DETERMINING CERAMIC APPLICATION METHODS INCORPORATING POWDERED METALS ENAMEL PIGMENTS AND SELECTED CLAY SURFACES

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF ARTS

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF HUMANITIES

AND FINE ART

BY

FLORETHA RICHARDS WILLIAMS, B.S.

DENTON, TEXAS

MAY 1981

ACKNOWLEDGMENTS

To De Neene and Dana for their days of tolerance.

I wish to thank my sisters: Thelma for the use of her typewriter, and Eunice for the initial typing and retyping during the early stages of this manuscript. A word of thanks is due Barbara Larabee who performed an inestimable service of proofreading and also, Susie Glosup for typing the final manuscript.

I am most grateful to my major professor, J. Brough Miller, who was a valuable guidepost in the refining of this manuscript.

TABLE OF CONTENTS

CHAPTER I

STATEMENT OF THE PROBLEM

Purpose of the Study

It has been the purpose of this research to reveal through an empirical study:

1. The degree of adhesion of powdered metals enamel pigments to clay surfaces.

2. Economy of the product for specialized usage.

3. Identification of key variables which affect the aesthetic quality of ceramic art work.

Justification for the Study

There is need for a study of this nature due to the lack of documented findings on the use of powdered metals enamel pigments for the enrichment of ceramic surfaces. The researcher is familiar with traditional methods of enhancing ceramic sufaces with slips and glazes. There is also an abundance of literature concerning the texturing of greenware with the intent of embellishing the surface. The intent is evident in most aboriginal wares.

In a text titled The Complete Book of Ceramic Art, Polly Rothenberg mentions decorating with lump enamels. Reference guidelines for this technique were not mentioned in the reading. Neither was there to be found any mention of powdered metals enamel pigments used to enhance the surface of ceramic wares.

Metals enamel is normally used on surfaces such as copper, gold, silver, etc. It has been used in a fast heating process, whereas, this study will be concerned with successfully adhering metals enamel to ceramic surfaces with a slow heating process inside a kiln.

Background Information

While experimenting with various firing techniques, surface treatments, and glaze formulas the researcher encountered a never ending discovery of the many possibilities of glaze and of the surface effects upon a clay body.

During the spring of 1975, John Glick, a noted potter of Farmington, Michigan, held a weekend clinic hosted by John Williams of Clay Suppliers, located on Beckley Avenue in Dallas, Texas. Glick's landscape boxes, non-traditional pottery, and functional wares displayed interesting surface treatments as well as innovative building techniques. Another workshop was led by Paul Soldner of Aspen, Colorado, who was brought to the Dallas Area through the efforts of El Centro College. He demonstrated his contemporary raku technique step-by-step from raw ingredients to finished wares. Most impressive were his stenciled-on human figures which made a final visual statement on the surface of pieces. The beauty of the accidental spontaneity and asymmetry associated with this Eastern technique impressed the researcher to further explore surface treatment.

While lecturing on glaze applications, the researcher was reminded of a previous lesson on copper enameling. If enamels were fused on to metals with the application of heat and transformed into a glossy, colorful state, why not apply enamels on clay surfaces? Some testing was done using a low-fire clay (earthenware) with a buff red hue when fired. Tiles were sprinkled with powdered metals enamel and fired in an electric kiln to an 06 cone. Adhesion was satisfactory, but most of the pigments did not show up well on the dark body. More tiles were prepared and kaolin slip was brushed on. Again pigments were sprinkled on, some were stenciled on, some were blended into the slip then sprigged on. Others were coiled and placed on the surface of thrown pieces. All pieces were bone dry before firing. From the various trials the most effective results were evident on the pieces containing kaolin slip. The researcher believes that extensive tests utilizing selected variables could produce a very satisfactory non-traditional technique of enhancing clay surfaces using metals enamel in powdered or lump state.

Definition of Terms

1. Aesthetic--"Of or pertaining to the beautiful, as distinguished from the merely pleasing, the moral, and especially, the useful."[1]

2. Binders--Vehicles used to promote cohesion in loose substances: thickening agent; an adhesive (Williams, 1980).

3. Champlevé--An enameling process. Designs are gouged out of the metal, filled with enamel and fused with heat leaving portions of the metal bare (Williams, 1981).

4. Clay body--A mixture of clays and other ingredients used to perform in a specific way (Williams, 1980).

5. Cloisonné--An enameling technique that involves the fusing of ground enamel inside small metal cells (Williams, 1981).

6. Coiling--Rolling clay with hands to make rope-like lengths for building or decorating (Williams, 1981).

7. Combination methods--making a ceramic form from both handbuilt and wheel-thrown shapes, etc. (Williams, 1981).

---

[1]William Alan Neilson, ed., Webster's New International Dictionary of the English Language, 2nd edition (Springfield: G. & C. Merriam Co., 1968), p. 42.

8. Earthenware--"Porous pottery that matures at a low-firing temperature."[2]

9. Empirical--"Derived from experience; derived from observation without reliance on theory."[3]

10. Enamel--" A vitreous composition applied by fusion to the surface of metal, glass, or pottery."[4]

11. Engobe--"A slurry of glaze materials used as decoration on green or bisque ware."[5]

12. Glaze--"A glass-like coating fusion bonded to a ceramic surface by heat."[6]

13. Kaolin--"China clay; a white firing, highly refractory primary clay."[7]

14. Leather-hard--A stage when clay is moist enough to carve, but too stiff for reshaping (Williams, 1981).

---

[2]Polly Rothenberg, The Complete Book of Ceramic Art (New York: Crown Publishers, 1972), p. 265.

[3]Albert and Loy Morehead, eds., Webster's Handy College Dictionary (New York: The American Library, Inc., 1972), p. 157.

[4]Polly Rothenberg, The Complete Book of Ceramic Art, p. 265.

[5]Leon I. Nigrosh, Clay Work: Form and Idea in Ceramic Design (Dallas: Hendrick-Long Publishing Co., 1975), p. 190.

[6]Ibid., p. 191.

[7]Ibid., p. 191.

15. Metals enamel--Commercially prepared enamel designed to be used specifically on gold, copper, silver, etc., and not commonly used on ceramic surfaces (Williams, 1981).

16. Oxidation--"When the flame gets all the oxygen it needs to burn with maximum efficiency."[8]

17. Solder--A prepared alloy used to join two metals together with the application of heat (Williams, 1981).

18. Sprig--"A relief decoration added to a clay surface."[9]

19. Stoneware--"A high-firing clay with little or no rate of absorbency. Closer to porcelain than earthenware, it is more plastic and depends upon its impurities for its color and texture."[10]

20. Unity batch--when the sum of ingredients in a recipe equal out to 100, thus changing the formula into a usable recipe (Williams, 1981).

---

[8]John B. Kenny, The Complete Book of Pottery Making, 2nd ed. (Pennsylvania: Chilton Book Co., 1976), p. 213.

[9]Daniel Rhodes, Clay and Glazes for the Potter (Pennsylvania: Chilton Book Co., 1974), p. 308.

[10]Paulus Berensohn, Finding One's Way with Clay (New York: Simon and Schuster, 1972), p. 158.

21. Vitreous--"The hard, glassy and nonabsorbent quality of a clay body or glaze."[11]

22. Wet Packing--a technique of applying moist enamel (Williams, 1981).

Delimitations

The study was conducted within the following delimitations:

1. Based on personal experience, clay bodies were selected to receive surface treatments. The clays were: T. W. U. stoneware, John William's earthenware, and white stoneware.

2. A selected number of metals enamel in powdered and lump state were chosen. Some of the enamels were: opaque Chinese red, black, green, blue, yellow, and transparent red.

3. Binders were chosen for testing. These binders were clay slurry (from selected clays used in this study), Elmer's glue, and polycell (wheat paste).

4. Small Orton Standard Pyrometric cones were used exclusively in this study.

5. Firing took place in an oxidation atmosphere (electric kiln) at cones 04, 05, 06, and 010.

---

[11]Leon I. Nigrosh, Clay Work: Form and Idea in Ceramic Design (1975), p. 158.

6. Location for experimentation was the T. W. U. Fine Arts Department in Denton, Texas, and the ceramic studio at Skyline Center in Dallas, Texas.

7. This study was not intended to be an exhaustive investigation, but rather an empirical one to incorporate metals enamel pigments with clay bodies for specialized usage in decorating ceramic surfaces.

8. Ceramic forms were made by wheel-throwing, handbuilding, and combinations of these two techniques.

9. Ceramic forms were comprised of each of the selected clays.

10. The primary means of embellishing ceramic surfaces was the application of metals enamel. A final treatment was the application of a transparent glaze.

11. An experimental development of methods and processes used by the researcher is inclusive in this manuscript.

12. A listing of supply sources for major components is given in appendices.

13. Findings on test pieces were charted and selected finished works were photographed for inclusion in this manuscript.

14. Illustrations, charts, and photographs of the work in progress are included in this manuscript.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

While examining pertinent data for this study, the researcher found that there are hardly any available records dealing with metals enamel fused on to ceramic surfaces. What has been researched and recorded is an immense amount of information concerning the adornment of metals and some glass items with enamels. In The Complete Book of Ceramic Art, Polly Rothenberg gives information on clay with lump enamels, but does not include powdered metals enamel. Other references discuss enamel fused to metal, glass, and ceramics. But information on methods and techniques on how to use metals enamel as ceramic surface treatment is almost nil.

Enamel, in art, is vitreous glaze or composition of vitreous glazes fused on a metallic surface. There is little difference between glass, ceramic glaze, and enamel apart from the fact that enamel is made to withstand the stresses set up by the expansion and contraction of the metal during and after firing in the furnace.[1]

---

[1]Valerie Conway, Introducing Enamelling (New York: Watson-Guptill Publications, 1970), p. 7.

Enamels are usually fired at lower temperatures than glazes.

No one knows the date marking the birth of the enameling technique. However, jewels, sculptures, wares, trinkets, and painted enamel toys have been adorned with this vitreous material. It is believed that the process was first used in the fourth century B.C. by metal workers in Greece who employed the technique to create color accents in jewelry or to imitate precious stones. Since that time, enameling has been used to decorate plates, sculpture, devotional objects, and painting.[2]

For some time it was only the wealthy that could buy or commission a fine piece of enamel. It was a custom for the church and the noble families to support the talents of enamel craftsmen, thus enabling them to spend all of their time creating priceless enamels for their patrons.

Enameling was revived in England by Alexander Fisher and others in the Art Nouveau period.[3]

---

[2]Colliers Encyclopedia, 1974 ed., S. V. "Enamel".

[3]Geoffrey Clarke, Francis and Ida Feber, The Technique of Enamelling (New York: Reinhold, 1967), p. 88.

When enamel is used as a decoration, it may be applied in several different ways. Some traditional application methods found by the researcher to be significant to this study are cloisonné, champlevé, and sgraffito. The researcher felt that these techniques were simple enough in execution to adapt to clay by substituting clay coils for wire and slip for solder.

Cloisonné is the oldest known enameling technique, dating back to the early dynastic period in Egypt. It is done with fine wires which are bent to form cloisons or enclosures that contain areas of color.[4] This technique permits precise and dramatic color contrasts by separating different colors.

Champlevé (literally, raised field) is the second oldest of the enameling techniques, with its earliest forms dating from the Eighteenth Dynasty (1567-1320 B.C.) in Egypt. In champleve, portions of the metal are lowered and filled with enamel so that the finished surface is part polished metal, part enamel, and it is perfectly smooth.[5]

---

[4]Dominic Dispasquale, Jean Delius, Thomas Eckersley, Jewelry Making an Illustrated Guide to Technique (New York: Prentice-Hall, Inc., 1975), p. 51.

[5]Ibid., p. 55.

A similar technique in ceramics, would be incising designs into the surface of leatherhard ware and filling the depressions with wet enamels.

Sgraffito means scratched. In this type of decoration, designs are scratched into a coating of enamel so that the bright color of metal shows through. In ceramics, designs are scratched in a coating of engobe so that the contrasting color of the body shows through.

The researcher felt it important to point out that, because of the characteristics of clay, the possibility of substituting clay for metal, in some cases, would result in a favorable outcome.

The predominant surface on which enamellers worked was metal. The most recommended one being copper because it is well suited for this method. It is available, relatively inexpensive, fairly easy to cut and shape, and is a color which combines well with enamels. Its melting point is high enough to allow freedom in fusing the enamels. Clay is also abundantly available, relatively inexpensive, and easy to manipulate. Clay is a medium that behaves in a particular way according to the conditions imposed upon it. A

sensitivity to it can be acquired through prolonged experience. The choice of a clay for specialized usage should be made based on experience.

In this study the researcher employed three clays that were readily available, relatively inexpensive, and with which she was most familiar.

Enameling seems to have been practiced among many cultures, with each contributing to or refining the technique in some way. The enameling art spread as craftsmen learned new skills and traveled to other countries.

Today, innovative breakthroughs in technology and attitude have brought bold and startling new methods to the studio of the artist-craftsperson. Today, anyone who loves beauty may purchase or create fascinating art work. Exciting treatment brings an ever increasing range of experimental approaches to traditional processes. Considering the unique characteristics of the two materials involved in this study, the researcher can add something of her own expression.

CHAPTER III

METHODS AND PROCEDURES

The investigator carried out research accordingly:

Phase I: Examination of Relevant Literature. During Phase I the investigator examined such relevant literature as Kenneth Bates' Enameling Principles and Practice and The Complete Book of Ceramic Art by Polly Rothenberg. She also searched literature in an effort to find pertinent data concerning firing procedures, application methods or any information similar to her study. The researcher examined reference material such as the Art Index, Ceramic Abstracts, Master's Abstract, and Comprehensive Dissertation Index. Other significant sources included periodicals such as Ceramics Monthly, and Crafts Horizons.

Phase II: Studio Work: Experimentation and Production.

During phase II the investigator experimented with selected clay bodies, metals enamel pigments, and binders to produce certain decorating techniques for ceramic surfaces. Samples were made by mixing in varying percentages, selected clay slips and powdered enamel

pigments, and enamel pigments and selected binders. Test tiles were made from these samples and fired to cones 04, 05, 06, and 010 in an electric kiln. This means that they were fired in a neutral atmosphere.

The forming methods chosen by the researcher were simple in operation and thought to be best suited for the selected media and techniques. Small pieces were thrown, some handbuilt, and decorated.

Phase III: Evaluation of Findings, compilation of Production Guidelines, Preparation of Manuscript, and a Showing of Graduate Studio Work. During Phase III the researcher made further observations from research findings and studio work. She then prepared the manuscript, and arranged a showing of selected graduate work and of small pieces adorned with metals enamel pigments.

CHAPTER IV

PRODUCTION GUIDELINES

Choosing the Selected Clay Bodies

Certain clay bodies were selected to incorporate with metals enamel and successfully fuse it on to the surface of ceramic wares. The intent being for aesthetic reasons, not related to physical function of the objects.

The investigator was familiar with the earthenware and the T. W. U. stoneware, also the clays were readily available and on hand. However, the researcher feels that almost any other body that one prefers to use would prove satisfactory. The third clay, white stoneware, was chosen to maximize contrast of the very light body to the pastel creations of enamel and clay. The researcher was partial to these three clays because of her studio experience.

It was felt that these clays possessed certain desirable colors and textures giving them a probable success factor for use in this study.

Choosing the Selected Enamels

When choosing metals enamel for this investigation, the researcher had to consider the total properties of the enamels. Also there is a wide range of colors that is virtually unlimited. The researcher made use of mostly bright enamel hues as listed under Delimitations in Chapter I. It interested the investigator to examine the opacity and transparency of the enamels. Opaque enamels let no light pass through. They adorned the white stoneware pieces in most cases. Ceramic ware constructed from the earthenware was decorated, for the most part, with the transparent enamels. These enamels permit light to show through. This allowed sgraffito designs scratched in slip on the darker clay body to be viewed.

Incorporating Enamels and Clay

After preparing metals enamel for use, initial samples were made by impregnating moist lumps of each of the clay bodies with the enamels (to be referred to as clayenamels from this point throughout the study). They were blended with a palette knife (and with fingers) to assure a homogeneous mixture (see figures 1 and 2).

Recipes for clayenamels were as follows:

Batch #1	Batch #2
1 part clay body 1 part metals enamel	1 part clay body 2 part metals enamel

Batch #3

1 part clay body
3 parts metals enamel

A level tablespoonful equals one part in all recipes throughout this investigation. Droplets of water were added when mixture from increased amount of metals enamel became crumbly. To insure more plasticity, Elmer's glue can be added.

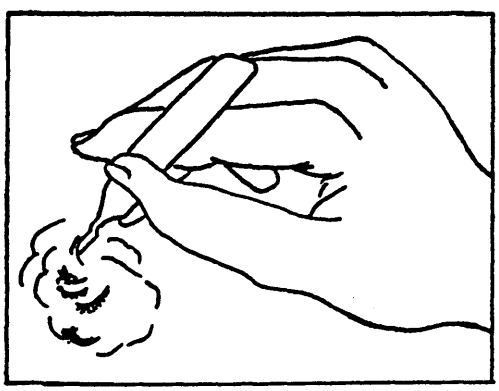


Figure 1.
Blending batches with palette knife.

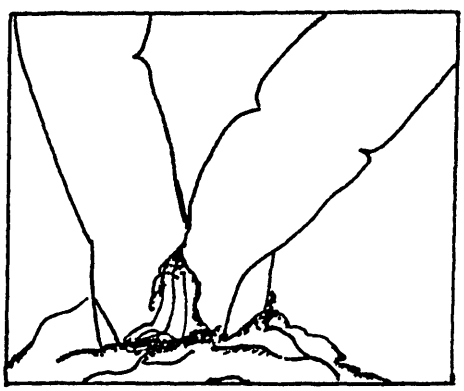


Figure 2.
Blending batches with fingers.

Other samples were made by mixing powdered metals enamel with such binders as polycell (wall paper paste)

and Elmer's glue. It was necessary to use these binders because metals enamel, unlike clay, does not become plastic with the addition of water. The researcher had to decipher a method of making the union plastic to apply to surfaces and remain in place for firing.

Batches for binders and metals enamel are as follows:

> 1 part polycell, or Elmer's glue, and enough metals enamel sprinkled until mixture yields a soft malleable lump that is not crumbly. The amount of enamel is equivalent to 2 1/2 to 3 parts. Droplets of water were added to the Elmer's glue batch for easy workability.

The above recipe could be doubled or tripled depending on the desired amount needed.

A temporary bond was necessary during the transitory period between the chemical bond and what was ultimately to take place after the firing--a ceramic bond. This union of two materials blended together to make a malleable consistency resembling bread dough. This dough was labeled and stored in plastic and later used for "wet-packing"[1] and "sprigging"[2].

---

[1]"Wet packing": refer to definition of the term, Wet packing, p. 8.

[2]"Sprigging": refer to definition of the term, Sprig, p. 7.

Some lumps and coils were left to air-dry for later use to press into soft clay walls.

Making Test Samples

The degree of fusion of metals enamel to ceramic surfaces was a primary concern for the researcher. For this test, clay tiles of varying shapes were cut out and sprinkled with each of the powdered enamels (see figure 3). Greenware pieces were sprinkled and kept in an undisturbed place to prevent blowing powdered pigments away while drying. Bisqued tiles were handled the same with the exception of a thin application of Elmer's glue.

Coils and beads of each of the powdered metals enamel and each of the moist clays were made to test for brillance of color. Some were placed directly on the tiles (Plate 1.). These samples did not require that a great deal of enamel be utilized.

Each tile was labeled for later identification.

Firing the Enamel and Clay Samples

Samples were left to dry completely, then bisque fired to cones 04, 05, 06, and 010 (as stated in Delimitations under Chapter I) in an electric kiln. Some of

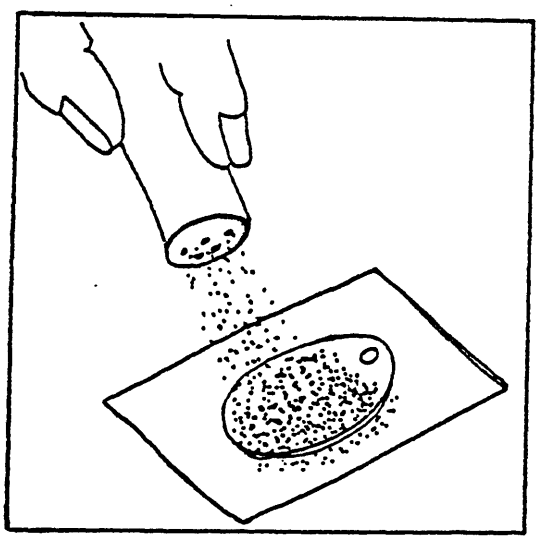


Figure 3. Sprinkling enamel on fired bisque tile.

the earthenware samples were fired for a second time after application of a commercially compounded clear gloss glaze. Additional firings were done to achieve a different outcome. This time bead samples were made from two parts enamel and one part clay. As anticipated by the artist, the increase in enamel induced melting in the samples. The kiln shelves were prepared with 1/4 of an inch of dry kiln wash to prevent molten and fluid enamels from sticking to the shelves.

Constructing and Embellishing Ceramic Wares with Enamels

The investigator explored several examples and variations of decorating techniques. The enameling process dictated innovative ideas. Fired samples resulted in an array of interesting surfaces.[3] The researcher took advantage of these consequences and constructed ceramic forms she thought aesthetically compatible to major components involved.

The forming methods chosen by the researcher were those of wheel throwing (small bottles, jars, and plates), handbuilding (slab boxes and platters, knee pots, etc.), and combination pieces.

Embellishing techniques included the use of "Clayenamels" that were attached to the surface of fairly stiff, but moist ware. The pieces of plastic clay were hand-fashioned spontaneously while working on the piece (Plate 2). Slip was used as a bond between the two during drying. Another of the applique techniques was to use coils of the same nature and affix to a "slipped" area, then paddled with a board to make a ribbon-like design. The artist found that the coils could be used as built-in decorative surfaces by making swirls, lines, holes,

---

[3]Refer to Appendix p. 41, Fired Sample Chart.

and lumps. Some wares were thrown first and height was added by handbuilding the top with "clayenamel" coils. This also created an interesting color contrast. Each coil was made from a lump the size of a small egg. This was squeezed out, laid on a table and rolled back and forth, applying light, even pressure, by keeping hands parallel with the table, and use the full length of the fingers and palms (see Figure 4). Continue to roll until desired size is achieved.

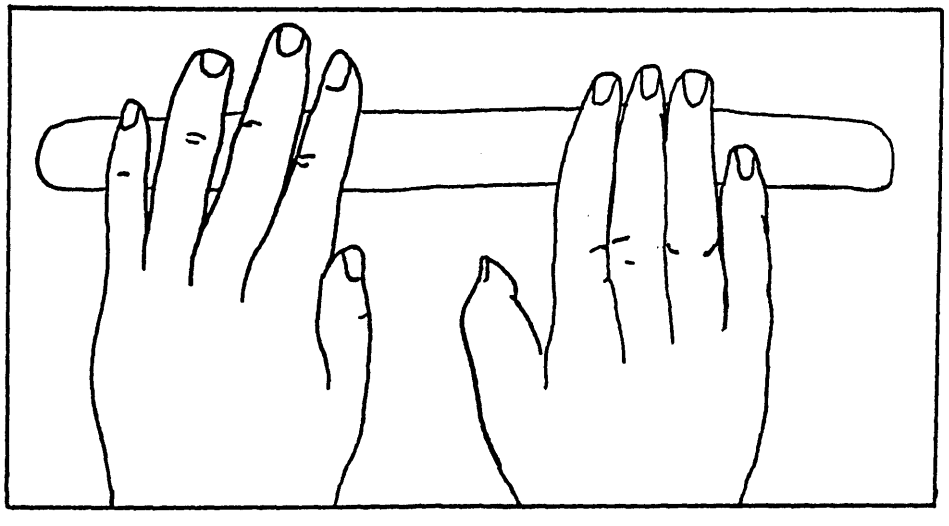


Figure 4. Making clayenamel coils.

After thrown piece had stiffened enough to support additional weight, coils were attached. It was found that controlled drying was necessary for pieces

with attachments. Plastic bags served the purpose. Pieces dried slowly to prevent cracks forming between joining pieces.

Sharp instruments such as dental tools were used to carve into the surface of slightly leather-hard pieces (see Figure 5). The malleable dough lumps were deposited into the depressions. This method was adopted from the enameling technique, champlevé. After carvings were done, the artist thought that pieces fashioned after another enameling technique, cloisonné, would certainly be viable. Delicate strips of clay were employed like wires. They were bonded to a moist ceramic form with slip. The design left an enclosure for enamels to be later deposited.

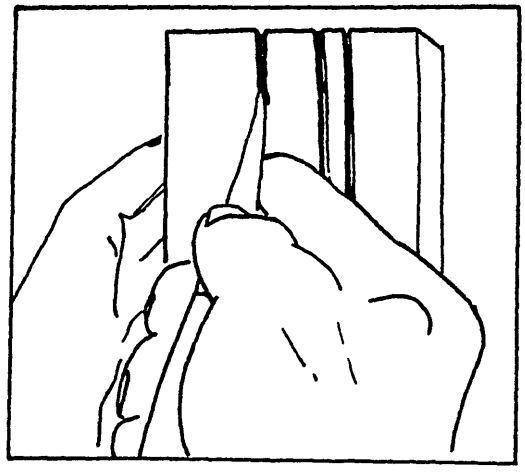


Figure 5. Carving wall of leatherhard ware.

This method was traditionally used as an enameling technique to prevent colors from bleeding into one another. Ceramic forms treated this way had to be flat or slightly curved because the artist anticipated a higher degree of melting and running from lumps and beads made from binders and enamels. Some pieces were designed to accommodate runny enamel lumps (Plate 3).

Pressing clayenamel lumps and beads into the surface of moist ceramic forms was another application method used in this study (see Figure 6). The earthenware piece was thrown, altered, and slipped with Kaolin. Lumps were placed in a scored (scratched with pin) area to mechanically bind the lumps. This is a technique common to ceramics.

Common glaze application methods such as dipping, pouring, and brushing were tried by the researcher. However, these variables did not enhance the surfaces of ceramic art work. The problem of "settling" was encountered. It was difficult to keep the solution of water, glue, and enamel in suspension, yet fluid enough for either of the application methods.

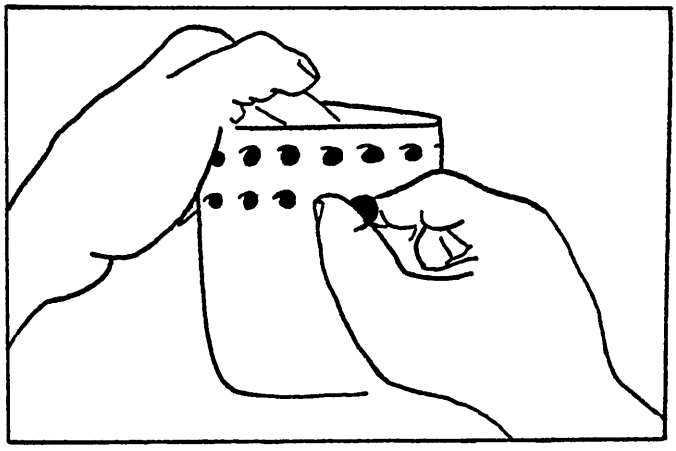


Figure 6. Pressing lumps into moist clay wall.

Final embellishment applied to the pieces was a clear gloss glaze. The glaze served as a sealer and offered no competition to the enamels.

All test samples and wares were fired in an electric kiln. All wares were bisque fired at cone 010.

Findings

Fortunately, fired clay and glass have a coefficiency of expansion which is similar enough to make it possible for the glass to be melted into the clay and to stick to it during cooling without undue strains developing between the glass and the clay.[1]

All of the samples tested for adhesion of metals enamel to clay resulted in a favorable outcome. The selected firing range allowed for sufficient flow and fit between enamels and ware. The majority of the findings in this investigation remained significantly consistent. Enamels became molten and flowed more when blended with binders and then glaze fired.

Mixtures of binders and enamel retained a true pigment after being fired. The organic adhesives (polycell and Elmer's glue) burned out and did not alter the colors. After a firing of clayenamels (clay mixed with metals enamel) there was a notable difference in pigment, especially with the reds. There was only a small trace of the original hue. This is a common reaction for transparent enamels, especially reds.

---

[1]Daniel Rhodes, Clay and Glazes for the Potter, (Pennsylvania: Chilton Book Company, 1974) p. 242.

The clay is inorganic and contains ingredients that would alter the enamel pigments during a firing.

Pastel tones were created from batches of metals enamel and the white stoneware body. Lava-like textures resulted from an 05 firing of white stoneware and an equal proportion of metals enamel. This condition was more noticeable in the black and the reds.

Most of the ceramic application methods proved to be viable and useful to the ceramic-artist. Techniques common to enameling were effectively incorporated with clay and employed as a method of increasing the aesthetic appeal of ceramic surfaces.

Favorable results were achieved from all components. Individual preference could decide which of the variables would be best suited for use.

The economy of the enamel for specialized usage did not exceed the projected budget. The intent of the study was to utilize metals enamel as the principal mode of decoration. The quantity of materials used was small and inexpensive. Enamels were used sparingly on small ceramic pieces. Care was taken to prevent copying the enameled look (common to metal enameling). Few pieces were made to resemble the traditional glazed or enameled

technique. With careful consideration, the artist employed decorations as an integral part of the total design.

The firings proved economical because of the number of pieces that could be tested during a single firing. Perhaps the most expensive item used in the study was the enamel pigments. The researcher used commercially prepared metals enamel which offered a broad palette of bright colors.

Because of the company's refining process the product would be far more superior to what any lay-person could produce. Furthermore, the researcher is more concerned with the end result of ceramic application methods. The researcher only wanted to establish feasibility of the adaptation of metals methods and enamel pigments themselves to that of ceramic surfaces.

The researcher used two commercially prepared clays and a commercially prepared glaze.[2] The T. W. U. stoneware claybody was prepared by the artist from a recipe given to her by her professor, J. Brough Miller.

---

[2]Refer to Appendix p. 39, Supply Sources.

T. W. U. Stoneware

Perla fire clay	60%
Kentucky OM4 ball clay	16
Soda feldspar	14
Blasting sand	10
TOTAL	100%

Bentonite - 1 cup

Red iron (coloring agent) - 1%

Summary and Conclusion

The intent of this study was to incorporate vitreous metals enamel into engobes derived from various clay bodies and determine appropriate application methods to enhance the aesthetic character of ceramic surfaces. In an effort to explore a non-traditional technique of decorating ceramic wares, the artist was also determining the feasibility of the product for specialized usage.

Resource materials were investigated in an attempt to find suggestions that would be relevant to this study. Little information was found. The writer based this investigation on empirical knowledge from studio experimentations.

Most of the ceramic application methods proved to be viable and useful to the ceramic artist. Some of the methods could be incorporated into ceramic objects other than pottery. Application of metals enamel would work as efficiently on slightly inclined ceramic surfaces. The researcher discovered a method of handling a medium that was commonly used on horizontal metal surfaces and utilized it on a vertical ceramic surface.

The writer has presented a development of ceramic application methods including the forming of the pieces, from wet to dry stages, the firing techniques involved, and the incorporation of metals enamel and clay bodies.

This study has revealed that commercially prepared metals enamel with modification, by incorporating into clay bodies, can be treated as one would metallic oxides but, treatment with more, predictable results.

Ceramic pieces produced from this investigation are based on an overall aesthetic appeal, and function primarily for the fulfillment of displaying works of art.

Results from test tiles for adhesion and maintaining pigmentation are photographed and included in this manuscript. It must be noted that these samples are achieved in a standard kiln (described earlier under "Delimitations"), using selected clay bodies, metals enamel, binders, and clear gloss glaze. Researcher believes that one could conduct the same tests in one's own studio, following the same directives, and would probably create similar treatments.

APPENDIX A

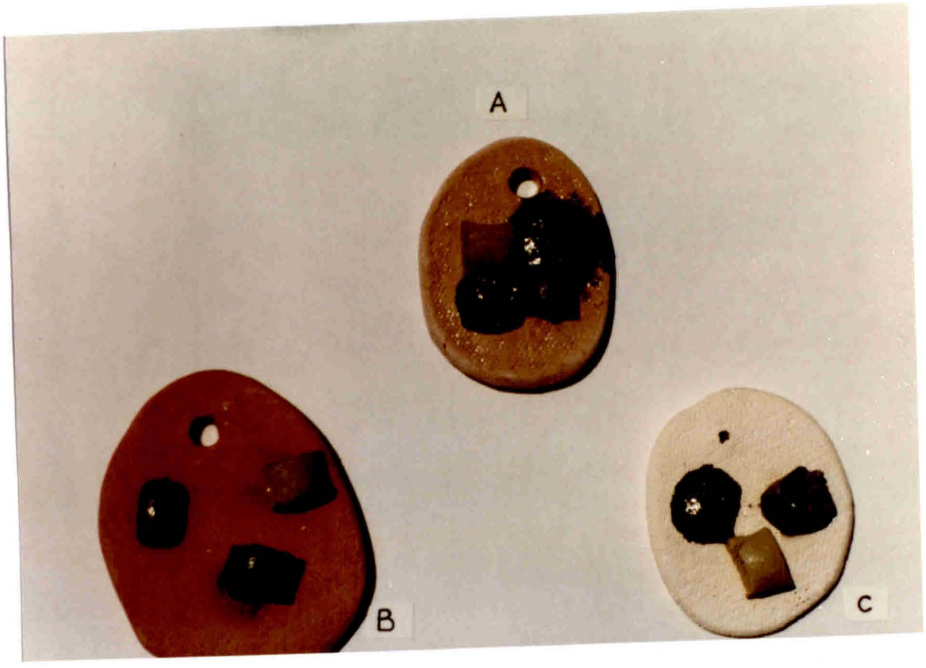


Plate 1

Plate 2

Plate 3

APPENDIX B

FIRING SCHEDULES

A. Firing cone 010 Bisque and Test Samples
B. Firings cone 04, 05, and 06 Test Samples and Glazing

A.	8:30	9:30	10:30	11:30	12:30	1:30
TOP SWITCH	OFF	LOW	LOW	MED	MED	HIGH
MIDDLE SWITCH	LOW	LOW	MED	MED	HIGH	HIGH
BOTTOM SWITCH	MED	MED	HIGH	HIGH	HIGH	HIGH
TOP PLUG	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED
MIDDLE PLUG	OPEN	OPEN	OPEN	OPEN	CLOSED	CLOSED
BOTTOM PLUG	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
LID	VENTED	VENTED	VENTED	CLOSED	CLOSED	CLOSED

B.	8:30	9:30	10:00	11:00		
TOP SWITCH	LOW	MED	HIGH			
MIDDLE SWITCH	LOW	MED	HIGH			
BOTTOM SWITCH	LOW	MED	HIGH			
TOP PLUG	OPEN	---→	---→	CLOSED		
MIDDLE PLUG	CLOSED	---→	---→	CLOSED		
BOTTOM PLUG	CLOSED	---→	---→	CLOSED		
LID	CLOSED	---→	---→	CLOSED		

APPENDIX C

SUPPLY SOURCES FOR CLAYS, GLAZES, AND METALS ENAMEL

Earthenware

John Williams*
Clay Suppliers
1127 S. Beckley Ave.
Dallas, Texas
(214) 946-3450

White Stoneware

Bruce Mayo
The Pottery Workshop
Olla Podrida
7300 Valley View Lane
Dallas, Texas
(214) 233-4872

Metals Enamel

Thomas C. Thompson Company
1539 Old Deerfield Road
P.O. Box 127
Highland Park, Illinois
(312) 831-2231

(05-06) Clear Glss Glaze

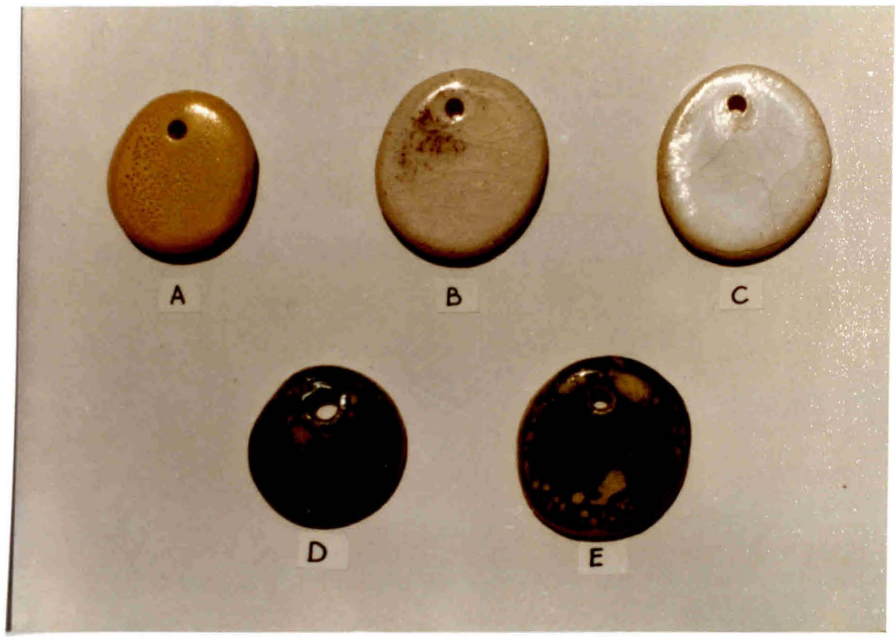
American Art Clay Company, Inc.
4717 West 16th Street
Indianapolis, Indiana

*John Williams--currently employed with:

Trinity Ceramic Supply, Inc.
9016 Diplomacy Row
Dallas, Texas
(214) 631-0540

APPENDIX D

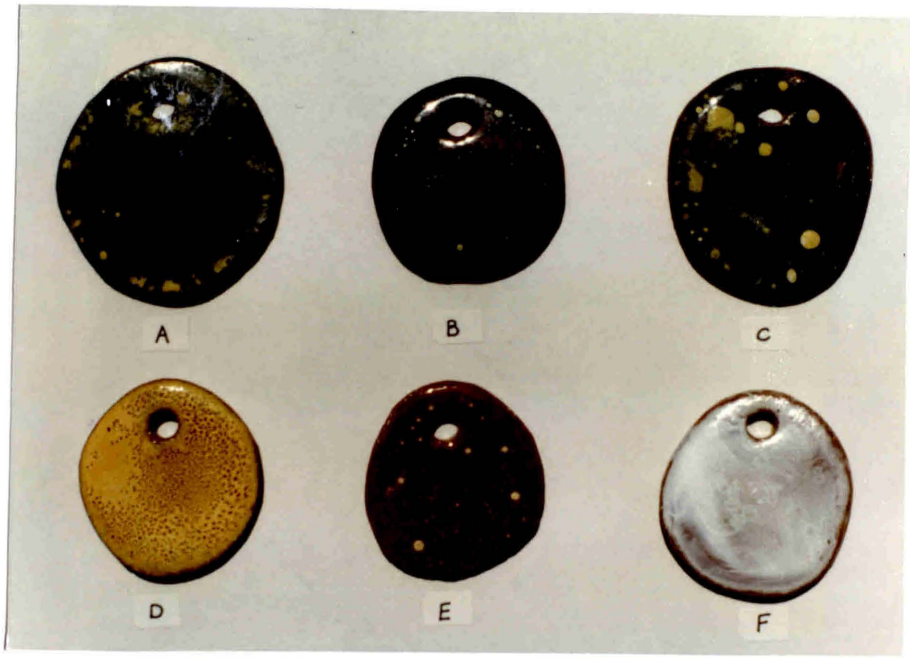
FIRED SAMPLE CHARTS



White Stoneware Cone 05

1 coat of flux, 2 coats of enamel

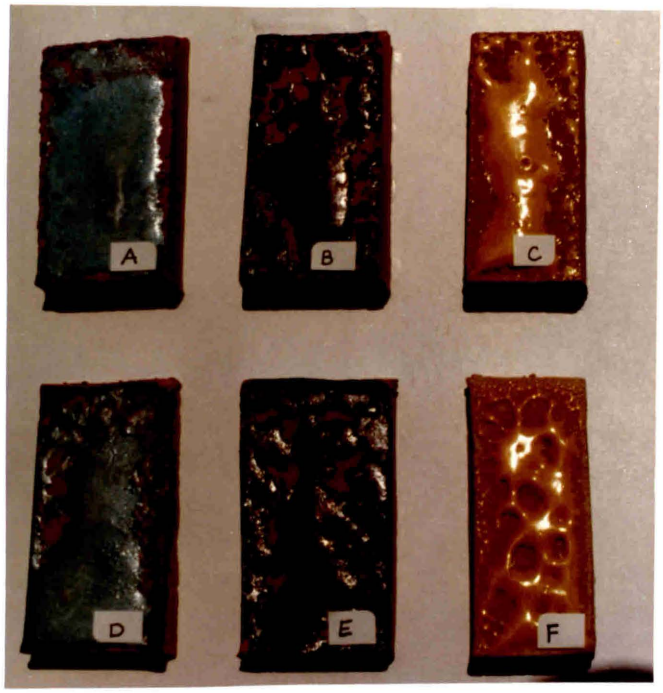
A Yellow
B Transparent red
C White
D Blue
E Green



Earthenware Cone 05

1 coat of flux, 1 coat of enamel

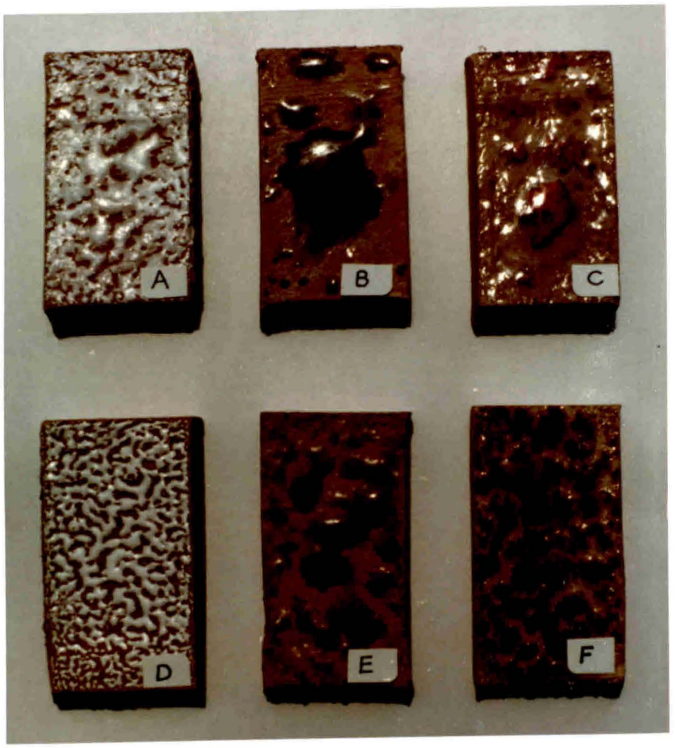
A Blue
B Transparent blue
C Green
D Yellow
E Transparent red
F White



Earthenware Cone 04

Top row: 3 coats of enamel, 1 flux
Bottom row: 2 coats of enamel, no flux

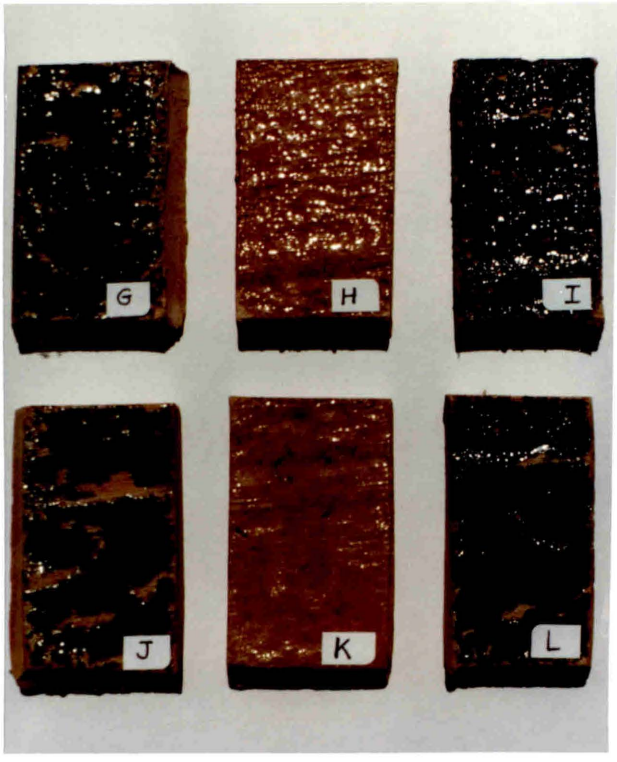
A and D Turquoise
B and E Black
C and F Yellow



T. W. U. Stoneware Cone 04

Top Row: 1 coat of flux
2 coats enamel
Bottom row: 2 coats of
enamel

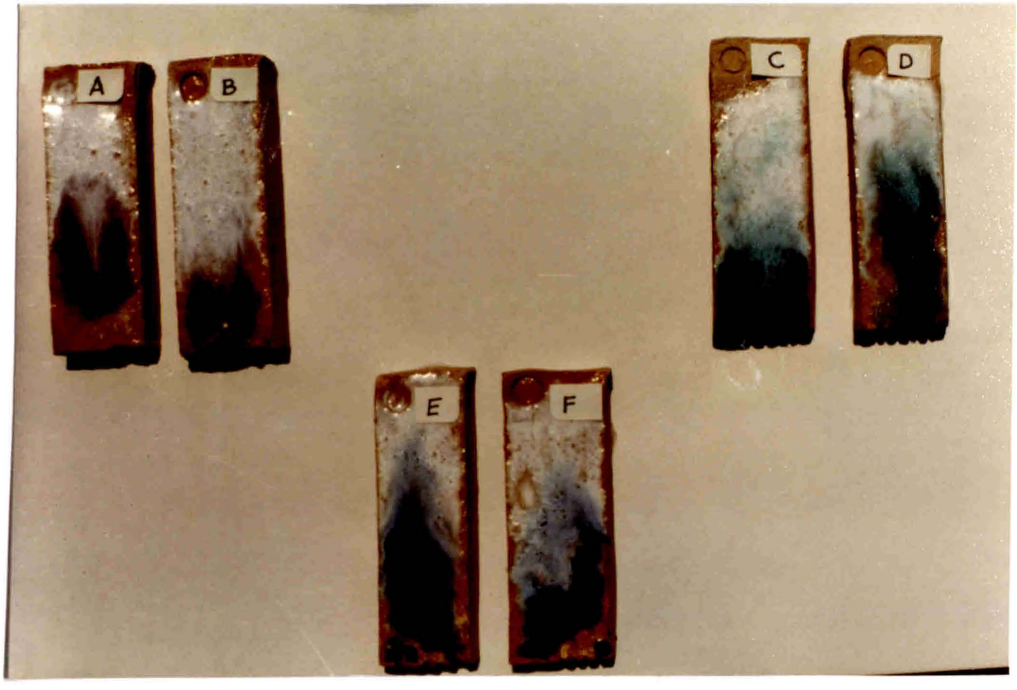
A and D White
B and E Brown
C and F Opaque Chinese red



T. W. U. Stoneware Cone 06

Top row: 2 coats of enamel
2 coats of flux
Bottom row: 1 coat of flux,
2 coats of enamel.

G and J Green
H and K Transparent red
I and L Black

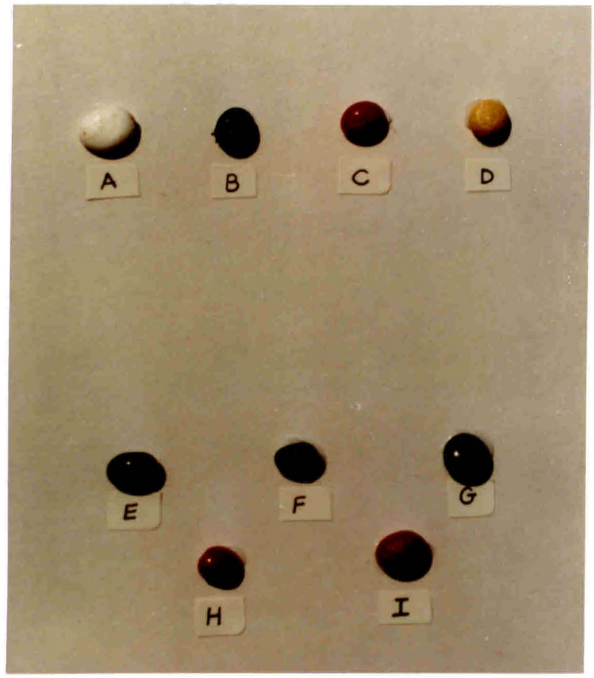


T. W. U. Stoneware Cone 06

B, C, and F 1 coat of white over flux. Bottom half enamel

A, D, and E 1 coat of white, no flux Bottom half enamel

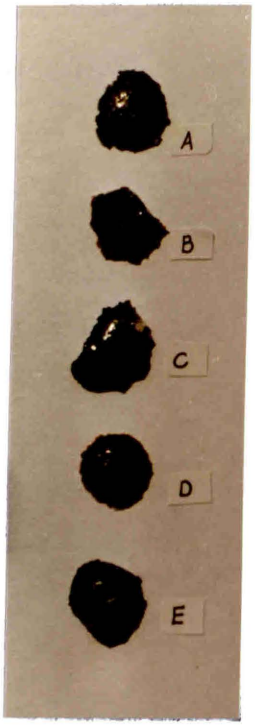
A and B Brown
C and D Turquoise
E and F Transparent blue



Enamels and Binders Cone 010

A - D Mixed with polycell
E - I Mixed with Elmer's glue

A White
B Green
C Transparent red
D Yellow
E Black
F Green
G Blue
H Opaque Chinese red
I Transparent red



A Green
B Opaque Chinese red
C Black
D Transparent red
E Blue

Earthenware enamel — 1 part clay, 2 parts Cone 04

APPENDIX E

COLOR PORTFOLIO OF

STUDIO WORK

Plate 1. A.

C.

B.

Earthenware Pieces

A. Slipped with Kaolin, topped with transparent blue lumps on shoulder.

B. Assorted enamel threads on lid.

C. Binder (glue) and enamel beads pressed in greenware.

Plate 2. A. B.

A. Cloisonné technique

B. Champlevé technique

Plate 3. Earthenware

Kaolin slip (sgraffitoed), wet packed with binder and enamel.

A. B. C. D. E. F.

Plate 4. Sample pots with varying shoulder angles to test flow of molten enamels.

A. TWU stoneware

B. White stoneware

C.-F. Earthenware

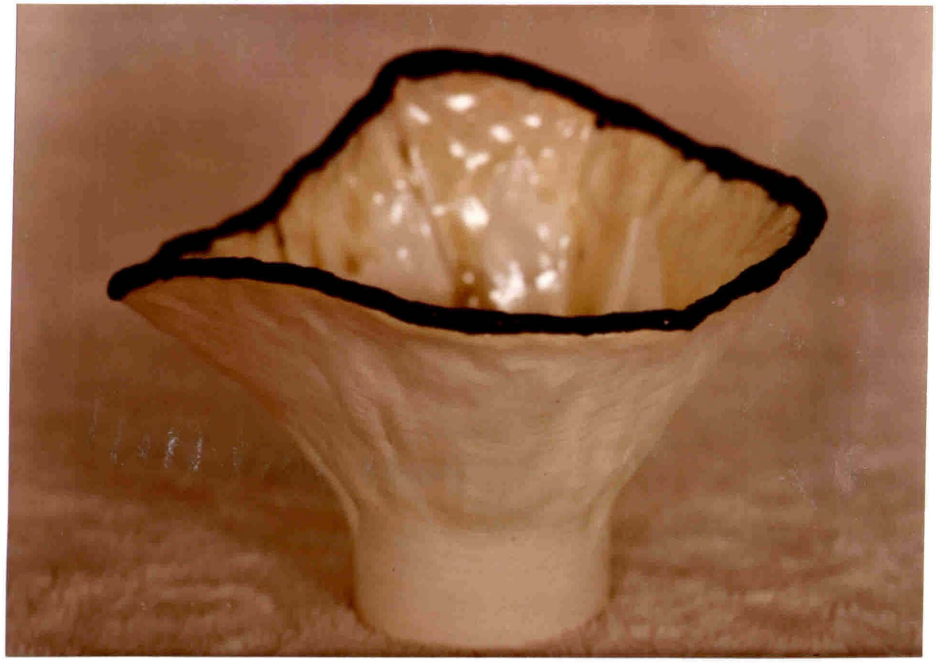


Plate 6. White stoneware knee pot with green clayenamel trim and transparent red flowing.

Plate 7. Earthenware bottle and lidded box studded with clayenamel beads.

Plate 8. White stoneware lidded box. Cloisonné technique.

Plate 9. White stoneware vase with green enamel and binder.

EARLY GRADUATE PIECES THAT LATER INFLUENCED THE STUDY OF SURFACE TEXTURE

Plate 10. Raku Body
Stoneware glazed and fired

Plate 11. Glazed stoneware.

Plate 12. Raku goblets.

Plate 13. Raku Body
Stoneware glaze.

SELECTED BIBLIOGRAPHY

Berensohn, Paulus. Finding One's Way with Clay. New York: Simon & Schuster, 1972.

Clarke, Geoffrey; Francis and Ida Feber. The Technique of Enamelling. New York: Reinhold, 1967.

Conway, Valerie. Introducing Enamelling. New York: Watson-Guptill Publication, 1969.

Dispaquale, Dominic; Jean Deluis, and Thomas Eckersley. Jewelry Making. New York: Prentice-Hall, Inc., 1975.

Kenny, John B. The Complete Book of Pottery-making. New York: Chilton Book Co., 1968.

Nigrosh, Leon I. Claywork: Form and Idea in Ceramic Design. Dallas: Hendrick-Long Publishing Co., 1975.

Rhodes, Daniel R. Clay and Glazes for the Potter. New York: Chilton Book Co., 1968.

Rothenberg, Polly. The Complete Book of Ceramic Art. New York: Crown Publishers, 1972.

MAGAZINES

Ceramic Monthly, Davis Press Company, Columbus, Ohio.

Crafts Horizons, American Crafts Council, New York.

DICTIONARIES

Morehead, Albert and Loy Morehead, eds. Webster Handy College Dictionary. New York: The American Library, Inc., 1972.

Neilson, William Alan. Webster's New International Dictionary of the English Language, 2nd ed. Springfield: G. & C. Merriman Co., 1968.