

# On the piece mold-casting technology of the bronze *gui*-tureens in the Shang and Zhou Dynasties

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## Abstract

Bronze *gui*-tureen is an important category of bronze vessels in the Shang and Zhou Dynasties; during the about 1500 years of its use, *gui*-tureen has had complicated evolution in the shapes and styles, some of which were because of the progresses of the casting techniques and some were because of the social demands. This paper discusses the interrelationships among the shapes, decorative patterns and casting techniques of bronze *gui*-tureens and the social demands, especially the influences

to the evolution of the double-handles given by the technical and social elements. The casting techniques of *gui*-tureens could roughly reflect the relationships among the productive and social backgrounds and the general bronze vessels as ritual vessels in different temporal stages.

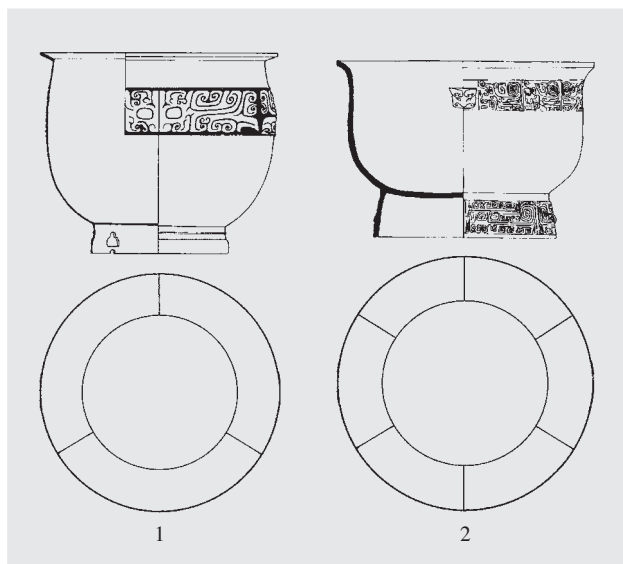
## Introduction

The bronze *gui*-tureen is one of the most important vessel types among the Shang and Zhou ritual bronzes. It appeared throughout the Bronze Age (ca. 17th–3rd centuries BCE) in China, and its evolution represented the whole process of the rise and decline of Chinese ritual bronzes. In terms of bronze mold-casting technology, the shape of the *gui*-tureen, typically a round body with a ring foot, is representative among the vessel shapes of Chinese ritual bronzes. Therefore, a case study on the changes in the casting technology of the *gui* presents an ideal lens through which we can see the evolution of ritual bronze piece mold-casting technology. Our current understandings on the bronze casting technology have enabled us to discuss the different casting techniques in different periods of the Chinese Bronze Age and the trends of development. From these understandings we can make further observations on the connection between the evolution of bronze piece-mold casting technology and the social background of the ritual bronze usage in the Shang and Zhou Dynasties.

## Two basic types of the bronze *gui*-tureens and the developments of their casting mold-making techniques

The shape of a bronze *gui*-tureen can be classified variously according to whether or not it has two handles on its body, or whether there is a square base under the ring foot, or whether it has additional feet below the ring foot, and so on. Whether a *gui* has handles and how the handles are attached to the body are the main factors influencing the making of the molds used for casting the *gui*. In what follows we will discuss the evolution of the casting mold making techniques of the two types of *gui*: one with handles and the other without, respectively.

1. The early development of the *gui* without handles. The earliest *gui* we know to date is the animal masked one of the late Erligang Period discovered in Tomb 2 (M2:2) at Lijiazui at Panglongcheng Site in Huangpi, Hubei (Figure 1:1). During the following Yin Xu Period, this type of handleless *gui* further develops. It appears often in high-ranking burials, and there are often more handleless *gui* than those with handles. For instance, in Fu



**Figure 1** The handleless *gui* and their piece-mold assembly patterns.

1. The *gui* from Lijiazui at Panlongcheng Site (M2:2);
2. The *gui* from Dasikong Village at Yin Xu Site (M539:30).

Hao's tomb at Yinxu Site in Anyang, Henan, four of the five unearthed *gui* are handleless. But in the early Western Zhou Dynasty, this type of *gui* decreases dramatically. It is almost completely replaced by the *gui* with handles. During the time from the Erligang Period to the early Western Zhou, this type of handleless *gui* has two stages of development: the first has a simple form and the second more complicated. In the simple form stage, the *gui* is cast using three pieces of outer molds in addition to the inner and the bottom molds. For example, the Lijiazui *gui* (M2:2) from Panlongcheng has three groups of animal mask design decorating the belly (Figure 1:1). These three patterns are bordered perfectly with the three seams where the three pieces of outer molds join, and no other seams are found. This means that in the casting of this *gui* only three pieces of outer molds were used.

In the more complicated form stage, six pieces of outer molds are used. That is, in addition to the three mold seams as in the previous stage, three more seams could be found along the symmetrical axes of the three animal mask patterns (Figure 1:2). This casting mold assembly is common from Phase II of Yinxu Period to the early Western Zhou Dynasty, and disappears after the handleless *gui* declines. The *gui* of Yinxu Period often have six flanges, which align with the jointing seams of the six pieces of outer molds.

In the fabrication of circular vessels such as the handleless *gui*, the most economical and practical choice is to trisect the outer mold. That's why other types of ritual bronzes, such as *zun*-vessel and *lei*-wine jar of the Erligang Period, like the *gui*, are also cast in three pieces of outer molds. While ritual vessels of the Yinxu Period have more complicated piece-mold assemblies. In the case of *gui*, the number of the outer molds doubles from three to six. Similar trends can also be observed in the casting of other ritual bronzes. As in the case of the handleless *gui*, the circular ritual vessels are all cast in three or the multiple of three pieces of outer molds. This becomes the basic principle for the casting of the circular bronze vessels.

Another property of the bronze vessels related to casting technology is the decor of the vessels. Since the outer molds are divided into three pieces, the decor is also divided into three groups, and the jointing seams of the molds define each unit of the decors. Before the late Western Zhou, almost all the division of the horizontal decors on bronze vessels matches that of the piece-molds. On the other hand, decors also influence the division of the piece-molds. In the aforementioned complicated stage, the division of the outer molds in multiple of three is mainly to meet the demands for more refined and multi-layered decor which becomes popular after Phase II of Yinxu Period. This kind of dynamics between the shapes, decors and the casting techniques of the vessels last till the Spring-and-Autumn Period.

2. *Gui* with two handles appear later than those handleless ones, but quickly become the mainstream. Before the Yinxu Period, occasionally there are *gui* with

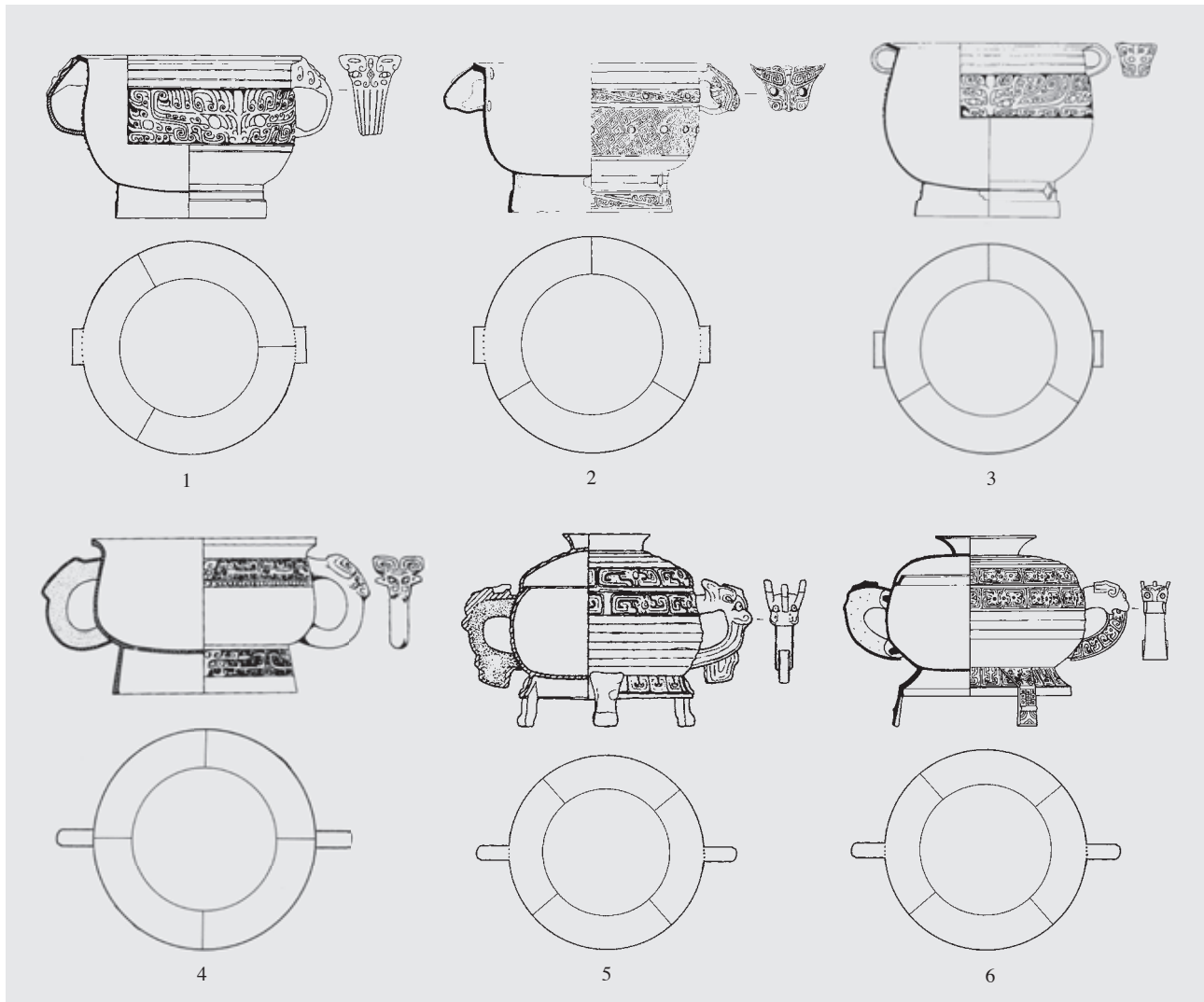
two handles. But by the end of the Yinxu Period, they increase dramatically in numbers. During the Western Zhou Dynasty and the Spring-and-Autumn Period, the assemblage of the *gui* with the *ding*-tripods in ritual presentation becomes the common and popular. After the decline of the importance of ritual vessels in the Warring-States Period, *gui* only appear occasionally in high-ranking burials. The changes in the casting techniques in the fabrication of the *gui* with two handles relate mainly to the different treatment of the two handles. The following six types represent its technical evolution in six stages:

Type I: the outer mold is divided into three pieces, and the mold assembly is not different from that for the simple form of handleless *gui*. The three seams where the molds join separate the three units of animal mask decors on the body, and also align with the three holes on the ring foot. The earliest handled *gui* comes from Tomb 1 of Lijiazui (M1:5), belonging to Phase I of the mid Shang Dynasty at Panlongcheng Site (Figure 2:1). The two handles are later cast onto the belly after the main body of the *gui* is finished. It is worth noting that only one of the handles aligns with one of the seams, and the other handle is placed in the middle of one unit of the animal mask decors. The placements of the two handles and the three seams are asymmetrical. The relative positions of the two handles in relation to the three seams are the same to those of the two handles on *ding*-tripods and *li*-cauldrons to their three seams. All these relations are restricted by the piece-mold casting technology of their time.

Type II: the mold assembly and the way the two handles connected to the body are the same as in Type I, but the two handles are now placed symmetrically in relation to the three seams and the decors. The two handles on the handled *gui* with dragon heads, studs and *leiwen*-square spiral pattern found in Chenggu Bronze Group (Figure 2:2), belonging to the late stage of the mid Shang Dynasty, are also cast onto the body. The handles protrude perpendicular to the wall of the vessel, thus in the mold assembly the molds for the handles should be also placed perpendicular to the wall of the *gui*. It is technically a difficult task. But this is how the handles are cast in the early form of the *gui* with two handles.

Type III: the mold assembly and the placement of the two handles are the same as those in Type II, but the two handles are cast together with the body of the *gui* at one pour. For example, the *gui* found from Yangjiawan at Panlongcheng Site (M11:13), datable to the Yinxu Period, is such a case (Figure 2:3). When the handles are cast together with the main body, a core is placed between the handle and the outer surface of the vessel, thus there are traces of the mold joints on the outer surface of the *gui*.

The placement of the two handles varies in the early period, which indicates that the technology for casting the handles is not mature enough. *Gui* with two handles have not yet fully developed. This is probably because of the technological limitations at the time. However, in these cases, the changes in the mold assembly are all related to



**Figure 2** Bronze *gui* with two handles and the diagrams of their mold assemblies.

1. Type I from Panlongcheng (M1:5); 2. Type II with dragon heads, studs and *leiwen* decors from Chenggu; 3. Type III from Panlongcheng (M11:13); 4. Type IV from Houjiazhuang at Yinxu (HPKM1601:R1078); 5. Type V from the cemetery of the Guo State at Sanmenxia (M2001:75); 6. Type VI from the sacrificial pits in Xinzheng (K2:12).

the placement of the handles and the way they connect to the body. One-time casting is the goal of technological pursuit. Thus, the appearance of the one-time cast handles in Type III meets the aesthetic demand for symmetry. But because the two handles in Type III are not placed along the seams of the outer molds, it is extremely inconvenient in the process of assembling the molds. The handles on the *gui* from Yangjiawan is smaller and simpler than earlier handles, which must be due to the technological limitation. It is under these circumstances that the handled *gui* made by one-time casting in Type IV appear in the Yinxu Period.

Type IV: the two handles are cast together with the body of the *gui* at one pour of metal, and the two handles align with the seams of the outer molds, which is common during the Yinxu Period and early Western Zhou Dynasty.

The belly of this type of *gui* is decorated with two or four units of decor, and the joints of two units align with the two handles. At the axis of each unit of decor there is an animal head. The seams of the outer molds, which are also the borders of the decor, and the symmetrical axes of the animal heads exactly quarter the vessel body. For example, the *gui* from M1601 (HPKM1601:R1078) at Houjiazhuang in Yinxu Site has two animal heads in high relief on the upper belly between the two handles, and three dragons in each side of the animal heads (Figure 2:4). But often the belly of this type of *gui* is decorated with two units of animal mask design, and during the Yinxu Period some *gui* have a flange below the animal head. These extensively decorated *gui* may have, in addition to the vertical division of the molds, horizontal division of the molds. But the principles for the mold assembly of

the body are the same as those for the handleless *gui* in the complicated form. All these technical treatments are for the purpose of fine decor on the vessel. On the other hand, there are also plain *gui* without any or with simple decors. In these cases, there are only two seams along the handles, and the technical treatment is rather simple.

The mold assembly of Type IV of *gui* marks a new stage in the development of casting technology. The handles align with the seams, thus it is easy to cast the handles directly out of the main body. Thus the handles are enlarged into a large semicircle in the shape of an animal crossing from the neck to the lower belly of the *gui* (Figure 2:4). From now on, the vertical semicircular animal-shaped handles become the standard form. In other words, the mold assembly for the two-handled *gui* begins to go beyond the trisection of the handleless *gui*, but begin to have bisection or the multiple of two parts division centered by the arrangement of the two handles. If we compare the handleless *gui* in the complicated form (Figure 1:2) with the Type IV two-handled *gui* (Figure 2:4), though the shape and the decor are very similar, the handleless *gui* has three units of animal mask decor, six-section division of the outer molds, while the Type IV *gui* has only two units of animal mask decor and quarter vertical division of the outer molds. For different shapes of the vessels, different mold making and assembling techniques are applied, marking the maturity of bronze casting technology.

*Gui* in Type IV appear in Phase II of the Yinxu Period, and rapidly spread to most of the two-handled *gui*, and reach its peak in the Western Zhou Dynasty. Among the 38 *gui* unearthed from the cemeteries of the Yu State near Baoji, Shaanxi, 36 are two-handled *gui* and both handles are cast together with the body at one pour. Moreover, 29 are cast with the mold assembly mode of Type IV. During this period, the handles become more and more ornate, and some *gui* even have four handles. But the basic principles for the mold assembly stay the same.

Starting from the mid or late Western Zhou Dynasty, the handles and the body of the vessel begin to be cast separately; further development in the mid Spring-and-Autumn Period is the use of welding to attach the handles to the body of the vessels. These are the last two stages of the development in the mold assembly of the *gui*.

Type V: The vertical seams of the outer molds are located in the either sides of the handles, so that the two handles can be easily welded onto the body of the *gui*. This type of *gui* appears in the mid Western Zhou, but is popular during the early Spring-and-Autumn Period. Such as the *gui* unearthed at the cemetery of the Guo State (M2001:75, Figure 2:5).

Type VI: the mold assembly and the placement of the two handles are the same as that in Type V, but the two handles are welded onto the body of the vessel through projecting stubs on the outer surface of the body. This technique appears in the early or mid Spring-and-Autumn Period, and since then it becomes the standard form of the mold assembly for bronze *gui* casting. Belonging to the

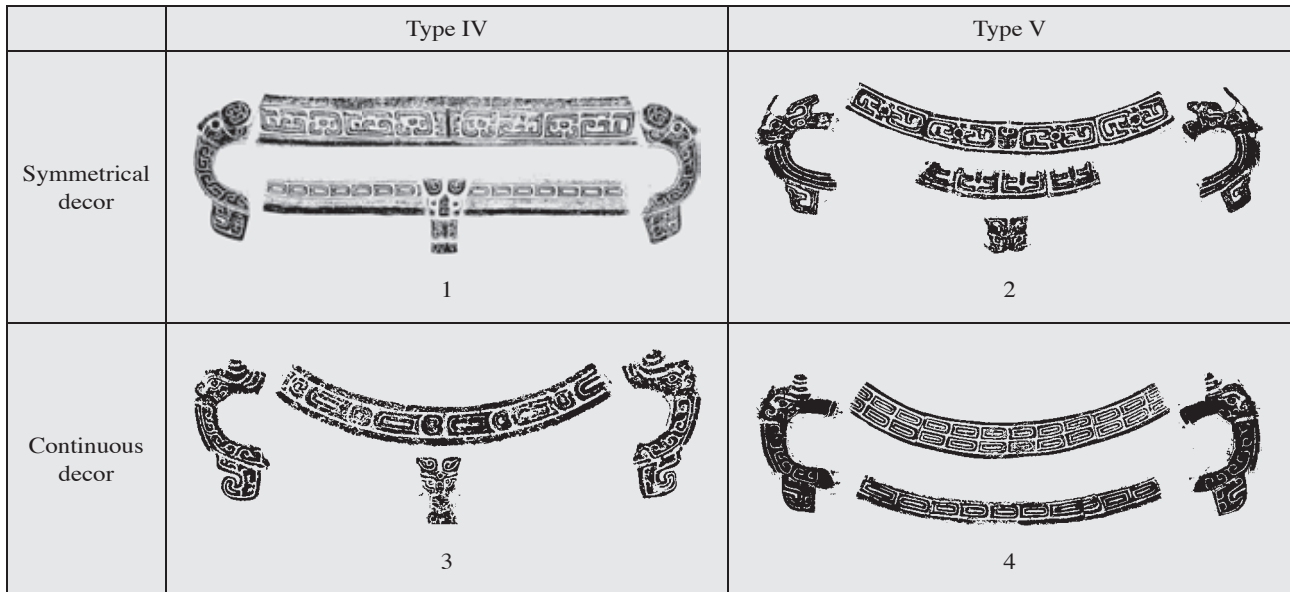
mid Spring-and-Autumn Period, the 16 *gui* unearthed at the sacrificial pits in Xinzheng all have their two handles welded in this way (Figure 2:6). A large number of *gui* are unearthed from burials of the Chu State of the Warring-States Period, such as the four *gui* with square base unearthed from M10 at Heshangling in Xichuan, Henan, all handles of which are welded onto the body.

The trajectory of the development of the mold assembly for two-handled *gui* is clear. When the two-handled *gui* first appear before the Yinxu Period, the changes in the mold assembly is centered on the joining techniques of how to attach the handles to the body of the vessel. First the joining method is simply cast-on. In the late Yinxu Period, the method of casting the handles together with the body at one pour becomes mature, and this mold assembly is used during the peak of development of the two-handled *gui*. In the Spring-and-Autumn Period, the technique of casting the vessel parts separately becomes popular.

### The trend of the technological development in the casting of the *gui* and the social background

In the evolution of the mold assembly for the *gui*, the beginning of Type V in the mid Western Zhou Dynasty marks a significant technological development in the casting of *gui*. This is the transformation from the technique of casting the vessel at one pour during the Yinxu Period and Western Zhou Dynasty to the technique of casting as separate parts and welding them together in the Eastern Zhou Period. But the process of this vital transformation and its social background are not very clear yet. It is during the mid Western Zhou that a great change in the style took place. After this, the bronze assemblages, the shapes of the vessels, the decor, the casting technology, and even the social meaning of the bronzes in early China changed dramatically. What is the motive for the development of casting technology? Does the technology influence the development of the vessel shapes and decor, or the casting technology is created to meet the demand of new vessel shapes and decor? This is an interesting question.

Starting from the mid Western Zhou Dynasty, there are two aspects of changes in bronze decors. The first is in the main motif: the animal mask, the bird, and other imaginary animal patterns since the Yinxu Period are replaced by the horizontal “s” pattern, the double-ring pattern, and the wave pattern (Figure 3). These newly appeared decors are mostly in the simple shape of a narrow band of ribbon. The other aspect is in the layout of the decor: since the Erligang Period, decors such as the animal mask all symmetrically display along an axis. The new decors break the old tradition of symmetry and begin to display the units of decor continuously (Figure 3:4). It is a long process for the continuous decor to completely replace the symmetrical decor finally. For example, the bronze *gui* unearthed at the cemetery of the Guo State and the Lu Bo Dafu 鲁伯大父 *Gui* in the traditional



**Figure 3** The relationships of the layout of the decors and the mold assemblies of the bronze *gui*.

1. Shili *Gui*; 2. Lu Bo Dafu *Gui*; 3. Meng Zheng Fu *Gui*; 4. E Hou *Gui*.

antiquarian collection, both datable to the early Spring-and-Autumn Period, still have the horizontal “s” patterns symmetrically display. Both aspects of changes have the tendency to simplify the decor and also to reduce the difficulty in making the decors.

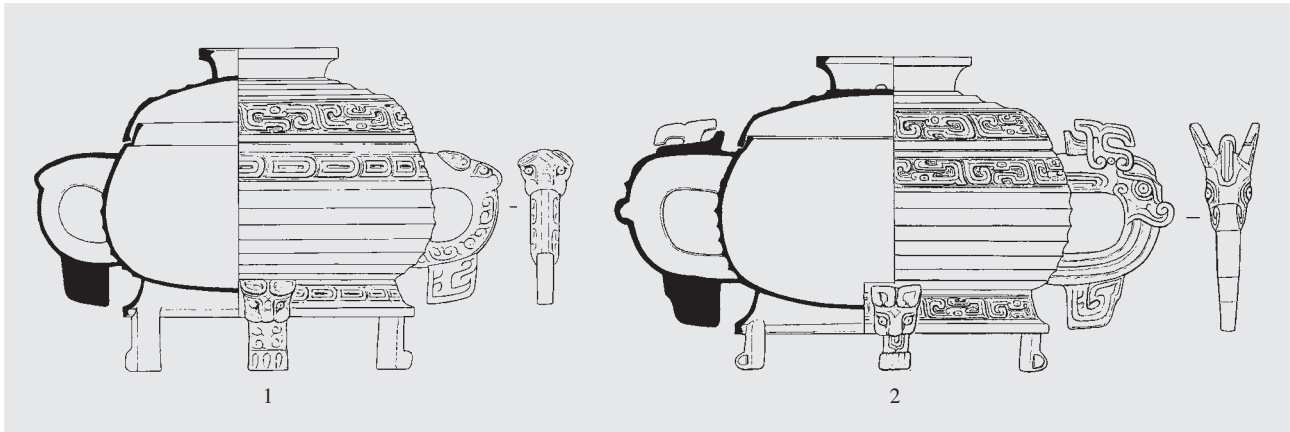
There seems no direct relationship between the appearance of the simple geometric decors during the mid or late Western Zhou and that of the Type V *gui*. Based on our observation on the 23 sets of *gui* of the mid or late Western Zhou Dynasty unearthed at Zhouyuan in Shaanxi, 15 sets are in the Type IV, and only four sets are in Type V. This indicates that the appearance of the two-handled *gui* with simple geometric decors do not correlate with the new casting technology. On the other hand, the Type V mold assembly also has no obvious cause and effect relationship with the layout of the decor. Among the *gui* with symmetrical decor, there are Type IV *gui*, such as the Shili 师夔 *Gui* (Figure 3:1), but also Type V *gui*, such as the Lu Bo Dafu 鲁伯大父 *Gui* (Figure 3:2). Similarly, among the *gui* with continuous decor, there are Type IV *gui*, such as the Meng Zheng Fu 孟郑父 *Gui* (Figure 3:3), and also Type V *gui*, such as the E Hou 噩侯 (Marquis of E) *Gui* (Figure 3:4).

All the abovementioned *gui* in Type V have high-relief animal head decor with long horns. Our observation indicates that other late Western Zhou *gui* with handles decorated with long animal horns also use the Type V mold assembly. Therefore, it is possible that the application of the long animal horns is the reason why these *gui* are cast using the method of separate pours of metals. Starting from the mid Western Zhou Dynasty, the two handles of the *gui* are often decorated in high relief. The top of the animal heads first has two snail-shaped or flat horns. It is relatively difficult to detach the molds of

the horns in high relief if the whole vessel is cast at one pour. Among the five San Che Fu 散车父 *Gui* with the same shape and same inscription unearthed from a bronze hoard at Shaochen in Fufeng, Shaanxi in 1960, two of the *gui* with the double-ring pattern have the horns flatly attached to the animal heads at the top of the handles, which belong to Type IV (Figure 4:1), while the other three *gui* with the horizontal “s” pattern have the horns in high relief on top of the animal heads, which belong to Type V (Figure 4:2). It is obvious that the two handles on the *gui* with double-ring pattern are cast together with the body of the vessel at one pour, while the handles on the *gui* with the horizontal “s” pattern are cast separately and then attached to the vessels. Comparatively, the handles on the former are smaller and closer to body of the vessel than those on the latter. This phenomenon can be shown clearly in these two types of *gui* in Figure 3.

From the above discussion, it is clear that the two handles in Type V *gui* are pre-cast in the late Western Zhou Dynasty, and are cast-on after the early Spring-and-Autumn Period. In joining technique, it is obvious that the casting-on technique is much easier than the pre-casting. Thus, the changes in the mold assembly in Type V reflect the development of the technical choice from difficult to easy. In considering the changes of the mold assembly from casting at one pour of metal to in separate pours, and again from casting-on to welding, it is clear that trend in technical development is the process of simplification over a long period.

In fact, after the formation of the Type VI mold assembly, the simplification tendency doesn't stop. First, the technique for welding the handles onto the body simplifies further. In the early and mid Spring-and-Autumn Period, the handles is attached to the vessel with



**Figure 4** The different mold assemblies of the San Che Fu *Gui*.

1. The San Che Fu *Gui* with double-ring pattern; 2. The San Che Fu *Gui* with horizontal “s” pattern.

a flux composed of mainly copper, such as those on the aforementioned *gui* unearthed from the sacrificial pits in Xinzheng. The test on an early or mid Spring-and-Autumn Period *gui* in the Freer Gallery shows that the flux is composed of 60.48% of copper, 22.9% of tin, and 9.4% of lead. After the mid Spring-and-Autumn Period, the handles and other appendages on ritual bronzes are joined with a low-temperature flux composed of tin and lead. A CT scan to a *gui* with wave pattern of the late Spring-and-Autumn Period collected in the St. Louis Art Museum shows that the handles are welded to tenons on the outer wall of the vessel and the air bubbles are formed during the cooling down process of the flux. Comparing with the copper flux, the use tin-lead flux is obviously much easier technically. But the strength of the connection is lower and the flux is prone to oxidization. That’s why handles on bronze vases and *gui* often detached from the vessels when unearthed in modern times.

The development of the mold assembly technology of the Shang and Zhou Dynasties reflect the production technology and social background of ritual bronze use in early China. In the early Bronze Age, that is, before the mid Western Zhou Dynasty, the ritual bronzes are in the rising stage of development. The changes in bronze production technology are not only to meet the social needs for different shapes, decors and the effects of ritual bronzes, but also to adjust and improve the effects of ritual bronzes. The appearance of the more difficult techniques such as the one-piece casting is invented for that effect. However, in the late Bronze Age, that is, after the mid Western Zhou Dynasty, the social prestige of ritual bronzes in society begins to decline. The bronze production becomes standardized and simplified, which reflect in the use of less difficult techniques of separate

casting and welding. All in all, the casting technology, represented by the mold assembly technique, on the one hand, facilitates the artistic achievement of the Chinese ritual bronzes, but on the other hand, reflects the social reality of the ritual bronze usage in early China.

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## Postscript

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