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To the Graduate Council:

I am submitting herewith a thesis written by Pamela Elizabeth Hassler entitled "Polychromatic Metal Designs." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Related Art, Crafts, and Interior Design.

Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor for
Graduate Studies and Research

POLYCHROMATIC METAL DESIGNS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Pamela Elizabeth Hassler

June 1973

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P. E. H.

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ABSTRACT

This study was conducted to explore means of creating objects in which the most important design element was that of color contrast. The materials used were limited to silver, copper, brass, wood, and enamel. These materials were integrated in different combinations to produce relatively flush, multicolored or polychromatic surfaces. The techniques explored were lamination, inlay, cloisonné, "married metals" process, fire-gilding, and fusion. Other contrasting elements such as texture were minimized in order to accentuate the contrast of color. This study resulted in the completion of eight objects which were visually successful in terms of color contrast.

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CHAPTER I

INTRODUCTION

In this study the researcher was involved in creating objects using metal, wood, and enamel in which the most important visual element was that of color contrast. The term "polychromatic" refers to the multicolored visual effect of these objects.

Contrast is one of the most important and exciting elements of design. Some examples of contrast are: warm-cool, thick-thin, curved-angular, light-dark, rough-smooth, and transparent-opaque. The contrast between colors involves a warm-cool or light-dark contrast.

> The word light or color connotes richness, health, and wholeness. Light, thus color, is not merely a spatial sign of the environment; it is a basic human need. In hunger for color is expressed one of man's deepest grasps of reality.[1]

When making objects entirely of silver, the researcher often felt a need for a touch of color for warmth or contrast to enhance the cool, sleek quality of the silver. Other metals such as brass, gold, and copper have an inherent warmth and color which when used with silver, produce a warm-cool contrast. Ebony produces a light-dark contrast with silver. Cocobolo wood, with its dark, red color, produces both a warm-cool and a light-dark contrast with silver. Enamels are available in a myriad of colors and, depending upon the colors used, produce either a light-dark or a warm-cool contrast with silver. In each of the objects

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[1]Gyorgy Kepes, Language of Vision (Chicago: Paul Theobald and Company, 1967), p. 134.

produced in this study, the researcher used silver, either in a dominant or in a subordinate role, with materials of contrasting color.

I. The Problem

The purpose of this study was to produce polychromatic objects in which the most important visual element was that of color contrast. Achieving this effect involved the selection of materials which would complement one another and still be technically capable of being used in combination. Combining different types of materials in the same piece also required a study of certain metalsmithing, enameling, and woodworking techniques which were necessary for the construction of these objects.

II. Limitations

The types of objects produced were boxes, two-dimensional wall pieces, and a few jewelry pieces. The type of object designed depended upon the suitability of the materials and techniques to the function and design of the object.

The materials used fall into two categories: (1) metallic and (2) non-metallic. The metals used were gold, silver, brass, and copper. The non-metallic materials used were ebony, cocobolo wood, and enamel.

The techniques used depended upon whether the object was constructed entirely of metal, or if it were metal in combination with one of the other materials. The color contrast in objects constructed entirely of metal was achieved by fire-gilding, "married metals" process, and a fusion technique.

The techniques used on objects of a metallic:non-metallic combination were lamination, inlay, and cloisonné.

III. Procedure

Eight objects were completed according to the limitations of this study. The objects in order of their completion are:

1. Laminated box (ebony, brass, and silver)
2. Box with inlaid lid (silver and cocobolo)
3. Enamel wall piece using cloisonné (enamel and silver)
4. Three part enamel wall piece using cloisonné (enamel, silver, and gold)
5. Inlaid bracelet (silver, ebony, and brass)
6. Hair clasp using "married metals" technique (copper, silver, and brass)
7. Fire-gilt necklace (silver and gold)
8. Necklace using fusion technique (copper and silver)

As an artist, the researcher's first responsibility in this study was to produce visually exciting objects. The purpose of experimenting with the different techniques used in this study was not to master these techniques, but to find ways of producing objects with the desired visual effect.

Each object was designed to enhance the contrast of different colored metals and the contrast of metal with wood and enamel. In order to achieve this, other contrasting visual elements such as textural differences were kept to a minimum. Also, the different materials were not merely used as separate units within the piece, but were integrated

into one another to produce a relatively flush multi-colored surface.

CHAPTER II

REVIEW OF RELATED LITERATURE

Beginning with the Egyptians and the Greeks, craftsmen of different ages have employed a variety of techniques and materials to create polychromatic designs.

> The practice of inlaying or overlaying parts of a metal object with patterns formed from wires or plates of a different material is one of considerable antiquity. Beautiful specimens of the craft have come down to us from ancient Egypt, and from the Mycenaean Age of Greece (1400 to 1000 B.C.). Works of the skilful craftsmen of China and Japan, and of the Islamic metalworkers of India, Persia and the Near East are to be found in many museums, and they teach us that a fine piece of craftsmanship need not be made of one material only: there is a charm to be found in the enrichment of a surface by a tastefully designed inlay. . . . Our Mediaeval craftsmen knew this, and in addition to their use of repoussé or chasing, they employed partial gilding, niello decoration, inlaying or enamelling to enrich their surfaces.[2]

I. Metals in Combination with Non-metallic Materials

Almost any material the craftsman wishes to use may be combined with metal. Among those which have been used in the past and are being used by craftsmen today are wood, stone, gems, ivory, bone, tortoise shell, enamel, and plastic. In any of these combinations the metal may play a dominant or a secondary role depending upon whether it is inlaid

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[2]Herbert Maryon, Metalwork and Enamelling (New York: Dover Publications, Inc., 1971), p. 148.

in the non-metallic material or the non-metallic material is inlaid in the metal.[3]

Stone Encrustation

> The artistic use of coloured inlays can be carried back to a remote epoch both in Egypt and in Babylonia, and in regard to the former country and the objects exhibited in London in 1910 by the British School of Archaeology in Egypt were to most people a revelation. Coloured pastes, arranged to produce figure designs in undercut sinkings in stone, were then seen to have been in use at the close of the 3rd dynasty, in the fifth millennium B.C. . . .[4]

Two of the most important examples of Egyptian inlay are a pectoral of Sesostris II, which was found in the tomb of Princess Sit-Hathor-iunet at Lahun and a dagger of Princess Ita excavated at Dashur, both of which can be dated approximately to 1800 B.C. Both pieces are made of gold and inlaid with pieces of turquoise, lapis lazuli, carnelian, and garnet, the inlays being held in position by ribs soldered to the gold base.[5]

Another piece shown by the British Museum was the funeral mask of Egyptian Pharoah Tutenkhamon dating about 1000 B.C. This piece was done in gold repoussé and inlaid with lapis lazuli, carnelian and green feldspar. Also acquired by the Museum were some early Greek pieces of gold jewelery of the Mycenaean period from Aegina, dating about the

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[3]Oppi Untracht, Metal Techniques for Craftsmen (New York: Doubleday and Co., 1968), p. 212.

[4]G. Baldwin Brown, The Arts and Crafts of Our Teutonic Forefathers (Chicago: A. C. McClurg and Co., 1911), p. 176.

[5]Sir Harry Garner, Chinese and Japanese Cloisonné Enamels (Rutland, Vermont: Charles E. Tuttle Co., 1962), p. 17.

same time and inlaid in the same manner as the funeral mask, and some inlaid objects of ivory, probably from Phoenicia, that were found in the north-west palace at Nimrud in Assyria.[6] The inlay of these pieces resembles enamel but is actually composed of crushed, colored stones held in place with some kind of adhesive.[7] This same technique of inlaying crushed gem stones in metal depressions is widely used by craftsmen today in Mexico, and has been practiced for centuries by craftsmen of North Africa and India.[8]

Inlay work similar to the polychrome style of the Egyptians appears also in work produced in the seventh century B.C. in Kuban, South Russia. These were inlays of amber in metal and were followed by the inlay of other materials by the Scythians and Sarmatians.

> The methods of polychrome decoration follow those adopted in Mesopotamia, but the geometric designs are replaced by the so-called "Scythian animal style" with its lively and realistic representations of wild animals, which has close associations with the art of Central Asia and Siberia.[9]

Charles Loloma is an outstanding American craftsman working in this technique today. His silver bracelet inlaid with turquoise is represented in the "Objects: USA" exhibition.

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[6]Brown, p. 177.

[7]Kenneth F. Bates, Enameling, Principles and Practice (New York: The World Publishing Co., 1951), p. 22.

[8]Robert Von Neumann, The Design and Creation of Jewelry (Philadelphia: Chilton Company, 1961), p. 102.

[9]Garner, p. 20.

Enameling

The next step in the development of polychrome decoration was that of enameling. Enameling is the logical outcome of the incrustation technique of the Egyptians. The two types of enameling techniques discussed in this study are champlevé and cloisonné, since both techniques leave areas of bare metal in contrast to areas filled with enamel.

Champlevé and Egyptian inlay both have much the same appearance, the difference being that the Egyptian inlay material is held in place by an adhesive, while enamels are actually fused onto the surface of the metal by heat.

> . . . it is remarkable that the Egyptians, extremely adept at coloured inlays and past masters in the manipulation of vitreous pastes, never seem to have fused these pastes for the production of enamels. So far as we know the art was practised first in the Caucasus about 1000 B.C., and by the Celtic peoples in Gaul and Britain in the last centuries before the Christian era. Neither the Egyptians nor the Phoenicians nor any of the Mediterranean peoples seem to have employed it, save in so far as it was practised to a limited extent and in a somewhat amateurish fashion by the Greeks from about the fourth century B.C. The Greek enamel, used on a small scale in gold jewellery, was of the thinly-fused or encrusted kind, but that of the Caucasian and Celtic enamellers, though partly encrusted, was mostly in the more substantial champlevé technique.[10]

Champlevé appeared first in the third century A.D. in the work of Celtic metalsmiths who used enamel to decorate the shields and swords of their warriors. "Early Greek writers describe the barbarians of the north-west as having a method of pouring molten enamel into cavities cut into their weapons and armour."[11] Numerous examples of Celtic and

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[10]Brown, pp. 195-196.

[11]Brian Newble, Practical Enamelling and Jewelry Work (New York: The Viking Press, 1967), p. 7.

Saxonian enameling have been discovered dating from the Sixth to the Ninth Century A.D. The colors used are mainly lapis blue, red, and white. Examples of both Roman and Celtic champlevé work on bronze may be seen today in the British Museum, the Cluny Museum, the Louvre, the Victorian and Albert Museum and many American museums.[12]

Champlevé flourished during the Gothic period in art history. It was used to decorate bronze statues and cathedral embellishments. The process used during this period was still much the same as that of the Celts.[13]

In the twelfth, thirteen, and later centuries, the town of Limoges in Central France became a center from which great quantities of champlevé work proceeded. Thousands of reliquaries, crosses, altar vessels and other works were sent to all parts of Europe. In most of this work each decorated space is filled with broken opaque colours, often blues and greens, touched with white. The metal left bare in the champlevé is usually gilded.[14]

Hede Howaldt-Von Nagel is an enamelist working in the United States today who works in the champlevé technique. She produces bowls in which the recesses are etched out with a ferric chloride solution and then filled with enamel.

Traditionally, cloisonné has been the craft of the goldsmith while champlevé has been that of the coppersmith.[15] The reason for this is

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[12]Bates, pp. 22-23.

[13]Bates, p. 125.

[14]Maryon, p. 184.

[15]Garner, p. 16.

because cloisonné is the most economical means of working in gold. In champlevé, areas of metal must either be etched or gouged out to provide depressions to be filled with enamel. In cloisonné, thin sheet can be used for the base and the cells can be built up by the addition of thin ribs of wire. Cloisonné is considered to be the oldest enameling technique. There is evidence to show that Greek goldsmiths were using this technique in their jewelry in the Fourth Century B.C.[16]

One of the greatest periods of cloisonné work was from the Ninth Century until the Eleventh Century in Byzantine enamels. The Byzantines used pure gold for their work and the cloisons were made of extremely thin gold wire not more than 1/100 inch thick. "Their colors, both opaque and transparent, are well defined, clear and simple, producing a strong, bold, but always sensitive design statement."[17] A representative sample of Byzantine enamels may be seen today at the Metropolitan Museum of Art in New York.

Byzantine cloisonné was introduced into Europe by Theophano, a Byzantine princess, who married King Otto II of Germany. She took Byzantine craftsmen with her to Germany who worked in gold cloisonné using the same type of designs they had used in Byzantium. German craftsmen adapted these new techniques into their own styles and were soon practicing cloisonné as well as champlevé and gilding.

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[16]Bates, p. 21.

[17]Kenneth F. Bates, The Enamelist (New York: The World Publishing Co., 1967), p. 12.

> Sometimes the craftsman was not satisfied to use only one technique, but used the champlevé to inlay a bold pattern in the background and worked the fine lines of the cloisonné method into his figures and animals. This kind of mixed work is later in date than the pure champlevé and shows a logical transition from the simple to the more complicated.[18]

Although the Chinese and Japanese have been masters of cloisonné for centuries, their work is not representative of metallic:non-metallic contrast. In Chinese cloisonné, the wires are so small that they are just barely discernible and the piece is dominated by the enamel. The metal wires are used mainly as a means of separating the colors rather than as a contrasting element.

Of the contemporary American craftsmen working in the cloisonné technique, the work of William Harper best illustrates the possibilities of metallic:non-metallic contrast in enameling. He uses gold and silver wires of varying widths in his cloisonnés. The wires act not so much as partitioning walls for the colors as in Chinese cloisonné, but as design elements in themselves.

Two other American enamelists famous for their cloisonné technique are Margaret Seeler and Kenneth Bates. Both have worked extensively in this technique, although, in both cases, their cloisonné work shows a dominance of the enamel over the metal.

Robert King, a contemporary American craftsman, has produced silverware inlaid with enamel which demonstrates the polychromatic technique. His work is represented in the "Objects: USA" exhibition.

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[18]Bates, Enameling, Principles and Practice, pp. 28-29.

Inlay

The term inlay is used here to describe those processes by which metal may be inlaid into non-metallic materials or those materials may be inlaid intact (as opposed to the Egyptian method of inlaying crushed material) into the metal.

Inlay was a popular technique used during the Renaissance. Andrea Massari of Siena was one of the first to use inlays of ivory, pearl, and silver. Tortoise-shell and brass were inlaid in the same manner. The two layers of the materials to be used were sawed out together. The pieces of each layer were then counterchanged with each other so that the design was composed of both materials. Cabinets were often treated in this way with combinations of ivory, sandalwood, and ebony. In Spain, cabinets were made in a manner similar to mosaic out of ebony and silver.[19]

The inlay of tortoise shell was popular in Victorian England. This process, known as piqué work, was used on watch and cigarette cases, small boxes, jewelry, combs, and other small articles. "Minute, round wire of fine gold or fine silver was hammered or inlaid, usually in geometric patterns, into the tortoise shell, much like miniature rivets, except that they did not pierce the shell."[20]

One of the materials most commonly used in conjunction with metal has been wood. Any hardwood of a close and compact grain and durable

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[19]Julia de Wolf Addison, Arts and Crafts in the Middle Ages (Boston: The Page Company, 1908), p. 306.

[20]Untracht, p. 218.

nature may be used as inlay material (ebony, cocobolo, zebra wood, rosewood, black walnut, cherry, oak). Wood is a particularly versatile material for inlay. It may be inlaid into metal or have metal inlaid into it. "The use of wood as a background into which metal plates or wire are inlaid is an old technique still utilized in Poland and in the Near and Far East."[21]

The inlay of metal into wood has been practiced for centuries in India. Known as tarkashi work, it can be described as damascene on wood. It consists of the inlaying of brass wire into the wood surface to form geometrical or floral designs of a regular and symmetrical nature.[22] The centers for tarkashi work are located in Lucknow and Mainpuri where craftsmen produce boxes, screens, trays, tables, and other kinds of cabinet furniture decorated in this technique.[23]

Chiniot and Punjab, India, are also well-known for their brass inlaying. The designs of the pieces produced in Chiniot are bolder with more freedom of execution than the ones produced in the Punjab. The inlay is not confined to wire as in Mainpuri, but often includes thin plates of metal cut to the required shapes. In this case, the brass is not actually "inlaid" but is "laid on" and fixed in place by minute nails. Travancore, India, also produces wood inlay items, the metal used generally being copper instead of brass. In Aurangabad and in the

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[21]Untracht, p. 212.

[22]Rustam J. Mehta, The Handicrafts and Industrial Arts of India (Bombay: D. B. Taraporevala Sons and Co., Private Ltd., 1960), p. 64.

[23]Untracht, p. 213.

Ratnagiri district, colored woods, generally in two or three shades, are often interspersed with brass.[24]

Besides the more traditional inlay materials such as wood, ivory, enamel, tortoise shell, and stone, new designs are possible for the contemporary craftsman with the use of plastic. Plastic is ideal for inlay techniques and may be treated in much the same manner as enamel. "Plastic materials are so versatile that the great danger lies in the conscious simulation of other, perhaps more difficult to work, materials."[25]

II. Contrasting Metals in Combination

> The attractive contrast in color and texture of metals has been the basis for the development of many decorative metal techniques that have developed over the centuries. Techniques that employ overlaid or appliquéd metals (swami work), inlaid metals (damascene work), and metals of differing colors joined by soldering (married metals, mokume), fusion (niello), and, most recently, braze welding, have each produced distinctive results.[26]

Overlaid or Inlaid Techniques

Swami work is an overlaid technique practiced today in the South Indian city of Tanjore. The technique consists of applying embossed or repoussé medallions and flat-cut shapes of contrasting metals, usually copper and silver, on a metal background. The basic shape upon which these pieces are appliquéd is usually of brass.

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[24]Mehta, p. 66.

[25]Von Neumann, p. 8.

[26]Untracht, p. 134.

> This work displays a purely Hindu character, both because of the ornate style of design, full of small detail, and because the subjects of the medallions are mainly religious in nature, often depicting Hindu deities and sacred animals. Almost the entire background metal is covered in a carefully arranged pattern, always geometrically placed, of half domes, stamped pieces, engraved and stamped patterns, inlaid wire, and repoussé medallions. One piece is almost a dictionary of decorative metal techniques.[27]

The inlaying of soft metals into bronze, iron, and steel has been practiced for centuries in many parts of Europe and Asia. The armor produced in the Middle Ages and the Renaissance was decorated in this way. Metal inlay is still practiced in India and the Moslem countries in much the same manner as it has been practiced for thousands of years. The earliest form of this technique consisted simply of carving or engraving lines and depressions into which a softer metal was hammered.[28]

Damascene work involves the inlaying of gold or silver wire into bronze, iron, or steel. It was first practiced in ancient China and Egypt. It became a widely practiced art in Damascus (from which we get the name "damascene") and spread to North Africa, Spain, and India. Today it is practiced in a specialized form known as "kuftgari" by craftsmen in India.[29]

The chief centers for damascene work done in India today are Jaipur, Alwar, Sialkot, Travancore, Kashmir, and Bidar.

> Jaipur and Alwar, renowned for their skilled artisans, still produce damascened swords, daggers, elephant goads and even shields to a very limited extent and mostly for ceremonial purposes. Muslim craftsmen show an admirable skill and pride

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[27] Untracht, p. 134.

[28] Von Neumann, pp. 100-101.

[29] Untracht, p. 150.

> in the laying of wire to form verses from the Koran, verses of poetry and prayers to bring good fortune. In Travancore, the damascened designs are chiefly floral and suggestive of Dravidian influence, the work consisting of fine gold wire beaten into a background of steel on which the pattern is first engraved and undercut.[30]

Another style similar to damascene is Bidri work. This technique takes its name from the town of Bidar in the state of Andhra Pradesh, India. There are today about a hundred workers practicing this craft in Bidar. This technique consists of the inlaying of pure silver (wire and sheet) into cast objects. The objects are first cast out of a non-ferrous zinc alloy and then decorated with silver placed in grooves flush with the surface. After the object is inlaid, it is oxidized to a deep black, while the pure silver remains white, producing a strong light-dark contrast. These objects are usually decorated with Persian floral and geometrical motifs.[31]

Soldered Polychrome Techniques

Another method of producing objects composed of different colored metals is simply that of soldering these metals together so that their surfaces are flush.

"Mokume" is a laminating process used by the Japanese to decorate their sword guards or "tsuba." The earlier pieces decorated with this technique consisted of layers of iron of varying compositions which were welded together. After welding, the layers were forged into a solid sheet on the anvil. After the piece was shaped, it was subjected

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[30]Mehta, p. 28.

[31]Untracht, p. 138.

to an etching solution which attacked the various layers of metal in varying degrees. This produced a pattern of raised ridges resembling wood grain or bark. As this technique developed, the interest shifted from the etched effect to the color contrast of the different metals used. Unlike the earlier mokume, the metal surface is level and consists of varying thicknesses of silver, copper, and special Japanese alloys.[32]

Albert Paley, a contemporary American craftsman, has produced work in the mokume technique. Most expressive of this was a pin he produced which involved the lamination of 150 layers of 14 karat gold, silver, and yellow gold which were hammered from the back and then filed to reveal the various metals.[33]

Thomas Bambas, an American metalsmith now teaching at Wichita State University, has produced work in the soldered polychrome technique. His silver pitcher in the "Objects: USA" collection is inlaid with 14 karat green, red, and gold panels.

Another polychrome technique which employs soldering is "metales casados" or "married metals." This technique was used in Pre-Hispanic Mexico and has recently been revived by Los Costillo, a family of silversmiths who work in Taxco, Mexico. In this process, objects are made from a combination of separate pieces of silver, copper, brass, and nickel all soldered together by their edges to form a single sheet.[34]

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[32]Untracht, p. 182.

[33]Wendell Castle, "Exhibitions," Craft Horizons, January/February, 1970, p. 44.

[34]Untracht, p. 184.

Fused Polychrome Techniques

"Niello" is a fusing technique which has a great deal in common with champlevé. The main difference is that in champlevé the recessed areas are filled with enamel, whereas in niello a compound of lead, sulphur, and copper is used to produce a strong light-dark contrast.[35]

> Mediaeval craftsmen seem to have had a keener realization than have their modern representatives of the aesthetic value of touches of colour or of black in their gold and silverware. . . . Their niello was generally composed of a mixture of metallic sulphides. It provided that strong note of black or dark-grey which is found to be so valuable in a lighter colour scheme.[36]

Niello was practiced in Greece, Egypt, and Cyprus as early as 1400 B.C. It became a popular technique during the Renaissance and was used to decorate armor and other metal work. Several formulas for niello have been handed down by such notable metalworkers as Theophilus, Pliny, and Cellini.[37] Present day production of niello work is virtually limited to Thailand. Philip Fike, a contemporary American goldsmith, has experimented with the formulas for niello for several years and has had considerable success in devising new methods of application and fusion.[38]

Fire-gilding is a method by which pure gold may be fused onto silver. Until modern times the gilding of silver was achieved by the use of an amalgam of mercury and gold. This amalgam was spread over the

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[35]Ernle Bradford, Four Centuries of European Jewellery (New York: Philosophical Library, Inc., 1953), p. 140.

[36]Maryon, p. 161.

[37]Von Neumann, p. 115.

[38]Von Neumann, p. 116.

area to be gilded and the mercury was driven off by heat leaving the pure gold fused to the surface of the silver. The fire-gilded surface is less even than a plated surface and is not practical for large areas, but used in small areas it has two distinct advantages over modern plating techniques: (1) Because 24 karat gold is used in the amalgam, the gilded surface is a much deeper yellow color than a plated surface. In polychromatic designs, this richness of color creates dynamic contrast with the silver. (2) The plastic qualities of the amalgam allow its application into small etched areas or grooves in the silver giving the appearance of gold inlay. Benevenuto Cellini, the Renaissance goldsmith, gave detailed instructions for gilding in his treatises on goldsmithing.[39] The gilding formula in this study was derived from Cellini's formula by Arline Fisch, a contemporary American jeweler.

A fusing technique now being practiced at Southern Illinois University by Richard Prillerman involves the fusing of non-ferrous metals of different melting points. The metal of lower melting point is melted in a crucible, and at the same time, the metal of higher melting point is heated to cherry red or just below its melting point. When these stages are reached in both metals, the metal of higher melting point is immersed in the molten metal of lower melting point, and the flame is removed. In this way the metals are fused. After fusing, the ingot thus formed may be rolled or forged into sheet and used to construct

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[39]C. R. Ashbee (trans.), The Treatises of Benvenuto Cellini on Goldsmithing and Sculpture, by Benvenuto Cellini (New York: Dover Publications, Inc., 1967), pp. 96-97.

metal objects. The beauty of this method is that the two metals retain their distinct colors, but are strong enough to be worked as a single sheet of metal.

CHAPTER III

PRESENTATION OF DATA

The pieces executed for this study employed many of the traditional techniques discussed in the previous chapter and special techniques which solved the particular problems of the researcher. This chapter explains the techniques used to complete these designs and the problems encountered by the researcher.

I. Laminated Box*

Procedure

The first piece completed in this study was a laminated box constructed of ebony, silver, and brass. Sheets of varying thicknesses of these three materials were sawed out in graduated sizes of the same shape. Since the sheets were to form a hollow box, the inside of each sheet was sawed out leaving a negative space within the shape. Each shape was sanded on a flat steel plate to insure that all pieces were completely flat. The silver and brass pieces were soldered together and then glued to the ebony. After joining, the unit thus formed was filed and sanded inside and out until all the layers were completely smooth and flush. The top, bottom, and rims of the box were not glued in place until all the layers had been sanded.

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*See Figure 1, Appendix.

Results and Problems

The piece was visually successful in terms of color contrast. The dark ebony produced dramatic contrast with the layers of silver and brass. The brass did not contrast dramatically with the silver after polishing, but as the brass oxidized, it became a much warmer gold color and was more distinguishable from the silver.

The piece was not as successful in terms of craftsmanship. This was due mainly to the type of glue used and the method of application. Two types of glue were used: (1) a two-part hardening epoxy and (2) contact cement. The epoxy gave a thin, hard coat, but was too brittle to allow filing or sanding after it had hardened. This may have been caused by improper proportions of resin and hardener, or by the oily nature of the ebony which may have resisted the epoxy. The contact cement was strong and durable, but did not dry to a sufficient hardness to prevent slipping of the layers.

II. Silver Box with Inlaid Lid*

Procedure

The second object produced in this study was a box composed of silver and cocobolo wood. The contrasting effect of the silver and wood in the lid was achieved by inlaying and overlaying. The main design of the lid was sawed out of a silver sheet and riveted onto the wood. A small pattern of silver dots was accomplished by riveting silver wire of varying sizes into the wood.

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*See Figure 2, Appendix.

Problems and Suggestions

Several methods of wire inlay into wood were attempted by the researcher, but with little success. When round wire was hammered into the groove cut for it, the wood spread during hammering and became too large to hold the wire tightly. This may have been remedied by using a harder wood and a softer metal.

The most successful means of inlay was accomplished by sawing out the groove in the wood with a #2/0 sawblade, and inlaying cloisonné wire placed on its edge into the wood.

III. Enameled Plaques Using Cloisonné*

Procedure

The type of cloisonné technique used in this study differed from the more traditional technique in two ways:

1. Eighteen gauge fine silver sheet and 16 gauge square fine silver wire were used to form the cloisons. Since the goal of the problem was to create contrast between the silver and the enamel, it was important that the silver be of sufficient size and weight to maintain its own identity within the framework of the enamel.
2. The silver was used not so much as a partitioning element as in traditional cloisonné, but as a design element in itself.

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*See Figures 3 and 4, Appendix.

Problems

Several samples were fired before all problems were worked out of this technique. The problems were as follows:

1. Air bubbles formed within the enamel causing small holes and pits in the enamel surface.
2. The silver foil used in some areas began to float to the surface of the enamel.
3. Fissures and cracks formed around the silver wires, and the silver actually began to fall off the piece.
4. There were crazes under the surface of the enamel between the pieces of silver.
5. Where very long pieces of silver wire were used, the tension in the wire sometimes caused it to raise off of the piece.

Solutions and Suggestions

It was found by the researcher that the air bubbles and floating silver foil were caused by the same source. The ground coat under the foil was a hard-fusing white enamel which matured at a much higher temperature than the temperature needed to adhere the silver. Although the silver had adhered to the ground coat in some areas, there were still air pockets underneath the foil which bubbled to the surface after successive firings. This resulted in floating foil and pits on the surface. It is suggested that foil be applied in fairly small size pieces, as this minimizes the chances of the formation of hidden air pockets under the foil. The problem was eliminated by firing a soft fusing enamel

coat underneath the foil and wires, and by applying the foil in small pieces with a sufficient number of air holes in them.

The crazes and fissures were found to be caused by the expansion and contraction of the silver during firing and cooling. The larger the piece of silver, the more drastic the rate of expansion. This problem was reduced by removing the fired piece from the firing kiln to a kiln just below the maturation point (around 1350 degrees Fahrenheit) and allowing the piece to cool gradually in the kiln to room temperature. Another means of reducing this problem would be to use a very thin gauge silver sheet (24-36 gauge). The appearance is the same as the heavier gauge, but the chances of cracking are drastically lessened.

The problem of adhering especially long wires onto the enamel is best solved by weighting the wires down as soon as the piece is removed from the kiln while the enamel is still molten. Another suggestion in avoiding this problem is to anneal the wires, and make sure they are properly flattened before firing them onto the enamel surface.

IV. Inlaid Bracelet*

Procedure

The materials used for this problem were silver sheet and a mixture of ebony, brass, and silver filings. The design for the area to be inlaid was sawed out of 18 gauge sheet silver. This sheet was soldered onto a sheet of 22 gauge silver. After soldering, the piece was hammered into bracelet form. After shaping, the depressions cut out

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*See Figure 5, Appendix.

of the silver were filled with the ebony mixture and fast-drying contact cement. After the inlay material was completely dry, it was filed and sanded flush with the silver bracelet.

Problems

During shaping, the 22 gauge silver sheet received the impression of the heavier gauge inlay design. This caused the inside of the bracelet to appear warped. This problem might have been avoided had a heavier gauge sheet been used.

Suggestions

The depressions for the inlay material may be formed in several ways. The researcher used the sawed method because the sawed line was more even than some other methods. Other possibilities for creating these depressions might have been by etching, gouging, or grinding out the depressed area rather than building up the area with the sawed out sheet.

V. Hair Clasp Using the Married Metals Process*

Procedure

The polychromatic area in this piece was created by a soldering technique called the "married metals" process. This process consisted of sawing out three different colored sheets of metal simultaneously. The metals used in this case were copper, silver, and brass. After sawing, the pieces of each sheet were counterchanged with the pieces of the other

*See Figure 6, Appendix.

sheets so that the design was composed of the three different colored metals. The pieces were then soldered together. In order to solder pieces in this manner, the entire area had to be flooded with solder, and the excess filed away.

Problems

After the polychromatic sheet was polished, the researcher attempted some repoussé work on the piece. It was found that the sheet was too brittle to receive hammering without cracking along the solder joints. Small samples were dapped and they, too, proved to be too brittle for this type of work.

One of the main problems during soldering was keeping the pieces properly aligned. The heat caused some warpage during soldering, and warped pieces had to be hammered flat again before they could be properly soldered.

Suggestions

This technique produced a very effective type of coloration. If executed properly, "married metals" sheets could be very handsome when used in a flat design, but shaping of these sheets is not recommended by the researcher.

VI. Fire-gilt Necklace*

The necklace itself was constructed of sterling silver. Small areas were fire-gilt to give contrasting areas of color. The following

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*See Figure 7, Appendix.

procedure does not include the construction of the necklace, but deals only with the technique of fire-gilding. The formula for this technique was adapted by the researcher from a formula by Arline Fisch.

Formula for Pure Gold Amalgam

1. Five grams of pure gold and 40 grams of reagent grade mercury were placed into a clean glass jar with a glass stopper.
2. The mixture was allowed to stand for 12 to 24 hours.
3. A small crucible was heated which had been coated with yellow ochre so that the amalgam would not adhere to the crucible.
4. The amalgam was poured into the hot crucible.
5. The crucible was heated from underneath until the mixture was boiling (barely discernible bubbles or "quivering").
6. The amalgam was poured into cold water.
7. The amalgam was then strained through a cloth (gauze or cheesecloth) and stored in a clean glass container.

Application of the Amalgam

1. The necklace was heated and pickled after construction and major polishing.
2. The area to be gilded was scrubbed with a brass brush and dipped in mercuric nitrate.
3. The amalgam was applied with a wooden spatula.
4. The piece was heated very slowly with a low flame outdoors

untill all the mercury had vaporized and the gold had bonded successfully.

5. This process was repeated several times until the desired thickness and color were achieved. A sufficient coat of gold had the appearance and color of yellow ochre.
6. The surface was then textured with a steel matting tool.

Suggestions

The quality of the amalgam depends upon the form of gold used. Twenty-three karat gold leaf worked well but was extremely expensive. A less expensive form called pure gold cylinders is available at dental supply houses and worked quite well. Thicker forms of gold (such as sheet) may take months to amalgamate properly and will give a lumpy appearance after application.

Different finishes may be obtained on the fire-gilt surface. A steel burnisher produces a brilliant finish while a wood burnisher or pumice produces a matte finish.

Extreme caution must be taken during the heating process. Mercury vapors are extremely poisonous. Its vapors are heavier than air, so exhaust vents are needed below and behind if the piece is heated inside. It is advisable to wear a vapor mask during the burn-off period.

VII. Neckpiece Using the Fusion Technique*

Procedure

The materials used in this piece were copper and silver. The technique for the polychromatic area of the neckpiece involved the submersion of a metal of a high melting point (copper) into a molten mass of a metal of a lower melting point (silver). The procedure for this technique was as follows:

1. A copper coil of 16 gauge square wire was formed.
2. Approximately one ounce of sterling silver was melted in a crucible with a flat bottom.
3. During the last stages of melting the silver, the copper coil was held under the flame until it became cherry red.
4. When the copper reached the cherry stage, and the silver was completely molten, the copper was plunged into the silver and the flame removed.
5. After fusing, the piece was filed flat and rolled through a rolling mill until the desired size and thickness had been achieved.

Suggestions

Any two metals of varying melting points may be used in this technique. One advantage of the fusing process is that the sheet thus formed is strong enough to be shaped and worked as if it were one metal.

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*See Figure 8, Appendix.

Because the sheet is formed of metals with different melting points, the lower temperature metal can be reticulated without melting the second metal. This creates a very unusual effect. Colorant agents such as liver of sulphur or copper sulfate may also be used to accentuate the contrast of the two metals.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

All of the objects completed in this study were successful in terms of color contrast. Some contrasted more dramatically than others because of the intensity of the values (as in the case of the laminated box of ebony, silver, and brass). Intense color contrast does not insure the visual success of a piece; however, some objects were more visually effective because of their design, form, and/or craftsmanship. Many elements come into play during the creation of a piece, and color contrast is but one of them. Color contrast is, however, a valid element to be considered by the artist and, when used skillfully in conjunction with other elements, can be an enhancing factor in the success of a piece.

Since it was not the intent of the researcher to explore every technique to its fullest extent, it is, therefore, recommended that a more intense study of these techniques be made. Any one of the polychromatic techniques has enough possible variations to merit a thorough investigation by future researchers.

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APPENDIX



Figure 1. Laminated box.

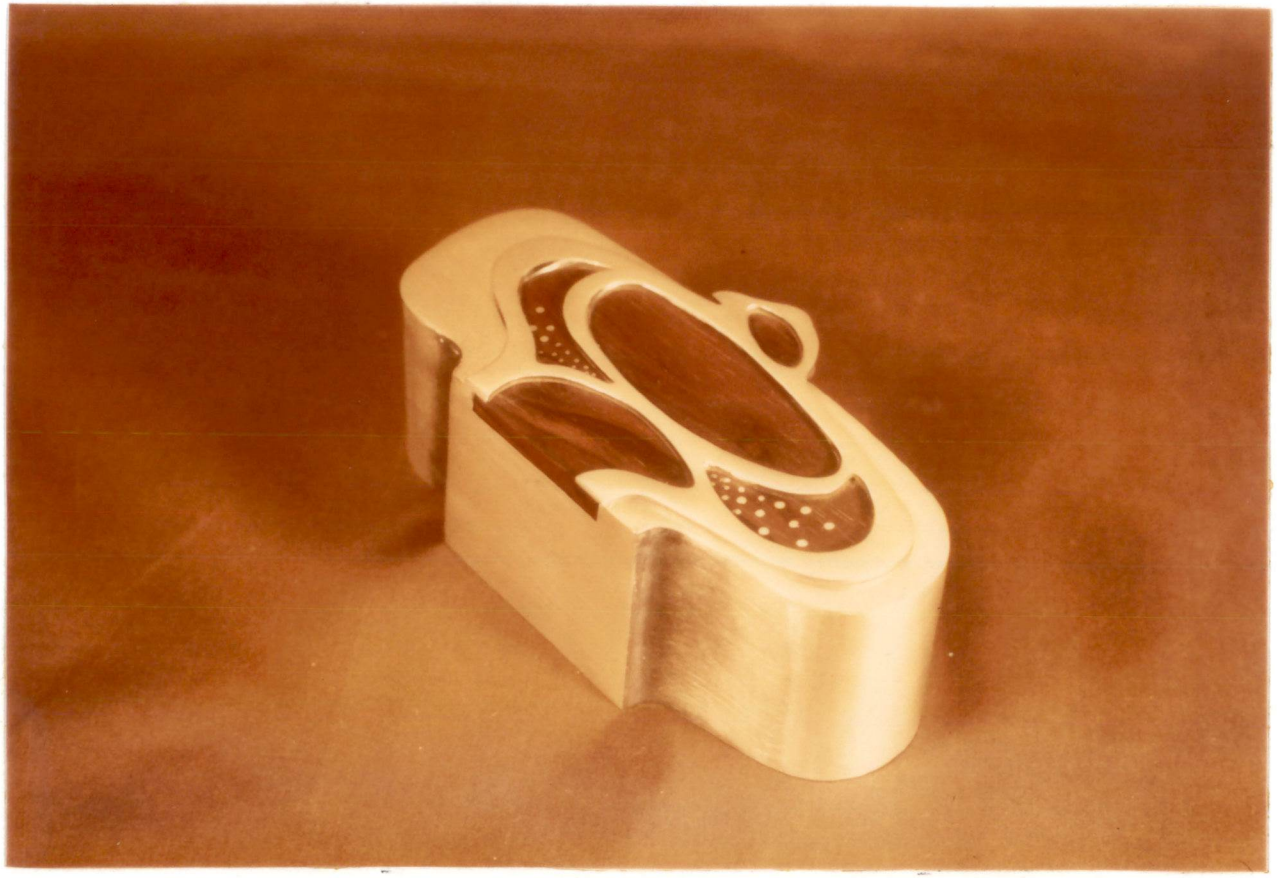


Figure 2. Box with inlaid lid.



Figure 3. Enamel wall piece.

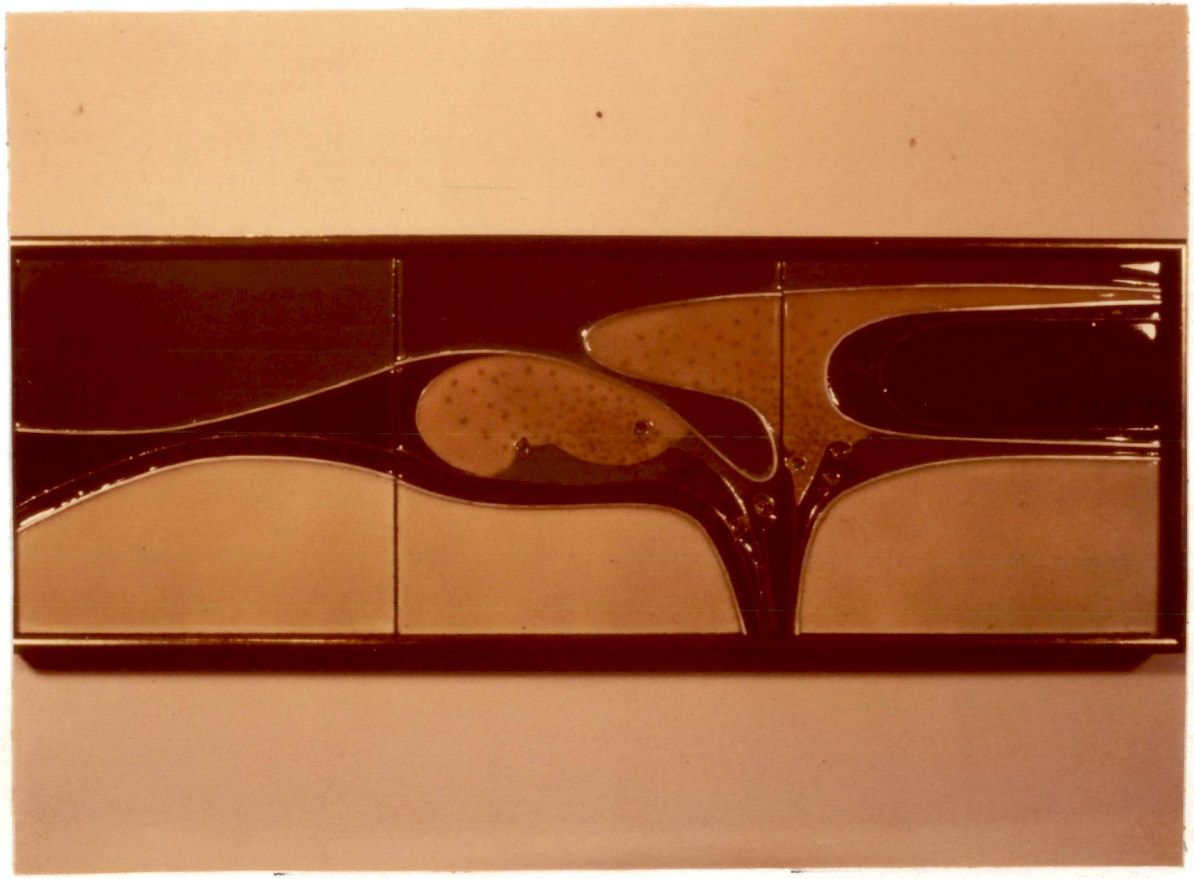


Figure 4. Three part enamel wall piece

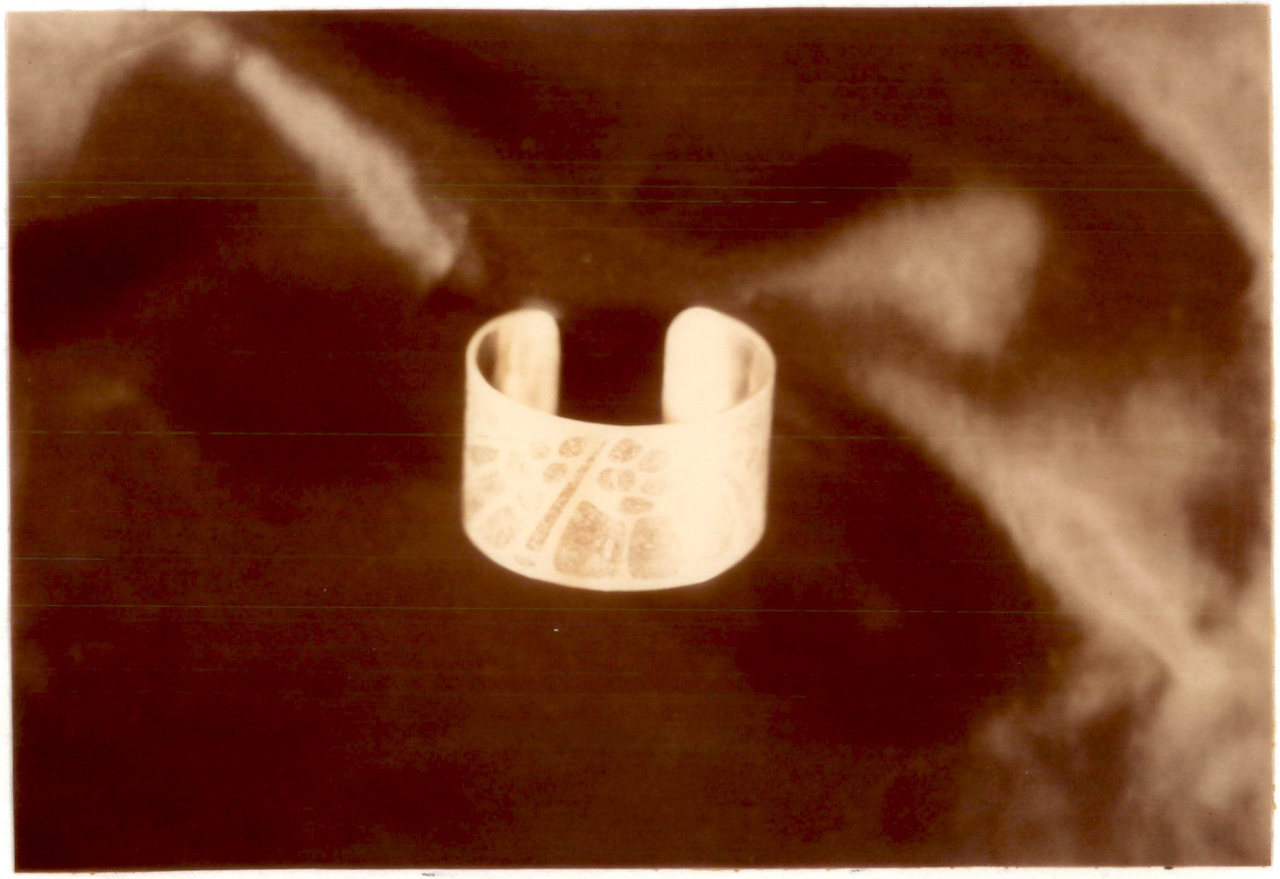


Figure 5. Inlaid bracelet.



Figure 6. Hair clasp.



Figure 7. Fire-gilt necklace.



Figure 8. Fused necklace.

VITA

Pamela Elizabeth Hassler was born March 23, 1948, in Memphis, Tennessee. She graduated from the Hutchison School in Memphis in June, 1966 and attended the University of Colorado during the year 1966-1967.

Ms. Hassler received a Bachelor of Fine Arts degree from the Memphis Academy of Arts in June, 1972. At the Academy she majored in Metal Arts and won the Jewelry Prize in both 1971 and 1972. She served on the Student Council from 1969 to 1971 and taught painting and drawing in the Saturday School classes in 1970.

She has exhibited work in the 16th Mid-South Exhibition at Brooks Memorial Gallery in Memphis 1971, the Cheekwood Museum in Nashville 1971, Memphis Academy of Arts 1971 and 1972, the Regional Craft Biennial at Louisville Art Center 1972, the Craftsman's Fair in Gatlinburg 1972, Arrowmont School of Crafts 1972 and 1973, and the 10th Annual Piedmont Crafts Exhibition at the Mint Museum of Art in Charlotte, North Carolina, 1973.

She graduated from The University of Tennessee with a Master of Science degree in Related Art, Crafts, and Interior Design, with an emphasis in metals and enameling in June, 1973.