UNDERSTANDING CULTURAL DIFFERENCES IN NURSING UNIT DESIGN WITH THE SUPPORT OF SPACE SYNTAX ANALYSIS:

Are Chinese nursing units designs different from their U.S. counterparts?

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Abstract

This study is to understand cultural differences in nursing unit design with the support of space syntax analysis. It opened with the question of whether seemingly westernized Chinese nursing units still retained certain characteristics of Chinese socio-cultural preferences. The particular socio-cultural factors under consideration in this study focused on communicational needs that had been identified as being very important for the optimum organizational performance of nursing units.

Based on the review on cross-cultural organizational studies and Confucianism, three main characteristics of Chinese national schema were identified: collectivism and the importance of maintaining social networks; the high "power distance", coupled with a tradition of respect for hierarchy; and the respect of "face." This then led to some key spatial implications: territoriality, hierarchy of space, and clear demarcation of front-stage and back-stage space.

In order to find out whether and how cultural implications of space are manifest in Chinese nursing unit design, an in-depth comparative spatial analysis was conducted on six Chinese and six matching U.S. nursing unit plans. Each pair of plans represents the examples of one typical nursing unit typology. Both visual graph analysis and axial map analysis were conducted and several spatial metrics that were related to encounter, communication, territoriality, hierarchy, and privacy were evaluated. The results of spatial analysis revealed significant national differences in the application of nursing unit typologies. The Chinese cases had significantly lower mean visual connectivity ($p<0.05$) and much lower mean visual integration values compared to the U.S. cases. However, with respect to physical accessibility, the Chinese cases had significantly higher mean connectivity ($p<0.05$), much higher mean integration, and a lower number of axial lines per space than the U.S. cases. The results show dissimilar spatial strategies applied in the U.S. and Chinese nursing unit designs. The configurations of the Chinese cases were designed to better support movement and face-to-face communication, thus reflecting the collectivism and frame-based orientation of Chinese culture.

Although both the U.S. and Chinese cases demonstrated a sense of hierarchy in space, there was a strong trend that the Chinese cases had larger skewness values of the distribution of integration values than the U.S. cases with the same typology. Moreover, the structures of colored axial maps also demonstrated that there was a strong sense of territoriality in most Chinese cases. In addition, the Chinese cases had larger proportion of backstage space which supported the Chinese cultural preference of preserving "face." This study has proven space syntax as an effective tool in revealing cultural differences in nursing unit design.

Keywords: *cultural differences, nursing unit typology, space syntax analysis, cross-cultural organizational studies, comparative study*

Theme: *Building Morphology and Performativity*

INTRODUCTION

Although medical care has been provided in China since 500 BC, inpatient nursing unit, as a highly institutionalized medical building type, was introduced to China by the medical missionaries only two hundred years ago (Renshaw 2005). Since 1840s, the concept of modern hospital and nursing units has been gradually disseminated in China. An increasing Western influences have been witnessed in the design of contemporary Chinese hospitals, due to the increased exposure of native designers to global design trends, and to the greater frequency of collaboration with international design firms (Liu 2006). It is unclear to what extent the seemingly modernized Chinese hospitals and nursing units retain characteristics of Chinese cultural preferences and spatial behaviors. Therefore, this study aims to explore whether Chinese nursing units design are identical with their counterparts in the U.S or their spatial configurations have been adapted to the socio-cultural needs of Chinese.

Culture is a broad and complex concept. This study focuses on examining the issues of cultural preferences related to face-to-face communication from the caregivers' perspective. Effective face-to-face communication among caregivers is imperative in strengthening teamwork and overall healthcare delivery in nursing units (Wood, Farrow, and Elliot 1994). Communication also helps mitigating initial perceptions of stressful work situations, offloading the stress from work (House and Wells 1978). Although nowadays communication in healthcare settings is implemented through various media, face-to-face communication is still the most preferred mode in hospital context. According to Coiera and others' (2002) observation, face-to-face conversation accounted for 82% of the total communication in hospital. Much of this communication is, in fact, informal, unplanned, and opportunistic.

As a carrier of culture, communication patterns are strongly impacted and regulated by culture (Chen and Starosta 1998). According to Zimring and Peatross (1997), national schemas and organizational culture affect "the direction of communication, mode of communication, groups sizes involved with decision-making, the nature of people involved with decision-making, and the mode of supervision and control exercised." (p. 210) Design of the physical environment should be an element that both reflects the culture preferences of communication and mediates characteristics of these communication patterns (Zimring and Peatross 1997).

Therefore, three key research questions are investigated:

1. What are the cultural differences of communication between U.S. and China; and what are the spatial implications?

2. What spatial metrics can be used to measure cultural properties of communication?

3. What are the spatial configurational differences between Chinese and U.S. nursing unit design that support cultural preferences of organizational communication?

Methods

The study was thus developed in two parts: theoretical exploration and comparative case studies. The theoretical exploration investigated first three research questions by reviewing cross-cultural organizational studies, Confucianism, and space syntax studies. The goal was to establish the link between culture and communication, and further translates cultural properties of communication into spatial metrics. In the second part, the spatial metrics identified in the first part were used to measure and compare six Chinese nursing unit plans

with six matching U.S. plans, as examples of different nursing unit typologies. The purpose was to find out whether and how cultural preferences were manifest in Chinese nursing unit design by comparing to its counter parts in the U.S.

Theoretical exploration

What Are the Cultural Aspects of Communication in Chinese Inpatient Units?

Several scholars have examined the impact of culture on communicational behavior (Hall 1966; Hofstede 1984; Miike 2002; Triandis 1989). Among them, Geert Hofstede's dimensions of national cultures are among the most influential works to date in the study of cross cultural communication. Based on the extensive empirical investigations on employee attitude surveys within IBM subsidiaries in 66 countries, Hofstede (1984) defined four cultural dimensions. Among them, two dimensions seem to be particularly important for cross-cultural communication studies (Triandis et al. 1986; Yang and Bond 1990). They can be viewed as vertical and horizontal differentiation culture. The vertical differentiation refers to *power distance*, which is based on the distribution of power. The horizontal differentiation refers to *individualism/collectivism*, which is based on the distribution of responsibility.

Collectivism versus Individualism

China is featured as collectivistic culture whereas United States as individualistic culture (Hofstede 1984; Hofstede, Hofstede, and Minkov 2010). In collectivistic cultures, such as China, the group (e.g. work unit) is more important than self (Gao, Kao, and Ting-Toomey 1998; Triandis et al. 1988). It is very important for Chinese to establish and maintain proper social relationships within the group. Here the group is not a universal group, but more of a group bound by social networks. There is a sharp distinction between in-group and out-group members (Yum 1988). Frequent face-to-face interactions and especially small talks are imperative in maintaining the close ties among the in-group members.

Power Distance (High versus Low)

Based on the Power Distance Index (PDI) score, China is considered as a high power distance country (PDI score: 80), while the United States has relatively low power distance (PDI score: 40) (Hofstede, et al., 2010a). In countries with large power distance, the organizations are represented as clear tall hierarchical systems. The difference in power distance has a strong influence in communication patterns. For instance, in the work environment of high-power distance countries, subordinates are unlikely to challenge and contradict their bosses directly. The roots of Chinese people's high power distance can be traced back to the Confucianism philosophy that is deeply embedded in the Chinese culture with a history of more than 2000 years.

Confucianism

Hierarchy Social Structure (Dengji)

The essence of Confucianism is about hierarchical order (*Dengji*) and interpersonal relations. The hierarchical order in relations reflects not only in families but also in organizations. In workplaces, there is a well-defined hierarchical structure between supervisors and subordinates. A social unit is usually represented as a well-controlled tall hierarchical pyramid, which is congruent with the high power distance of Chinese organizations.

Social Network (Guanxi)

The Confucianism also considers building and maintaining proper human relationships as the basis of society. “The Chinese rely heavily on interpersonal relations, called *guanxi*, built and maintained through mutual obligations that begin with family and friends and extend to organizational acquaintances.” (Samovar, Porter, and McDaniel 2009, 300) The differentiable order of social network (*guanxi)* is closely related to the distinction between in-group and out-group that we mentioned in the collectivism cultural dimension.

Face (Mianzi)

The Confucian consideration of respecting hierarchical order (*dengji*) and maintaining proper human relationships (*guanxi*) has led to the development of communication patterns that preserve one another’s face (*mianzi*) (Yum 1988). According to Ting-Toomey (1988), “face” is a “strategy that protects self-respect and individual identity.” (p. 215) The preservation of face is dependent on the context and the setting, as the presence of others is an important factor that contributes to the feeling of “losing face.” (Yang 1945) As a result, a superior's disciplinary action to a subordinate in the Chinese organization is usually practiced by following the saying “extol the merit in public hall; rectify the wrongdoing in the private room.” (Chen and Chung 1994)

In order to save “faces” and preserve interpersonal harmony, people from collectivist cultures (such as China) prefer high-context instead of low-context communication style (Hall 1976, 1983). In high-context cultures, people rely on a broad range of social cues such as gestures and facial expressions to communicate. Face-to-face interactions become the most important way to communicate, in order to capture the between-line messages. In addition, it is important for people to be “spatially involved with each other,” so that they can be embedded in the context and keep informed, to ensure the collaboration and coordination of the team (Hall and Hall 1990, 23).

What Are the Spatial Implication of Chinese Culture and Related Organizational Communication?

The spatial implication of the collectivistic culture is that there are greater needs for group collocation, physical proximity, and better visual connections that can bring group members together and create internal solidarity. A space with higher visual connectivity and accessibility is helpful to create more opportunities of casual small face-to-face interactions, and maintain the bond among the group members. In addition, the focus on distinction between in-group and out-group requires identifiable boundaries between different user groups.

In addition, the Chinese organization with high power distance is represented as a tall hierarchical structure with clear order. The central authority and social status is represented as the inaccessibility and high sense of control of the physical location, which has been exemplified in many Chinese traditional courtyard houses (Xu 1998).

The Confucianism’s consideration of preserving one’s face (*Mianzi*) leads to a preference for high-context communication and privacy for back-stage communication. The needs for frequent face-to-face communication require a space that encourages encounter, and allows in-group members to be easily accessible to each other. At the same time, to ensure people can feel comfortable to contradict with supervisors or experts, or ask questions that might reveal their ignorance, or to admit mistakes and errors in China, it is important to have the back-stage in-group space with limited visual and/or physical access to front-stage public space. The differentiation is helpful for individual to control the social distance and avoid embarrassment in

public.

The translation between the national schemas of Chinese, special needs of Chinese organizational communication, and the spatial properties of physical environment are illustrated in the Figure 1.

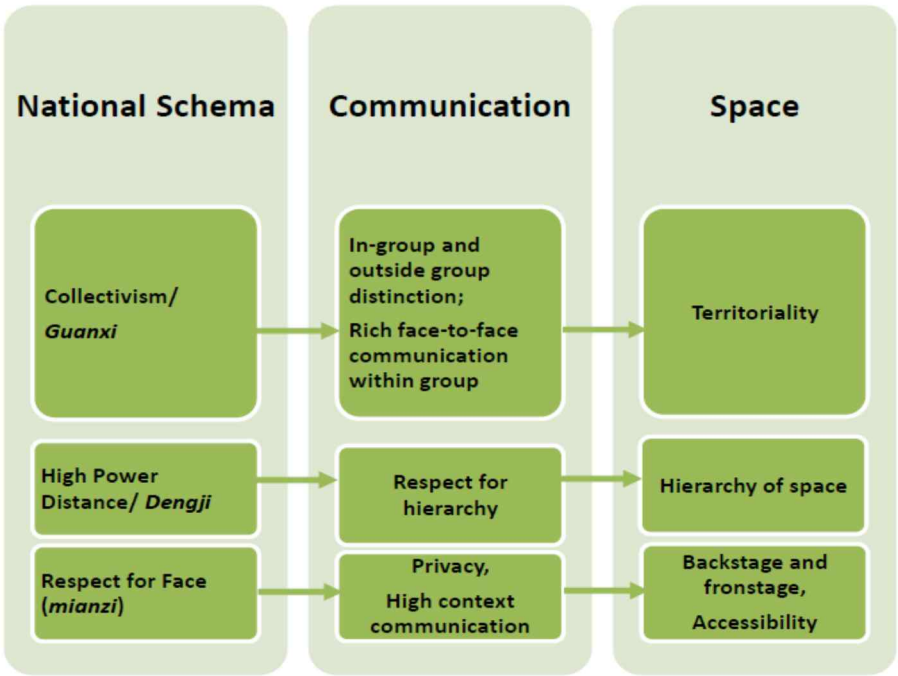

Figure 1: Link Chinese national schema to communication and spatial properties

What Spatial Metrics Can Be Used to Measure Cultural Properties of Communication?

Space Syntax has been proven to be effective in linking space, movement and communication in offices, labs, and museums (Hillier and Penn 1991; Penn, Desyllas, and Vaughan 1999; Peponis et al. 2007; Serrato and Wineman 1999), as well as revealing the cultural inputs reflected in the configurations of buildings (Hillier and Hanson 1984). More importantly, space syntax scholars have developed various analytical techniques, including axial map and visual graph analysis, and related metrics to describe spatial configurations and link physical environments with face-to-face communication.

For instance, Rashid and Zimring (2003) link five organizational constructs: *communication*, *control*, *territoriality, privacy*, and *status* with spatial configuration based on axial map analysis on five layouts of three government organizations. They find that in the organizations that encourage interaction, there are a fewer number of axial lines per workspace and higher interconnectedness of the axial structure. The strong territoriality is reflected in space as a well-connected local axial structure that is cut across by fewer axial lines, and has minimal connections with the global structure. The social status or power difference is reflected on the difference of integration values of the offices of managers and workers. In other studies, visual graph analysis is shown to be effective in evaluating the impacts of spatial configuration on face-to-face communication, collaboration, and social network (Sailer et al. 2007, 2009; Peponis et al. 2007).

Comparative case studies

Hence, in this study, both visual graph and axial map analysis were used to reveal differences in cultural and spatial implications between Chinese and the U.S. nursing unit design. The comparative study was conducted on six Chinese and six matching U.S. nursing unit layouts. Each pair of plans represented the examples of one typical nursing unit typology as defined in literature (Thompson and Goldin 1975; James and Tatton-Brown 1986), including: single corridor, racetrack, radial, triangular, cluster, and mutated racetrack (Figure 2). For visual graph analysis, all doors, windows, glass partitions, and low furniture that were below eye level were removed. Therefore the results represented the inter-visibility of the layout. The resulted measures from visual graph included mean connectivity, mean integration of the overall unit, the intelligibility of the layout (the correlation between connectivity and integration, R^2), the mean integration value of nurse station(s), patient zone, staff zone and circulation area. The detailed numerical results are reported in Table 1. For axial map analysis, all physical barriers that might prohibit movement were kept while drawing axial lines. Thus, the results of axial map analysis represented the accessibility of a layout and predicted patterns of movement. The resulted measures included the number of axial lines per space, mean connectivity, mean global integration, and the correlation between connectivity and global integration (R^2). The detailed results are reported in Table 2. The six pairs of layouts are colored based on visual integration values (Figure 3) and axial integration values (Figure 4), with the color moving from blue to red representing the values from low to high.

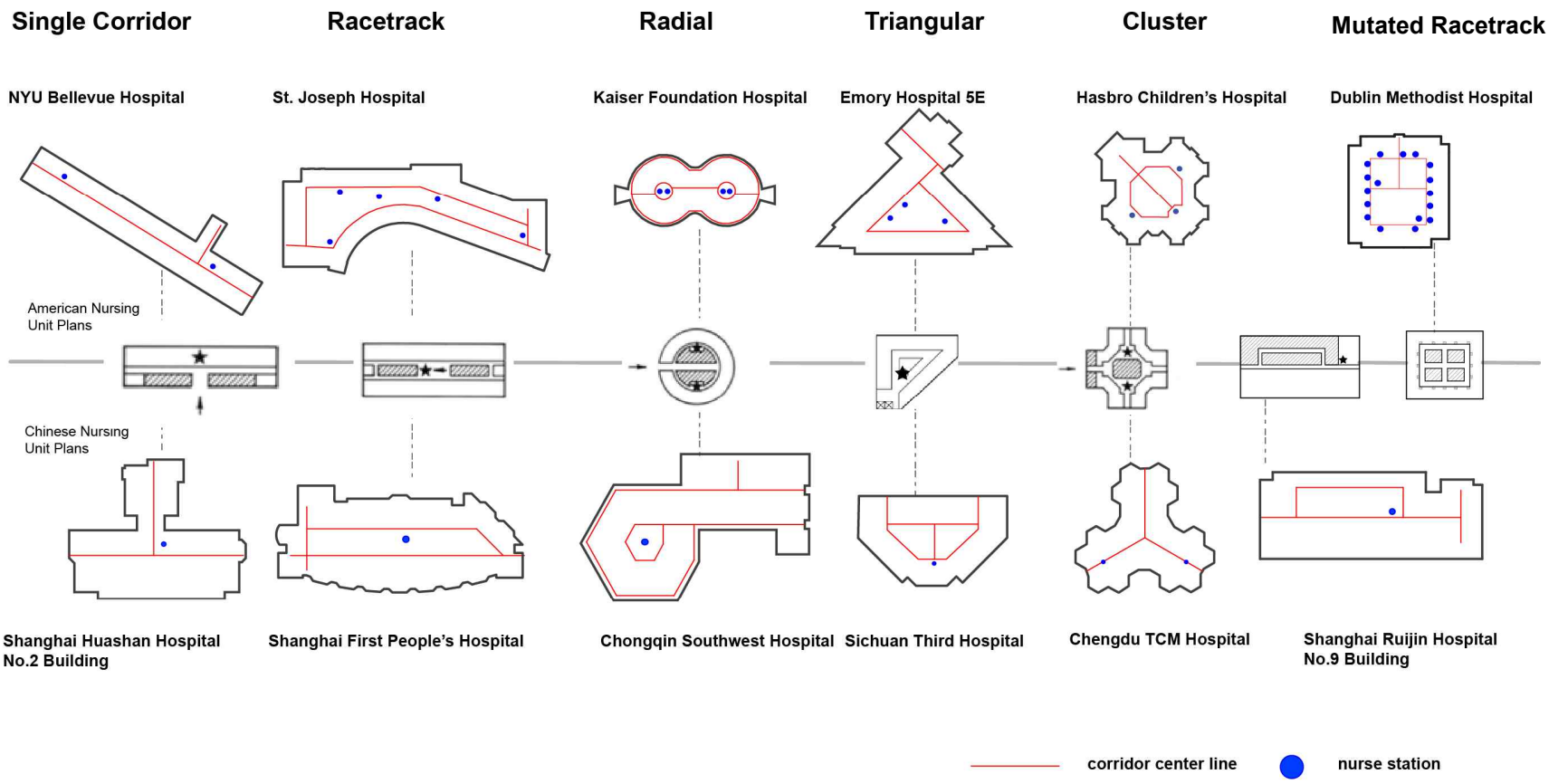

Figure 2: Selected U.S. and Chinese cases for nursing unit typologies study

Table 1: Visual Graph Analysis on selected U.S. and Chinese nursing unit layouts

NS: Nurse Station

Nursing Unit Typology	Region	Hospital	Total counts	Mean Connectivity	Mean Integration	R2*	NS integration	Patientzone Integration	Staffzone Integration	Circulation Integration
Single Corridor	USA	NYU Bellevue Medical Center	18812	1192.190	7.133	0.932	7.954	6.049	5.956	9.775
	China	Shanghai Huashan Hospital No.2 Building	8158	604.803	6.147	0.803	8.127	5.481	5.290	7.124
Racetrack	USA	St. Joseph's Hospital	36718	982.383	5.024	0.684	5.845	4.452	4.776	5.862
	China	Shanghai No.1 People's Hospital	18090	1056.740	6.839	0.881	8.943	6.326	6.391	8.379
Radial	USA	Kaiser Foundation	12653	646.568	6.176	0.802	9.230	5.700	7.451	6.468
	China	Chongqin SouthWest Hospital	8883	602.184	6.217	0.762	8.553	5.503	5.775	7.007

Table 1: Visual Graph Analysis on selected U.S. and Chinese nursing unit layouts (continued)

NS: Nurse Station

Nursing Unit Typology	Region	Hospital	Total counts	Mean Connectivity	Mean Integration	R2 (connectivity vs. global integration, p<0.0001)	NS integration	Patient zone Integration	Staff zone Integration	Circulation Integration
Triangular	USA	Emory Hospital 5E	13889	1532.410	8.400	0.879	10.739	7.160	7.749	8.186
	China	Sichuan Third Hospital	15467	593.140	5.102	0.781	7.525	4.536	5.401	5.652
Cluster	USA	Hasbro Children`s Hospital	29494	782.651	4.785	0.714	5.570	4.286	4.940	6.116
	China	Chengdu TCM University Affiliated Hospital	11004	529.430	4.860	0.703	6.545	4.287	5.423	5.619
Mutated Racetrack	USA	Dublin Methodist	13984	917.281	6.618	0.799	7.626	5.948	6.615	8.013
	China	Shanghai Ruijin Hospital No.9 Building	12656	619.049	5.841	0.844	7.842	5.525	4.753	7.335

Table 2: Axial map analysis on selected U.S. and Chinese nursing unit layouts

Nursing Unit Typology	Region	Hospital	No. Axial lines per space	Axial mean connectivity	Axial mean Global integration	R2 (connectivity vs. global integration, p<0.0001)
Single Corridor	USA	NYU Bellevue Medical Center	0.905	2.116	1.856	0.603
	China	Shanghai Huashan Hospital No.2 Building	0.729	4.229	2.479	0.910
Racetrack	USA	St. Joseph's Hospital	0.974	2.265	1.446	0.535
	China	Shanghai No.1 People's Hospital	0.731	4.807	2.520	0.782
Radial	USA	Kaiser Foundation	1.103	3.147	1.521	0.623
	China	Chonggin SouthWest Hospital	0.857	3.429	1.523	0.625

Table 2: Axial map analysis on selected U.S. and Chinese nursing unit layouts (continued)

Nursing Unit Typology	Region	Hospital	No. Axial lines per space	Axial mean connectivity	Axial mean Global integration	R2 (connectivity vs. global integration, p<0.0001)
Triangular	USA	Emory Hospital 5E	1.091	4.700	1.956	0.715
	China	Sichuan Third Hospital	0.957	3.455	1.515	0.685
Cluster	USA	Hasbro Children`s Hospital	0.757	3.062	1.048	0.543
	China	Chengdu TCM University Affiliated Hospital	0.603	3.314	1.256	0.605
Distributed	USA	Dublin Methodist	0.804	2.311	1.290	0.845
Mutated Racetrack	China	Shanghai Ruijin Hospital No.9 Building	0.838	3.774	2.037	0.722

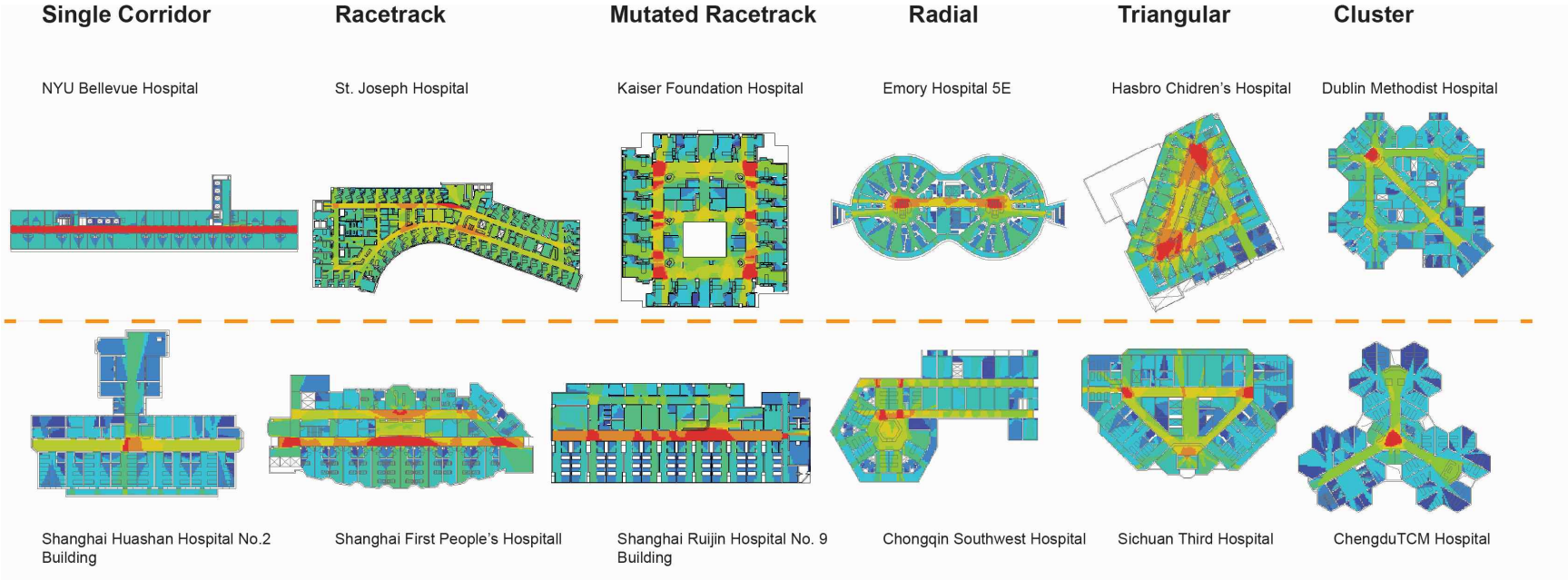

Figure 3: Visual graph analysis on the six Chinese nursing unit layouts and six matching American nursing unit layouts

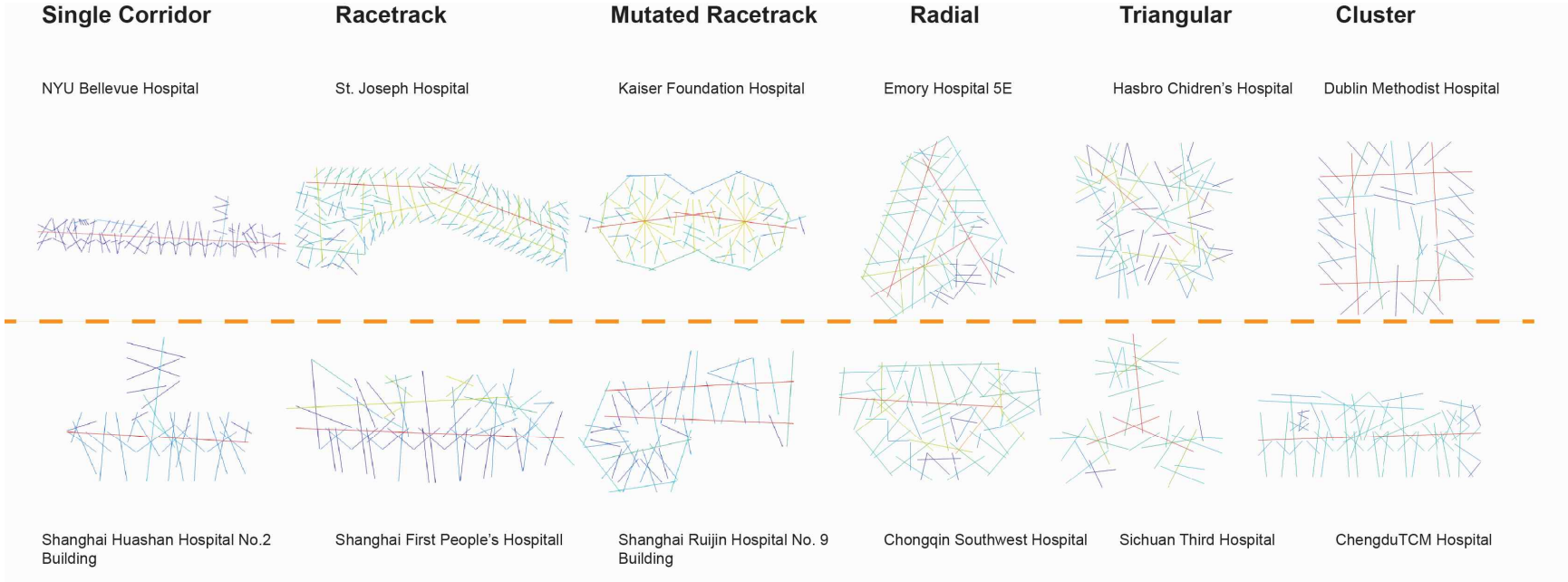

Figure 4: Axial map analysis on the six Chinese nursing unit layouts and six matching American nursing unit layouts

Results

Two different levels of comparisons were made on the results: (1) a comparison of U.S. and Chinese cases with the same typology; and (2) an overall comparison of U.S. and Chinese cases.

Comparison of U.S. and Chinese Cases with the Same Typology

Visual Graph Analysis and Axial Map Analysis on Single Corridor Layouts

For the visual graph analysis, the NYU Bellevue Medical Center had larger mean connectivity and mean integration values than the Shanghai Huashan Hospital, 1192.190 versus 604.803 and 7.133 versus 6.147 respectively. It shows that the space at the NYU Bellevue Medical Center is better connected visually, both at the local and global scale. These two layouts utilized different spatial strategies in the staff work areas. In the case of the NYU Bellevue Medical Center, there were two separate nurse stations and utility rooms, with shared treatment room, staff area, service room and lab at the center of the layout. By contrast, in the Shanghai Huashan Hospital No.2 Building, the care team was co-located in a zone that was composed of nurse station, treatment room, medication room and doctors' office. The adjacency between nurse station and doctors' office seems to be a strategy to facilitate nurse-doctor communication. In addition, in the Huashan Hospital, the doctors' offices were located deeper in to the layout with lower integration value (4.841) when compared to the nurse station and the treatment room (5.981). In the NYU Bellevue Medical Center, there was no designated doctors' office. Moreover, its difference between the nurse station and the staff office was way smaller (6.373 versus 5.809). The comparison demonstrates that the Chinese case has stronger sense of hierarchy and status. Nurse stations in both cases were located in a highly integrated area, yet with quite different strategies. The nurse stations in the NYU Bellevue Medical Center were located close to the highly integrated corridor overlooking patient rooms. By contrast, the nurse station in the Huashan Hospital was located near the integration core at the intersection of two corridors, with the purpose of controlling the in-and-out traffic (Figure 2).

The axial map analysis suggested that the patterns of interrelationship of the axial lines were similar in these two layouts, yet with some intriguing differences (Figure 3). Both cases were based on a T-shape primary order corridor. The more integrated west-east corridor connected all patient rooms and staff work areas, and the less integrated south-north corridor linked the patient and staff zone to the vertical circulation. However, the Huashan Hospital had higher axial mean connectivity and mean global integration than the NYU Bellevue Medical Center. Moreover, it had less number of axial lines per space than the NYU Bellevue Medical Center. This shows that, in the Chinese case, people need to make less turns to reach other spaces both at the local and global scale, which shows a better potential to encourage movement, informal encounter, and communication.

Visual Graph Analysis and Axial Map Analysis on Racetrack Layouts

For VGA, the Shanghai No.1 People's Hospital had larger mean connectivity and integration values, and higher correlation between the connectivity and integration values. That shows the layout of the Shanghai No.1 People's Hospital is visually well connected both at the local and global level. The rich interconnectedness of the layout may lead to a high potential of unplanned encounter and interaction. The St. Joseph Hospital had lower mean integration value but relatively high mean connectivity. It shows that the St. Joseph Hospital is visually well connected at the local level yet poorly connected at the global level. And that the layout is not intelligible to visitors since there is a weak correlation between the interface at the local and global level. The result is not surprising, as the St. Joseph Hospital has six sub-stations each overlooking certain number of patient rooms (Figure 2). Thus functionally the layout works as a combination of several sub-units. The high connectivity allows for a better control over each

sub-unit. However the long curved corridor and the staff support zone located at the center of the layout diminishes the visual connections at the global level. In both cases, the circulation area had the highest integration value, yet the staff zone and the patient zone were placed differently in terms of the inter-visibility. The nurse station in Shanghai No.1 People's Hospital was very close to the integration core, which might lead to strong visual control and high possibilities of encounter and interaction. On the contrary, the nurse stations in the St. Joseph Hospital had much lower integrated value. It means that nurses who work in those stations are less likely to have a good overall understanding of the whole unit and may feel isolated from the rest of the clinical team.

The axial map analysis also displayed dissimilar degree of physical accessibility between these two layouts (Figure 3). Similar to the results of the visual graph analysis, the Shanghai No.1 People's Hospital had the higher mean integration and mean connectivity values. It also had the fewer number of axial lines per space. Moreover, it had a strong correlation between connectivity and global integration. These findings show that the configuration of the Shanghai No.1 People's Hospital supports inter-group encounter and serendipitous communication. The St. Joseph Hospital had the larger number of axial lines per space and weaker correlation between connectivity and global integration. Therefore it had less intelligible local and global order and it diminished the chances for informal interaction.

Visual Graph Analysis and Axial Map Analysis on Mutated Racetrack Layouts

For VGA, we observed dissimilarities in the rank orders of the mean integration values of different functional zones in these two layouts. In the Shanghai Ruijin Hospital, staffs occupied less integrated area than patients. On the contrary, in the Dublin Methodist Hospital, patients were located in less integrated area than staffs. The dissimilarity in rank orders implies different spatial strategies for privacy and status. In the Chinese case, the focus was on demonstrating status by locating staff in a less visually connected space. These staff areas were visually segregated from the patient zone, in order to provide a backstage area that could maintain the privacy for staff and avoid them losing "face" in front of patients. The status and high power distance was further demonstrated in the very segregated location of the unit director's office. By contrast, in the U.S. case, patients were located in less visually integrated area, which allowed higher patients' privacy. The distributed nurse alcoves and the multidisciplinary "perching" team spaces around six round columns had high visual integration values, which indicated high possibilities of encounter and potential inter-group interaction.

For axial map analysis, the Dublin Methodist Hospital had more egalitarian axial structure (Figure 3). All patient rooms and most staff work area were no more than one-step-away from the wheel-like circulation core. There was no clear sense of territory and distinct spatial hierarchy. Some very integrated lines ran through spaces of different types, such as the patient zone, the staff zone and the circulation area. These were achieved by taking away the enclosure of traditional nurse station. The Shanghai Ruijin Hospital No. 9 Building had much stronger sense of territoriality and spatial hierarchy. The staff zone had a very highly inter-connected axial structure that was cut across by very few axial lines and weakly connected to the rest of the global structure. Therefore, the layout provided a distinct boundary between caregivers and patients.

Visual Graph Analysis and Axial Map Analysis on Radial Layouts

For visual graph analysis, these two radial layouts shared very similar patterns of inter-visibility both at the local and global levels (Figure 2). The mean connectivity, mean integration and the correlation between the connectivity and integration values were comparable in these two layouts. In addition, in both cases, the nurse station was located at a highly integrated area for the purpose of visual surveillance.

The results of axial map analysis also showed great similarities between these two layouts (Figure 3). They had comparable values of number of axial lines per space, mean connectivity, mean global integration, and the correlation between connectivity and global integration. However a careful examination on the structure of the colored axial map revealed some intriguing differences. No spatial territory was evident in the colored axial map of the Kaiser Foundation Hospital. The integration core was located at the center of the two radial units. The axial structure followed the geometric order of the layout. On the other hand, there was a strong sense of spatial territory in the configuration of the colored axial map of the Chongqin Southwest Hospital. There was a distinct demarcation of the boundary between the patient zone and the staff zone. In addition, the axial structure did not follow the geometric order of the configuration, as its integration core was lumped on one side of the layout that contained the staff zone. Consequently, in the Chongqin Southwest Hospital, there was stronger control over the interface between patients and caregivers. Meanwhile, the highly integrated corridors in its staff zone provided a good potential for in-group interaction among caregivers from different disciplines.

Visual Graph Analysis on Triangular Layouts

For VGA, the Emory Hospital 5E had much higher connectivity and integration values than the Sichuan Third Hospital (Figure 2). In addition, the nurse stations in the U.S. case had much higher integration values than those in the Chinese case. In other words, the nurse stations in the Emory Hospital 5E have richer visual connections to the rest of the configuration, thus better awareness of the whole unit. Despite the above differences, both layouts had strong correlations between the connectivity and integration values. These two layouts also had the same rank order of different categories of spaces.

The structures of the colored axial maps of these two layouts resembled more similarities than differences (Figure 3). No clear sense of territoriality could be observed from the configurations of both axial maps. Both layouts had strong correlations between the connectivity and global integration values, which implied the existence of an intelligible local and global structure with respect to movement and accessibility.

Visual Graph Analysis and Axial Map Analysis for Cluster Layouts

Again, the visual graph analysis of these two layouts presented more similarities than differences (Figure 2). Both layouts had comparable integration values and correlation between connectivity and integration values. Moreover, these two layouts had similar rank orders for different categories of space, with the circulation area having the highest integration value, followed by the staff zone, and the patient zone having the lowest integration value. The major difference of these two layouts was at the local level. The Chengdu TCM Hospital had lower mean connectivity value than the Hasbro Children's Hospital had. The implication here is that each node in the Chinese case has limited direct visibility towards other locations, thus leads to stronger sense of boundary and territoriality.

The axial map analysis also demonstrated similarities between these two layouts (Figure 3). Both cases had comparatively low number of axial lines per space, which suggested few turns were needed to reach other spaces in the unit. It could be attributed to the cluster/pod design that allows an easy access at the local level. They had comparable mean global integration. In addition, the correlation between the local and global interface was weak in both the Chinese case and the U.S. case. However, the Chengdu TCM Hospital had higher mean connectivity than the Hasbro Children's Hospital. Therefore the layout of the former was more accessible at the local level than the latter. The close connectedness of local areas helps to form the sense of community and territoriality in the Chinese case. The structure of axial maps further reveals the clear sense of territoriality in the Chengdu TCM Hospital. Few highly integrated axial lines linked various territories formed by the clusters. On the contrary, in the Hasbro Children's Hospital, the strong sense of territoriality was diminished by several short axial lines that ran through various pods.

Summary of Comparison of U.S. and Chinese Cases with the Same Typology

In sum, the comparisons of Chinese and the U.S. cases sharing the same typology showed different patterns, depending on the typology. For single corridor, racetrack, and mutated racetrack layouts, more significant national differences were found in the VGA and AMA. The Chinese design showed higher axial integration and lower visual integration, comparing to the U.S. designs. Moreover, the Chinese layouts for these typologies demonstrated higher sense of hierarchy, territoriality, and stronger demarcation of the boundary between front-stage and back-stage space. However, for radial, triangular, and cluster layouts, less differences were shown between the Chinese and their U.S counter parts.

In order to understand the differences in application of various typologies in China, we further conducted a large scale survey on 116 Chinese nursing unit plans gathered from three key publications covering best practices of Chinese hospital design over the last 20 years (Division of Planning and Finance/MOH and CHEA/AHA 1999; CHEA/AHA and CIA/AHA 2004; Lv 2008). We categorized the plans based on the time period and the nursing unit typologies they apply. The results helped to depict the pattern of distribution of different nursing unit typologies and the trend of nursing unit typology transformation in China (Table 3). The results demonstrate that Chinese nursing unit designs present unbalanced development on various typologies. Single corridor layout is one of the most popular typologies in China inpatient units. During 1989-1999, more than half of the collection of best practices is based on single corridor layout. During the period covering 1999-2008, the percentage of single corridor layout reduces yet still accounts as a majority of nursing unit design. Racetrack and mutated racetrack layouts have become more and more popular in China. More than 60% of designs apply either racetrack or mutated racetrack in 2008. Although there are increasing interests in exploring other typologies such as triangular, radial, and cluster layouts, the practices on these typologies are still comparatively rare in China. The lack of exploration on these typologies in China probably can account for the similarities in spatial configurations and properties when comparing the Chinese layouts to their U.S. counterparts with same typologies.

Table 3: A Survey of Chinese Nursing Unit Typologies during 1989-2008

Phase		Single corridor	Racetrack	Mutated Racetrack	Cluster	Radial	Triangular	Total
1989 -1999	Number	28	10	8	0	3	2	51
	Percentage	54.90%	9.61%	15.69%	0.00%	5.88%	3.92%	100%
1999 -2004	Number	18	8	19	1	5	3	54
	Percentage	33.33%	14.81%	35.19%	1.85%	9.26%	5.56%	100%
2008	Number	3	4	3	0	2	1	11
	Percentage	27.27%	36.36%	27.27%	0.00%	18.18%	9.09%	100%

Overall Comparison of the U.S. and Chinese cases

More significant national differences were revealed when we further grouped all six Chinese cases to compare with all six U.S. cases, and conducted an overall comparison.

Chinese Layouts Were More Driven By the Needs for Face-to-face Communication

The six Chinese and six U.S. nursing unit layouts were compared according to mean axial integration and mean visual integration values (Figure 6). The results show dissimilar spatial strategies applied in the U.S. and Chinese nursing unit designs. The Chinese cases had significantly lower mean visual connectivity ($p<0.05$) and much lower mean visual integration values compared to the U.S. cases. However, with respect to physical accessibility, the Chinese cases had significantly higher mean connectivity ($p<0.05$), much higher mean integration, and a lower number of axial lines per space than the U.S. cases (Figure 5). The high visual inter-connectivity and low physical accessibility of the U.S. cases allow good awareness of patients' condition and care coordination, yet restrict free movement. It strikes a balance between the needs for constant care coordination in nursing units and the individualism of the U.S. culture. On the contrary, in the Chinese cases, the reduced visual connections are mitigated by the high physical accessibility both at local and global level. As a result, the Chinese layouts encourage movement and face-to-face communication, thus reflecting the collectivism and frame-based orientation of Chinese culture.

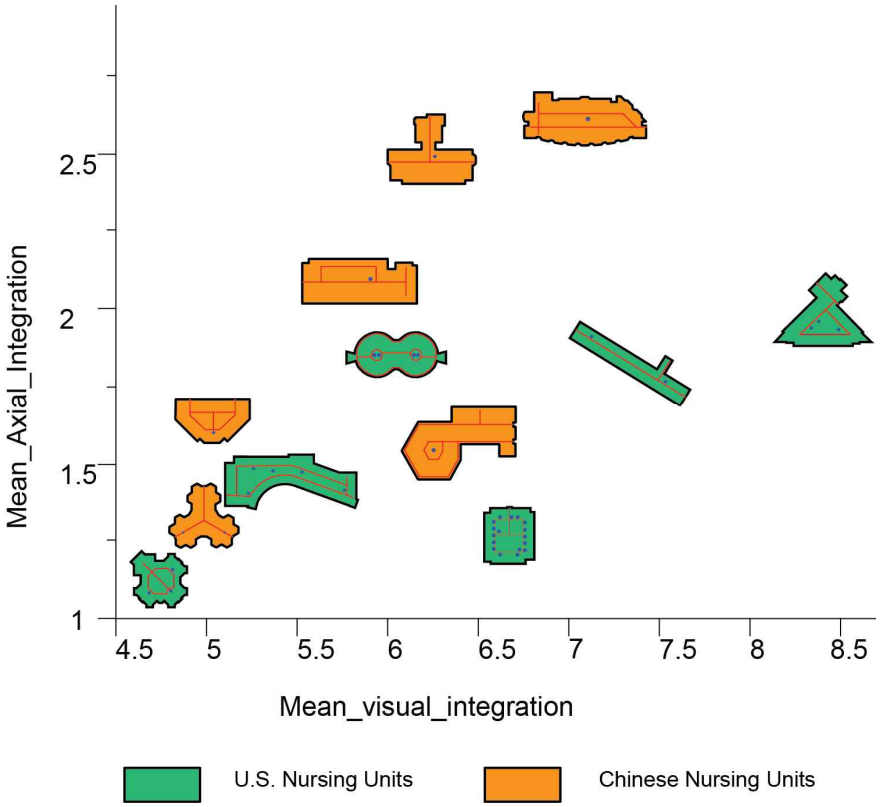

Figure 5: Six U.S. and six Chinese nursing unit layouts compared according to mean axial integration (based on axial map analysis) and mean visual integration values (based on visual graph analysis). Most of the Chinese cases have higher axial integration and lower visual integration when compared to the U.S. cases.

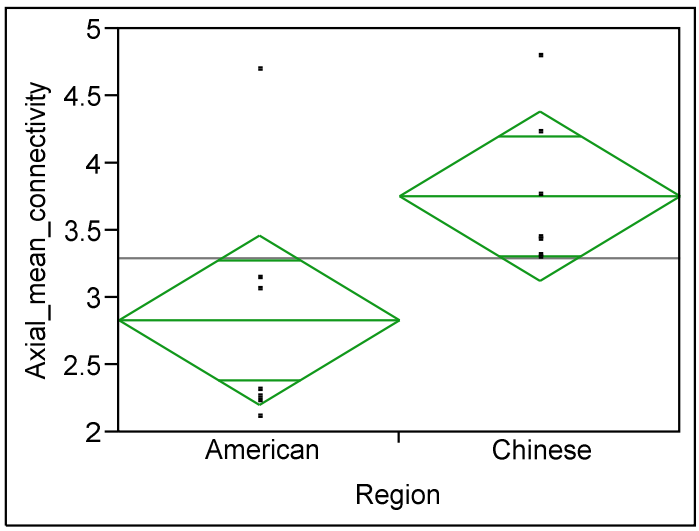

Figure 6: T-test of the mean connectivity based on axial map analysis between the U.S. and Chinese cases. The Chinese cases had statistically larger axial mean connectivity than the U.S. cases ($P<0.05$)

Chinese Layouts Demonstrated Stronger Sense of Hierarchy

Both the U.S. and Chinese cases demonstrated a sense of hierarchy in space, as the mean integration values for each functional zone, i.e. the staff zone, the patient zone, and the circulation area showed a clear hierarchical order. However, there was a strong trend that the Chinese cases had larger skewness values of the distribution of integration values than the U.S. cases with the same typology, although the difference was not statistically significant (Figure 6). Skewness is a measure of the asymmetry of the probability distribution of a random variable. The larger the skewness value is, the more unevenly distributed the values are. Therefore, the integration values of various functional zones in Chinese cases present larger variances and stronger sense of hierarchy when compared to those in the U.S. cases.

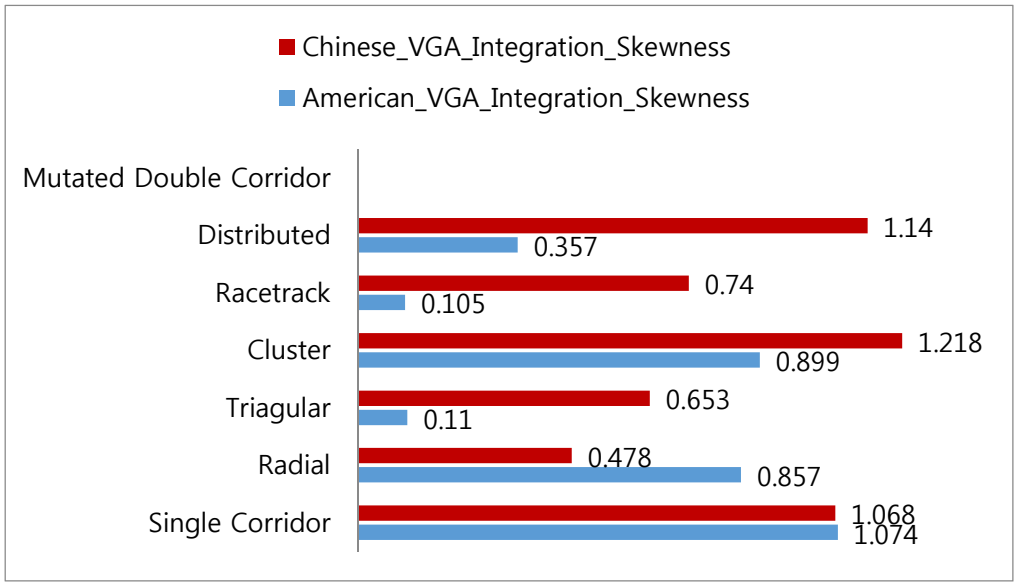

Figure 7: Comparison of the Skewness of the distribution of VGA integration values by country and typology.

Chinese Layouts Showed Stronger Sense of Territoriality

In most of the Chinese cases, staffs were co-located in one zone with well-defined boundaries. Moreover, Chinese designs had well-connected local structures that were weakly connected to the global structure. In the U.S. cases, there was no clear local structure. The sense of boundary was diminished by either breaking down the staff zone or linking it with other zones with highly integrated axial lines. The clearly defined boundaries and close connections within the staff zone seem to support the collectivism and the frame orientation of Chinese culture.

Chinese Layouts Had Larger Ratio of Backstage Space

To find out to what extend the Chinese nursing unit design are different from the U.S. designs in terms of supporting the avoidance of losing “face”, the ratio of backstage versus frontstage space is calculated. Frontstage is the space where patients and visitors could directly see and/or access, whereas the backstage is the space where patients and visitors had no direct visual or physical access. Results show that the Chinese cases had had a significantly higher ratio of overall backstage area versus frontstage than the U.S. cases ($p<0.05$) (Figure 7). Moreover, it was clearly evident that the Chinese cases had larger proportion of backstage space within the staff

zone, which supported the Chinese cultural preference of preserving “face.”

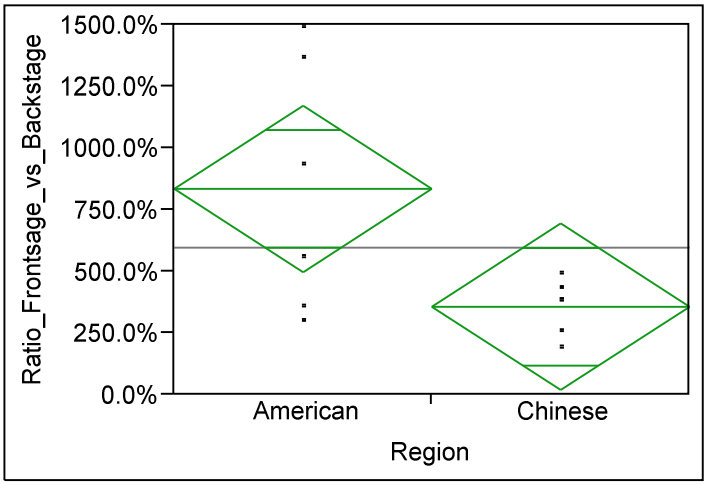

Figure 8: T-test on the ratio of overall frontstage space versus backstage space between the U.S. and Chinese cases

Summary of Overall Comparison

Based on the above findings, it is argued that the Chinese nursing unit designs are different from their U.S. counterparts because of socio-cultural preferences on collectivism, high power distance, and the preference of preserving “face”. The spatial configurations of Chinese nursing unit designs have been modified to support the related communicational needs. This finding supports what Bullock (1980) has pointed out in her influential book “An American Transplant: The Rockefeller Foundation and Peking Union Medical College.” She claimed that intercultural relations could not be simply described as “impact and response,” which is a one-way forceful transfer. Instead, it is based on “adaptation and assimilation.” Adapting means “to make suitable, especially by changing,” while assimilate means “to take up and make part of itself, or oneself.”

Contribution

This study is the first of its kind exploring the cultural dimensions of nursing unit designs. From a methodological point of view, this study has translated abstract cultural schema, organizational constructs, and complex spatial relationships into quantitative metrics. It brings together knowledge and methods from multiple disciplines, including cross-cultural organizational communications, healthcare architecture, and space syntax. This methodology allows the description of the generic properties of spatial layouts in a rigorous way, which makes the comparison of various building configurations from different cultures possible. The method and conceptual framework can be applied to understanding cultural differences in other building types as well.

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