

# The development of the spinning wheel in ancient China

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## REZUMAT – ABSTRACT

### Dezvoltarea roții de tors în China antică

Pe măsură ce cererea de textile a crescut în China antică, roata de tors a devenit mai larg utilizată în epoca neolitică și a fost responsabilă cu sarcinile principale de filare în ultimele câteva mii de ani. Această lucrare studiază schimbările de-a lungul timpului în ceea ce privește forma, diametrul și grosimea roții de tors din culturile Cross-Lake Bridge, Hemudu, Yangshao, Qujialing și Shijiahe. Formele de disc, de movilă, de bilă și forma de trunchi de con sunt considerate ca fiind cele mai bune forme de roată de tors din etapele ulterioare – în special roata de tors în formă de disc rotativ. Roata de tors cu un diametru de 2–9 cm și o grosime de 0,1 până la 9,0 cm a fost utilizată de-a lungul timpurilor preistorice. În perioada neolitică târzie, o roată de tors în formă de disc, cu un diametru de 3–4 cm și o grosime mai mică de un cm, a reprezentat cel mai des utilizat design. Acest studiu arată că modificarea formei, a diametrului și a grosimii roții de tors este rezultatul inevitabil al schimbării punctelor de proiectare ale instrumentului, ceea ce evidențiază îmbunătățiri ale eficienței filării.

Cuvinte-cheie: dezvoltare, roata de tors, formă, diametru, grosime

### The development of the spinning wheel in ancient China

As textile demand increased in ancient China, the spinning wheel became more widely used in the Neolithic era and was responsible for the main spinning tasks over the last few thousand years. This work explores the changes over time in the shape, diameter, and thickness of the spinning wheel in the Cross-lake Bridge, Hemudu, Yangshao, Qujialing, and Shijiahe cultures. The disc-like shape, mound-like shape, bead shape, and truncated cone shape are deemed to have been the best spinning wheel forms in the later stages – especially the disc-like spinning wheel. The spinning wheel with a diameter of 2–9 cm and a thickness of 0.1 to 9.0 cm was used throughout prehistoric times. In the late Neolithic period, a disc-like spinning wheel with a diameter of 3–4 cm and a thickness of less than a cm was the most frequently used design. This study shows that the change in the shape, diameter, and thickness of the spinning wheel is the inevitable result of the change in the tool's design points, thereby revealing improvements in spinning efficiency.

Keywords: development, spinning wheel, shape, diameter, thickness

## INTRODUCTION

With the development of gumming technology and increased human demand came the production of tools used for spinning: “spinning wheels”. Having a drafting, twisting, and winding effect, the spinning wheel improved the efficiency of spinning and reduced the labour necessary to perform it. With this tool, the quality of yarn became much finer than before, while the progress of the textile industry was accelerated [1]. In archaeological reports found in the Neolithic age, the spinning wheel is seen to have come in various shapes, sizes, thickness, and shades. In the design of spinning wheels, their size, shape, and weight, and the length of the twisting rod, are usually determined by the fineness and strength of the fibres to be spun [2]. The relationship between spinning wheels and spinning fibre categories is a popular topic of exploration for scholars. Zhang Chunhui has suggested that the shape, size, weight, and moment of inertia are closely related to the fineness of the yarn [3]. A spinning wheel used for spinning silk, for example, is smaller and lighter than that used for spinning linen. Meanwhile, the type used for spinning coarse yarn is larger and heavier than that for spin-

ning high count yarn; and a spinning speed made of small and thin wheels is faster, and thus more suitable for spinning high count yarn. Yabuuti Kiyos has observed that the truncated cone spinning wheel is used to imitate wool, while the disc-like spinning wheel is used for spinning linen [4]. Kathryn A. Kamp has shown that a spinning wheel diameter of 1.5 to 3.8 cm (from the Late Classic period) was suitable for spinning cotton [5]. Zeng Kang has revealed that yarn that is about a cm in diameter is spun from a spinning wheel with a diameter of 5–6 cm or a weight of 35 g [1]. Wang Di believes that it is impossible to demonstrate that the use of the spinning wheel is related to both the contraption itself as well as the people who use it [6]. Meanwhile, Song Zhaolin argues that the shape of the spinning wheel is not the only basis for judging the raw material of spinning – claiming that the position of the spinning wheel on the twisting bar is also an important index affecting spinning [7]. Such research has shown that the shape, diameter, and thickness of the spinning wheel are important for spinning. These aspects directly affect the moment of inertia of the spinning wheel and have a close relationship to the fibres and thickness of the yarn [3].

However, most of the aforementioned research cannot fully and systematically demonstrate the relationship between the shape or size of spinning wheel and fibre type or yarn thickness. Aiming to provide useful information about modern spinning and act as a reference for scholars, this paper explores the development and evolution of prehistoric spinning wheels in China.

### ORIGINAL METHOD OF SPINNING

The method of spinning in the distant past required the use of the hands or legs to twist fibres together. This method continues to be practiced in the modern countryside, as shown in figure 1. Splicing techniques requiring no tools, hand spinning and thigh-spinning were the two methods of spinning in remote antiquity. Both have been used for millennia to produce substantial quantities of yarn for textiles. During this time, the spinning speed was very slow, so the time required for thigh-spinning and finger-spinning was greater than that for spindle-spinning. This original method tended to be used for long bast or inner tree bark fibres, although short wool fibres are also thigh-spun by rubbing [8]. In this method, the finished yarn was rough in texture, like common rope. That is to say, until the attendance of spinning wheel, the original spinning only can spun ropes for daily life which were used as tools. Examples of this kind of rope have been found in Zhejiang Hemudu, as shown in figure 2. The rope had many uses: as a tool, marker, and material for knitting and sewing, as shown in figure 3.

No spinning wheel has been found among the archaeological findings from the whole-hand weaving

stage. Net sinkers and perforated weights have been found in abundance, however; leading researchers to conclude that they might be predecessors of the spinning wheel, based on their functionality being similar to that of the spinning wheel. Indeed, the rotation of the weight and drilling of these compound tools influenced the emergence of the spinning wheel. With the development of the spinning wheel, rope became much finer than it had been. In the Xi'an Banpo site, the fineness of the rope was 1 cm.<sup>1</sup>

### DEVELOPMENT OF THE SPINNING WHEEL

#### Shape

A spindle is a tool that minimizes the hand motions necessary to place twist into twist yarn. All spindles have two essential functions: they store the spun yarn, and they keep the yarn turning after it is set in motion by the spinner. Spinners apply torque to a spindle in a manner similar to setting a top in motion. The invention of the spindle accelerated the development of spinning. Spindle-spinning was 2.1 times faster than the average speed of all non-spindle techniques [8]. Available archaeological findings reveal the various shapes of spinning wheels. The earliest excavated spinning wheels were in Peiligang and Cishan [9, 10]. These spinning wheels show the original shape of the tools, which were formed through striking or grinding. Later, spinning wheels were shaped by kneading (figure 5). As the pottery handicraft industry developed, the shape of the spinning wheel changed according to the demands of its users (figure 6).

Table 1 shows the different shapes of spinning wheels excavated from Neolithic settlements. Spinning wheels of the same shape can be reclassified according to the structure of their edges, as shown in tables 1–3. Wheel shapes did not emerge at the same time; they changed with the historical development of the culture. To ensure the high efficiency of spinning wheels, Neolithic cultures experimented with various shapes for spinning. In the process of long-term use



Fig. 1. Method of spinning in remote antiquity (right), compared with practices in modern village (left and middle)



Fig. 2. Rope excavated at Hemudu



Fig. 3. Evidence of the use of rope (from left to right: record information with knots; rope marks on pottery; bone needles)



Fig. 4. Spinning wheel excavated from the Peiligang culture (left) (8,000 years ago) and Cross-Lake Bridge (right) (7,000 years ago)



Fig. 5. Spinning wheel excavated from Xi'an Banpo (5,000 years ago)



Fig. 6. Spinning wheels from different cultures. From left to right: Hemudu culture (6,000 years ago), Yangshao culture (5,000 years ago), Liangzhe culture (4,700 years ago), Shijiyahe culture (3,500 years ago)

and practice, the spinning wheels that were deemed inefficient, difficult to make or save, or as having poor rotation stability were eliminated. Another reason for the retired wheel designs across periods was the state of the fibre. Some spinning wheel shapes were not suitable for spinning fine fibre.

According to table 2 and table 3, the edge structure of the spinning wheel is an important factor in spinning. Many shapes are differentiated solely by a different edge structure. This structure can influence

the wheel's rotational stability, mass distribution, and torque – and thus affect spinning.

According to figure 7, the disc-like shape, truncated cone shape, mound-like shape, and bead-like shape had higher use frequency than others – especially the disc-like shape. The “工”-shaped, “凸”-shaped, and wheel grind-shaped wheels were infrequently used in ancient times.

#### Diameter

As figure 8 shows, the diameter of the spinning wheel varies from one cultural stage to another, as seen in

Table 1

CLASSIFICATION OF SPINNING WHEEL SHAPES							
Shape	Disc-like shape	Truncated cone shape	Bead-like shape	Mound-like shape	‘工’ shape	‘凸’ shape	Wheel-grind shape
Top view							
Side view							

Table 2

Shape	Disc-like shape		
Side view			

Table 3

Shape	Truncated cone shape		
Side view			

the spinning wheels unearthed from the Cross-Lake Bridge [11], Hemudu [12], Yangshao [13], Qujialing [14], and Shijiyahe cultures [15, 16]. In the case of the Cross-Lake Bridge culture, the diameter of the spinning wheel changed from 2.4 cm to 6.6 cm, as seen in figure 8. In this age, use of the spinning wheel was only starting, and people attempted to find the best size; small and large samples have been found from this period. In the following period, the discovered spinning wheels had a diameter of 5–6 cm.

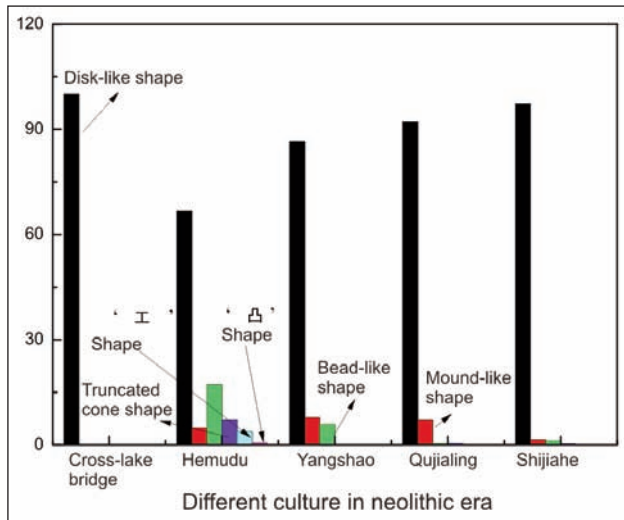


Fig. 7. Proportion of spinning wheels with different shapes in different ages

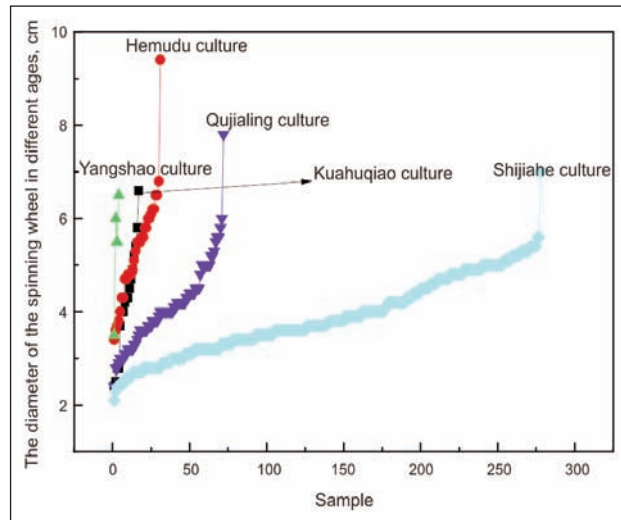


Fig. 8. Diameter of the spinning wheel in different ages

In Qujialing culture, the diameter of the spinning wheel decreased greatly in size until it was as small as 3–4 cm. The main reason for this trend was changes to the fibre that people used for spinning. Initially, the fibres were hard; when used for twisting, the fibre required a large torque, thereby requiring a larger spinning wheel [17]. As the fibre became more refined and the demand for yarn became higher, so the spinning wheel started to shrink in size. A diameter of 3–4 cm was determined to be the proper size for spinning.

The change in the diameter of the spinning wheel is related to the length and the degree of degumming of the fibres. According to the moment of inertia formula and law of rotation [18]:

$$J = \int r^2 dm \quad (1)$$

where:  $r$  is diameter;  $m$  – mass.

$$M = Ja \quad (2)$$

where:  $M$  is combined external moment;  $a$  – mass.

When the same torque is applied to a spinning wheel of the same mass and volume, the greater the diameter, and the greater the moment of inertia. The greater the moment of inertia, the smaller the angular acceleration and the smaller the angular displacement of the turn at the same time. As a result, the yarn is twisted less. Very short fibres – such as cotton, flax tow, and some wool – require more turns per inch to hold the fibres together in a yarn. Spinners need more time to insert more twists as fibre length decreases. In order to ensure maximum labour-saving and high-efficiency spinning, it is necessary to change the size of the spinning wheel. The transformation of the diameter is an effective method for this purpose. At the same time, the diameter reduction made the spinning wheel easier to carry and store; it could also reduce the weight, which is conducive to spinning short fibre yarn.

### Thickness

One of the important parameters of this device is the thickness of the spinning wheel. In archaeological excavations, spinning wheels are often found to have varying thicknesses. This attribute directly affects the spinning wheel's weight and rotational stability. According to major archaeological reports, the thickness of the spinning wheel changed as well, as shown in figure 9. The thickness of the front spinning wheel used in the Cross-Lake Bridge culture was 0.3–0.7 cm [19], whereas the thickness used in the Hemudu culture was 1–3 cm [19], showing that the thickness increased. This change is attributed to the production process of the spinning wheel. In the Cross-Lake Bridge culture, the spinning wheel was made by moulding ceramic pieces [11]. As time went on, they started to use kneading or wheeling. This progress indicates that wheels changed in line with the needs of users. The thickness of the spinning wheel was 0.5–1 cm in the case of the Qujialing and Shijiahe cultures. Moreover, this change ensured that the fibre was sufficiently degumming.

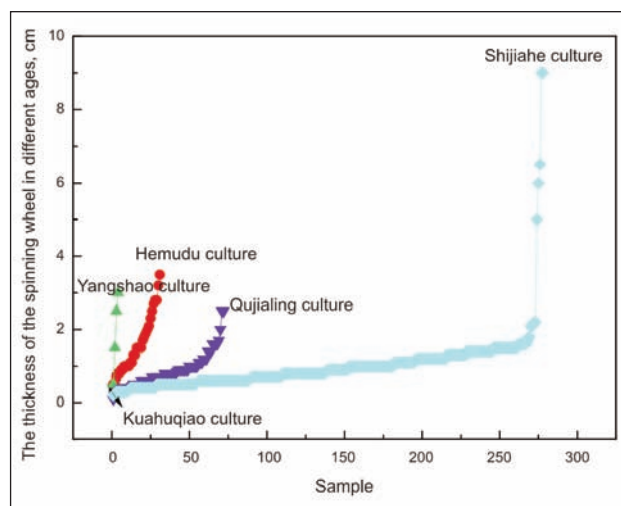


Fig. 9. Thickness of the spinning wheel in different ages

## CONCLUSION

Over time, the shape of the spinning wheel changed in accordance with attempts to improve their convenience and efficiency. The convenience and stability of the spinning wheel, as well as the state of the fibre produced, are the reason for the retirement of some wheel designs: spinning wheel shapes unsuitable for spinning fine fibre were eliminated. Consequently, the shapes most commonly used were: disc-like shape, mound-like shape, bead shape, and truncated cone shape – especially the disc-like shape. The edge structure of the spinning wheel is an important factor in spinning.

In Qujialing culture, the diameter of the spinning wheel decreased in size to reach a diameter of 3–4 cm. The thickness of the spinning wheel was 0.5–1 cm in the Qujialing and Shijiahe cultures. This type of spinning wheel had high-frequency usage in the late Neolithic age. According to the size change of spinning wheel,

it can be concluded that the spinning tension decreased because of the decrease of the weight of the spinning wheel. From the decrease of spinning tension, it can be inferred that the state of the spun fibers is changing. The changing of the state of the fiber and the size of the spinning wheel both inductive to spin high quality yarn.

This study also has some limitations, such as the fact that the statistics of the unearthed spinning wheels are not comprehensive enough. There is also no detailed explanation of the local textile culture in this analysis. While we will discuss the revolution of social life brought about by textile production in future studies, we hope that the findings of this paper can provide a useful reference for modern spinning research.

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