6-1-1976

Mass Production Techniques for the Studio Potter

James Halvorson

Follow this and additional works at: http://scholarworks.rit.edu/theses

Recommended Citation

This Thesis is brought to you for free and open access by the Thesis/Dissertation Collections at RIT Scholar Works. It has been accepted for inclusion in Theses by an authorized administrator of RIT Scholar Works. For more information, please contact ritscholarworks@rit.edu.
MASS PRODUCTION TECHNIQUES
FOR THE STUDIO POTTER

BY

JAMES M. SQUIERS HALVORSON

THESIS FOR THE MASTER OF FINE ARTS DEGREE

SCHOOL FOR AMERICAN CRAFTSMEN
COLLEGE OF FINE AND APPLIED ARTS
ROCHESTER INSTITUTE OF TECHNOLOGY
ROCHESTER, NEW YORK

JUNE 1976

THESIS ADVISORS

ROBERT D. SCHMITZ
JUDITH SALOMON
JANET R. KELLNER

Dr. R. H. Johnston, Dean
The aim of this thesis will be to explore mass-production techniques available for the studio potter. These will be a blending of industrial techniques of slip-casting and jiggering with wheel-thrown work. The potter's wheel will be used as a basis for experimenting with these processes. Fabrication of master molds and working molds, development of clay bodies suited for this type of fabrication and manipulation of the molded forms will be the main emphasis of this work.

Thanks to my Friends, Fellow Students, Faculty and Administration of School for American Craftsmen. Muchos gracias to Suzanne and Fred, the Midnight Rambler.
INTRODUCTION

I was first introduced to slip casting during brainwashing sessions in my beginning ceramics class. These philosophies stressed the quality and superiority of hand-made pots and claimed hobby ceramics was the source of ugliness in the field. Industrial production ware didn't fare much better; they were either fish-pitchers or forms that were homogenized to the point where they became very drab. Except for an occasional visit to a sewer tile factory and a lampbase company for scrap firebrick, mass production methods were ignored preferring handmade, one-of-a-kind items. After two years of working in a school studio developing these philosophies, a friend offered me a chance to help him set up a casting shop at a winery and having nothing to do at the time, I went to make wine bottles.

The winery was north of Milwaukee in a 100-year old partially restored wool mill and many nights were spent sitting by the mill dam discussing wine bottle design over a glass of cherry nectar. The winemakers had been producing wine bottles for three months, but had forgotten to take the clay shrinkage into account and now needed to have the molds enlarged. We based our design on contemporary German wine bottles and 19th century local salt-glazed pieces. From our drawings, three pairs of master molds and 50 production molds were made. The molds were clamped together on a large table with 8' clamps (to eliminate the necessity for individual rubber band clamps) and by pouring twice a day, we were able to produce 100 bottles a day, filling the 200 cubic foot kiln weekly. My co-worker began to develop molds to pour three bottles at once to ease production, as I left to return to studio production.

Several years later while working on Eastman Kodak's assembly line, thoughts began to develop to adapt mass production techniques to a studio pottery situation. I felt that it would be possible to slip cast basic forms,
then alter them once they were removed from the molds to create individual pots much easier and faster than hand-throwing each one. Drawings were done to develop the most versatile form and to see what the possibilities were to produce one-of-a-kind items from this limited form. From these drawings a block mold was made of a thrown vase form that could produce a one-quart pitcher after firing. Several castings were done, usually needing a two to three hour casting time as the mold was too dense. After several successive failures, the project was abandoned and other areas of ceramics were explored.

During the past year my work has gone through a cycle from one-of-a-kind utilitarian ware to individual sculptural forms to mass produced utilitarian ware. I have become more commercially aware to the development of a production line that I could comfortably produce and began to reconsider my original concepts of casting to develop a consistent wholesale series of work. With rising material and fuel costs I foresee it to be necessary for a production potter to either raise his prices to meet these costs, produce more pieces by simplifying his forms and working longer hours or to set up a communal production studio with slave labor to be able to make ends meet.

I have approached this thesis from this last viewpoint. I feel there is a definite limit that a potter can charge for a coffee mug that his customers can afford, and have tried to aim at my economic peer group as a market by trying to keep my prices as low as possible so the pots would be used, not stuck on a mantle because of their preciousness. It seems offensive to see a customer use a pitcher for flowers; either it is not a good functional pitcher or its cost makes it too valuable to risk breaking the piece. Although the pots are creative expressions of a designer-craftsman, I see them as being temporary items, pieces that can be replaced if broken, and made cheaply enough to avoid the
connotations of being a work of art.

In a shared studio situation, a wholesale line could be developed that would support the individual endeavors of each clayworker. This sequence of work I feel could be mass-produced using slip casting and jiggering as the main methods of manufacture. Much of the work for this line could be done by apprentices to produce the basic blank forms for the potters to do variations upon.

Probably the reason for lack of variation in many potteries across the country is the limitations that the technique places on the designer. The pieces must release from the molds so the industrial designer can allow no undercuts or sharp curves as the studio potter can. Handles, spouts and basic forms are all cast to create the same identical pieces over and over to be assembled by relatively unskilled workers. Jiggered plates and bowls cannot be too deep as they will crack as the clay dries after being formed over the mold by a template.

My approach has been to take the blank-molded forms and to do variations upon these by cutting them apart, inverting the pieces, adding thrown sections to the cast and manipulating the glazes to create individual pots. I feel that such a line could be produced consistently enough to be catalogued as a studio series of production. This would allow stores to reorder from the catalogue of forms, giving the potter a definite product to deal with. It would possibly allow a studio potter to approach department stores with his work, creating a market that is relatively untapped by American craftsmen. Fabricating such a series of pottery may often be approached as a job, but would possibly be enough of an income to support the development of new forms and techniques, or some of the non-commercial interest of the craftsperson.

The problems that lay ahead of me seemed simple enough: to produce the
models and working and master molds; to develop that clay-body-in-the-sky that would cast, jigger and throw well; and to cut or tear apart the forms and rejoin them into totally new pieces. The problems that developed were frustrating and discouraging; casting slips that turned solid overnight, pots that cracked for no rational reason, pieces that tore apart as the molds were opened and plates that refused to release from the molds in one piece.

Working in plaster, in carving and casting it was a relatively new experience, and translating the pot from the drawings to the model to the molds to the cast pot seemed to take forever. But the pots finally emerged and I was able to deal with my original concept of varying these forms and adapting mass production techniques to the studio pottery situation.

Herein I'll try to explain some of the industrial techniques that I adapted and the successes and failures that I had. I see this study only as a beginning point for myself and other potters searching for a way of making pottery faster. I hope to be able to set up such a studio production unit that I write about here in theory to see how I would react to this work on a daily basis, to see how work could be divided and shared by several people working on the same line of work, and to see how much freedom this type of production would really allow the studio potter.
DEVELOPMENT OF FORMS

I have worked as a potter/student/teacher for the past five years and have felt a need to develop a series of pots for production that would be timeless and not depend upon fads for success. It seems there have been times that I could have sold every hanging planter or goblet that I could make, but as people had planters for all their plants and they began to return to glass goblets, I ended up with an excess supply of wedding and birthday presents. A craftsperson must be able to dictate his market and educate them to the forms that he creates. Unfortunately, most studio designers aren't able to foretell the future and tend to follow last year's trends with a new flair or produce pieces that sold well at the last art fair.

I have found that the pitcher/water jug form is one that exists in every culture that has produced ceramics. Our modern society no longer needs large jugs to carry water from the well or stream, but our refrigerators are filled with a variety of beverages. To develop a line of pitchers to meet these needs presented a challenge to me. At first I approached this only from a visual standpoint, exploring the possibilities of the relationship between the body, spout and handle and ignoring many of the various requirements of the pitcher form. I ended up making forms that were unbalanced when full, didn't pour well, were impossible to wash or place in a refrigerator, but looked fine on the mantle with flowers. As I used some of my pitchers at home I began to notice the faults and the forms became simpler. Liquid flowed smoothly to the cup, and my hand still fit inside when fired to facilitate washing. I see one-quart and half-gallon pitchers as a necessity in the kitchen for mixing frozen juices and keeping cold beverages on hand during the summer, so I decided to explore these forms for a mass production line.

In developing a form that I would make a mold of I wanted to choose a shape
that could yield a variety of one-quart pitchers. In deciding to slip cast the form, I wanted to choose a design that could not be produced by easier methods. Many of my drawings were based upon pitcher forms that I was comfortable in producing and it then seemed that it would be easier to throw these in a series rather than going through the moldmaking process. Attempts were made to throw basic forms using a hand-held template, but unless it was held solid, the guide would chatter, causing the thrown pot to twist and pull off center. So I began to throw some of the pieces from my drawings to see the relationship between different spouts and handles on the same basic form. The form I chose for casting was a homogenized blend of these pitchers that I wanted to make as the final product. I hoped to take this basic pot, cast it a bit thicker than necessary and then return it to the wheel to pull this excess into a slightly different form. (This concept was somewhat derived from Captain Ceramics' line for the professional and amateur potter of precentered balls of clay and pre-started cylinders both "premoistened on prepinned bats and prewrapped in plastic to eliminate those tiresome first steps.""])\(^1\) This was to have a variety of production shapes that could be made with a limited number of mold styles. If a studio potter would make a mold for each form he produced, as is done in industry, too much of his time and space would be spent making and storing molds to make their use worthwhile.

I also decided on producing an octagonal faceted form to work with, as well as the standard thrown form. The faceted form is one that I had tried to produce several times before, but never explored enough to produce a uniform piece without exacting measurements. I tried throwing a thick pot then cutting the sides into it, but would usually cut through the sixth or seventh side, or ended up with a heavy pot as I didn't trim off enough clay. Casting such a
form would allow it to be easily produced with the precision measuring necessary only in the modelmaking stage.

The other main production item that I wanted to develop was a dinnerware line. Pottery most likely had its start as eating and cooking vessels, and the china manufacturers have played an important part in developing many of the techniques that are now taken for granted. Syracuse China Company has developed a series of ten plate shapes that have a variety of glaze variations to comprise their hotel china line. This allows the customer to have an individualized set while being able to reorder as pieces need to be replaced. I wanted to take this concept a bit further by using a basic plate and then throwing varying cups, bowls and tumblers to accompany this plate to give each set a distinctive style. I have always felt plates are a drag to make; throwing the pieces was easy enough, but trimming was a tedious step of production. As a result, I ended up with a good many warped or cracked plates mostly due to trimming faults in not keeping an even cross-section. As a result, I began to explore the jiggering method of forming. With this process, the eating surface is formed by a plaster or bisque mold while a template carves the foot and the back contour from a slab of clay. The pieces are removed from the mold and the rim trimmed to yield a uniform plate with a consistent profile. The plate can be produced with a good amount of compression to allow for a thinner plate than would normally be possible with throwing methods.

Rather than work with a commercial jigger arm, I wanted to develop an arm that could be produced by a potter/handyman and used with most any potter's wheel. This would avoid the potter having to buy an extra piece of costly equipment, and would make his wheel more versatile. The arm I built was welded from \( \frac{1}{4} \)" steel plate and pipe fittings and was produced for less than $20. It
JIGGER ARM ASSEMBLY
bolts directly to the work area of the Soldner electric wheel that I had been using and has performed fairly well. (figure 1)

MOLDMAKING

Once the forms were developed, I proceeded to make the models and the plaster and bisqued clay production molds. Although tooling plaster is a relatively economical and easy process, few operators of pottery factories spend time in the mold shop. This is a job reserved for a skilled modelmaker and often molds are purchased from a company that specializes in moldmaking.

Five steps are typically followed to produce working molds for slip casting. First it is usual to begin with an artist's sketch or an engineer's drawing of the shape that is finally desired...the next step is to form a three-dimensional model which exactly represents the original design. This may be sculpted of clay or plaster, but more often it is formed by screening plaster while it is in its plastic state, against a two-dimensional template. From the model a prototype mold called the block mold is cast. One of the principle purposes of the block mold is to produce one or more pieces to check the design before too much work is done. Except for being slightly smaller, the block mold is usually like the working mold in which the ware is formed."2

It would be possible to produce working molds directly from the model, but this is a slow process and often the model is destroyed in the process, especially when a clay model is made. To avoid this, a case or master mold is made of each section of the working mold. These case molds are positive castings of the parts of the block mold and are always made of either a denser plaster or plastic resin as it needs to keep exact details over a series of repeated castings. The pieces of the working mold are cast from these case molds and are assembled for production to begin. Taking the time for moldmaking may seem boring and frustrating to the potter, but having quality ware as the final outcome makes the time well worthwhile.
The first form to be prepared for casting was the octagonal vase form. First a model was made from a solid block of clay. This clay should be a smooth grogless body or plasticene, an oil-based clay that doesn't dry and shrink as rapidly as normal potter's clay. This form had a rim at the foot of the piece as well as at the throat. These were included to fit with the pitcher forms that I had been dealing with and allowed an obvious place for handles to spring from. After the block mold was made to test the casting qualities of the form, it was decided to eliminate the bottom rim as the pieces would bind due to the vertical contraction of the clay. (Figure 2)

To make the block mold, the clay model was divided along its vertical center and a 2-3" spare was added to the top of the piece. The purpose of the spare is to act as a reservoir for the casting slip as it is absorbed into the plaster mold. After the model is divided it is laid on its side and leveled with wads of clay in a wooded casting box. A plaster or wooden collar is made to fit tightly around the form at the dividing line. This collar should have a 45° bevel between it and the model which is filled with clay and smoothed to keep plaster from pouring through to the underside of the piece. The casting box is screwed or clamped around the piece and the unit is coated with a separator. (Figure 3) A variety of separators can be used, their purpose being to keep the plaster from sticking to the model or box. English Crown Soap is normally used as a separator. It is a jelly that is dissolved in hot water and is then ready for use.³ Vasoline works well in coating the wooden box as it will last for several castings. A combination of liquid soap (not detergent) and a lightweight oil works well when the Crown Soap is not available. A proportion of 8 bars of Fels Naptha soap, shaved into small chips and a half cup of light machine oil, such as "3-in-1 Oil," boiled with one half cup of water,
CAST SEEMED TO BIND BETWEEN THESE RIMS

MIDDLE RIM SIMPLIFIED TO CIRCLE

BOTTOM RIM ELIMINATED

2 OCTAGONAL VASE FORM
provides an adequate substitute. This is then whipped and applied to the case mold with a sponge or a brush as a lather. This lather is allowed to soak in and dry, then is washed with water and the process is repeated and dried. Care must be taken not to fill fine detail in with the separator, as the sharpness of design will be lost when the plaster is poured in.

When the mold is readied, the dry plaster is mixed with water to create a pourable slurry. Plaster \((\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2 \text{O})\) is made by calcining gypsum in rotary kilns. It is this dehydration, which causes the plaster to be in a constant thirst for water, that makes plaster the ideal mold material for slip casting. The plaster is mixed by sifting it into the water to avoid lumping. This allows each particle to be coated with a thin film of water and a slurry the viscosity of milk is produced. It would be possible to obtain a crystallization of 100 pounds of plaster with only 18.6 pounds of water theoretically, but since all mixes need more water to be workable, free water is held in the freshly set mass. This excess water holds the interlocking gypsum needles apart and has effects on the absorption and strength of hardened plaster. The strength decreases and the absorption increases as the parts of water per 100 parts of plaster increases.\(^4\) Depending upon the desired density, the following proportions are used as guidelines.\(^5\)

<table>
<thead>
<tr>
<th>type of mold</th>
<th>parts water/100 parts plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>slip casting molds</td>
<td>70-70</td>
</tr>
<tr>
<td>jigger molds</td>
<td>60-72</td>
</tr>
<tr>
<td>ram process molds</td>
<td>40</td>
</tr>
<tr>
<td>case and prototype molds</td>
<td>30-40</td>
</tr>
</tbody>
</table>

After the plaster is sifted into the correct amount of water, it is stirred to eliminate any lumps and to keep the plaster from settling. It is then allowed to set for about 3-5 minutes when the hydration begins to take place. The amount of time is dependent upon the water temperature, the amount
3 FORM PREPARED FOR CASTING

4 CASTING OF SECOND SIDE
of agitation and the density used. A hot, dense mass will set quickly and too much mixing affects the strength of the mass. The plaster mixture reaches a consistancy of thick cream at this point and is ready to be poured into the mold. The mold is agitated slightly to allow air bubbles to rise to the surface as the plaster is poured in. If the plaster has set too much before pouring, the air bubbles will be trapped, marring the mold surface. Next, the plaster goes through a period of plasticity where it can be formed by templates and shaped with tools. The plaster then hardens and heat is given off as the gypsum crystals form and interlock. After about an hour, the plaster begins to cool and it is possible to open the casting box to make the other half of the two-piece mold.

Once the box is removed, the plaster cast is flipped over and the collar removed. The model is left in place and the key notches are carved into the corners of the mold. (figure 4) These should be hemispheres about an inch in diameter. The mold is returned to the casting box and is coated once again with separator. It is then filled with plaster at least an inch above the highest point of the model. After this is set, the mold is separated with the aid of a hammer and metal shim and the model is removed. The mold is cleaned with water to remove the separator, dried for several days and is then ready for trial casting.

As mentioned earlier, it was found that the cast form would grab as it shrank vertically in the mold. This caused the pot to either tear along the seam as the mold was opened or crack around the middle rim of the piece. To eliminate this, the bottom rim was filled with plaster and was recast. There was still a problem with the form sticking to the mold, even with variations in the thickness of the clay shell and in the length of time left in the mold.
After a closer examination of the mold, it was discovered that one side was deeper than the other due to the inaccuracy of the clay model, causing one side to release before the other. The mold was coated with separator and a solid plaster cast was made to allow for a more accurate model to be made with the plaster. I was able to handle the model more so I could take more accurate measurements, build up, and sand sections until the desired form was reached. The moldmaking process was repeated to create another block mold from the refined octagonal vase form and a successful casting was made.

Once the block mold proved correct, it was time to make the case or master mold. For this, U.S. Gypsum Hydrocal plaster was used, being a much denser and harder plaster compared to the #1 Pottery Plaster used to this point. Using Hydrocal made the master mold much more resistant to wear so it would allow more working molds to be pulled from it before it would wear down. The masters were made by returning half of the block mold to the casting box and soaping it. The Hydrocal mixture of 40 water/100 plaster was poured in and allowed to set. This gave a positive of the block mold complete with the keys to cast the working molds from. Using a consistent form to make the working molds allows the parts to be interchangeable should a unit of a mold break or be chipped.

Choosing the proper material to make the master molds is important. A property of plaster that I discovered at this point was that plaster has a slight coefficient of expansion. I realized this as I was confronted with a block mold and a case mold fused together into a 25 pound mass of plaster. After a moment of panic (and thoughts of boat anchors) I managed to release the case mold by sawing part way through the block mold and cracking it with a metal shim and a sharp blow from a hammer. I also ran into this problem when I cast the working molds for my jiggering system, so I used a three piece mold
for their production. Typical expansion is only 0.17% on a linear scale and allowances for this are difficult to make as the expansion is dependent upon the thickness of the plaster. If a precision product is the desired end result, as in production of electronic ceramics, this expansion must be taken into account as the piece proceeds from the drawings to the model to the block and case molds. For this reason, some companies are utilizing plastic resin or hard rubber for case molds, as there is no expansion and many more molds can be removed without any loss of detail. Another definite advantage is the light weight of plastic when compared to the plaster. This is most applicable to the sanitary ware industry as a mold can be reduced from 220 pounds to 30 when plastic is used for the case mold.

Once the case molds were made, a new casting box was prepared to cast the production molds. This box was hinged along the center with a removable bottom and the corners filled in to allow for a lighter working mold. An inch and a half was allowed around the surface of the form to be cast to assure that there would be even drying of the cast form. The soaped case mold was pinned into this and clamped into place with a pipe clamp, eliminating the necessity of screwing it together as with the first box. The wooden box was also varnished to seal the wood so it was not necessary to soap the box each time. With the case mold in place, a mixture of 80 water/100 plaster was mixed and allowed to set to a thick cream consistency then poured into the mold. The box was vibrated and removed an hour after the plaster had set. There was little problem of binding with these molds as the working mold expanded away from the case mold. It was found after several castings that 15 pounds of wet plaster was needed to cast one side.

In the first set of molds there was a problem with air bubbles forming in
CASTING BOX - CORNERS FILLED IN TO REDUCE WEIGHT

HINGED BOX FOR CASTING OF PRODUCTION MOLDS

MASTER AND PRODUCTION MOLDS - OCTAGONAL FORM
the cast plaster due to the halves being cast vertically and the air having to go through 10" of plaster to reach the top. To alleviate this, the plaster was poured along the side of the box to avoid excess splashing as the plaster hit the bottom. Also, the mold was vibrated while pouring 2-3" layers of plaster. Another possibility to avoid air bubbles is to ladle the plaster onto the case mold until it is covered, then cast the rest of the mold immediately. It was important to have the plaster poured all at once as a line would occur if another batch of plaster had to be mixed to fill the mold. For this reason I usually mixed 16-17 pounds of plaster to allow for plaster leaking out of the mold and to assure there would be enough to have one solid mass. This excess was then used to cast small spout molds and blocks of plaster to be carved for press molds or stamps.

Occasionally there would occur air bubbles large enough to require patching. Usually these would be along the bottom of the mold where air would be trapped. The patching of these holes was a tricky task as the cast piece had to be wetted or soaped so that the water would not be sucked out of the additional plaster, causing a different density to exist in the patch. However, if the mold was soaped too much, the patch would not stick and would flake off during one of the first-slip castings.

Once the mold is cast it is necessary to cure the mold before use. This was usually done by soaking the mold in water and then allowing it to dry completely. Without the aid of a drying oven the plaster will take about a week to totally dry. If the molds are forced dry in an oven, care must be taken to heat and cool the plaster slowly as it has a very slight thermal expansion that can cause the mold to chip and crack if cooled quickly from over 100°F. Temperatures up to 225°F can be used until the mold contains about 20% free water.
Combined with rapid air circulation, lower temperatures can be used to drive off enough water to make the molds dry enough to use in a short period of time. Soaking the mold helps not only to clean it of the separator, but also opens up the pores between the gypsum crystals. The spaces form a continuous series of capillaries that drain the water from a casting slip. Because the size of the crystals is in the range of 2-5 microns, the pores are small enough to filter out the finest constituents of the clay body. Gypsum is a relatively soluble material and as the water is removed during the initial drying and during the first castings, the walls of the pores are dissolved and their diameter increased. Usually after 2-4 castings the release time becomes shorter and the cast pieces separate easier from the mold. This only happens in the early use of the mold however, because as the mold is used, a reaction between the sodium-based deflocculent and the gypsum takes place to form sodium sulfate which plugs the pores of the molds. Because of this, slip casting molds are only good for about 100 castings. After this the clay tends to stick to the mold unevenly or the release time and casting time increase to the point where it is more practical to make a new mold.

Production of the mold of the rounded vase form and the jigger molds followed pretty closely the same steps as the octagonal vase mold. The faceted vase had been divided along one of its corners while other methods had to be used to divide the round form evenly. The model was made of clay and thrown thickly; then a line drawn through the center of the spare on top. The model was placed on a level table and a square aligned with this top line. This then gave the dividing line for making the two piece mold.
The jigger mold for making plates followed a few different procedures mostly due to the difference in technique used. Whereas the slip casting molds were a hollow mold, a negative of the form, the jiggering molds were cast solid and formed one surface of the plate as the template formed the other. To develop the model for these a wheel chuck was first made. This allowed the molds to be removed from the wheel and returned to the same centered position. It was made by cutting a plywood disc with three pins to line up with the holes drilled in the Soldner wheel head, then building up a plaster ring on this disc. A notch was cut in the ring to lock the molds in place and the chuck coated with separator. A clay collar was then built up around the ring and plaster was poured in and tooled into the desired plate form. This gave a solid model with the form of the chuck cast into it so the molds would fit tightly on the wheel. Another method of making the model was to throw the eating surface of the desired plate in a thick slab of clay. This was then inverted when leather hard on the collar of clay thrown around the chuck and sealed together making sure that the form is centered. A small hole is cut in and the clay mold is cast solid in plaster. (figure 8) Once set, the clay is removed yielding a solid model for the jiggering process. The model can also be produced by holding a template of the contour of the form rigid and forming the plaster against it while it is in a plastic state. This method gives an accurate form with a minimum of tooling. Once the model is obtained, the master mold was made in much the same way as with the vase forms. Since the jiggering molds were positive molds the masters were made directly from the model. There was some problem with the positive molds expanding and binding in the master mold so the top half was sawn into two sections then banded with a metal clamp.
7  CHUCK FOR ACCEPTING JIGGER MOLDS

8  CLAY MODEL FOR JIGGER MODEL

CLAY FORM WITH PLATE
SURFACE THROWN IN
INVERTED ON CLAY RIM

HOLE FOR POURING IN
PLASTER (SCRAP CARVED SMOOTH)
There was much trouble in trying to get the plates to release from the jigger mold. The first ones would crack across the bottom before the rim would release, so a bat was placed on the foot so it wouldn't dry so quickly. Yet the plate would crack around the inside edge of the rim where it met the body of the plate. The next step was then to cut under the rim of the plate with a fettling knife to get the plate to release. Although this would mar the surface, several plates were able to be produced finally. After a closer examination of the mold I decided that the angle between the rim and the curved plate was too great and the clay was binding at this point. The model was then filled in and the master cut down at this point to allow for a gentler curve. When the plates still stuck, I then began to question the efficiency of my jiggering arm and process. The clay slabs were thrown on the wheel to get the desired thickness and size that I wanted. These slabs were then inverted on the mold and the clay was forced over the mold by hand. The arm and template was then lowered to trim away the excess clay. When the jigger arm was raised it would often hit the edge of the plate, so I would finish the rim with a sponge. The two mistakes that I detected were that the wet clay would grab on to the mold immediately and would stick. Also, by finishing the rim I was sealing the clay to the plaster. To correct this I would let the slabs sit for several hours so they would lose their wetness, but still be manipulatable. I also moved the template so the rim cutting edge was about \( \frac{3}{4} \)" from the actual rim on the mold. A wooden tool was then used to trim this excess clay away and to scrape the mold dry at this point. Finally after sitting for about two hours the plates would release and the rims could be tooled smooth and finished with a sponge.

At this point in my development of a studio jiggering system, I was
PLASTER MOLD

SECTION THICKER TO SUPPORT RIM IN FIRING

TEMPLATE

PLATE

THEsis PLATE - RIM FORMED BY TEMPLATE

SYRACUSE PLATE - RIM FORMED BY MOLD

9 PLATE PROFILES
fortunate enough to tour the hotel china production factory of Syracuse China Company. I had read about many of the industrial techniques, yet I still had questions that could only be answered by seeing them in operation. The rim of their plate molds were slightly different and answered my question of why mine didn't work. I had patterned my mold and template after drawings in R.E. Gould's Making of True Porcelain Dinnerware. (figure 9) One of my molds was changed to compare with the Syracuse molds and the plates released without any complications. Their clay was also much stiffer than could be manipulated by hand, allowing for less drying shrinkage. The plates and the molds were passed through a drying oven and the plates were removed bone dry. The rims were then polished and buffered smooth. The molds were designed so that the clay would slide up the mold as it dried, eliminating the possibility of it binding and cracking.

Although it may seem that the process of moldmaking makes adapting jiggering to the studio situation nonprofitable, I feel that the time saved producing plates makes up for this. At the time I was exploring this thesis, several juniors at School for American Craftsmen were developing their journeyman's piece, a required dinnerware set. In timing their plate production, I found that on the average it would take three hours to throw and trim 8-10 pieces. There was also a considerable amount of measurement necessary to produce a consistent group of pieces. An experienced potter may be able to shorten this time, but I found that by combining the throwing and trimming into one step with the jigger I was able to produce plates much faster. My production was limited by only having four molds to deal with (due to lack of storage space), but I was able to produce four finished plates in 30 minutes time total. This time was broken up over the course of the day as the clay had to dry through the various
stages. I feel that it would be possible to limit oneself to a dozen molds and be able to establish a rhythm to jigger plates two or three times a day. This limitation may be too restricting to many potters, but if the original design is basic and versatile enough, just glaze manipulation would give individuality to a set. The speed of this process would allow the potter to charge less for a dinnerware set, selling more sets as a result. Also, this whole process could be turned over to an apprentice as the skills required are minimal. The jigger arm gauges the form and the thickness of the plate so little measuring is necessary. By establishing set timing for removing the plates from the molds, an easy rhythm can be established.

**BISQUE MOLDS**

The main disadvantages that I foresee in adapting jiggering to a studio is in the drying of the plates in their various stages and the storage of the molds when not in use. The construction of special shelves would consolidate the molds, but if it were possible to have fewer molds this problem would be cut down. For these reasons I also explored the use of bisque molds for production use. These molds, formed of bisqued clay, have several advantages over the plaster molds. First, they are made from the material that the potter is most familiar with so he is able to manipulate the desired form easily. They are much more durable than the plaster molds as they are able to take greater heat shock (for drying), are more chip-resistant and rarely wear down after repeated use. They are more absorbant and dry faster than the plaster due to their larger particle size and the openness of the mold from the clay not being vitrified. Although the plaster is able to produce a much more refined mold and doesn't have to be fired before use, I feel that
BISQUE MOLDS
the bisque molds are much more versatile as the clay can be removed almost immediately, allowing it to be formed into a variety of shapes while it is still soft.

To fabricate identical bisque molds for production at first seems difficult if each is to be hand-modeled. The easiest way to solve this is to make a clay model and cover it with a 1" layer of plaster. Layers of plaster-soaked burlap or screen can be used to reinforce large molds. It is helpful to build up the plaster on a potter's wheel to allow the back side to be trimmed to have a flat level foot. This allows the mold to rest on the wheel-head so it can be rotated as a 3/4-1" clay slab is forced into the form. Beating it with a curved paddle or stone will compress the clay and guarantee that the details are picked up as well as eliminate any air bubbles that are in the slab. The mold was then centered on the wheel and a coil of clay added to the rim. This was then thrown to a certain inside diameter to allow the mold to be centered on a clay chuck when later used for production. A small handle was joined to the inside of the bisque mold to facilitate the inverting of the mold to release the plate and holes were poked in the slab with a needle tool to speed drying and lessen the chance of blowing up the mold in the firing.

Once fired, a clay slab was pressed over the mold either with a paddle or on the wheel with ribs, depending upon the form. These slabs were often textured before hand to give a unique quality to the mold-made plate. A coil of clay was then added to the scored slab and thrown to form the foot. The use of a feather attached to a stick aided in measuring the placement of this coil which was then forced into its final contour with the aid of a hand-held wooden template. Once the foot was finished, the rim of the plate was measured
and cut from the slab, but not finished at that point to avoid sealing it to the mold as with the jigger mold. It was possible to release the plate immediately and produce another with the same mold, but often the clay was too soft to maintain its form, so usually four plates would be produced in a series. By the time the last plate was footed, the first would be stiffened by the absorbent mold and could be removed and the rims finished. The clay was still soft enough at this point to rethrow the lip into slightly varying forms to give distinctly different plates from the same mold. Again, the total production time was less than throwing the plates in the normal procedure and there was much more leeway in producing textured plates. By using the bisque molds, I was able to produce two dozen plates before it was necessary to let the mold dry.

The moldmaking process is a time consuming and precise endeavor. For a studio potter who is used to producing dozens of pots each day, spending the time to develop models and production molds may seem to be a job lacking in spontaneity. However, it seems that if the shapes to be cast are inspiring ones to begin with, there would then be more of a desire to complete the molds as soon as possible to begin production. Adapting casting and jiggering to the pottery studio is something akin to many hand potters, yet it is an area that seems to be relatively unexplored and is open to experimentation.

**SLIP CASTING**

There are two main methods of slip casting used in the ceramic field. Solid casting is done by filling the molds with the liquefied clay and allowing it to dry into a solid form. This is used for producing handles and small pieces for figurines, as well as spark plugs and porcelain fuse blocks. Drain casting is used for hollow shapes by using a mold to form
the outside of a piece. This is done by filling the plaster mold with the clay slip and allowing it to sit for a short length of time. Because the casting molds have a reservoir on top it is not necessary to add more slip, as the water is absorbed and the level lowers. While the filled mold sits, the water is removed from the fluid adjacent to the plaster and a thin shell is formed. As this clay wall builds up, less water is able to pass through it causing the casting time to greatly increase when thicker walls are desired. Tests should be done to find the thickness built up after 10, 15, and 20 minutes or longer periods of time.

The casting time is dependent upon the density of the mold and the clay body composition. A mold with a low water content in the original plaster mixture will result in fewer pores between the gypsum crystals. As a result, the water is pulled from the slip slowly and the casting process becomes too time consuming. Molds with a density of 62-80 parts water/100 parts plaster should be used as they will be absorbent yet still strong enough to resist chipping in daily use. The clay body used should be one that avoids the fine particled sedimentary clays. These bodies, which are good for throwing, are too dense to allow the water to pass through them, as the clay shell forms on the face of the plaster mold. For this reason primary kaolins are the most common choice for the main clay content of the casting slip. A small addition of ball clay is helpful to increase the green strength of the cast piece to facilitate handling during trimming.

Once the clay shell has been sufficiently built up the molds are inverted and the slip is poured out. They should remain in this position for about 5-10 minutes, then be set aside to dry in an upright position. If the mold is turned back too soon, all the slip hasn't drained out and as a result a thick bottom
forms that takes longer to dry and will stick to the mold when opened. If the molds are left upside down for too long, bumps form on the bottom like stalactites where the slip drips down from the mold.

The drying time is also dependent upon the mold and slip composition as well as the humidity and temperature of the drying room. Some industries use driers to speed the removal of the ware from the molds especially when solid casting is employed. Without the aid of a drier the molds must be left for 2-5 hours before they could be opened. This was usually done by laying the mold on its back and inserting a spatula between the mold halves and prying the mold open. This was mostly done to see which side of the mold was releasing. Occasionally the molds had a dead spot due to a patch or one side would be exposed to an air current which would draw the water off that side of the mold first. The released side would be carefully lifted off so as not to damage the cast and the piece would be wiggled to loosen it from the mold. The spare is usually trimmed off about a half an hour after draining the mold by running a fettling knife between it and the mold. This allows the cast pot to release easier and eliminates the possibility of damaging the piece by handling it too much once it is removed from the mold. The seam of the piece also needs to be trimmed off. This is usually done when the ware is bone dry in most production situations as the piece is at its maximum green strength at that point. Because I intended to manipulate the cast forms I trimmed the seam after it came from the mold, care being taken not to damage the piece as it was still soft at that point. Even if the raised seam is trimmed level it will often reappear after the firing. This is due to the alignment of particles in the seam, in that they are not parallel to the others in the wall of the pieces so their shrinkage is not the same in the firing.
Deflocculation

One of the main qualities of clay that leads to its workability is the tendency for the particles to bind together. Each plate-like molecule slides on a water film allowing it to stretch and hold a form. The non-plastic materials in a clay body are held in place by the sticky clay particles. This characteristic needs to be reversed in order to make a casting slip fluid enough to use. The logical step would be just to increase the water content to render the clay body pourable. However, the clay particles will settle out after a period of time necessitating constant stirring. Also, the high water content results in a high, dry shrinkage which is unwanted as the cast piece will catch in the mold and tear if it shrinks too much. To properly develop a casting slip a chemical known as a deflocculent must be added. This changes the ionic charge of the clay particles so that they repel each other rather than binding.

Most deflocculents are sodium-based compounds, sodium silicate \((\text{Na}_2\text{O} \cdot 3.25\ \text{SiO}_2)\) and soda ash \((\text{Na}_2\text{CO}_3)\) being the most commonly used. Each of these compounds can be used singly but are more commonly combined to give the properties desired. For the amount of soda given the silicate always gives a more fluid slip but the carbonate slip casts quicker as it is more permeable. Soda ash gives a flabby cast when used alone and has a tendency to clump or form uneven spots in the casting.\(^{10}\) The proportions used must be determined by experimentation as different clays react differently to the deflocculents. As a guideline, three parts carbonate to four parts silicate will yield a fluid slip. Slight variations in the water used will also have an effect on the casting slip so that one slip recipe that works well in one area may have to be readjusted due to the mineral content of the water in another.
To determine the amount of water and deflocculent needed to make a clay body fluid, accurate tests must be made. Sodium Silicate, commonly available as water glass, is usually supplied as a liquid. "N" brand sodium silicate, most often stocked by ceramic suppliers has an analysis of 8.9 soda, 28.7 silica and 62.4 water. Dry sodium silicate and soda ash are both soluble in water so it aids testing to dissolve these compounds in water and add them with an eyedropper. This allows a better chance of them mixing with the clay body than if they are added dry. In doing this the water used also has to be taken into account in totalling the complete batch. Usually a 1000 gram batch was mixed for testing. This was a large enough quantity to test the casting qualities of the slip in a small cup mold and then observe the ability of the slip to be stored.

The dry batch is mixed with water into a slurry, allowed to dry and ground in a mortar and pestle. This assures that the clay and non-plastic materials are well mixed. As a starting point enough water was put in the mortar to render the clay body plastic. This is usually around 30% for most throwing bodies. (A body with 25% water of plasticity was finally chosen to be developed into the casting slip that I used.) I then added 10 ml. of the deflocculent solution of 42 g soda ash, 58 g of sodium silicate dissolved in 50 ml. of water. This was mixed into the water and the clay body was sifted in until it began to stiffen. More water and more deflocculent were added until all 1000 g of the body was blended to form a slip that flowed smoothly from a spoon. As a general rule, less than 1% deflocculent and less than 50% water should be used to obtain a fluid slip. A hand egg beater was used to mix these tests which gave more agitation than possible by wet grinding with the pestle. Once mixed, 100 ml. of slip was weighed to determine its specific gravity. (Specific
gravity is the weight divided by the volume - 100 ml.) A good casting slip will have a specific gravity of 1.65-1.9 and this can be used to compare the density of the slips. A test cup was cast to judge the casting time, its ability to pour from the mold, its drying time and how well it released from the mold. Many of the casts had a thin brown shell that occasionally peeled off like house paint (not a desirable quality.) Some of the slip tests jelled as they sat overnight but flowed after repeated stirring; while others turned solid and crumbled as they were being mixed. All these are cases of over-deflocculating the clay body and emphasizes the need for accuracy in such clay tests.

In mixing larger batches I usually had better luck as I could be more accurate with the measurements of the deflocculent. (I hope at some point in the future to retest some of the bodies that I discarded in my first series of tests because of over-deflocculation.)

Once a satisfactory slip was found, a 15 pound batch was made to test its casting qualities in the molds that I had intended to use for production. This was mixed with a drill and a paint stirring attachment for about thirty minutes. Due to the greater agitation, the electrolyte was able to have a greater effect on the clay particles and less water and deflocculent were needed. The slip was screened through a 60 mesh screen and allowed to sit overnight. The resultant slip seemed to jell more than desired by morning but when remixed with a bit more water it returned to its fluid state. Several pieces were then able to be cast and again a slight brown coloring was noticed on the surface of the castings. This was a buildup on the surface of the soluble sodium compounds left behind as the water was absorbed into the mold. Although they didn't peel as did some of the earlier tests, I felt that these soda deposits might effect the glazes so further testing was done changing the deflocculent.
I had on hand a sample from the R.T. Vanderbilt Company of Darvan #7, a non-soda deflocculant and decided to substitute this for the soda ash and to use the "N" brand sodium silicate instead of the dry silicate. From the technical literature supplied, the choice of Darvan #7 would be a good choice for several reasons. It would increase the life of the mold as it would cut down on the sodium sulfate clogging the pores of the mold. Its proportions are not as critical as it is possible to over-deflocculate the slip yet still have it perform well. Also its distributor claimed that it caused the ware to be more plastic easing trimming and, hopefully for my purposes, allowing me to carry out some of the variation ideas that had started me on this course of study. The 1000 g and 15 pound batches were retested and finally a 100 pound batch of slip was mixed. Again with the 15 pound batch less deflocculent and less water were necessary as I was able to create a fluid slip with only 38% water. This was desirable as it wouldn't soak the mold and the dry shrinkage was cut to less than 4%. This decrease I can attribute again to greater agitation. For the larger batch I used a clay blunger which mixed the slip at a high speed in a whirlpool motion so that the slip at the top would be pulled to the bottom of the mixer. After 2½ hours mixing, the slip was screened through a 60 mesh screen twice to remove the lumps and then allowed to set 24 hours before use to assure that the air bubbles from the violent mixing had escaped.

The basis of this clay body was a recipe for hotel china that was found in Newcomb's book, Ceramic Whitewares. I had gotten it to work with my jiggering setup so I wanted to try to adapt it for casting. I chose Pioneer (Georgia) Kaolin because it is a course kaolin allowing for a more permeable slip. My choice of Kentucky Special ball clay should probably have been changed to Old
Mine #4 or Tennessee #5 ball clay. Kentucky Special provided the green strength that the ball clay is included for, as well as whiteness and a degree of plasticity that I desired. However, it was a bit flabby at times especially when used for throwing, nearing the point of thixotropy. It wasn't a problem with the casting slip initially, but I feel that it caused undo cracking as pieces were rewet for manipulation. Also in remixing the scrap slip, it was a problem to determine the water to be added as well as the deflocculent. Most of the reclaim was then used to use for the jigger clay or for throwing. Being slightly thixotropic I felt that I had finally developed a good therapeutic clay body for the criminally insane. If it was thrown fairly stiff it could be formed into basically simple shapes, but anything larger than four pounds seemed to twist unnecessarily and was difficult to raise.

MANIPULATION

Finally after four months of moldmaking, clay testing and searching for solutions to the problems that I had encountered, I was able to start slipcasting on a daily basis. I had intended to complete this study in a five and one half month period so my time was rather limited to see whether my original concept was at all practical. It seems that the clay body's workability dictates the forms as much as the desires of the designer-craftsperson. This was definitely the case as I tried to execute some of the pitcher forms that I had originally designed the mold around. The clay would emerge from the mold fairly leather hard. Because of this, it was difficult to stretch the clay for pitcher spouts or to pull handles off the pot. Spout molds had been made previously but their design seemed to be too forced to justify their use. Handles had to be attached when they were the same dryness as the pot body.
Applying them to the bone dry pot worked, but the handle had to be made to the exact form to start with which was difficult without fingerling the pot too much. The logical step would have been to make a handle mold to cast the desired handles, but this had been avoided as I wanted to use a variety of handles on the pieces to vary the pots. So for the time being I set aside the pitcher form and began to work solely with variations on the body of the pot.

The round vase forms were the first I began to deal with. They were cast first thing in the morning, and were out of the mold ready to be manipulated by early afternoon. They were usually realigned on the wheel and anchored with wads of clay. Most often I would trim off the top 2" or so and try to work the neck of the form in a bit to close the pot off into a bottle form. Care had to be taken to keep water from sitting in the bottom to the piece while it dried as that was guaranteed to crack the pot. Unfortunately the clay seemed to have no desire to move more than a half inch horizontally and as a result the neck of the octagonal vase was added after as a simple variation. The molds were originally designed so the throats were the same so this interchange could take place with a minimum of effort. Coils of clay were often added and this soft clay was then thrown to give the pot a varied lip. The coil could be drawn about 3" before it began to twist, allowing quite a variety of vase forms to be produced. I soon found the round form boring to deal with, not being able to produce the pieces I had made the mold for, and began to play with the form in multiples. Some luck was had but I found that it provided a very classical shape if the cast was turned upside down. I began to invert both the round and faceted forms, cutting them apart and joining various sections back together. Decorative bits of clay were added and the finished pieces were allowed to dry
very slowly. Even with the slow drying there was considerable cracking from, soft and leather hard clay being joined together. I had been used to working with a stoneware body that I could join clay of varying degrees of dryness together with little cracking and it was hard to then think in terms of the limitations of the dense china clay body. I began to cast the pieces thicker by letting molds sit filled for an hour. This allowed them to be removed from the mold at a softer state without losing their shape. With these I was able to join the sections together but had problems with the clay sagging at times as the clay was rewet.

**RHYTHM**

After several days of experimenting with the workability of the cast pieces, I began to develop form variations that seemed to naturally repeat themselves. These were ones that I felt were produced the easiest from the molds yet still had a bit of individuality to them. I found that I could develop approximately 20-25 distinct variations and from these there were 12-15 I felt I could do on a daily basis. My daily production was lower than if I had thrown all the pieces, but I feel this was due to only having 9 molds to deal with, and establishing new work rhythms. Working alone a potter could probably handle 15-20 molds comfortably, planning his workday to cast twice. Much of the time needed in utilizing molds is taken up in physical labor of moving them around-casting, draining, opening and drying them. This could easily be delegated to an apprentice or a hired worker allowing the potter to spend his time varying the forms and developing other lines of work.

A rhythm was soon established working with the variety of molds and forms. Slabs for the bisque and jiggered plate molds were prepared the day before and
wrapped in plastic. Usually the first duty of the day was to stir the slip a bit and set up the molds for casting. They were filled and the timer usually set for 60 minutes. While I waited, plates were able to be produced and set aside to dry. As the pieces dried in the molds, I would often finish pieces cast the day before or prepare plate slabs for a second round of plates or for the following day. A day to day rhythm was established that could become fairly routine producing the basic pieces to be dealt with. I feel such a rhythm also allows time for experimentation outside the mold-produced line.

**APOR GLAZING**

One of the tasks of ceramics that I have always approached reluctantly is glazing. The making of the pots is a sensual experience of forming the earth into whatever shape I desired, yet these are often made only to fill the kiln as it is the excitement of the firing that continues my fascination with clay. Somewhere between these two lies glazing, often a patterned afterthought or just a glass coating to make the object watertight. Many times the glazes didn't turn out as planned, hindering my acceptance of what was actually produced. As a result, I strove to develop strong forms that didn't depend upon a brilliant color to make them successful.

Slowly my work began to echo this dislike of glazing as I began to glaze less of the surface of my pots. I had started to make "American style Raku" pottery (also known as "Mechanics Illustrated Raku") which for the most part explored the reduction marking of the process rather than the "Fake Raku" luster glazes. When I began to work with stoneware temperatures again I found that most of my glazing was done with slips, allowing me to deal with the color
variation of the pieces as I was still fabricating the form. This soon led to salt-glazing where the reaction between the sodium-based vapors and the clay formed a sodium-alumina-silica glass. The vapor glazing process seemed to be what I had been looking for. It seemed to connect the firing and glazing into one process with the glaze patterns being dependent upon the way the pots were stacked into the kiln. I began to control the variables of the firing to obtain different results from each kiln load. As a result, I had no preconceived ideas of what the pots would look like returning, much excitement to the process.

Soon I began to develop a vocabulary of salt slips and successful variations. I cut down on the amount of salt that I had been using and substituted soda bicarbonate and carbonate compounds to achieve the desired glass build up. Instead of the usual salt glaze orange peel texture I have been able to produce a glazed surface which is fairly smooth. This glaze is often crazed however, due to the excess of soda flux. Several times other fluxing compounds were added to the salt-soda mixture to provide a hard transparent glaze relatively free of crazing. An addition of 7-9% boric acid to the salt will lower the melting point resulting in a smoother glaze with brighter colors.\(^\text{12}\)

The main advantages to using vapor glazing are being able to once fire the majority of the work as well as eliminating much of the glazing labor. Color variations are dependent mostly upon slips and oxides allowing for a greater interaction between the clay form and the glaze as the potter is able to comb and carve through the slip, control the texture of the brush and vary the thickness of the slip. Many of the same techniques can be used in stoneware firing under a clear glaze, but often the spontaneity of the piece is lost due to the bisque firing stage. I find satisfaction in being able to remove the pot from
the wheel ready to be loaded into the kiln as soon as it is dry. Pieces maintain their freshness and occasionally I am able to create a piece that still has a feeling of being in motion as it is on the potter's wheel.

**CONCLUSION**

At the outset of this thesis I began with several preconceived thoughts of what I wanted to achieve. In many ways these ideas were based upon my misinterpretation of industrial processes, yet I feel that this lack of understanding has helped me in many ways. I have been able to adapt the basic concepts of the techniques without being held back by a restricted procedure. Using a commercial jigger or being taught slip casting and mold making by an industrial technician would have been a one-sided education and I don't feel that I would have experimented as much as I have. Although it is more time consuming and less economical, learning by trial and error emphasizes the experiences and is often a better way to learn. There were several times that I felt a need for someone to simply answer a question, or to point the way to a solution, but these questions were soon solved as I worked with the process. The information that I have gained could have probably been covered in a week's time working with experienced persons on the subject, yet there would have been many techniques that would have to be unlearned.

I now see myself at a point with the moldmaking, casting and jiggering processes that is a very basic beginning. As I work developing forms that fit these techniques and rhythms that I establish, the forming process will then take a back seat to the creative touch. It would become second nature as does throwing after a period of time. Being able to vary the molded forms and thinking of them as individual pots has allowed me to remove some of the...
sterility of the typical cast forms and has further convinced me of the possibilities of developing such a line of work.

Acceptance of industrial techniques is something that I find many crafts-persons reluctant to do as most have chosen their trade as a rebelling against these techniques. The Bauhaus attitudes of using scientific achievements to their fullest should be reconsidered, for developing a mass-produced product allows it to be made quickly and efficiently so it can be sold at a reasonable rate. Because there has been a progressive social preference toward hand-crafted objects in the past ten years, industrial designers are beginning to aim some of their products to capture part of this market. To compete, the studio craftsperson either produces work that could not be made by industry or he should modify his work to compete with some of these industries without compromising his standards of quality and individuality. This whole concept that I have herein explored seems to offer to me many new possibilities and channels to develop my work along. This is the seed that I have chosen to plant and only time will tell if it will blossom to bear fruit.
1  Ceramics, Captain, Captain Ceramics' Artworks Catalogue, Decatur, Illinois, 1976, p. 3.


5  Ibid., p. 35.

6  Ibid., p. 33.

7  Ibid., p. 34.

8  Ibid., pp. 37-38.


BIBLIOGRAPHY


APPENDIX

Casting/Jiggering Clay Body

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky Special</td>
<td>9.5</td>
</tr>
<tr>
<td>Georgia Kaolin</td>
<td>33.0</td>
</tr>
<tr>
<td>Flint</td>
<td>35.0</td>
</tr>
<tr>
<td>Custer Feldspar</td>
<td>21.0</td>
</tr>
<tr>
<td>Dolomite</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>100 lbs.</td>
</tr>
</tbody>
</table>

Water: 35 lbs or pints
"N" Brand Sodium Silicate: 180 ml
Darvan #7: 180 ml

At Cone 9 this fires to a dense white body, translucent where thin. It has a 4% dry and 15% fired shrinkage and was found to have a 25% water of plasticity for a throwing body. When mixing for throwing or jiggering do not include the deflocculents. For casting the amount of deflocculent may vary slightly due to length of agitation and other factors. It tends to be a bit thixotropic after aging and does not throw well.

Porcelain Glaze Cone 9-10

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash Feldspar</td>
<td>43</td>
</tr>
<tr>
<td>Whiting</td>
<td>18</td>
</tr>
<tr>
<td>Edgar Plastic Kaolin</td>
<td>8</td>
</tr>
<tr>
<td>Alumina</td>
<td>9</td>
</tr>
<tr>
<td>Flint</td>
<td>22</td>
</tr>
</tbody>
</table>

Good hard clear base glaze for porcelain and whiteware. Addition of 2% Red Iron Oxide gives nice celadon. Works good over and under slips.

1234 Leach Cone 9-10

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball clay</td>
<td>10</td>
</tr>
<tr>
<td>Whiting</td>
<td>20</td>
</tr>
<tr>
<td>Flint</td>
<td>30</td>
</tr>
<tr>
<td>Kona F-4 Feldspar</td>
<td>40</td>
</tr>
<tr>
<td>Bentonite</td>
<td>5</td>
</tr>
</tbody>
</table>

Another good clear base but it crazes some if too thick. Addition of 12% Red Iron Oxide and 5% Manganese Dioxide gives a nice rich chestnut/gold color that tends to be a bit fluid breaking nicely over high points. Also works well with slips.
Cookie Jar Yellow-Green Slip

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Art Clay</td>
<td>70</td>
</tr>
<tr>
<td>Feldspar</td>
<td>20</td>
</tr>
<tr>
<td>Whiting</td>
<td>80</td>
</tr>
<tr>
<td>Ball Clay</td>
<td>10</td>
</tr>
<tr>
<td>Rutile</td>
<td>10</td>
</tr>
</tbody>
</table>

Yellow in oxidation, green in reduction. Turns a nice gold in the salt kiln. This glaze is a bit fluid, breaking nicely into rutile streaks when used over another glaze.

Yellow-Orange Slip

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Art Clay</td>
<td>60</td>
</tr>
<tr>
<td>Spodomene</td>
<td>10</td>
</tr>
<tr>
<td>Whiting</td>
<td>30</td>
</tr>
<tr>
<td>Kaolin</td>
<td>10</td>
</tr>
</tbody>
</table>

This glaze has a nice color with the right reduction firing; it can be a sick pale yellow with the wrong reduction, but it is always nice in salt.

Black Slip

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany Slip</td>
<td>95</td>
</tr>
<tr>
<td>Whiting</td>
<td>5</td>
</tr>
<tr>
<td>Cobalt</td>
<td>5</td>
</tr>
</tbody>
</table>

This is a strong black slip. Turns midnight blue under clear glazes.
flaming famine productions