Metal and clay vessels

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METAL AND CLAY VESSELS

By

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B. A. University of Montana, 1966

Presented in partial fulfillment of the requirements for the degree of

Master of Arts

UNIVERSITY OF MONTANA

1967

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Dean, Graduate School

MAY 26, 1967
Date
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My thesis deals with the forming of bronze and clay vessels; the purpose of which is to explore the characteristics of the materials to readily interchange qualities of their visual and textural surfaces.

I was prompted to undertake this investigation because of the ancient Chinese bronze and clay ceremonial vessels produced with such great success during the Shang period in China; the Shang period being equivalent to 1,300 - 1,100 B.C. on our present calendar.

The emergence of the bronze vessel in China was preceded by roughly one thousand years of pottery work. The potters of the proto-Shang period eventually attained clay forms with highly smooth, decorated surfaces. It seemed to be a natural transition for the people of this time to move from the smooth clay vessels with intermittent rising to bronze vessels having much the same designs and general form. It is interesting to note the clay vessels of the Han dynasty (200 B.C. - 200 A.D.) strongly resemble the bronze vessels of the earlier Shang period in their overall form and glaze coloration.

I have used the shell investment for the cire perdue casting of the metal vessels.¹ The shell investment was developed by the Avnet-Shaw Art Foundry of New York five years ago; however this material was not available for purchase for some time.

Some 3 - 4 years ago Mr. Donald Haskins and Mr. Peter Voulkos began studying the feasibility of adapting many of the materials and methods used by industrial foundries for use in the small, privat-

¹See Appendix.
art foundry. The eventual availability of the shell investment material was probably the major industrial commodity attained and used by Mr. Haskins and presented to the public by him (4th National - International Sculpture Casting Conference, University of Kansas) in May of 1966.

This new approach to casting has greatly facilitated the artist-craftsman because of the ease with which the investment is applied, burned out and cast; as opposed to the bulky and most often faulty solid investment molds used by the foundryman for some four thousand years.

A wax positive must first be made for the cire perdue casting process. Whatever impressions are made in the wax will reappear in the metal. Working first in the wax does take away from the directness of execution, however one cannot work directly in the molten metal when it is in its most formable state without extreme danger of injury; consequently the only alternative available in treating the metal is to work on its surface after the piece is cast and allowed to cool. This is far too time consuming and impractical unless one has a bank of power tools with which he can attack the surface of the metal.

Commensurate with forming vessels which are visually and texturally richer in their surface areas I attempted to bring a certain amount of rigidness to my clay vessels, not only through the physical treatment of their surface but also through the subject the vessel deals with; i.e. clay vessels created as armored knights, the extreme rigidity of the metal transferred to the clay, fingerprints and
impressions of objects so readily a part of my clay vessels - found also in the metal vessels, the use of low fire metallic glazes to decorate the clay vessels and the multi-colored heat patinae on the bronze vessels resembling the vari-colored glazes on the handformed clay vessels.

I submit the following photographs of my work (presented in three stages) as evidence that an evolution has occurred in my work with bronze and clay vessels; specifically, that the cylindrical ceramic vessels prompted the simple cylindrical bronze vessels; that the ensuing ceramic vessels were a sophistication of the first series of both ceramic and metal vessels; that the above ceramic and bronze vessels were responsible for the latest development in working with the most recent bronze vessels.
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PART I
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Figure 2. Reclining Nude Vessel 10"x4-1/2" cast bronze (anterior)
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Figure 2. Jomon Burial Urn (detail).
Figure 3. Rudimentary Soldier Pot 21" x 21" stoneware clay (anterior).
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Figure 6. Ring Storage Vessel 2-1/2" x 2-1/2" cast bronze (anterior).
Figure 7. Ring Storage Vessel (posterior).
Figure 8. Ring Storage Vessel (side view).
APPENDIX

SHELL CASTING

COMPANIES:
NALCO CHEMICAL COMPANY
Metal Industries Division
9165 S. Harbor Avenue
Chicago, Illinois 60617

MATERIALS:
NALCOAG 1030
NALCOAG 1129
NALCAST PIW
NALCAST S-2
ULTRAWET 60-L
Glo-Coat Wax, (liquid)

MAKING THE SLURRY:

Place 5 gal. of NALCO 1030 or NALCOAG 1129 in a metal container (preferably stainless steel or brass). Add PIW to the liquid, mix with a power mixer and continue to add to and mix the slurry until it is the consistency of warm honey. Add four - five drops of ULTRAWET 60-L to the slurry and mix again. If you add more than the above amount of Ultrawet to the slurry, it will start to foam and then you must add a defoaming agent in order to clear the slurry. The bubbles in the slurry will prevent it from adhering evenly to the wax positive.

Allow the slurry to stand (keep covered) for 6-8 hours before using. When ready to use, the slurry must be mixed in order to bring the PIW (fused silica flour-325#) back into suspension. Mixing must be done not only at the beginning of the investing process but prior to each coat.

BODY:

NALCAST S-2 provides the body of the shell mold. The S-2 is sprinkled on the slurry to form an anchoring base for the following coat of slurry.

I am sure any refractory grog may be substituted for the S-2; it must be entirely free from dust however, consequently the grog must
be washed and sifted. If any dust is present in the grog, when applied, the dust will be the first to touch the slurry and the larger grains of grog will only partially adhere to the slurry. In this state the shell mold will laminate either during the burn-out or at the moment the mold is poured.

**GATING:**

The only reason for risers from the body of the positive to the pour cup is to insure complete removal of the wax from the mold during the burn-out. The shell is porous enough to allow the air to escape as the metal enters the mold. The risers do help strengthen the pour cup and gate assembly and there is thought that the risers aid also in the prevention of shrink gaps in the cast. This however is not of great importance in casting positives of small dimension.

On a positive of ten or more inches in height, the pour gate should be attached approximately mid-point on the wax.

![Diagram of gating system](image)

The shell is placed in the kiln on the pour cup so the wax will have a direct route of escape from the mold.

A hollow wax positive should have a solid investment core instead of the shell investment unless the core area and entrance are large enough to easily facilitate applying the shell. Unless there is good air circulation, even with the 1129, the slurry will not dry properly and the shell will slough when placed in the kiln for burn-out. When a solid core is used, the temperature must be cut back sharply after the shell has begun to vitrify and the wax begins burning. If this precaution is not taken the core may break up from the excessive heat—the result being the appearance of blow holes in the finished piece.

**INVESTING THE SHELL:**

The surface tension of the wax must first be destroyed before the shell is applied. Normally the surface of the wax is covered with a thin coat of Glo-Coat floor wax. This coating enables the slurry to completely cover the wax during this face-coat stage. If an area of the wax refuses the slurry then an additional coat of the floor wax must be applied after the first coat of slurry and S-2 has dried.

Dip the wax positive in the slurry and rotate the piece to allow the slurry to settle in all the depressions present in the wax surface, (if the slurry runs off the piece to freely the slurry must be thickened), and continue rotating the piece until the slurry begins
to set-up (a thin skin will begin to form on the slurry - covering the entire surface. DO NOT set the piece in the container of S-2 while applying the S-2. This will force the S-2 through the slurry and into the wax causing small blowholes in the metal surface. DO NOT place the piece on a table or any hard surface until the coat of investment has dried properly (10-15 minutes). Each coat will take approximately this much time to dry properly.

The above steps are repeated four times.

If only half the positive can be dipped in the slurry because of size, make sure the four coats of shell investment end at the same point or line and that the succeeding coats, on the remaining area, overlap that line.

BURN-OUT:

The invested piece is allowed to dry for 6-8 hours before being placed in the kiln. Holes are drilled through the shell to the wax surface approximately 3-4 inches apart. On any sharp edge of the shell and along the gate system the shell is cut with a hack saw to expose the wax. If the temperature fluctuates in the room you are working in, the shell must be cut as soon as possible after it has dried enough to handle.

The above must be done to accommodate the expansion of the wax. The shell investment is not strong enough to withstand the pressure of the wax expansion, and it will crack. The drilling and cutting of the shell must be done to facilitate the expansion of the wax when it is placed in the kiln.

The holes and cuts are repaired when the shell is removed from the kiln by covering them with a small amount of slurry. The remaining heat of the shell will partially vitrify these repair spots, and the heat of the metal entering the mold will complete this vitrification.

The kiln is preheated to 1800-2000 degrees F. and held at this temperature. The shell is placed in the kiln and fired until the shell is clean of all wax and carbon. Ideally, the kiln should be a bottom-load kiln. This makes loading and unloading the piece more comfortable as the heat is held in the kiln and thus the chances of dropping the shell mold or getting burned at this time are minimal.