Research on Human Trajectories inside Large-scale Commercial Facilities—A Case Study of Nanjing Grand Ocean Department Store

Shi Yi*, Hu Xinyu2, Peng Chuhui2

1 Department of Urban Planning, Southeast University, Nanjing, Jiangsu, 210096, China
2 Department of Urban and rural planning, Nanjing Forestry University, Nanjing, Jiangsu, 210037, China
* Corresponding author’s e-mail: shiyi@seu.edu.cn

Abstract: Accompanied with the socioeconomic development, commercial buildings are becoming more and more important in people’s daily life. A reasonable design of commercial dynamic lines cannot only attract more consumers, but motivates them into consumption to a certain extent, bringing increased passenger flow and economic benefits to department stores. Starting with the research on human trajectory, this paper sums up its law both at the same and different layers, as well as that of trajectory stops, with a view to providing new ideas for the layout and dynamic line design of the internal spaces of large-scale integrated shopping malls.

1. Introduction
Modern commercial buildings, as the place and carrier of consumption behaviors, are closely related to our daily lives. The overall planning of the consumer dynamic line is of great research significance in that it is a key factor of a successful commercial building design. We should design this line reasonably while meeting the requirement of internal functions in spatial organization so as to maximize the value of commercial spaces by making consumers mentally contented, extending their staying at department stores and stimulating consumption.

Foreign scholars have obtained comparatively abundant research results on the dynamic line design of large-scale commercial facilities. In his Design of Cities, Bacon holds that urban forms and motion forms are closely connected. By analyzing how the two are connected with each other, he points out that people perceive the space in movement, during which the space becomes relevant to people. And the form of things is the result of their inner working. [1] Researches on commercial buildings abroad are comparatively mature both in theory and practice, and a relatively complete theoretical system of space and behavior, dynamic line and path has been formed. However, explorations and practice on consumer dynamic line mostly concentrate on city space area, while researches and applications of the consumer dynamic line in the commercial setting are limited.

Although commercial buildings started late in China, they developed rapidly by consulting foreign research experience, and many theoretical studies have been carried out. Zhuang Weimin from Tsinghua University expounds the "dynamic line" in his book Architectural Programming, holding that it refers to the users’ activity line in traffic spaces inside commercial buildings and provides the arteries through which the users can act continuously in commercial buildings and the goods be
delivered. It has features of instantaneity, inductivity, directness, order, relative independency and so on. Therefore, the dynamic line system can also be regarded as the system of traffic space, and the plan of the dynamic line as the basis of space planning. Before the space planning is carried out, it is necessary to plan the dynamic line. [2] Although researches on commercial buildings are still young in China, great progress has been made in fields like distribution of consumption behaviors, environmental space design and so on. However, a set of complete theoretical framework of spatial planning has not been formed and the systematic induction of the formation and effect mechanism of commercial dynamic line is insufficient as a result of the shallow depth of relevant researches. The dynamic line design and spatial organizations are often disjointed, and explorations on human trajectory are also insufficient.

The classical dynamic line design, which is often based on the structured and systematic data and patterns obtained from previous work, is just a rigid imitation of successful cases and lacks thinking on real human trajectories.

There exist a number of large-scale commercial buildings having a high reference value in cities. Therefore, this study, aiming to supply guidance for the future design of the consumers' flow line and spatial layout, takes Nanjing Grand Ocean Department Store as the research object to observe and record the human trajectories inside department stores and summarize the universal laws under the thinking of the consumers' flow line and consumer demand from the perspective of consumers' behavioral psychology.

2. Research Method

2.1. Case Study
Nanjing Grand Ocean Department Store is situated at the intersection point of Zhongshan South Road and Huaihai Road in Qinhuai District, Nanjing city. Located in Xinyi business circle which is known as "the First Chinese Commercial Loop", it is a flagship store under Grand Ocean Department Store Group Co.Ltd. It begins operations on January 1, 2003 and is a typical and representative large-scale integrated shopping mall with an area of sixty-six thousand square kilometers.

In this study, through a detailed on-site field investigation of Nanjing Grand Ocean Department Store, we observe, measure and photograph the inner space of the store, understand its basic functional and organizational structure, and obtain real-time distribution information of shops.

2.2. Statistic Method of Research on Human Trajectories at the Same Layer
Early tracking survey reveals that consumers tend to have a circular walk aimlessly after entering a certain layer. On each occasion their stay is brief—averaging about ten minutes. That is to say, they may either choose to stay for something interesting or just leave this layer. Therefore, we choose ten minutes as the survey time spent on each set of data.

We select consumers who have just entered a certain layer as the research object and record their walking trajectories within ten minutes. The data obtained from people whose stay is less than ten minutes will be involved in the analysis of human trajectories at different layers.

3. Result
Based on above analysis, we summarize the general laws of human trajectories inside large-scale integrated shopping malls. By research and investigation, we find that consumers’ choices of shopping routes have chanciness and randomness. Assuming that we have selected a certain range as the planar space of a department store, evenly arranged inside with various stores, as is shown in Figure1: Human trajectories in this area will distribute disorderly as shown in the diagram, which can also be classified into the circular type and the linear type (Figure2). That is to say, human trajectories going back to the originating point and forming a closed ring finally can be classified as the circular type; while the others will be classified as the linear type.

The common internal layout of large-scale integrated shopping malls can be simplified as the
layout model shown in Figure 3. First of all, we arrange a circle of stores along the periphery of the mall to function as the consumption point, catering to people’s consumptive habits, namely, they prefer to go counterclockwise along the periphery of department stores. Then, transportation hubs shall be set up near peripheral corridors, so that consumers can begin to circle around the mall along peripheral shops after entering the layer. As shown (Figure 4), we arrange store groups formed by the concentrated distribution of multiple stores in center positions while setting aside enough space for transportation corridors, making it possible for consumers to enter the staging areas of the plane from any turnoff in the outer ring and go in a ring along the store groups. This avoids the situation where the staging areas have a lower consumer flow and provides more route choices for consumers(Figure 5). Finally, we arrange the sale areas easily attracting consumers and stimulating consumption on the other side of the transportation hubs, which can also help divert the consumers to stores and areas distributing along the radial direction that located neither near the transportation hubs nor in the outer ring(Figure 6).
As shown in the above figure, the ideal human trajectories of large-scale integrated shopping malls generally include the following several kinds: circular trajectory formed along the periphery of the mall (Figure 4); circular trajectory formed along the center positions of the mall (Figure 5), the linear trajectory formed near the sales areas (Figure 6) and so on. Combined with the track record of human trajectories inside the Great Ocean Department Store, the types and characteristics of human trajectories in large-scale integrated shopping malls can be summarized as follows (Table1):

Table1 The types and characteristics of human trajectories in large-scale Integrated shopping malls*

| the types of human trajectories | Characteristics |
|---------------------------------|----------------|
| outer-ring type                 | Circle around the outermost corridor of the mall for a week |
| O-type                          | Surrounding any non-outermost corridor of the mall, and the path forms an obvious O-type single ring back to the origin into a small ring |
| 8-type                          | Surrounding any non-outermost corridor of the mall, and the path forms an obvious 8-type double ring back to the origin into a small ring |
| L-shaped                        | The human trajectories is L-shaped |
| C-shaped                        | The human trajectories is C-shaped |
| S-shaped                        | The human trajectories is S-shaped |
| W-shaped                        | The human trajectories is W-shaped |

*Source: Author plotted

The ideal human trajectories belonging to the outer-ring type can be simplified as the model shown in Figure 7, namely, consumers, after entering a certain layer from the transportation hubs, circle around this layer along the peripheral stores and finally leave it from their starting positions. For trajectories belonging to this type, stores located in the outer ring can be easily seen by consumers, where they make some purchases; while those centrally located are easy to be ignored. Trajectories belonging to this type mostly occur in plane layouts with a clear peripheral line and less turnoffs.

The ideal human trajectories belonging to the inner-ring type can be divided into type 0 and type 8. The type 0 trajectories can be simplified as the model shown in Figure 8, namely, consumers, after entering a certain layer from the transportation hubs, circle around this layer along the stores centrally located and finally leave it from their starting positions. The type 8 trajectories can be simplified as the model shown in Figure 9. Similar to type 0 trajectories, these trajectories also form a circle along the stores centrally located; while the difference is that they form more than two inner rings along multiple
stores centrally located. For trajectories belonging to the two types, the consumption behaviors mostly occur in store groups along the way. And most of these trajectories occur in planes where gather numerous store groups and consumption points and the consumers tend to be guided to walk in a circle.

The basic models of human trajectories belonging to the linear type can be divided into four types: L-shaped, C-shaped, S-shaped and W-shaped. These trajectories can be simplified as models shown in the above figure (Figure 10—13). L-shaped trajectories belong to the simplest linear type; while C-shaped and S-shaped trajectories, actually, are complicated variant forms of the L-shaped ones. Both C-shaped and S-shaped trajectories have a tendency to form circles. However, they are distinguished from trajectories belonging to type 0 and type 8 for failure in forming circles. W-shaped trajectories, in essence, are the linear trajectories with repeated paths. Human trajectories belonging to the linear type can be found in plane layouts of all forms and have various forms. There are many other complex models besides the four typical trajectories mentioned above.

4. Conclusion and suggestion
In terms of the dynamic line and layout design inside large-scale integrated shopping malls, we wish to make the following proposals:

First of all, it is suggested that attention should be paid to the arrangement of stores situated in the outer ring in large-scale integrated shopping malls, which is helpful in guiding the circular dynamic line, helping consumers perceive their locations and proving them with a comfortable shopping experience.

Secondly, it is suggested to reduce the number of stores centrally located and establish atrium in
large-scale integrated shopping malls. Stores centrally located are easily forgotten in terms of human trajectories at the same layer, where the consumers are less likely to stay. At the same time, consumers, by force of habit, may not choose stores situated centrally as the starting point of their shopping routes. What’s more, corridors crisscross these stores and the road is also not smooth and easily repeatable, making consumer feel puzzled about their positions and giving them terrible experience.

Finally, it is suggested that the sale and discount areas be arranged near the transport hub in large-scale integrated shopping malls. Generally, stores having a good geographical location is liable to arouse consumers’ concern, while the amount of their residence time depends on how much the goods provided by a certain store attracts the consumers. The sale and discount areas, with special promotional characteristics, can always prompt consumers to stay longer and motivate them into consumption.

References
[1]Bacon, E. N. (2003) Design of Cities. China Architecture & Building Press, Beijing.
[2]Zhuang, W. (2001) Introduction to Architectural Planning. China Water & Power Press, Beijing.
[3]Jacobs, J. (1992). The Death and life of great American cities. Vintage Books.
[4]Moughtin, J. C. (1999). Urban design: street and square. Urban design: street and square. Architectural Press.
[5]Gehl, J. (2006). Life Between Buildings. VAN Nosrand Reinhold.
[6]Venturi, R. (1965). Complexity and contradiction in architecture: selections from a forthcoming book. Perspecta, 9, 17.
[7]Zhu, Z. (2012) E. N. (2003) The configuration principle of Aldo Fan Aick. Journal of Human Settlements in West China, 2:3-8 (Chinese).
[8]Li Y. (1980). Portman's "shared space". Journal of Architecture(6).65-70.(Chinese)
[9]Solomon, M. R. (2012). Comportamiento del consumidor (sustituye a 9789702610861).
[10]Zhuang, W. (2001) Introduction to Architectural Planning. China Water & Power Press, Beijing. (Chinese)