~~~rc- Philosopher-Artisans of a Forgotten World- Reflections from Ancient Chinese Mirrors:

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1. Background

1.1 Bronze in Ancient China

Bronze casting technology had been known in China since at least 2750 BCE, which is the earliest known bronze object to date (Shoukang 1986). Bronze was a core component of the ancient Chinese world, because it was cast to serve the principle affairs of the state: ritual and war. Control of bronze objects not only meant control of access to heaven since bronze was the principle material for ritual objects but also the instruments of war (Chase 1991).

Resources required to make bronze were within the borders of Han China including copper, tin and lead. 800 copper ore deposits are known in modern China, and most produced copper in ancient times (Shoukang 1986). Bronze smithing required a knowledge of which alloy should be used for a particular use so that they had very good control of alloy composition and their properties.

Origins of bronze in the modern geo-political borders of China were not exclusively of Han Chinese invention. The ancient village of Cherchen in Xinjiang Uyghur Autonomous Province provides incontestable evidence that Indo-European Bronze Age cultures had penetrated the borders of modern China before the Shang period and that the villagers of Cherchen had a knowledge of bronze smithing. These Xinjiang discoveries have led to a major paradigm shift in the concept of bronze-working in China. Then, too, are the discoveries in Ban Chiang in the 1960's where the discovery of pre-Shang bronze working was a major component of the culture of the Viet and Thai. In addition, the culture surrounding the alien Sangsandui people in southern China, highlights the parallelism of the development of bronze working in pre-Shang China.

2. History of Chinese Mirrors

Mirrors may have evolved out of circular reflecting disks, that may have been used to concentrate the sun's rays to light a fire (concave) or may have been used for purely vanity's sake. This utilitarian phase, however, was minor. Cultures to the north of the Shang and early Zhou states, including Siberian, Turkic-Mongolian and Manchurian were rarely engaged in the manufacture of trite looking-glasses to see oneself. Their primary purpose was reflection -- on the world, the cosmos. Indeed, the artisans who designed them were philosophers who invested their visual motifs with recondite meanings as they linked their patrons to an unseen world that was embodied in metaphors and symbols of eternality.

Symbolisms were embodied in the design elements of the day, so that when we approach their symbols in this modern age we must immerse ourselves in the recondite knowledge of the ancients who produced them and cast ourselves in the role of patrons of this highly evolved art of eternity.

Design elements on the Chinese mirrors, from the Later Chou, the period of the Warring States, and the short-lived Chin Dynasty (6th through the 3rd centuries BCE) appear abstract and enigmatic. Below their surficial calm they reflect a psychological turmoil of a Chinese mentality struggling in the midst of civil war, economic uncertainty, and the collapse of a feudal system that ruthlessly sought to impose its will on a nation fractured by terror.

The result is mirrored in the design elements we find on mirrors of this period, for they are revealing testimony to the power of the artisan-philosophers who were able to capture in images -- as poets in words -- the pulse of the people and their ethos. The calming effect of mantras and repeated ritualistic formulae were embodied by these masters of the visual image in their carefully crafted circles of reflection -- designed in an effort to ward off disaster. The apotropaic intention of these repetitive devices was effective, since we know the numbers of these mirrors flourished and we know that they were replicated many times. The artisan-philosophers were victorious over the forces of darkness in their production of these "abstract" design mirrors of the Later Chou, the Warring States, and the Chin dynasties in producing their mirrors of light.

The simplest and most basic patterns, con­stantly recurring on these mirrors, con­sisted of a broad band incised within the outer rim, and a second band circling the boss at the center, with a relatively simple design filling the space between them. The ground design was scrollwork suggesting writhing clouds (tight cloud-scrolls -- was the ancient emblem of the Sky), over which is sometimes im­posed a linear pattern made up of interlaced dragons. So obvious, yet so recondite and ancient -- dragons interlaced as though in a yu pia, the ancient perforated jade which was the ancient Chi­nese emblem of the Sky. The meaning is clear. The forces of darkness are now in harmony and are overcome.

A cloudlike ground underlies or contains, a celestial dragon whose head forms a loop-boss. An "open" center immediately recalls the perforated jade disc *(yu* pia) often ornamented with small, tight cloud-scrolls, which was the ancient Chi­nese emblem of the Sky.

2.1.Pre Chinese mirrors

2.1.1. Laioning

One pre-Chinese Asian mirrors comes from the modern Chinese Province of Liaoning and is made of jade, a prized material thought to have auspicious qualities. (Fig. 1)

2.1.2 In addition, undecorated disks have been discovered in burial tombs placed both on top of and next to the deceased probably to capture the reflective glow of the sun and speed the deceased on their journey. Some of these were related to shamanistic activities of various Siberian groups.

2.2 Earliest Chinese Mirror



Figure 2. Drawing of Earliest Chinese Mirror, Xia Dynasty (2100-1600 BCE) from O’Donoghue, D. M. 1988

The earliest decorated bronze mirror is 9 cm in diameter and has a simple seven -pointed star against a hachured ground (Fig. 2). It was discovered in a tomb in modern day Qinghai province and dates to the Xia Dynasty (2100-1600 BCE).

2.2.1 A mirror with a similar star-shaped pattern is from Atlantica

Figure 3. This represents a further refinement in the representation of the star pattern as a series of five continuous arcs and the hachured ground has been replaced with a ground of hooked feather-like scrolls and granulation. Both fig. 2 and fig. 3 have stars with odd numbers of points, seven and five respectively.

2.3 eastern Zhou era (771-256 BCE)

By the eastern Zhou era (771-256 BCE), mirrors attained the status of a unique object in the Chinese tradition with their form and decoration becoming distinctive among the other bronze objects of the period (O’Donoghue 1988).

The earliest archaeological evidence for mirror production in China was found at Houma, a foundry site in Shanxi, where ceramic casting molds were discovered. Shanxi is also the home of Sangsandui, an early bronze foundry with a mysterious history. The major period of production at Houma was 600 - 500 BCE, although foundries may have begun to appear earlier at the site (O’Donoghue 1988). Mirrors were initially produced in small numbers, but came to be a major production type during the late Zhou and Han Dynasties. To satisfy the demand of the court and court officials, government foundries were located in dynastic capitals or at times, secondary capitals. Regional centers were also active, especially those with copper mines in their vicinity and a sufficient urban development to ensure a high level of consumption as in Shaoxing, Yangzhou and Huzhou (Chou 2000). Mirror production flourished from the Warring States period (475-206 BCE) until the Tang dynasty (618- 906). They were expensive luxury goods with only people from the privileged classes being able to afford them. It was during the Tang dynasty that private workshops, as opposed to government foundries, arose and spread probably due to the rising merchant class being able to afford mirrors (Chou 2000). Bronze mirrors continued to be produced after the Tang dynasty, but not to the same extent. During the middle of the Qing dynasty (18th c.), they began to be gradually replaced by glass mirrors, and an industry, which had continued for almost 4000 years, came to an end (Shoukang and Tangkun 1993).

2.3 Form of Mirrors

The majority of mirrors are round, but square and rectangular mirrors have also been produced. The back was decorated while the front was finely polished creating the reflective surface. The decorated side of the bronze was full of symbolism especially in the earlier mirrors. The Chinese believed that by using symbols representing the universe, it would be possible to acquire some of the universe’s power to gain both strength and protection from evil. For example, round shapes represented Heaven, the Earth was square and small domes represented stars and constellations. Cast inscriptions were added to the decoration of mirrors beginning around 200 BCE during the Western Han period (Lawton 1982). The inscriptions, like incantations or prayers, were meant to attract supernatural powers and bring good fortune for the living or, if placed in tombs, to assist the dead by keeping evil spirits away (Bulling and Drew 1971). The mirror could be held in the hand or grasped by a cord passed through the pierced knob on the back. The knobs are often simple domes, but can be decorative and some even take the form of an animal. Besides being hand held, it is also assumed that mirrors were placed on stands or frames, but very little evidence has survived to substantiate this claim. Images of mirror stands are found in numerous art sources including paintings and carved stone (Yang 1996). These stands were probably made of wood and did not survive, but a Han period bronze mirror and its gilt bronze stand have survived, as is seen in Figure 2. Occasionally, mirrors were made with handles. The earliest excavated ones date to 2000-300 BCE and were discovered in tombs in Xinjiang, the westernmost provincial region of China (Mei 2000). They then do not seem to be found again until the Tang (618-906) or Song (960-1279) dynasties (Yang 1996). The handle appears to be a Western influenced addition and was never extensively used on Chinese mirrors. This basic form of the mirror as a cast metal object with a highly polished reflective surface and a back with relief decoration remained unchanged throughout the approximately 4000 years of bronze mirror history in China. The overwhelming majority of these mirrors were made in a single cast and after polishing the surface, no other applied decoration was added. The following are some examples of the small minority of mirrors that vary from this norm.

2.3.1 Double Plate Mirrors

During the Zhou dynasty, two layer mirrors were produced, and HUAM has six of these rare mirrors in its collection. They were made in both square and circular form and are constructed of two pieces. One section has a raised rim allowing the second section to carefully fit into it. The front reflecting plate can be inserted into a slightly larger back or, vice versa. There are no rivets to join the pieces, and they seem to be held in place by friction and perhaps with the help of an adhesive. Some double plate mirrors, including one at Harvard, have their plates attached by cartouches that bridge the junction of the two pieces in numerous places as is seen in Figure 3. The mirrors were adorned with two types of decoration: turquoise inlay (Fig. 4) and circular metal inlays (Fig. 5). The small pieces of irregularly shaped turquoise were adhered into straight walled channels that appear to be cast. The adhesive on one mirror (1943.52.155), which was analyzed by FTIR, was a natural gum. The circular silver and gold inlays were composed of a thin layer of precious metal attached to a lead dome possibly by cold pressure welding. According to Jacobson, cold pressure welding was an early technique used during the Zhou dynasty before amalgam gilding was invented. The bronze surface may have been prepared chemically, then the metal sheet was applied to the surface by careful preheating and burnishing (Jacobson 1984). Another possibility is amalgam gilding because mercury was detected on three of the silver inlays on 1943.52.152. Mercury gilding with both silver and gold was used in China by the late 4th century BCE The metal was dissolved in boiling mercury, the resulting paste smeared on an abraded surface and the piece was fired below 500°C (Jacobson 1984). Once the metal inlays were manufactured, they were fitted into sockets in the bronze. There were no traces of adhesive in the sockets of missing inlays indicating they may be held in place by friction alone.

2.3.2 Gold and Silver Backed Mirrors

During the Tang Dynasty, the decorated side of some mirrors was made of gold or silver sheet with repoussé designs (Fig. 6). The metal sheet was set into a recess in the bronze and may be held in place with adhesive. Adhesive visible at the gold bronze interface on one mirror (1943.52.159) was sampled and identified via FTIR as an animal glue and flour paste. It is not known for sure if this is the original adhesive because it could also be a later restoration. This type of mirror is often quite small (about five centimeters in diameter), but can range up to about sixteen centimeters in diameter. They were produced in small numbers, and due to their expense, they must have been a high status object.

2.3.3 Painted Mirrors

Mirrors were also painted although few examples have survived intact making these mirrors extremely rare. Harvard has one example in its collection (Fig. 7) depicting numerous figures and horses against a red background. Analysis of the pigments was undertaken at the Fogg Museum in 1937 and showed that the red paint was cinnabar, the white was chalk, the brown was a mixture of cinnabar and charcoal black, the blue was azurite and the dark blue was smalt. The mirror was reexamined in 1956 and a new sample of the dark blue revealed there was indigo underneath the smalt.

2.4 Uses of Mirrors

Mirrors had many uses, which were both practical and spiritual. They entrapped reflections that had previously only been seen on the surface of still water. The same as today, this reflective surface was used as a vanity mirror. Early on, craftsman began the production of convex mirrors, which would reduce the size of the reflection so the face was seen in proportion. Mirrors were also used to start fires from the sun and may have been used to gather dew in their concave backs. Dew was valued for its purity and was used by Taoist priests for purposes of divination and worship (Hall 1935). In addition to these practical uses, mirrors were valued for ritual purposes associated with the power of reflection. Chinese spirits, both good and bad, are supposed to throng the earth and plaque the living. Mirrors have the power to ward off evil since the form of any invisible spirit will become visible when reflected in the mirror. Taoist scholars are said to have worn a mirror hanging down their back so they could pursue their studies without fear of being harmed by the invisible spirits all around them (Rupert and Todd 1935). Nothing was considered more powerful in warding off these evil spirits than the threat of making them visible in the mirror. Similarly, marriage mirrors were created for a bride to carry on her lap during the wedding procession and were later hung over the marriage bed to repel evil forces and ensure continuing good fortune for the couple. These mirrors have auspicious symbols chosen to express the idea of marital unity, especially pairs of animals. During the Tang dynasty, the phoenix represented a happy omen in marriage, and they were usually depicted on marriage mirrors of that time period (Cammann 1946). According to ancient tradition, the phoenix is monogamous and has a deep affection for its mate making it the perfect symbol to use on a marriage mirror. Not only the living, but also the dead were protected by mirrors. In burial, mirrors were often placed face up on the breast of the deceased to protect them from evil spirits. Mirrors were also buried along side their owners with food, drink and the other prized and necessary possessions to ensure a comfortable eternity (Rupert and Todd 1935). Mirrors have continued to be used over the years in China and can still be found in private homes, on shop fronts and on public buildings as protection against the spirits.

2.5 Molds

The earliest mirrors were made using direct, ceramic molds. They were made in two sections: one side was flat for the reflective side and the other side contained the decorative back. The decoration was created directly in the clay by carving and/or by the use of stamps. In general, this resulted in a crisp and two-dimensional design. The clay was fired and then used to produce only one mirror because the mold was broken to remove the cast bronze. During the Han dynasty, soapstone molds were occasionally used. The advantage of using stone to cast bronze was that the foundry could reuse the mold multiple times. It is not known for certain if the molds were used to cast bronze, because they also could have been used to create a wax positive for lost wax casting. Lost wax casting was known in China from about the 5th century BCE (Moy 2005), and although the date it was first used for mirrors is unknown, it appears to be the exclusive technique from the Tang Dynasty (618-906) onwards. Lost wax casting had two advantages over direct ceramic mold made mirrors. Numerous copies of a mirror can be produced from one mother mold, and there was much more design freedom because more three-dimensional and undercut shapes were possible.

2.6 Finishing

The front, reflective side of mirrors was highly polished and often burnished leaving no abrasive scratches. The finishing of the back, decorated side differed depending on the manufacturing technique (Chou 2000). In general, the finishing work on direct ceramic mold mirrors tended to be limited to polishing the raised, flat designs, chiseling concave linear design elements and the rotary abrasion of depressions, small domes and center knobs. The background was left as cast with no finishing work carried out on it (Fig. 8). In contrast, the designs on lost wax cast mirrors were more extensively finished with nearly all surfaces smoothed including the background (Fig. 9).

2.7 Composition

The composition of the bronze alloy to cast the mirrors was carefully chosen. The mirrors are composed of about 70% copper, 25% tin and 5% lead. As Chase (1991) points out, pure copper is difficult to cast because of its high melting point, and the fact that it absorbs gasses, especially oxygen, while molten. After the copper is poured and cools, gas bubbles form resulting in a very porous metal. The addition of tin not only lowers the melting point, but also acts as a deoxidizer helping to prevent porosity. As more tin is added, the color changes from red to yellow to silver and the hardness and brittleness increase. The addition of lead does not change the color, but up to three percent increases fluidity, helping the alloy pour more easily during the casting process and any amount facilitates the ease of grinding and polishing. Lead does, however, decrease the tensile strength, and leaded bronzes cannot be hammered or they will break. The copper-tin-lead ternary alloy that was used was very hard and brittle, but the silver colored metal took a very good polish and was ideal for a reflective surface. The mirrors, however, are also found with a lustrous black patina. The color difference is one of the most intriguing aspects of these bronzes. The question is whether the black color was intentional or was the result of a silver colored mirror being buried for hundreds of years. This issue has been widely studied, debated and is still not fully understood.

3. Analytical Techniques

The guiding principle in choosing the analytical techniques used to examine the mirrors was that they should be as far as possible non-destructive and preferably non-invasive. With this in mind, the following techniques were chosen:

3.1 Microscopic Examination

Low power binocular microscopy was used to examine the bronzes, and the resulting observations were recorded on a survey form for each object. Particular attention was paid to identifying traces of manufacture including any evidence for lost wax casting and any finishing work like polish marks, rotary abrasions and chisel marks. In addition, the different patinas and corrosion products were examined in depth.

3.2 Examination Under Ultraviolet Light

The mirrors were examined under ultraviolet light using a Spectroline Black Light Long Wave Ultraviolet Light Model B-100. The lamp was held approximately five inches from the mirrors and slowly moved across the entire surface looking for overpaint and adhesives from previous restorations.

4. Results and Discussion

4.1 Corrosion

The first thing that stood out about these mirrors was the spectacular natural corrosion. Very few early bronzes survived without being buried. As a result, the typical archaeological corrosion products were found on the mirrors, the most common being tin oxides and copper carbonates. The tin oxide, which forms on the surface of these high tin bronzes, was a transparent, insoluble, passive layer that protected against further corrosion. This was why many of the mirrors had large areas of very well preserved metal. When the tin oxide layer was disrupted, the metal below corroded resulting mostly in cuprite, malachite, azurite and copper chlorides, but lead corrosion products were also present.

4.2 Redeposited Copper

Redeposited copper was also found on the surface of many of the mirrors. Researchers in China examined forty-five corroded bronze fragments excavated from Tianma-Qucun, Shanxi, a Zhou Dynasty site (1027 BCE – 221 BCE). Besides discovering redeposited copper in the structure of thirty-three metallographic samples, they found a few fragments with copper visible on the surface (Wong and Merkel 2001).

4.3 Textile Pseudomorphs

Many of the mirrors were buried inside or in direct contact with textiles leaving textile pseudomorphs in the corrosion layers (Fig. 10). These pseudomorphs yield information on early Chinese textiles when actual examples of weaving do not exist, and researchers have studied them identifying the fibers and thread counts.

4.4 Metal Composition

The elements present on the metal surface of the mirrors can be visually inspected as the products of copper oxidation. Although this technique is not ideal for examining corroded metal surfaces, it did prove to be very useful as a quick alloy assessment. It verified that some mirrors were low tin bronze, some were high tin bronze and some were leaded high tin bronze. It is to be expected that numerous other elements would be detected using spectrophotometer such as those elements including silicon, iron, calcium, potassium, manganese, chlorine and titanium that migrated into the metal from the surrounding earth while the mirrors were buried. These expected results are consistent with elements found in published soil analyses (Chase and Wang 1997) although the titanium could also have been introduced as a restoration material.

4.5 Restoration Materials

Cracks, break lines and other surface damage could be disguised with false corrosion products, and examination under ultraviolet light was instrumental in identifying that none showed this form of treatment. Arsenic in an area of green corrosion probably indicates the use of emerald green pigment. Blues could be pulverized azurite, but ultramarine and cobalt blue can also be used. Greens can be pulverized malachite and and lead carbonate could produce the whites. Researchers have discovered false corrosion products on ancient Chinese bronzes. Gettens (1969) analyzed numerous objects and found false corrosion products composed of ground malachite and azurite and pigments like emerald green, Prussian blue, artificial ultramarine and zinc oxide, barite, cobalt and iron oxide.

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