THE CODE OF MANZANA: INVARIABILITY, SIMPLICITY AND CHANGEABILITY

Zhang Liang, Xu Guangyao, Zhang Yanying,
Department of Architecture, Zhejiang University, Hangzhou, China
Director: Prof. Hou Deqian
Mail: 601179998@qq.com
       395311856@qq.com
       493798416@qq.com

ABSTRACT

Originally, City is an enormous and intricate system. However, Cerdá simplified the complicated system into a basic unit, the Manzana, which is the unique code belonging to Barcelona found by Cerdá and based on his analysis to the history of the city, life of its citizens, and some other cases. Being at the core of Barcelona Eixample plan, it gradually formulates the enormous city system of Barcelona and thus paves the way for its future development. Starting with the rules of Invariability, Simplicity and Changeability, the three principles in Yi, this thesis regards the Manzana as a Yin-Yang body, with Yin and Yang power complementing and coexisting with each other. By restoring the codes hidden behind the 550 Manzanas in Barcelona, the thesis tries to explore the common ground between the physical space of the city and the binary life of the people living in it.

Key words: Manzana, Principles in Yi, Changes between Yin and Yang, City
Barcelona, the capital of Catalonia in Spain, has a population of 4.2 million and covers an area of 3200 square kilometers. It is mainly composed of two parts, Ciutat Vella and Eixample. In the mid-19th century, the Eixample designed by Cerdá determined the city layout of Barcelona and continuously serves to be the guideline of its urban development over 150 years. It impresses every visitor going there with its clear and regular road system and its unique multi-level, high-density pattern of neighborhood. Eixample and Ciutat Vella, which boasts a long history, combine to create an urban environment full of vitality and cultural atmosphere in Barcelona today.

1. The Eixample’s plan

Comparing the achievement of Barcelona today with the city Cerdá faced when he began the new town planning 150 years ago, we can be more comprehensive understanding the greatness of the Eixample’s plan.

In the beginning of Cerdá’s planning, the limited city town could not meet the boosting life demands of the increasing population. In the process of industrialization, a large number of migrant workers had flooded into the Medieval town, causing a tremendous decrease in the city’s living standards. As early as 1753, the project of Barceloneta new city had tried to solve this conflict, in fact it did not help much.

Faced with such an unhygienic city with bad living conditions, Cerdá, instead of eliminating the old town, had decided to keep it with its original historical value, which had contained the citizens’ collective city memory. In Cerdá’s eyes, the new town and the old town had their respective historical duties. The old town should not impede the development of the new district, while the plan of the new town should also catch up with new industrial civilization and the development of the times, that is, it should meet the needs of both the citizens and the new age.

Ultimately, challenging the layout of a traditional city, Cerdá’s planning offered a new town that directly faced the old town: Grids made of geometrical shapes ensured a more hygienic city, while wider streets which acted as passages of air and traffic circulation could receive plenty of sunshine. This blueprint also facilitated the installation of sewage treatment systems and other service systems.

In the Eixample planned by Cerdá, one most important feature is the regular square-grid road pattern, which is called “Golden Manzana” and forms the multi-level urban space in Barcelona and contributes to its people’s colorful life. By employing the three principles of Invaribility, Simplicity and Changeability in oriental Yi theory to interpret the Manzana codes in Cerdá’s Eixample design and explore how to construct various cities out of limited units, the oriental philosophical thoughts are put in touch with occidental ideas of city layout directly, providing us for a new view for Barcelona and its urban planning.

2. Three Principles in Yi

As a source of Chinese culture, Yi theory shows quite a universal value. It deals with all the laws concerning the birth and development of the universe. The core idea of Yi can be concluded as the theory of Yin-Yang, according to which, everything in the world has two opposite sides, that is, Yin and Yang, opposite and yet
complementary to each other. According to Yi theory, the three principles—Invariability, Simplicity and Changeability, serve to be the fundamental power maintaining the circulation of the universe, and meanwhile reveal nature’s law of function and evolution, inspiring orientals on their knowledge of the universe.

2.1 Invariability

Invariability refers to the truth that despite all other things are changing anytime and anywhere, there is a permanently stable one, from which all other things derive. It can be said to be the premise of the universe’s development. But what is the one? We call it Tao in Tao Te Ching written by Lao Tsu.

And what is Tao? Alternating between Yin and Yang is called Tao. Religious people name the one “God”, “Master” or "Buddha". Philosophers call it “Ontology”, while scientists call it “Function”. Anyway, name makes little difference. Everything changes, but the one remains the same.

2.2 Simplicity

An old Chinese saying goes like that things remain essentially the same despite all apparent changes. The “same” here refers to the objective and purpose. The whole sentence means that even though the things in the world are complicated and changeable enough, their nature or aim keeps the same. Similarly, the principle of Simplicity in Yi theory profoundly reveals the underlying meaning of this sentence. It says that no matter how mysterious the universe is, it appears to be plain and ordinary after people living in it get quite a lot of knowledge and thus have a better understanding of it. We take the world to be intricate and tangled for we do not know the underlying rules of it, which is, in fact, simple and fundamental. This is also the essential truth of Simplicity principle in Yi theory. Therefore, when dealing with an intricate problem, we need to find the core idea underlying it step by step so as to adapt ourselves to any difficult conditions we may meet in future.

2.3 Changeability

Changeability presented in Yi theory indicates that nothing in the world would keep the same, including living beings, thoughts, conditions, behaviors, buildings, affairs and so on. In other words, nothing is in a static state. Everything must change. The thing happened last second may be totally different next second. People’s feelings or moods change with that of time and environments. For Wise men or great works, if they do not want to fall into the obscurity of history, they have to swim with time and space, be sensitive enough to catch the wind of change and meanwhile adapt themselves to it.

The three principles in Yi help us to gain a correct view and understanding toward things in the world and distinguish their appearances from their nature. It happens that the three principles have certain relationship with the street blocks in Barcelona designed by Cerdá. Thereby, we employ the principles in Yi to decode the Manzana.

3. Magic of Manzana: the Invariable Scale

In Spanish, “street blocks” are represented by the word “Manzana”, which also has the meaning of “apple”. Apple is not standard in its shape as a cube, for the lack of four sharp edges.
Cerdá made a bold and abstract attempt in designing Barcelona city. He took a "Manzana" as a basic block and then repeated it in large amounts until the city had completed. Benefiting from unfixed boundary of Manzana, these street blocks could extend their edges with the passing time so as to adapt to the process of urban expansion and change. Each Manzana was fixed in their side length which was equal to the width of its streets around the corner. In this way, Cerdá turned a four square block into an eight square one with four angles of 45 degrees in cutting the bevel edge. And meanwhile he saved a place for the design of a courtyard in the Manzana, whose shape was similar to an apple without core. Coincidentally, the shape of the Manzana was quite similar to that of Eight Trigrams presented in Yi theory which was the eight combinations of three whole or broken lines formerly used in divination. Perhaps this was the subconscious agreement between western thoughts and eastern ideas (Pic 1, 2).

(Pic 1) (Image source: Barcelona the urban evolution of a compact city)
(Pic 2) (Image source: http://wenda.chinabaike.com/z/shenghuo/20131222/721686.html)

Every Manzana was designed in accordance with the mathematical rule in a strict way. The length of every single side was 113m and that of the hypotenuse of the corner was 20m. One side along the street was 85m. Besides, each block had a square courtyard with 50mx50m. Meanwhile, in order to ensure good ventilation and lighting to courtyard, Cerdá set a rule that buildings located within the Manzana should not be over 16m in their height and be no more than 5 stories. Road was basically 20m wide, in which the pavement and roadway was 10m wide respectively. In a word, all of these scales set for buildings and streets were quite comfortable for residents in the city (Pic 3,4).
It is deserved to be mentioned that the street size of Eixample was designed according to the turning radius of rail transit. The idea of planning the rail transportation in internal structure of city came from Cerdá’s background of railway construction studying. He knew the steam technology very well and thought that application of steam tools into production would benefit residents in their trips and perhaps would brought fundamental changes to transportation. Of course, the scene he imagined that trains went through the road freely was eventually replaced by that of motor traffic. Anyway, we can conclude that Cerdá was well prepared for the city planning and designed amounts of details to make his ideas come true in three-dimensional level. Cerdá’s style in city designing can be traced from today’s Barcelona city in terms of the plane function, the height of section and the street size of it. Hence, unlike the general urban planning which only concentrated on the design of the plot of two-dimensional area and function, Cerdá’s design can usher the development of the whole city in the future (Pic 5).
It can be drawn that Cerdá means to make such an eight-side shape and its copies, which distribute in the Eixample area equally, become part of the city. The Manzana, like the city’s cells, reproducing and generating unlimitedly, shows that an ideal society where people enjoy equal living conditions is urgently needed. According to Yi theory, however, these invariant value and fixed units serve to be the foundation of various and abundant city space in Cerdá’s planning. These simple units, working in groups repeatedly in a certain form, evolve into a complicated city system and generated specific plan, height and space atmosphere as time going on. Although the surrounding circumstances have been constantly changing, the basic rule always remains the same, which exactly conforms to the principle of Invariability in Yi theory. Based on a large number of investigations on the residents’ lives, plenty of studying on Barcelona’s history, comparison among an abundance of successful cases and personal experiences, Cerdá managed to make much sense of the results produced by Invariability principle of Yi theory applying in city planning.

4. Symbiosis of Yin and Yang in Manzana: the Simple Image

The common units of grid square city are tetragon, while in Cerdá’s Eixample plan, city blocks are shaped as octagon which are called Manzana, with empty space inside and open street space outside. What Manzana presents is a simple graphic image with virtuality and reality interacting with each other. The seemingly simple ways of space subtraction and figure-ground relation entail the principles presented in Yi about the complementary, interconvertible and symbiotic management of Yin and Yang. The buildings and courtyards inside form a space where virtuality and reality co-existing. The open street space and the building volumes along the Manzana establish a new topological relationship of Yin and Yang. Moreover, the Manzana’s 45 degree chamfers of four angles change the original outer street space of negative Yin attributes into a positive space of Yang attributes.

4.1 Courtyard and Building

Inside each Manzana, there is a 50-meter-long courtyard, which provides adequate light and sunshine as well as good ventilation for all the residents living in the Manzana. Every family owns a natural space which makes it possible for them to live in the city while enjoy the countryside life with close contact to nature (Pic 6).
Judging from the physical space of the city, within a Manzana, buildings are solid volumes of Yang attributes, while the inner courtyards are incorporeal space of Yin attributes. And within the inner courtyard, facilities and structures of landscape are corporeal objects of Yang attributes, while the grass land and pools are of Yin attributes. However, in terms of people’s behaviors and activities, the space inside buildings allows for private and personal life at home and thus should be classified as a negative space of Yin attributes. Meanwhile, the courtyards provide residents with a space for outdoor activities and communication, being open and public-oriented, and thus belong to positive Yang attributes (Pic 7).

Therefore, the peculiarities of Yin and Yang in space can reach a state of coexistence and intergrowth resulting from interaction and interconversion under different dimensions of time and people’s activities.
4.2 Open Street and Building Enclosure

Although each Manzana is enclosed by buildings leaving the courtyard space right in the middle, leading to a basic spatial structure with Yin attributes inside and Yang attributes outside, not all Manzanas are enclosed all around. Instead, according to different needs and conditions of different blocks, some Manzanas are constructed based on 2 or 3 already existed streets by designing 5-story strips of buildings to form a eight-side shape. In Cerdá’s Barcelona Eixample plan, there are basically four major types of Manzanas, which are three-side enclosure of U-shaped, two-side enclosure in parallel way along the street, two-side enclosure of L-shaped and two-side enclosure in parallel way in the center of the unit (Pic 8). The combination of these four prototypes acts as the original code of various spaces in Barcelona in Cerdá’s Eixample plan (Pic 9).

By properly handling the layout of building enclosure and open street space along the street, Cerdá’s Barcelona Eixample plan makes the introverted courtyard space open to the urban public space, bridging the gap between home life and public city life. The Yin space and Yang space of buildings and courtyards match with each other and ascend to a state of interaction and symbiosis (Pic 10,11).

(Pic 8) (Image source: Owner-drawing)

(Pic 9) (Image source: Owner-drawing)

(Pic 10) (Image source: Barcelona: the transformation of urban form)

(Pic 11) (Image source: Cerdá Planning beyond the urban)
4.3 45 Degree Chamfer
On the basis of tetragonal unit in common grid square city, Cerdá cut four corners off the tetragonal unit into 45 degree chamfers, with the chamfer length of the hypotenuse being equal to the width of the street. In this way, a tetragonal unit becomes a Manzana. Meanwhile, the intersections of the streets are enlarged, which greatly reduces the congestion situation occurred at the crossing. What's more, the blind spots caused by the right angle of buildings near the crossing have been eliminated because of the hypotenuse in 45 degree chamfer, which makes citizens live a safer and more convenient life (Pic 12,13). Every four Manzanas in adjacent position combine together and form another active space for residents to rest, stay and communicate with each other, in every 113 meters of walking. Believing that the intersections of roads would be ideal places for citizens to get together, Cerdá plans to build some pavilions there for people to hold activities. (Pic 14,15).

The intensive orthogonal road transportation system offers a variety of convenient paths, which will help to ease the traffic pressure of main roads. The public activities on streets and the semi-public activities held in the courtyards of Manzana coexist at the same time, contributing to the vitality of the city. The open courtyards and the central street parks serve to be links among Manzanas, blocks and streets, with the Yin and Yang attribute of these spaces interacting and interconverting according to man’s activities.
4.4 Symbiotic Image of Yin and Yang

Through the above analysis of the attributes of inside and outside spaces in Manzana, we may understand the relationship between Manzana and Yin-Yang in a graphical form. The building volumes around the Manzana and the courtyard inside it set up a binary spatial pattern which has the attribute of Yin inside and the attribute of Yang outside. However, such spatial pattern of Yin-Yang is just like a Tai Chi diagram with no fish-eye in it. Though it has Yin and Yang attributes apparently, it is still and monotonous. Actually, in Tai Chi diagram and the original oriental opinion, there always exists something of Yin in Yang attribute and something of Yang in Yin attribute.

Thus, the process of opening at least one side of Manzana to the public and cutting off four corners of the square by Cerdá can be understood as putting the virtual space of yin attribute into the original real space of yang attribute. It’s just like the appearance of fish-eye in the Tai Chi diagram. In this way, we get to understand why the Tai Chi diagram of Yin-Yang is a dynamic figure, and how it keeps moving and changing all the time.

Originally, there exist Yin and Yang attributes in Yang and Yin themselves, which means it must have the Yin attribute in something of Yang itself and the Yang attribute in something of Yin itself. When the internal cause in the original Yin and Yang grows and expands, it will devour the original structure of Yin and Yang, and get into a new balance. The conversion of Yin and Yang completes and the original fish-eye is regenerated by the new one, which will be the new internal cause in this structure. Again and again, the circulation never stops so that the Tai Chi diagram keeps moving all the time. The truth in it is the coexistence, interaction, interconversion and circulation between Yin and Yang, which is a basic law accounting for the Changeability of everything in the universe (Pic 16).

(Pic 16) (Image source: Chen Lin “the thinking about Tai Chi diagram” “decoration” the second issue in 2006)
As a matter of fact, the Manzana itself is a Yin-Yang body, with the courtyard inside it, buildings around it and streets outside it all constantly making conversion between Yin and Yang attribute. Manzana’s open interfaces to the public and central street parks act as carriers in the process of conversion between Yin and Yang in the city space of Barcelona, while citizens’ private life at home and public activities outside serve to be the basis of it. Barcelona finally becomes an ideal city where a variety of activities are held with Yin and Yang in a balanced state (Pic 17,18).

(Pic 17) (Image source: Owner-drawing)
5. Permutation and Combination of Manzana: the Easy Order of Yi

Yin and Yang attributes of urban space interact, interconvert and coexist in different dimensions of time, space and human activities. Due to the conversion between Yin and Yang attributes of the internal and external space in Manzana, as well as the combination of different Manzana units, spaces of different attributes, corresponding to different city lives, are created. These spaces, activities and their attributes keep changing at every moment, leading to an equal and balanced city.

5.1 Block Combination Design

Although width of the streets and height of the buildings are limited in Cerdá’s Barcelona Eixample plan, patterns of the city’s space are somewhat abundant. Each Manzana only has 2 or 3 building volumes existing on its boundaries, which means that there is at least one direction open to the public. At the same time, locations of building volumes and ways of their enclosure are both varied. What’s more, the location and layout of public green parks in each block are different too. Usually they are surrounded by 8 Manzanas which vary from each other, so the combination of Manzanas and public spaces will be in various ways. There are public facilities in the center of each block, such as school, hospital, museum, church and so on, which can be shared by the citizens in the nearby 25 Manzanas. As to the remaining space, it will be for city gardens’ use.

Therefore, from the two variations—building enclosure and open space of the city—derive various ways of permutation and combination. The blocks or the city constituted by them are quite flexible and diverse in space use, avoiding dullness, lifelessness and sameness in city design. Under the guideship of Changeability in Yi theory, the city develops in a healthy and positive way (Pic 19, 20).

Therefore, the grid square city in Cerdá’s Barcelona Eixample plan is not just to divide the land parcel into same sized squares by roads or streets in a simple, mechanical and two-dimensional way. Also, after the segmentation of land, it’s not just to sell land to different land agents to construct all sorts of strange buildings in various sizes and different forms. Instead, Cerdá’s Eixample plan is the result of a careful and comprehensive consideration based on a three-dimensional space (Pic 21).
5.2 Blocks and Center of the Streets

For their different ways of building enclosure and flexible arrangements of courtyard space, adjacent Manzanas group together to form more diversified structures of city space. At the same time, the junction of two streets sandwiched between four neighboring Manzanas shows a similar shape to Manzana because of the 45 degree chamfer of four neighboring Manzanas around the crossing center, with its interior design as various and flexible as that of Mazana. Following the same isomorphic order between Yin and Yang, they achieve the same effect in spatial design. We call the space of central street parks “empty Manzana”, while the original Manzana “solid Manzana”. These “empty Manzanas” and “solid Manzanas” locate alternately, being the basic urban texture of Barcelona as well as the most outstanding feature of it. They act as platforms of citizens’ daily life and communication (Pic 22).

We will give a simple example in order to get a more intuitive and better understanding of the interacting relationship between Yin and Yang reflected in the “empty Manzanas” (central street park) and the “solid
Manzanas” (unit of the block). As the below figure shows, we presuppose a citizen’s walking route from point A where locates the apartment he lives to point B where lies an urban public green field. We can see that, along this route, the citizen need to walk through the courtyard of Manzana, go across the street, and then pass by several Manzanas and through the courtyard again, and finally reach the public green field. The Yin and Yang attributes of the spaces he goes through interconvert constantly with his changing behaviors and activities. Meanwhile, along the walking route, there is an open space for stay and rest almost every one hundred meters long so that he can help himself to choose a place to refresh himself, with each resting place being comfortable enough to relax and delight him. At last, this man walks from his apartment to the public green field, finishing his transporation from private activities of Yin attribute at home to open activities of Yang attribute held in the public park (Pic 23).

6. From Yin and Yang to Variety: From Manzana to Barcelona

Although there are three principles in Yi theory, these three come to one actually, with Simplicity coming with Changeability, and Changeability with Invariability. Following the basic law of the complementary combination of Yin and Yang, the Manzanas in the city layout of Barcelona develop into all kinds of physical spaces and make colorful activities become possible, all of which depend on the fundamental scale of Invariability, saying “the three principles come to the one Tai Chi”. Yi theory says that Yi has Tai Chi, which evolves into Yin and Yang, and Yin and Yang further evolve into four symbols, and four symbols further evolve into eight trigrams. This is the Tao in Yi theory accounting for the phenomenon that everything in the universe comes from Yin and Yang.

6.1 Tai Chi & Manzana

Tai Chi, as an object we observe, comes to be the first in Yi’s viewpoints to the world. This object is a unity of opposites, which is constant and stable in nature, and only being of this kind of nature, can it be called “Tai
Chi”. The Manzana element in Barcelona is the object we observe in this research and is believed to be the Tai Chi in Barcelona urban planning. It is the core of the city as a whole.

6.2 Yin and Yang & Manzana

When analyzing the inner world of Tai Chi, we can trace two powers going against with and yet complementary to each other so as to keep the Tai Chi in a stable and constant state. The two powers are known as Yin and Yang. The basic spatial structure of Manzana—Yin attributes inside and Yang attributes outside—stand for Yin and Yang, which combine together to create a space where Yin and Yang power interacting with each other and residents live their daily lives.

6.3 Four Symbols & Manzana

Yin and Yang is not a terminal. Actually, it can be further divided into four symbols, which is a conception for further study of Yin and Yang. Yin and Yang are more of a spatial concept, while the four symbols derived from Yin and Yang take both space and time into account. Yin and Yang just show the relationship of binary opposition and unification between two things or within a thing itself, while the four symbols tell the whole process of a thing’s going from the very beginning to the very end. That is to say, not only the present but also the past and the future are kept alive in the four symbols.

When it comes to the Manzana of Barcelona city, the various ways of courtyards’ opening to the outside world and the design of 45 degree chamfer make it take on various forms, and this is the so called “four symbols”. To design a Manzana in a more advanced way, the space and activities inside it are not the only factors that should be taken into consideration. The integration of the Manzana and its neighboring Manzanas as well as the open space among them turns out to be quite important, which is the first step from Manzanas to a city.

6.4 Eight Trigrams & Manzana

Eight trigrams is a conception similar to “category” or “collection”. Hence, it would not be concrete in its sense. In fact, it is only a notion used to catch the general characteristics of some things. According to Yi, there are both common senses and differences among objects, and the former makes objects group together to be categories while the latter makes them classified into different ones. Object and category are two relative conceptions. Things get together because they are of the same category; get separated, of different category. Category can be seen as images, which are represented by eight trigrams.

In Barcelona urban planning, according to the needs and conditions of different spaces, and centering on several urban green lands of different themes, Manzanas group together to form different geographical patches of the city. In this case, the Manzana play the role of object and the blocks can be regarded as category. Objects of the same category group together, which is where the truth of eight trigrams lies. And all of these go to an organic city as a whole finally, which is equal to the concept “everything” in the context of Yi.

6.5 City & Manzana

Originally, City is an enormous and intricate system. However, Cerdá simplified the complicated system into a
basic unit, the Manzana, which is a compact city, also an invariable rule. Nevertheless, the elements of this rule are flexible and changeable enough to construct a complicated, adaptable and dynamic city through various ways of permutation and combination.

Manzanas flock together to form blocks; blocks group together to form communities, which further assemble to form urban areas, with a city as a whole being the final product. In this process, the Tao of Yin and Yang permeates all the way. As a result, Barcelona, on the one hand, takes on a balanced and harmonious city appearance, and on the other hand, shows a changeable and multilayered landscape, which is a good case of the use of eastern philosophy “from one to all” in western urban planning. We can consider the Manzana both as a compact city and as a basic unit of a city. In this way, we can say that the Manzana is “too large to expand and too small to compact”, which is the real connotation of the principles in Yi (Pic 24,25, 26).

(Pic 24) (Image source: Owner-drawing)
References

Monographs:

Journal Articles:
[4]. Wu Shensui & Meng Qiuyue, “The Study on *Book of Changes* and the Tao Te Ching”, [Baidu library]
[6]. Chen Mingshao, “Study on the Origin, Connotation and Time Background of *Book of Changes*”, [Culture Survey]
[8]. Huang Ji “The Thinking and System of Cerdá’s Barcelona Eixample Plan” [Degree Thesis]—Master’s degree thesis of Zhejiang University, 2012(3)
[12]. Gai Shijie & Dai Linlin “Analysis on the City Street of ‘Barcelona Model’— Take Las Ramblas for Example”, [Chinese and Overseas Architecture], 2009(1)
[15]. February 1974, Cerda, a past as a future, N0.100. Cuadernos de Arquitectura y Urbanismo (special edition)
[18]. De Sola-Morales, M, 2010, Cerda/Finsanche, Edicions UPC, Barcelona (Spanish/English text)