

Research of Regional Design Based On The Invention and Innovative Design Of The Yellow River Waterwheel's Traditional Characteristics

Decheng Zhao¹, Yiwen Shang¹, Wei Liu¹ and Gang Liu²

¹North Minzu University, Yinchuan City, Ningxia, China

²Lanzhou Technology of University, Lanzhou City, Gansu, China

Abstract—Traditional instruments have distinct regional characteristics, most of which are environment-friendly items. On the basis of imitation, this paper explores the application of modern technology, design ideas and methods to the re-revolutionary design research of the regional adaptation mechanism of traditional objects is an important subject of regional design. Taking the traditional Lanzhou Yellow River waterwheels as an example, this paper makes a brief analysis of the structure, function, historical evolution and imitation characteristics of the traditional waterwheels, on the basis of which, the modern design method is used. In this paper, a series of design proposals for the structural evolution of the Yellow River waterwheels are put forward. These proposals are of great reference value for the study of regional design methods combined with the revitalization of traditional culture and ecological construction.

Keywords—regional design; the Yellow River waterwheels; the ecological design

I. IMITATION DEFORMATION®IONAL DESIGN

Imitation, deformation and composition are the basic thinking mode of the plastic arts. Simulation is related to the selection of the design theme and decides design conception. Deformation and composition absolutely decide how to design, which determines the feasibility of the design. Such as the Beijing Olympic Sports Center - bird's nest, its the imitation of the form of original nest. Designers' selecting nest form as symbols of the sports center is the most critical step of the creativity. How to combine the function & structure of the Olympic Stadium with nest form perfectly, is the key process of change and composition. So imitation is one of the learned methods of the human, and its provides luxuriant ideas and resources. [1]

Along with the culture and the accelerated development of tourism industry, modern design, based on the regional traditional culture, meets a better opportunity. An important direction of regional design is to extract symbol mode and function model which belong to traditional culture, and use them into modern design in order to meet local people's psychological identities, while creating a different aesthetic psychology.[2] With the Yellow River running through, northwest culture city lanzhou, also has many characteristic region culture symbols. The most typical representative are a sheepskin raft and Yellow River waterwheel. The Yellow River waterwheel is also the

most celebrated regional symbolic items, but it did not originate from lanzhou. With the imitation and improvement of other similar irrigation facilities, it was gradually improved perfectly.

II. THE REGIONAL CHARACTERISTICS OF WATERWHEEL & WORKING PRINCIPLE

Waterwheel, also known as "tian che", appeared in ancient Ming dynasty, dated from 1556, was invented by predecessor Duan Xu, which was based on improvement and redesign. (figure 1) It is a kind of old pumping irrigation device, using the impact of natural current of the Yellow River. Like the huge ancient wheel, the diameter reaches 10-20 meters. The huge axle is in the center with two rows of parallel spokes equipping radially, and at the end of spokes, the scraping - water boards are quipped. Rectangular wooden tanks are installed with the same distance between the adjacent scraping - water boards. Tongue is installed with the same height as the the diameter of wheel, used to receive water running down from rectangular wooden tanks. Stone dam installed on both sides of wheel is used to fix the huge wheel and gather water. Each tank is full of water in turn, ascending slowly. When the height of tank reaches the peak value, water in tank will be delivered into the tongue. Water flows through the tongue and then enter the field finally.

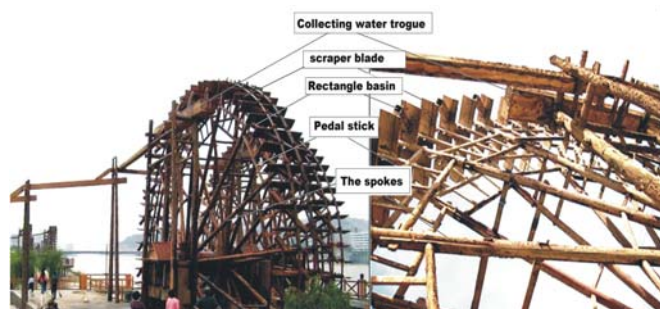


FIGURE I. THE STRUCTURE AND MORPHOLOGY OF YELLOW RIVER WATERWHEEL

The traditional way of life is mostly supported by localized instruments. These instruments have a process of technological evolution that adapts to the natural environment of the region and friendly to the environment. At present, the global environment is getting worse and worse, the ancient Yellow

River waterwheel has very important ecological significance in the present time. First of all, the topography of China is high in the west and low in the east, the terrain in the upper reaches of the Yellow River has declined significantly, the river falls greatly, the banks on both sides of the valley are very important farmland for the local people, and the impact of rapid water flow is a very good clean energy source. The energy of the river itself can be used to irrigate the farmland, which accords with the principle of taking measures according to local conditions; In addition, the traditional wooden water tanker of the Yellow River is also a regional cultural symbol in the upper reaches of the Yellow River. At the moment when the Chinese government respects regional culture and develops local tourism, it inherits the traditional water tanker and can also develop cultural tourism in poor areas. It has the value of poverty alleviation by tourism. But the traditional culture must be combined with the modern consumption. The innovative design based on the traditional apparatus should be the combination of innovation and imitation, discard the inheritance, do not go back to ancient times, and not simply negate it. It endows the traditional apparatus with a new connotation of the times and a modern form of expression.



FIGURE II. THE STRUCTURE AND MORPHOLOGY OF IRRIGATION EQUIPMENT & FACILITIES OF THE SOUTHWEST AREAS

A. Regional Conditions of Waterwheel's Existence

With strong regional characteristics, traditional utensils which can be passed down, shows that contains rich natural regional and social cultural information. It reflect-es the specific agricultural production mode in areas with large drop feet, mainly used in the Chinese Western transition zone which include qinghai-tibet plateau, Yunnan-guizhou plateau and the loess plateau. But at different places, the shape and size of waterwheel are not completely the same. As far as Chinese geographical terrain is concerned, lanzhou is located at the border zone from qinghai-tibet plateau transition to the loess plateau.

Due to terrain drop and rushing current, all these factors create the suitable conditions, which brings about the birth of waterwheel. On the one hand, valley alluvial fan causes fertile farming soil, on the other hand, long distance between cultivated land and river needs the bigger wheel. Other crucial factors, such as extreme drought, the larger evaporation capacity, need

huge amount of water. These conditions finally determines the specific shape and structure of the Yellow River waterwheel.

B. Simulation & Regional Variation Characteristics of Waterwheel

The Yellow River waterwheel was created by Duan Xu, an ancient local official who was born in Lan Zhou city Gan Su province. It was based on essential innovations, combined with the similar irrigation equipment & facilities of the southwest provinces, according to local pumping irrigation device (figure 2). So it reflects the regional adaptability of nature.

According to agricultural device map records, the Wang Zhen in Yuan dynasty, who was inspired by the scoop waterwheel in Tang dynasty invented small irrigation equipment - high drum scoop waterwheel, and later designed so-called waterwheel with huge size. [3]

1) Differences between scoop waterwheel and Yellow River waterwheel

a) The huge diameter

The maximum size of diameter has reached 20- metre, in other words, the height of lift irrigation is nearly 20 meters. This situation is determined by the local geographical characteristics which include turbulent water flow, deeper erosion canyons, high bank etc.

b) The higher density of spokes

The total number of horizontal and vertical ribs, (commonly known as the board stick, shown in Figure 1) installed between adjacent spokes, are very abundant. As the structure is connected with the wedge-shaped tenon joint, so the overall framework of the waterwheel is relatively more firm. Relatively compared with scoop waterwheel, it has the greater weight and larger amount of water.

c) The greater density of water-scraping plate

Water-scraping plate, fixed outside spokes, has much more greater density. With greater bucket distribution density, the lift irrigation amount is also great.

d) Suitable wood with higher density& better corrosion resistance

Manufacturing wood materials are mainly used with local so-called hardwood which mainly include elm, locust etc, and all these materials have better resistance to water erosion, reflecting excellent geographical adaptability.

III. INNOVATION DESIGN OF TRADITIONAL YELLOW RIVER WATER VEHICLE

Analysis with structure and function of Yellow River waterwheel has an important reference significance to modern innovative design. Design philosophy of the ancients has an important reference value to modern design, which also means that we can gain enlightenment and inspiration from imitation of ancient artifacts both in form and function. The difficulty of Creative Design based on imitating is determined by have new usage features, not only are the concepts of morphologically semantic signifier and signified.

The value to design and imitate mainly contains these aspects which include imitation and deformation of the existing design, making analysis of the similarity in the principles and functions, reasonable use of the existing technical conditions etc. Modern design, based on traditional material culture, should also pay attention to maintaining the heritage value of the cultural symbols. (figure 3)

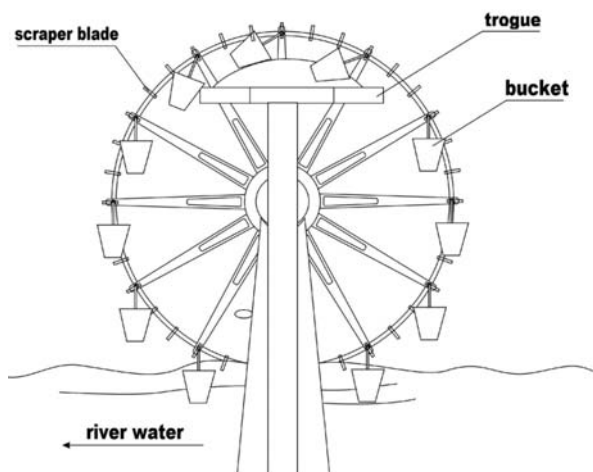


FIGURE III. THE STRUCTURE SCHEMATIC DIAGRAM OF GRAVITY HANGING

A. Design Flaws and Weaknesses

The situation which uses a concentric shaft connected between the two bearings of the waterwheel, brings about these defects and problems which include lower efficiency in amount of lift irrigation, great damage to equipment, frequent maintenance, spoke rods and brackets's easily erosion by moss and microbial, affecting of appearance, higher requirements in manufacturing materials etc.

In the same location, oblique water tank can not simultaneously achieve two functions. When reaching the bottom, it can only scoop water, and at the top, it can complete the pouring function. As pouring-water action begins from the middle and higher position of waterwheel until the top, however, water tank, used for gathering, can only be installed at the top.

Water tank can not always maintain the state level, during the rotation process of waterwheel. There exists serious waste and inefficient use of water in tank.

B. Innovative Design & Improved Methods

1) The use of gravity hanging

We can put the bucket hanging at the end of spokes of wheel to realize the function of the upward transportation of water. The basic principle is shown in Figure 3. The structure has the same principle as a Ferris wheel, when bucket reaches the top, it complete automatic pouring.

2) Parallel four-bar linkage mechanism

It is a kind of mechanical connection device, the biggest characteristic is that in the rotation process, connecting rod plane which goes around the two fixed hinged points will always keep

the state level. Edges of parallel four-bar mechanism are always in horizontal state and four angular points are hinged points.

The four hinged points present three-dimensional distribution state, and the space position is shown in figure 4 a/b.

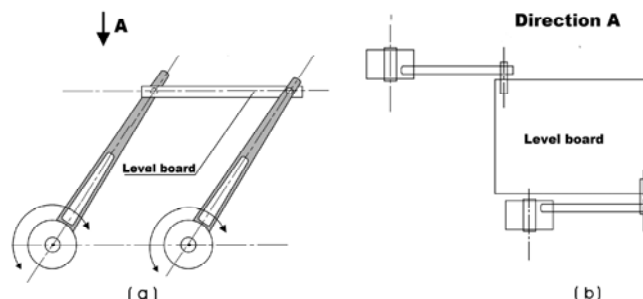


FIGURE IV. THE STRUCTURE SCHEMATIC DIAGRAM OF PARALLEL FOUR-BAR LINKAGE MECHANISM

We put of these unit together, and make them turn in synchronization. In other words, several parallel double crank rod systems share a fixed edge and two hinged points. Innovation point is here.

In the basic form design process, it is the common situation, that we share common basic unit form, as one of the most universal design methods. We put the two same wheel shape devices together in the position of parallel and dislocation, and meanwhile After installation of flat between the parallel spokes, it constitutes a parallel four rod rotation institutions group, sharing a side, (as shown in figure 5)

This structure has already obtained the invention patent [4], and leading to a series of innovation design related to images of the Yellow River water wheel.

C. Innovation Design Cases & Details

3) Improved & redesigned case of water wheel

We install a valve on tank, which can open and shut down automatically with the help of permanent magnet. We realize these functions which consist of automatically collecting the water and drainage through difference relationship of gravity among magnetic gravity, the water pressure and the gravity of valve cover. It is shown in figure 5.

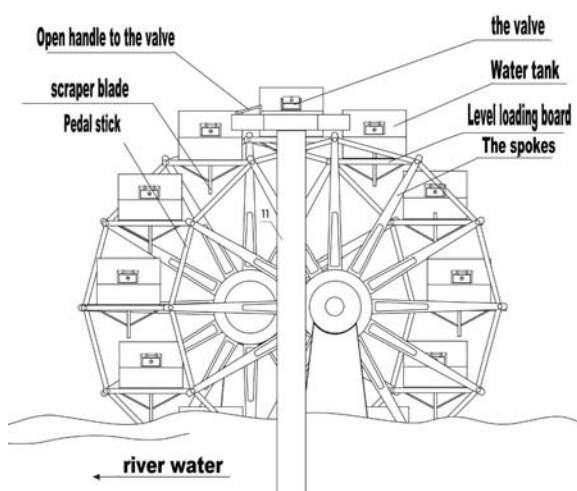


FIGURE V. THE STRUCTURE SCHEMATIC DIAGRAM OF REDESIGNED WATER WHEEL

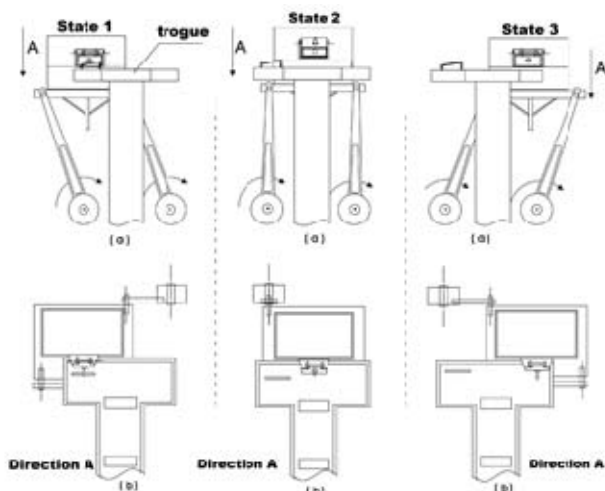


FIGURE VI. THE BASIC PRINCIPLE DIAGRAM OF THE DEVICE

4) The basic principle of the device

When water warehouse filled with water rises to the same level as the position of water tank, the handle belonged to valve will hit the switch on the water channel and this action will directly lead to the valve is opened, subsequently, the water will be discharged. The principle is shown as condition 1 (a), (b) in figure 6.

When the valve cover (4) is in open condition and reaches the maximum, meanwhile the amount of water will achieve the maximum with the condition that the attraction power of the magnets will disappear, the water force is more powerful than gravity of the valve cover, the current will cause valve cover opened. The operating principle is shown as condition 2 (a), (b) in figure 6.

After the drainage function has been done, accompanied with the weakened water power, the valve cover will be automatically shut off under the influence of magnetic force

ultimately. The principle diagram is shown as condition 3 (a), (b) in figure 6.

Compared with the old Yellow River waterwheel, the new waterwheel device is completely different from the old Yellow River waterwheel in rotating mechanism. 1) the new invention requires two non-concentric but same height spindles, whereas the traditional waterwheels have only one spindle, which belongs to an independent single-wheel rotation system. there are also many differences in material and Specific structural and technics aspects. 2) The traditional waterwheel is a wooden structure. The new waterwheel device adopts rust-proof steel truss structure.

These characteristics are essentially different from those of the dragon-bone water lift and the overturning car in the south, This large-capacity water truck requires a great impact on the water flow, and can only be used in the western region where physical features of a place is large and the water flow speed is high. It is obvious that the traditional water tanker and the design of the invention have the continuous characteristics of the evolution of utensils in both the regional cultural characteristics and the regional ecological aspects of the mode of production, which should be the main principle of the innovative design of the traditional utensils

D. Other Creative Design based on structural Innovation

Manned sightseeing entertainment facilities with the model of water wheel. The basic idea is to install cabins on the flat in rotation, and during turning process, cabins are always in horizontal position. The innovation device is imitated from the basic structure and framework of waterwheel is based on redesign.

In the rotation process, the cockpits always maintain a state level, and this make tourists not only feel stimulation, irritation but security. This special design makes passengers effectively overcome the fear or dizzy symptoms, and it also suitable for middle-aged, old people and children to use for amusement.

On the one hand, this water-driven amusement device not only enrich the cultural content of the Yellow River tourism, increasing aquatic amusement project, but develop the tourism resource, improving tourism economy income.

Clark whistler, an American anthropologist, points out: "from a cultural point of view, invention is a new relationship that is conceived or observed from old experience, not experience itself". It is indisputable that all the concrete experience contained in such an invention must have come from the environment. "[5] In fact, many traditional objects have become inspiration and creative sources of modern design. So that traditional objects in its regional function and form aesthetic aspects are carried forward and utilized. Lanzhou, as the central city of northwest China, is relatively short of tourism resources, so it is very important to develop the tourism cultural resources of the Yellow River. The traditional Yellow River sheepskin raft and the ancient Yellow River water cart are two major signs of Lanzhou tourism development, but they have lost their previous functions of passenger and irrigation, mainly by visiting and watching. Under the impetus of the new tourism economy, how to develop the traditional Yellow River artifact culture, make it

not lose the charm of regional culture, and have the modern diversified tourism demand function, is one of the difficult problems faced by Lanzhou regional creative industry. The rotation of the Yellow River water vehicle is the figure of

Lanzhou region image, a little association can know that this parallel rotation mechanism can be designed as a Ferris wheel ride entertainment device.

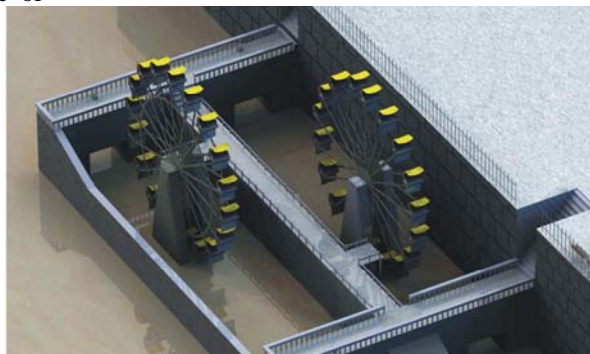
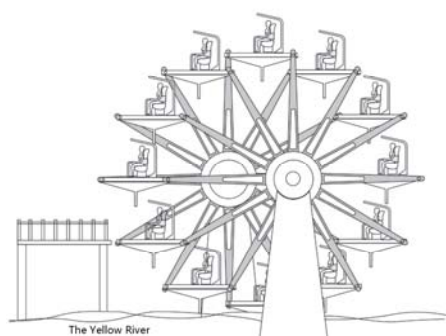


FIGURE VII. MANNED SIGHTSEEING ENTERTAINMENT FACILITIES

On the basis of this parallel rotating mechanism, we can also develop "water wagons for sightseeing" (figure 7), so that tourists can also ride a new type of "water cart" after watching the traditional water vehicle. This will greatly enrich and deepen Lanzhou Yellow River tourism project content. Its basic idea is to install the ride bin on the parallel rotating flat plate, under the plate is the driving paddle plate, using the water energy drive, the cockpit is always in the horizontal position during the rotation process, so that the tourists in the fun is not dangerous. In particular, when the paddle board turns to the upper part of the passenger, it can prevent the water from getting wet to the passenger. During the rotation, the cockpit is always in a horizontal state, so that the passenger can effectively overcome the fear or fainting symptoms while experiencing thrilling and dangerous experiences. Suitable for the physical condition is not very strong and middle-aged elderly and children to ride pleasure. Some associations of image design come from the experience of regional life.

Designers and artists who have grown up in a certain place for a long time can't help to rely on the local regional symbol image in their visualize thinking. As Donald A Norman, a famous professor of design psychology in the United States, says: memory is not only knowledge stored in the mind, but also the combination of information stored in memory with information from the outside, which determines our behavior [6]. The image of water cart is the deep-rooted symbol impression of Lanzhou people. As a local designer, its subjective aesthetic always has geographical universality. This may be the main reason why the above-mentioned designs generally carry the visual feeling of the Yellow River water truck in the form image.

IV. CONCLUSIONS

The ancient Greek philosophers, such as Socrates, Aristotle and other great characters once pointed that the artistic creation originates from the imitation and re-creation of natural and real life. Design is one of the cultural inheritance means in a certain region, and the imitation is common mode by which people universally gain culture.

Imagination related to image design derives from regional life experiences. Designers and artists living in a specific

regional environment will involuntarily influenced by the local regional symbol image, especially his image thinking.

The famous American semiotics aesthetician Susanne Langer said: "Both Design and art originate from imitation" [7].

The Yellow River Waterwheel is a deeply rooted symbol impression of Lanzhou, and its regional culture characteristics deeply influence the local designers' aesthetic images and their design style. The creative design based on the traditional culture of Gansu Province, especially the invention and innovative design of the Yellow River waterwheel's traditional characteristics, will ultimately become the theme and development direction in local design field in the long run.

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