

Concerning string cutting, *tuo* (emery wheel) cutting and *tuo* carving – and discussion of the date the *tuo* began to be used

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Abstract

This paper discussed the jade-carving techniques, summarized the characteristics of blade saw cutting, thread cutting and wheel cutting, and then pointed out that there should not be any wheel tool or wheel cutting technique in the prehistoric period and the Xia, Shang and Western Zhou Dynasties. The metal wheel tool first appeared in the Spring-and-Autumn Period. Since then, the jade art was improved more and more because of the development of private craftsmanship, the commerce and the destruction of the rigid ritual system.

Keywords: Emery wheels–history; jades–techniques; microwear analyses; simulation experiments; thread cutting

The origin of the issue

For the past decades the large number of jades unearthed representing the Hongshan, Liangzhu, and Lingjiatan Cultures has given rise to extensive discussion of the prehistoric art of working jade. Based on the legacy of the dynastic tradition, it has, up until today, been very difficult to determine what tools and what methods were used to work jade. More often than not, scholars have relied on trace remains on the surface of jades to determine tool signatures. For this reason, there has not necessarily been unanimity about the interpretation of these remains, and discussions have led to various and different points of view. Depending on the researches in the past years focusing on simulation experiments of working jade and microwear analyses of jade working, this paper puts forwards some suggestions, especially when and how the emery wheel began to be used.

The emery wheel was not used in the prehistoric methods of rough shape cutting

The two pointed ends of five horizontal deeply grooved cuts remaining on the surface of a jade cylindrical object from M2 at the Yaoshan Cemetery of Liangzhu Culture in Zhejiang has been identified as showing evidence of cutting with an emery wheel (Figure 1). Scientific analysis by means of simulation experiments by specialists at Taipei's Palace Museum demonstrated, nonetheless, that

a hand-held straight blade was used with moist sand as a medium on a cylindrical object to produce the concave groove could also form a deep and wide trough with two shallow pointed ends (Figure 2). The latter shapes are proof that a straight blade rather than emery wheel was used to the cut the jade.

The arc-shaped cutting marks on the jade *cong*-prismatic tube with tall body excavated from the Liangzhu burial M3 at Sidun, Wujin County, Jiangsu, has been described as showing trace use of the emery wheel. Researchers have tried to restore the original diameter of what they identified as use of the emery wheel. Simulation experiments of Chen Qixian proved that fine string with wet sand could be used to cut the jade, and that after cutting the string and sand left an arc shape that was high in the middle and low at the ends with varied diameters. These trace remains compare well with the similar arc shapes made on a large piece of jade about 30cm in length unearthed from M31 at Yingpanshan, Jiangpu County, Jiangsu of Neolithic Age (Figures 3 and 4), thus, proving again, that the emery wheel could not have been used.

Based on simulation experiments compared with excavated jades the following points proving use of string cutting to create the arc shaped traces may be made: 1) the arc's direction moves inward (centripetally); 2) the diameters of the multiple groups of arc thread shapes differ in becoming shorter as they move inward; 3) the arc-shapes lack uniformity, left and right halves are not symmetric (although it is easy to make the mistake of judging them uniform), and it is not possible to restore a

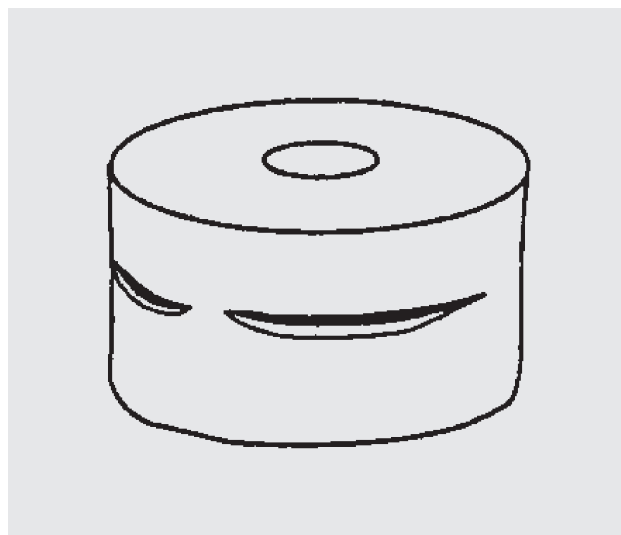


Figure 1 The jade cylindrical object from Yaoshan M2.

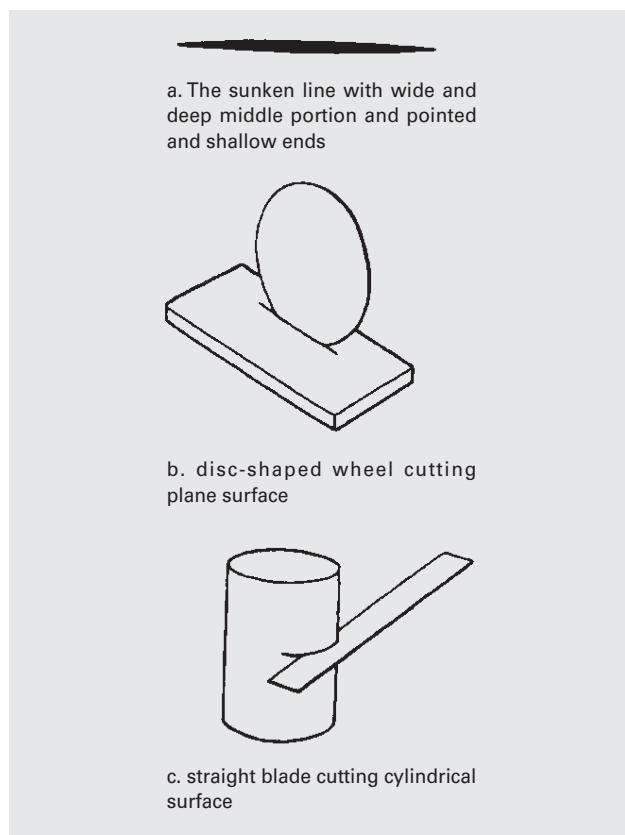


Figure 2 Modern blade cutting simulation experiments (illustrations from Deng and Shen 2007).

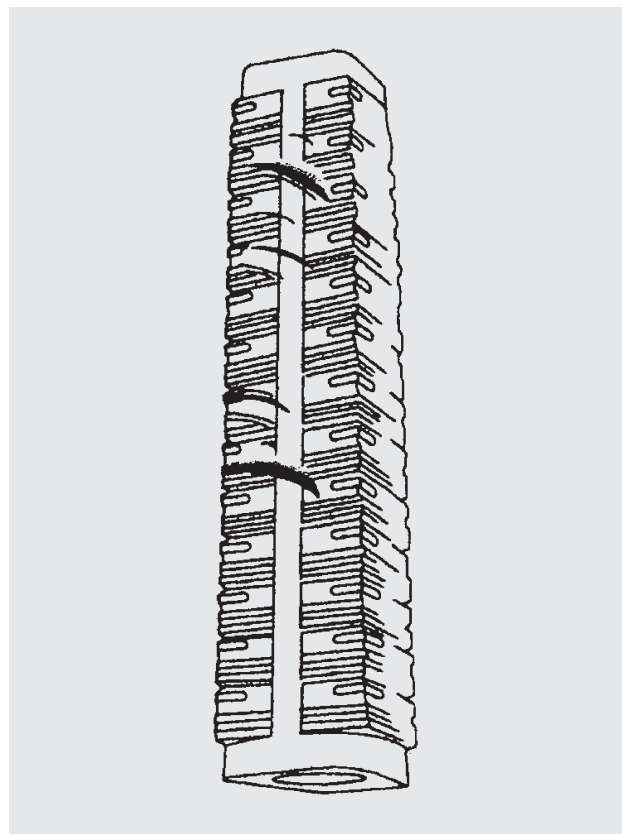


Figure 3 Jade cong-prismatic tube of Liangzhu Culture (M3 at Sidun Site in Wujin County, Jiangsu).



Figure 4 The string cut traces on the jade material of late Neolithic Age (Yingpanshan M31 in Jiangpu, Jiangsu).
Left. the reverse; right. the side

perfect circle from these two halves; 4) the outer edge of the arc creates a concavity so that the inner edge slightly bulges. These four features are the opposite in effect of what traces are left by the emery wheel, as noted by the following: 1) the arc moves outward (centrifugally); 2) the diameters of the arcs are similar; 3) the two ends of the arch are symmetric and can be restored into a circle;

and 4) the inner edge of the arc creates a concavity and the outer arc edge bulges. In addition, the emery wheel cut of an arc is rather refined, thin and even.

The features discussed above regarding string cutting also characterize jades from Xinglongwa, Hongshan, Hemudu, Majiabang, Songze, Liangzhu, Xuejiagang, Lingjiatan and Yangshao Cultures, in addition to crystal

jue earrings unearthed from remains of the Baojing Wan prehistoric site in Zhuhai, Guangdong (Figures 5 through 8). The most examples of string cut jades are the over 60 examples unearthed from Liangzhu tombs at two cemeteries, Yaoshan and Fanshan in Yuhang, Zhejiang.

In addition, a great number of jade leftovers made by blade cutting and string cutting or both of them with arc-shaped line remains derive from two jade workshops of Liangzhu Age at Dingshadi in Gourong, Jiangsu and Tangshan at Yuhang, Zhejiang, as well as from Neolithic remains at Mopandun in Dantu, Jiangsu.

We can speak about a common prehistoric method of working jade that involved using blade cutting and string cutting yet not the emery wheel cutting. The area of Gansu, particularly the Qijia Culture mainly employed blade cutting methods.

The ornamental motifs on prehistoric jades were not

made by emery wheel cutting

Carving tools made of flint, obsidian and black quartz have been unearthed from residential or workshop remains at Mopandun, Dingshadi, and Tangshan Sites. Simulation experiments proved that these tools can be used to carve sunken lines and motifs on the surfaces of jade. Today there is general consensus that prehistoric jade ornament was carved using tools with a high hardness, such as flint, obsidian, quartz and agate. Nonetheless there are still those who state that carved lines with pointed ends and wide grooves represent the use of the emery wheel (hereafter “emery wheel hypothesis.”).

Actually, a hand-held tool with sharp point can be used repeatedly in carving and producing concave grooves or lines with shallow pointed ends, as represented by the perforations on the stone knives from Yangshao and Longshan sites as well as by the carved lines on a stone

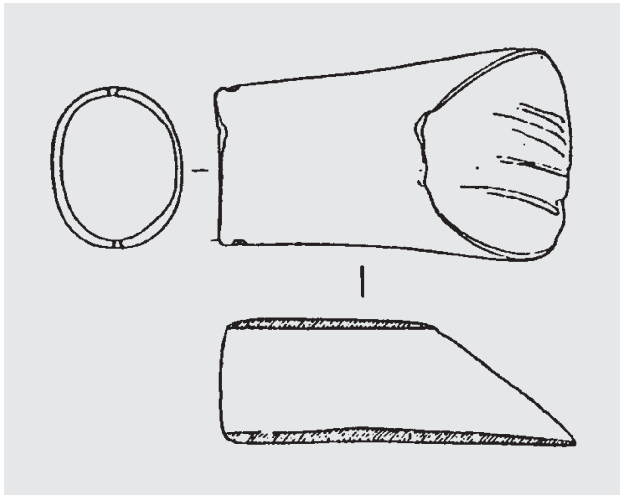


Figure 5 The hoof-shaped hair tube of Hongshan Culture (from Sanguandianzi Site in Lingyuan County, Liaoning).

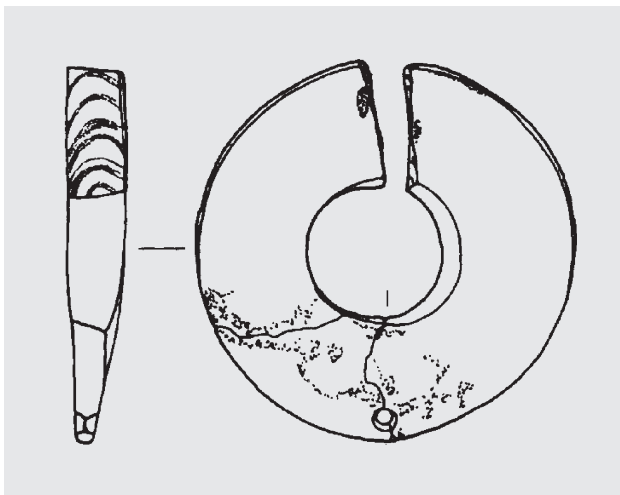


Figure 7 The jade ring of Liangzhu Culture from M5 of Yaoshan Cemetery.

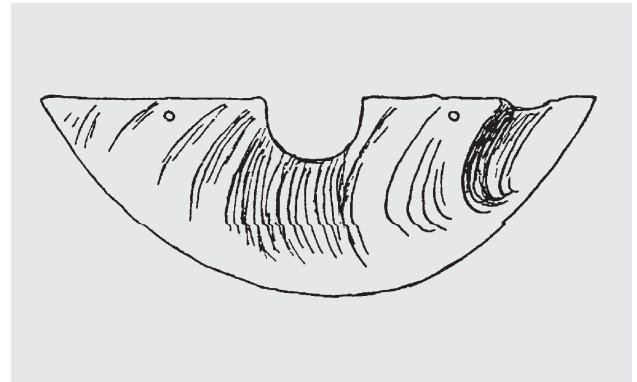


Figure 6 The *huang*-semicircular pendant of Songze Culture (from M91 of Songze Cemetery in Qingpu County, Shanghai).



Figure 8 The cylindrical jade object from M16 of Fanshan Culture.

spade from the Lingjiatan Culture (Figures 9 and 10). The author witnessed a simulation experiment: holding in the hand an agate tool, the experimenter repeated carving lines into a jade's surface in producing a shuttle-shape with wide groove and shallow pointed ends (Figure 11).

Hand carved lines and emery wheel carved lines differ. The former form concave grooves whose bottom part may be bumpy and uneven, whereas the latter's concave groove although also uneven, the tendency rather is to form an arc-shaped groove base (employing sand to abrade the surface).

If one examines under 60-power magnification the linear dragon motif decorating the white jade plaque from

the large tomb of Duke Jing of the Qin State of the late Spring-and-Autumn-Period from Fengxiang, Shaanxi, three linked grooves in concave short arc-shape are visible (Figure 12). This microscopic view represents the typical remains of emery wheel-carved lines. Based on the shape of the grooves, we know the diameter of the emery wheel was 1cm and 1-2mm thick. In analyzing the ends and space of the carved line, one has to distinguish whether the line bottom is arc in shape or not. Those maintaining the "emery wheel hypothesis" typically lack any close observation of the jade piece and how it is worked, and for this reason their theories cannot be supported. Although the grooves carved into the jade



Figure 9 The reverse of the jade human figurine of Lingjiatan Culture (From 87M1 of Lingjiatan Cemetery in Hanshan).

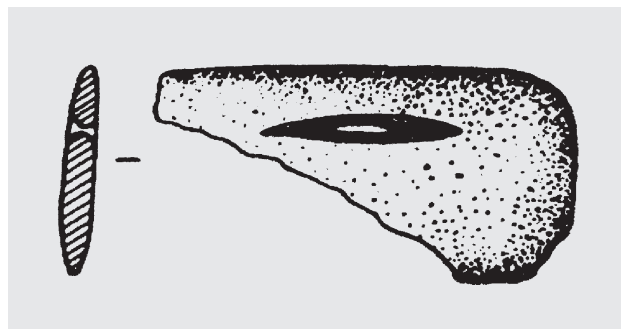


Figure 10 Perforated stone knife of Yangshao Culture (From Fulinbao in Baoji City, Shaanxi).



Figure 11 The hand-cut sunken lines on the modern Hetian jade.



Figure 12 The jade plaque with dragon motif from the tomb of Duke Jing of the Qin State and the grooves on it made by wheel cutting.

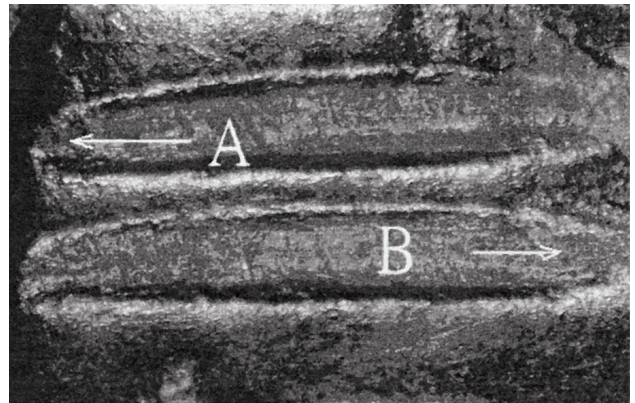
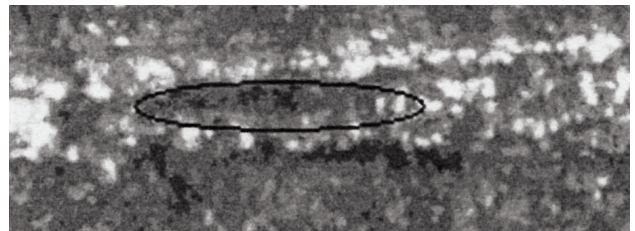


Figure 13 The wheel-cut traces on the mane of the horse figure on the “Eight steeds and plum flower” of the Qing Dynasty.

cylindrical object from M2 at the Yaoshan Cemetery have been identified as made with an emery wheel, this is hardly conceivable since the bottom of this carved line was actually straight and grooved, which was carved by a thin blade.

The emery wheels today and in antiquity were not completely similar. Today's metal emery wheel applied with synthetic diamond with a remarkably high hardness is able to directly carve or cut jade without the assistance of abrasives. The two sides of the wheel can form a sharp blade. The edge of the emery wheel before the Ming and Qing Dynasties were used to press against the sand in order to abrade the jade surface in creating a concave groove, so it should be made rather thick. The detail of a horse's mane carved into one decorating the “Eight Steeds

and Plum Flower” pendant unearthed from a Qing tomb in Anqing, Anhui, if magnified 60 times, may be used to illustrate Qing period emery wheel carving (Figure 13). The wheel leaves a broad and deep line whose middle is a concave groove with ends that are shallow yet curve in a round arc. So we would rather say that the sunken lines with wide and deep middle portion and pointed and shallow ends are signs of hand-held tools than that of emery wheels.

Based on the popularity of engraving lines of some prehistoric jades that are smooth, straight and even, or that are created with remarkable deft, fine and curving, there are still scholars who advocate the use of the emery wheel. These theories do not stand the test of examination through high magnification and actual observation.

The emery wheel carving was not used in jade work during Xia, Shang and Western Zhou Dynasties

In 1976 the Art Research Group of the Beijing Jade Carving Factory maintained that the ornament on the jade handle-shaped object unearthed from K4 at Erlitou Site had been worked using an emery wheel. They argued 1) that a hand-held bronze blade assisted with abrasives could carve a straight line, yet the lines of the human and animal faces on this handle-shaped object are sharply curving, while a bronze blade when worked has no room to turn thus making it difficult to create a curving line, and therefore the use of a rather large disc-shaped edged bronze wheel was employed and 2) The ends of the lines are shallow and narrow, and the middle wide and deep. The research group maintained that the entire decorative scheme was created using the bronze emery wheel.

The engraved line décor on Liangzhu Culture jades is created with a pointed flint stone implement. The engraved lines of the human and animal masks on Liangzhu jades are refined, flowing and their flexures are far much larger than that of the Erlitou jades. The first criterion of the Art Research Group of the Beijing Jade Carving Factory maintaining that only a bronze implement could have done is clearly insufficiently demonstrated. As for their second criterion, there is no evidence of an arc-shaped concave trough, and for this reason there is no proof for use of a hand or emery carving.

Certain scholars have maintained that the double sunken lines of the animal mask on the jade from M373 at Anyang (66ASM373) were created by a rotating made using a small emery wheel. The reasoning is that 1) the two ends of the line are shallower and the middle of the line is deeper and 2) where the line twists and turns it appears to be branching or forking. However, the 1) did not mention whether an arc-shaped bottom in the middle of the line is present, thus there is no way to solve the issue of the using of hand-held tool or emery

wheel carving. And the 2) is difficult to be corroborative evidence for emery wheel carving: the sunken lines of the animal mask are rather straight and wide, each wide straight line is made with a hand-held carving tool that has been repeated many times, thus there is no firm evidence for the rotating made by an emery wheel.

Still others consider that the curving sunken line on the upper limb of the jade tiger unearthed from a mid Western Zhou tomb at Rujiashuang in Baoji, Shaanxi, was worked with an emery wheel. Because no one can offer an explanation for this, it is a difficult position to maintain.

In addition to the discussion of examples examined with the naked eye, following the traces subject to microwear research we may make the following observations:

1. The methods used to work jades unearthed from the Shang tomb M54 at Huayuanzhuang Locus East, Yinxu, Anyang and from the Western Zhou tomb at Zhangjiapo, Chang'an, Shaanxi, involved a sandstone type blade to cut the jade slab and a string cutting method, as well as a stone flake or stone core to directly scrape or rub against the jade material.

2. Due to microwear trace analysis it is evident that the emery wheel was used on the late Spring-and-Autumn Period jade carvings from the tomb of Duke Jing of the Qin State at Fengxiang, Shaanxi and the Spring-and-Autumn jade headpiece of a girdle pendant unearthed from a Han tomb at Sanjiaowei, Tianchang, Anhui. The metal emery wheel created a long straight line consisting of multiple short straight lines attached successively (Figure 14). We determined that the emery wheel was very thin, measuring approximately 1-2mm thick and was extremely hard, and for this reason could only be made of metal material. In the *Heming* 鹤鸣 (The Crane Ringing) chapter of the *Shijing* 诗经 (Book of Poetry) it is sung: 'the stones that mar the hill will grind the corn Those stones that mar the hill will polish gems (它山之石, 可



Figure 14 The jade headpiece of a girdle pendant of the Spring-and-Autumn Period unearthed from Han Tomb M1 at Sanjiaowei, Tianchang, Anhui and the wheel-cut traces on its dragon motif.

以为错……它山之石，可以攻玉。English translation by James Legge)” hinting that during the Western Zhou Dynasty metal tools to work jade had still not been adopted. Our conclusions based on microwear analysis appear to corroborate literary records – an outcome not by chance or coincidence.

The appearance of the emery wheel during the Spring-and-Autumn Period

From the Neolithic Age through Western Zhou, those owning jades were limited to a small portion of the upper classes of society, including state lords and aristocrats. They depended upon clan members or their own retainers to create jades; they were not produced in a large scale. The Shang jade workshop at Xiaotun Locus North, Anyang approximated 6 by 2.5sq m in size, which at the time could contain three to five jade workers. During the Western Zhou, the jade working area was considerably larger but under the rule of “handicraftsmen and merchants are fed by the officials”, the work continued to be run by craft labor employed by the royal court and aristocrats. At this time production and the economy were still not advanced. The precious jades were not marketed. According to a paragraph in the *Wangzhi* 王制 (the Royal Regulations) chapter of the *Liji* (Book of Rites): “Those who had rank-tokens, the long (*gui*-scepter) or the round (*bi*-disc), and gilt libation-cups were not allowed to sell them in the market-places (James Legge's translation).” An inscription on the bronze Wei *he*-pitcher unearthed in 1975 from a tomb in the reign of King Gong of the Western Zhou Dynasty at Dongjia Village in Qishan, Shaanxi records a farmland trade paid with jade artifacts. From the Neolithic Age onwards, tools and crafts used for working jade appeared to have satisfied society's needs.

By the time of the Spring-and-Autumn and Warring-States Periods, private land ownership and private urban commerce had evolved to the extent that every aspect of society was greatly stimulated, and major changes took place. Extortion by wealthy state lords and aristocrats led to flaunting one's own wealth and striving for the most glamorous artworks, in particular seeking out the most beautiful jade piece. In addition, the love for jade and its association with virtue increased and underscored the influence and power of jade. Jade served as a symbol of status for lords and ladies; jades were extremely popular ornaments. According to the *Yuzao* 玉藻 (the Jade-bead Pendants of the Royal Cap) chapter of *Liji*: “Anciently, men of rank did not fail to wear their girdle-pendants with their precious stones (jades; James Legge's translation),” and in the *Shijing* there are many instances of this circumstance. These ladies and lords might not own jade-working slaves; their jades now were sought on the market. According to the *Zihan* Book in the *Lunyu*; Zigong said, ‘there is a beautiful *gem* here. Should I lay it up in a case and keep it? Or should I seek for a good price and sell it?’ The Master said, ‘Sell it! Sell it! But I would wait till the price was offered (James Legge's translation).’” In the record of the 16th year of Duke Zhao in the *Zuo*zhuan

it is recorded that the Great Minister Han Xuanzi of the Jin State desired to procure a jade ring from a merchant of the Zheng State through the Zheng Government but was refused. During the Spring-and-Autumn Period the story about the jade *bi*-disc of He records that the leading role of Bian He as just an ordinary person but was expert in distinguishing true jade. The story underscores the popularity at the time for jade as a highly valued craft amidst ordinary people.

The desire for high quality jade based on material, shaping, and decorative motifs, became widespread throughout the realm by the Spring-and-Autumn Period. As a competitively sought object in trade (as measured through increased rate of production, reduced waste, and creation of beautiful and refined jade artworks) production was expedited and the working of jade revolutionized through the introduction of the metal emery wheel and wheel carving, just as related above based on microwear testing and examination.

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Postscript

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