

Research on One of Topological Structures of Pictographic Characters

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Abstract—Closed curve is proved to be a topological structure of pictographic characters in topological language and also proved to be the essence and constant factor in the evolution of shape and structure of Chinese characters by some examples in this paper. Therefore, as the invariant in the evolution of shapes and structures of pictographic characters, closed curve should come down and can be used in font or graphic design.

Keywords—Chinese character; Closed curve; Oracle bone script; Bronze script; Small seal script; Clerical script

I. INTRODUCTION

Chinese characters, as the only pictographic character still popular today, must contain some very vital elements. In order to explore these valuable elements, this paper mainly studies and analyzes the evolution of shapes and structures of the most representative pictographs in Chinese characters. The time span of the study object was limited in the period of oracle bone, bronze, small seal and clerical script.

The early Chinese characters have a certain relationship with pictorial characters. Pictorial characters use images, positions, relations and auxiliary lines to show the things and intentions. Those are where ancient Chinese characters are drawn, and are represented by various simplified “graphics”. Among them, the graphics of objects constitute the pictographic characters, the graphics of events constitute the characters for things and the symbolic ones constitute the characters for meaning [1]. Although we can't simply call Chinese characters pictorial characters, in the evolution of shapes and structures of Chinese characters, oracle bone, bronze, small seal and clerical script has always retained a certain pictographic elements and uses lines to express meanings. In addition, Mr. Chan in his book *The Origin And Principle of Chinese Characters* stated: “the most of basic pictographs, in oracle bone and bronze script, are almost pure pictures, but in the evolution of large seal, small seal, clerical and regular script, the distortion has happened, the pictographic features have reduced and symbolic nature has shown [2][1].” Therefore, in order to express clearly, in Chinese characters, the early pictographic characters (mainly refer to the characters of oracle bone script and bronze script) and the characters developed from them are called pictographic characters. The specific shapes and structures of pictographic characters of oracle bone and bronze script are called pictographic figures, and this period is called pictographic figure period. For small seal and clerical script, because their

distortions has happened, pictographic features have reduced and symbolic nature has shown, the specific shapes and structures are called pictographic symbols and this period is called pictographic symbol period. Pictographic characters are the main research objects in the paper.

Through the analysis and study of shapes and structures of pictographic characters in those two periods, we find that, in their evolution process, some of them have essential factors which have no or very little change. These factors make them always mean the same things.

Topology is a subject that studies the unchanged nature of shapes under the continuous variations. Some essential graphical factors in the evolution of pictographic characters also have happened to conform to the topological transformation rules.

At the same time, the shapes and structures of pictographic characters are composed of strokes, which can also be regarded as lines or curves. Therefore, the paper introduces topological theory to analyze and study the evolution of shapes and structures of pictographic characters, so as to obtain the changing rules. And we use the mathematical definition of topological transformation to describe the evolution. Due to the extent of the paper, we only talk about one unchanging essential graphical factor in the evolution of pictographic characters: closed curves.

II. CLOSED CURVE AND TOPOLOGICAL TRANSFORMATION RULES

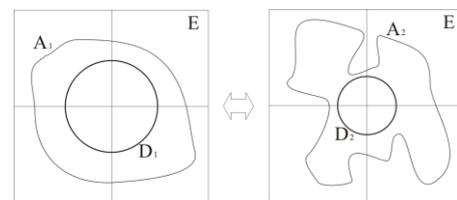


Fig. 1 Curves A_1 and A_2 homeomorphism [3]

In topology, the topological property reflects features of the shapes on the whole structure. If you don't take shapes apart and adhere together, they can be freely deformed (such as shrinkage, tension or bending, etc.) and the whole structure would not be destroyed. It means that their topological properties will remain unchanged, and we call the deformation process as topological transformation. The properties that

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shapes remain the same after the topological transformation happened are the topological properties^[4]. In topology, all shapes derived from topological transformation are called homeomorphisms. The essence of homomorphism is that the shapes obtained by topological transformation can be changed back to the original shape by reverse transformation.

As shown in fig.1, E is Euclidean plane (because pictographic characters mainly appear in plane media, so we choose Euclidean plane curves as the research objects). Curves D_1, D_2 are the boundary of the closed disk, and curves A_1, A_2 are curves obtained by shrinkage, stretching or bending of curves D_1, D_2 respectively. Obviously, curve A_1 can be obtained by stretching and bending curve D_1 , so curves A_1 and D_1 are homeomorphisms, and the transformation is topological. Curve D_1 can be obtained by shrinking and bending backwards curve A_1 . Similarly, curves A_2 and D_2 are homeomorphisms and their transformation is topological. Curves D_1, D_2 are the boundary of the closed disk and homeomorphisms, and the transformation is topological. So let's call curves A_1, A_2 homeomorphisms, and the transformation is topological. Here we call curves A_1, A_2 closed curves.

The above description indicates that the transformation between any two closed curves is topological transformation and they are homeomorphisms. In other words, we can do any shrinkage, tension or bending to a circular rubber band, as long as no coincidence point come out, and the process of deformation is topological transformation, during which all shapes happened are homeomorphisms. On the other hand, as shown in fig.2.1 and 2.3, in the process of deformation, the curve B adhered and the curve C fractured, so the two curves are different from the curve D_1 in fig.2.2, and the three curves are not homeomorphisms.

It is said in the Chinese translated edition of *Rambling Topology*^[5], written by Soviet Polchinski, etc., "if consider the Russian alphabet constituted by curves, letters III and E are homeomorphisms, and letter O, a closed curve, is different from other Russian letters, such as letters III and E, and to be no homeomorphism with them." It means characters also can be studied by topological theory for the authors. The paper has the same opinion and thinks that Chinese characters with pictographic elements also can be seen as a figure constituted by curves. And maybe because of the complex structure and connotation of Chinese characters, the research of their topological structures will be more valuable than that of alphabetic characters.

So, the whole meaning of the topological theory talked above combined with the form of pictographic characters, can be understand as the following: in the evolution of shapes and structures of pictographic characters, closed curves as essential graphical factors of pictographic characters when making form changes that does not change its closed curve characteristic, the deformations of them can be seen as topological transformations. In the evolution of pictographic characters, if the deformation of the closed curve belongs to topological transformation, it can be seen as a topological structure, and also as a kind of "invariant" in their shapes and structures. This

kind of topological structure or "invariant" is of great importance to the evolution of pictographic characters.

III. TOPOLOGICAL TRANSFORMATION RULES OF CLOSED CURVE IN THE EVOLUTION OF SHAPES AND STRUCTURES IN PICTOGRAPHIC CHARACTERS

A. Closed curves as contour lines of pictographic characters

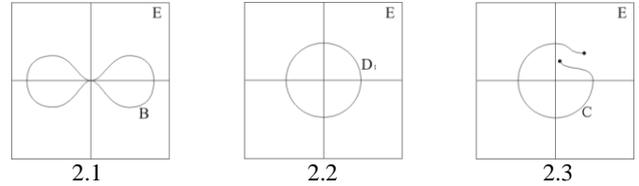


Fig. 2 Curves B, C and D1 are not homeomorphisms

There are many pictographic characters that have closed curves as their contour lines. Here only two representative groups of pictographic characters are selected for the analysis and research. In the paper, the bodies of the pictographic characters are shown in gray, and as topological structure, closed curves are shown in black lines. When the Chinese character shows for the first time, the English meaning of it is showed in the brackets behind.

1) The evolution of shapes and structures of the pictographic character "日(sun)"



3.0: the image of "日"



3.1: oracle bone 3.2: bronze 3.3: small seal 3.4: clerical

Fig. 3 The evolution and topology structure analysis of the pictographic character "日"^{[6][8]}

The character in fig.3.1 is oracle bone script "日", which is generally regarded as a typical pictographic character. However, compared with the real object (sun) for which the pictographic character "日" is represented, it is believed that the above one of fig.3.0 is the real image of "日" or "sun", which can be seen from the compound characters in oracle bone and bronze script^{[2][123]}. As a self-explanatory character, the oracle bone script "日" in fig.3.1 has an extra indicative dot compared with that in fig.3.0^{[2][116]}. No matter "日" is a self-explanatory or pictographic character, they are all based on the pictograph, extracted the essence of sun, and shown in the most simple shapes and structures to express the meaning. So, we call the image of "日" as the pictographic figure. Observing evolution of shapes and structures of "日" from oracle bone and bronze script in the pictographic figure period to small seal and clerical script in the pictographic symbol

period, great changes have taken place. The contour lines changed from a circle into a box, and a center point into a short horizontal line. First of all, our research objects are the pictographic elements in the evolution of shapes and structures of pictographic characters. So, the indicative dot is not our research object. Second, the contour line of “日”, closed curve, has changed from round to square, when it develops from oracle bone script to bronze script, to small seal script and to clerical script. And the deformation of it is belonged to topological transformation (the principle is proved in the first section).

It can also be understood that, as the pictographic feature of sun, the closed curve, has been come down from pictographic figure period to pictographic symbol period. Therefore, the paper argues that the evolution of shapes and structures of “日” follows the topological transformation rules, closed curve is the topological structure in the evolution, and it also is the pictographic feature of “日”.

Now, we may speculate that closed curve also can be an important topological structure of pictographic characters and an important “invariant” in the evolution of their shapes and structures. In order to prove this point accurately, the evolution of the pictographic character “身(body)” are analyzed as following.

2) *The evolution of shapes and structures of the pictographic character “身(body)”*



4.1: oracle bone 4.2: bronze 4.3: small seal 4.4: clerical

Fig. 4 The evolution and topology structure analysis of the pictographic character “身” [6]225

According to Paraphrasing Letters and Characters (Shuo Wen Jie Zi), the pictographic character “身” originates from the body shape of a pregnant woman. As shown in fig.4.1, the oracle bone script “身” expresses the fact of pregnancy with a closed curve. In order to be more conspicuous, the bronze script “身” was developed, and an indicative dot was added to the closed curve for emphasizing. In the later pictographic symbol period, although the indicative dot of “身” evolves into a horizontal line, just like that of “日”, small seal and clerical script “身” still inherits the closed curve for pictographic meaning of pregnancy.

The pictographic character “身” evolves from a pictographic figure to a pictographic symbol, “the pictographic elements of small seal and clerical script have become more and more distortion, and the characters become symbols” [2]11. But the closed curve as the most important pictographic feature (raised abdomen of pregnant woman) is inherited. Now, as a symbol, although the character “身” has several meanings, the meaning of pregnant remains one of its connotation, such as the word “身孕” (pregnancy), or especially in some

dialects is expressed as “有身子” (have the body). So, the closed curve is a pictographic feature and the topological structure of “身” in the evolution, and has the meaning of pregnancy.

Thus, it can be confirmed that closed curve is topological structure of some pictographic characters and also an important “invariant” in the evolution of shapes and structures of some Chinese characters.

B Closed curves as no contour lines—the evolution of the shapes and structures of pictographic characters of “母” (mother) and “女” (female)

“母” and “女” of oracle bone script in fig.5.1 is an image of a woman with her crossed hands putting on the lap and her bottom sitting on the heels, (Japanese women, deeply influenced by Chinese culture, still use this kind of posture to sit, and call it seiza, which means proper or correct sitting). The crossed hands and the body together forms a closed curve. The difference between the two characters is that “母” uses two dots (not indicative dots, but pictographic features) to show conditions of the breasts of women giving birth to babies, the feeding breasts.

The closed curves of these two characters are quite different from those of “日” and “身” talked before. They do not come from the fixed contour lines of a thing, but from the closed curve formed by the temporary movement of human body. In pictographic characters, although this type of closed curve is relatively few, it also plays an important role in the evolution. In fig.5.2 and fig.5.3, bronze script and small seal script, the closed curves, formed by crossed hands and body together, as the topological structure, has been come down just fine. However, the closed curves of “母” and “女” in clerical of Qin have been transformed (as shown in fig.5.4), to be broken and no longer closed. But, the lower halves are closed and still can be seen as closed curves formed by crossed hands and body together. The really interesting thing is that the opened curve of “母” in clerical of Qin has been folded back to be a closed curve in the clerical of Han again and never opened (as shown in fig.5.5), while that is quite opposite for “女”, only the lower part of the closed curve kept after it opened in clerical of Qin.

The reason of the quite different changes of “母” and “女” in form lies in the pictographic meaning of the topological structures. The closed curve in pictographic character “母” expresses the double images of the crossed hands and the breasts which mean female and feeding at the same time. It is unable to express the both original meanings if the topological structure, the closed curve, is broken. It is necessary to keep the closed curve changed follow the topological transformation rule to come down the two pictographic meanings. In pictographic character “女”, the lower part of the closed curve is sufficient to express the crossed hands which represent the special female sit posture, seiza, and even female.

Nowadays, closed curve, as the topological structures of “母” and “女” at the same time but not the same type in a really ingenious way, expresses their subtle different meanings. As the scholar Chen wenmin said in *The Origin and Principle of Chinese Characters*, “pictographs are the soul of Chinese characters”^{[2]120}. Their pictographic figures are so close, but they both use different closed curves as topological structures in the evolution and continue to express each other's core pictographic meanings. Although the two closed curves are not the contour line in the characters, both are formed from images of the gestures. So, they are pictographic topological structures, the invariants of the evolution of shapes and structures of “母” and “女”, and the soul of the two characters, and should be come down in the evolution of the two pictographic characters.

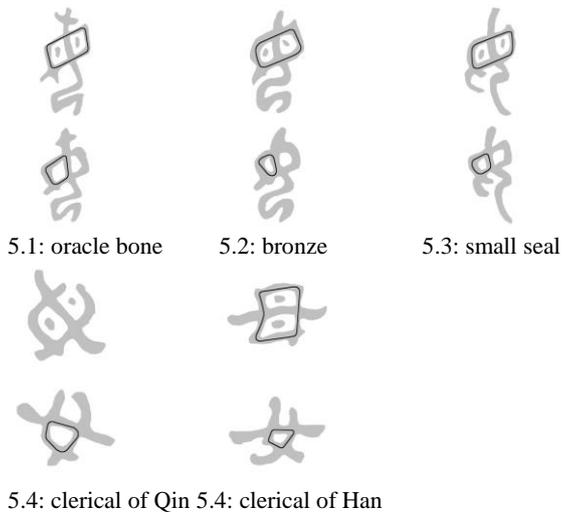


Fig.5 The evolution and topology structure analysis of the pictographic character “母” and “女”^{[7]105}

IV. THE APPLICATION OF TOPOLOGICAL TRANSFORMATION RULES OF CLOSED CURVE IN THE EVOLUTION OF PICTOGRAPHIC CHARACTERS “文”(LETTER) AND THE DESIGN OF THE EMBLEM OF 2008 OLYMPIC GAMES

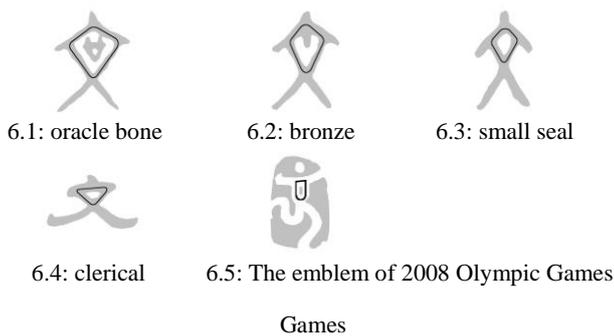


Fig.6 The evolution and topology structure analysis of the pictographic character “文”^{[7]165} and the topology structure of the pictographic character in the emblem of 2008 Olympic Games

As shown in fig.6.1, the oracle bone script of a pictographic character “文” is expressed by a human body

with opening arms and legs that seems ready and happy to accept the tattoo pattern in the middle of the chest (Tattoo has appeared in primitive society. Based on the primitive religious beliefs, tattoo is a symbol of honor which means wisdom, courage, or adult, etc.). The closed curve of it is represented the trunk contour line. Due to tattoo patterns are so complicated and varied, in fig.6.2, the tattoo in the bronze script of “文” has already reduced to a short vertical line, and the small seal script and clerical script ones have no tattoo at all. The contour line of the human body, the closed curve, has been kept to express the condition of tattoo, and is passed down as one of the pictographic features of “文”.

Review the emblem of 2008 Olympic Games, “Chinese Seal • Dancing Beijing”. The designer restore the trunk line of human body to express the character “文”, the part of which is very like the character “口” (mouth). It makes people easily associated the designed “文” with the character “京” (Jing in the word of Bei Jing), and is in line with the concept of pictographic closed curve remaining unchanged. The changing process of design follows the topological transformation rule (the principle is proved in the first section). The designer deliberately processes the character “文” into a person running with open arms, which can also reflects the wisdom and courage (pictographic meaning of “文” talked above) of the Olympic people, and finally presents in the form of Chinese seal. By adopting the closed curve as the core of pictographic character “文”, the designer accurately expresses several meanings of the humanistic spirit of the Olympic Games, hosting in Beijing, the art of Chinese seal, and so on. The design of the emblem of 2008 Olympic Games has profound cultural meanings and is a very wonderful graphical design of Chinese characters (essentially the entire changing processes belong to the topological transformations).

As pictographic characters, the design of Chinese characters can have so much connotation and extension, which indicates that Chinese characters, because pictographs are their soul, have rich expressions to be presented.

V. CONCLUSION

Chinese characters have been developing all the time, and have become one of the most beautiful and expressive characters in the world. Experts and scholars think Chinese characters have been transformed from pictographic characters to symbols in the process of evolution of large seal script, small seal script, clerical script and regular script. The paper has the same point of view and illustrates the pictographic figures of the evolution of pictographic characters in topological theory.

Through topological analysis and research on some characters, the paper thinks that some of the original pictographic features have passed down in the evolution of pictographic characters from pictographic figures period to pictographic symbols period. For example, the closed curve as topological structure has been inherited for some pictographic characters.

At the same time, this theory also can be extended to all Chinese characters. So, when we found the essential factors,

namely the topological structure of Chinese characters in the evolution, the rules can be used for the creative designs of Chinese characters. Also, the topological structures, as the pictographic figures of Chinese characters, should be deliberately passed down, to preserve the soul of the Chinese characters: pictographs.

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