pattern Language——Towns, Buildings and Construction. Beijing: *Intellectual Property Press*:32-34
- [9] Sun Leilei, Huang Zhiqiang. Within childlike sequences, Beyond functional arrangements——A study on light functional space. *Architectural Journal*.2015.556(01):63-65.
- [10] C.C.Marcus, C.Francis.(Yu Kongjian).2010. People Places——Design Guidelines For Urban Open Space. Beijing: *China Building Industry Press*:25-33
- [11] Yoshinobu Ashihara.(Yin Peitong).1985. External Space Design. Beijing: *China Building Industry Press*:8-20