EXPERIMENTS IN THE USE OF GLASS IN PAINTINGS

by

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I. POTENTIAL OF GLASS AS A MEDIUM OF EXPRESSION

This project was conducted for the purpose of developing techniques of painting in the medium of glass and producing works using these techniques. Initial work in glass was primarily a problem in the manipulation of new (to the artist) material and an exploration of the potential of the medium for creative purposes. Research indicated that the chief usage of glass as an art material had been in the media of stained glass windows, mosaics, and etched and painted glass. Since this project was to be an experimental one it was considered the more worthwhile purpose to discover new ways of using glass rather than continue work in established techniques. One central idea governed the approach to each work: that the production seek to achieve a painterly quality using glass as the carrier of pigment.

Glass is a vitreous substance and its character and workability are influenced by virtue of existing in this physical state. It is a liquid that, as it cools, becomes increasingly viscous until it becomes hard, but without crystallization as occurs in most other liquides upon cooling. The atom structure is a random arrangement and fracture does not take place along cleavage lines as in most crystalline

substances but occurs in unpredictable directions. A vitreous substance will crystallize only when subjected for a long period of time to a temperature above its softening point. "Transparency is not an essential property of glasses."[1] The degree of transparency is determined by the chemical or physical composition; "a glass may be virtually opaque, by reason of the absorption of light by certain of its constituents, and some glasses are translucent, because of the presence of suspended crystals."[2]

Limitations imposed by the physical characteristics of the material provided an immediate challenge, and one that continued throughout the project. Although this challenge is, in one sense, purely technical, it has extensive aesthetic implications. By the very character of the material it is set apart from any other medium and as a consequence any theme expressed will be unique in manner of expression from that of any other medium.

Awareness of the relationship between the physical and the spiritual qualities leads to a second problem: that of using the material in such manner that it neither becomes subjugated nor is its character destroyed, and on the other hand that it does not overpower the theme expressed. Maintaining this relationship to a high degree of sensitivity amounts to maintaining the integrity of both material and

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[1]Samuel R. Scholes, Modern Glass Practice (Chicago: Industrial Publications, Inc., 1946) p. 3.

[2]Ibid.

content of a work.

Progressing from the initial concern, this second problem assumed increasing importance. Instead of 'what can be done with glass?' the question became one of how best to achieve a unified combination of glass as the material of creation and the idea desiring expression. Development proceeds to the next and final stage of chief emphasis on the expressive quality; how best can the material serve as a vehicle for the expression of the idea?

The most pronounced physical characteristic of the material confronting the artist is its inflexibility under normal studio conditions. There is a choice of reducing the material to small particles and imbedding these particles in a medium or subjecting the glass to sufficient heat to make it fluid. Changing the material from a sizable mass to small particles or a powder produces an alteration in the character of the material and accordingly makes necessary a different artistic application. It is of great importance to recognize the very different visual and subjective impact of sheets of glass, of chunks, and of powdered glass.

Conditions under which the heating process was carried on, that is, in a kiln, did not permit working the glass while it was in a plastic state. Therefore, altering the shape or joining of sections of material had to be dependent on the flow of the material within the kiln at a

high temperature. The influencing factors were the chemical compositions of the particular pieces of glass used, the temperatures to which they were fired, the length and rate of firing, and the manner of placing in the kiln.

A second characteristic of glass of great importance is its extreme sensitivity to the effects of light. In addition to the usual definition of color by light rays there is a particular quality produced by the relationship between the material and the light rays striking it. The reflective and refractive capacities, the absorption and diffusion, and transmission of light, while not always readily discernible as such, are closely attuned to the immediately observable character of the material. The degree of importance of light to the material is greater in this medium of work than in almost any other. Even the slightest variation in light will result in a very definite difference in visual impression.

II. CONSTRUCTION OF WORKS

This chapter will be devoted to a discussion of the means of construction of the individual works produced as a part of this project. While the chief material is glass, there are other materials used, in some cases as support for the glass, in others as an auxiliary material to further the expressive quality of the works. All of these supplementary materials were carefully chosen to form an harmonious alliance with the glass.

Construction is here taken to include the total process in the development of the work from the point of creative inspiration to the final details of finishing. The material and the expressive purpose are so completely interwoven that at no time can one be considered exclusive of the other.

Prior to discussion of the individual works certain methods of working with the material require statement and clarification. The source of glass was stained glass as used for windows, chunks of glass from a manufacturer of pigmented glass, and assorted colored glass jars, bottles, etc. All samples of material to be used in fired works were tested to determine the effects of various firing times and temperatures on the pigments, the fusibility with other

glasses, and the general physical condition of the glass after firing. The test pieces were retained for reference in selecting the particular glasses for later projects.

Firing the glass required a surface to which the glass would not adhere upon cooling. It was found that a layer of powdered flint on the kiln shelf worked satisfactorily. Pyrometric cones were used to indicate the time at which a desired temperature had been reached and temperatures are indicated by cone number.[1] Because of the effects of even slight variations in firing time, often affected by electrical power load reaching the kiln, and the atmosphere within the kiln, whether it be an oxidizing or a reducing atmosphere determined by the materials within the kiln, it was considered the better practice to fire all of the pieces of one work at the same time. The high degree of sensitivity of glass to sudden or rapid changes in temperature required that the kiln be cooled to room temperature before opening. Where firing time is given it refers to the time required to reach the cone temperature and does not include cooling time.

For breaking up sheets of glass a glass cutter was used whenever possible. However, in the case of some extremely hard glasses, the following method was found to be more satisfactory: the glass was placed directly on the surface unit of a hot plate for about one minute, then

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[1]Temperature equivalents for cone number are given in Appendix I.

removed with metal tongs and dropped into cold water. The sudden change in temperature caused fractures within the piece and by tapping with a ball peen hammer irregular shapes were obtained. Continued tapping would reduce the pieces to the desired size. This was the method used wherever small particles were desired. It is worthwhile to mention here that glass broken by physical force, as opposed to the fracturing caused by the shock of sudden temperature change, has greater reflective and refractive capacity; but it is also more tedious and physically hazardous to the artist under usual studio conditions.

Following the initial experimentation with handling the material attention was directed toward two structural approaches: (1) incorporating the glass into the basic physical structure of the work, (2) mounting the glass on a support of another material. In both cases it was necessary to determine a structural method that would prove to be physically sound. Kiln capacity and area of kiln shelves limited the size of pieces that might be fired to a maximum of nine by eleven inches in area. For a painting to exceed these dimensions it was necessary to devise a method of joining fired sections. This was accomplished by using fibreglass cloth saturated with polyester resin[1] which provided an easily workable, strong, and durable bond.

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[1]For further information concerning this material see Appendix II.

Where glass pieces were to be mounted on a different material experimentation with various bonding agents indicated those most satisfactory for the particular work. For small sections of glass fired on the bed of flint and having a roughened under surface, polymer resin base adhesives were suitable. Larger sections and glazed surfaces required encasing in a continuous film of polyester resin which in turn adhered to the supporting material. The polyester resin is not suitable for use over an oil base paint or on a surface that may have an oily film. For this reason, glass pieces were cleaned with a detergent before applying the resin.

In discussing each work the actual construction procedure is given, followed by observations of the completed work relative to use of material and subject matter.

Blue Figure was begun with a drawing on paper over which rectangles of single strength window glass were arranged leaving some areas of the drawing uncovered. Strips of copper foil, one-eighth inch in width, were mounted on edge on the sheets of glass along the lines of the drawing beneath the glass. To maintain the original shape and size of the sheets of glass, copper foil strips, three-eights inch in width, were shaped around the edges of the glass sheets in such a way that the strips extended above the surface of the glass one-eighth inch. The foil

strips were secured by a polymer resin adhesive.

The color-bearing glass for this piece was to be opal glass, a relatively dull finish, translucent glass used in stained glass windows. As mentioned earlier, preliminary test firing had established the effect of firing to a particular temperature on the surface of the glass and the changes in color. On the basis of these tests the colors were chosen for the actual work. Each area enclosed by the copper foil strips was then filled with broken pieces of the opal glass of the chosen color. It was found that this glass was more easily handled if broken by the heating and cooling method and the pieces cut from sheets of glass were roughly three-fourths inch square in area and smaller. This method was found to be more satisfactory than cutting the glass to actual shape and size of the area to be covered. Since the glass would be fired above the softening point it would flow into one mass. After covering the glass sheets with the opal glass they were then placed on kiln shelves covered with the powdered flint and fired to cone 05. Approximately eleven hours was required to reach the desired temperature.

Because of the high temperature to which the glass was fired and the length of time maintained above the softening point, considered necessary to achieve the change in color and surface quality, the material was after firing extremely fragile and some breakage occurred during cooling. Using a transparent, quick-setting glue, the breakage was

repaired and the pieces placed face down in the original design. The exposed backs of the pieces were coated with a polyester resin, covered with a layer of fibreglass cloth, and the resin given time to harden. This process was repeated twice with additional layers at points of greatest strain, i.e., where the separate pieces of glass met. Excess fibreglass cloth was trimmed away after each application had hardened. Twenty-four gauge copper wire was run through the center of one-fourth inch woven nylon cord and shaped to conform to the outer edges of the composition with two three-inch projections, perpendicular to the surface, on each end. These projections were designed to hold the work away from the wall in order that more incidental light be permitted to pass through the glass (the fibreglass cloth and resin still permitting translucency). Two more projections of cord and wire designed as hangers were mounted in from the edges. A final layer of fibreglass cloth and resin was added to secure the cord and the projections were saturated with the resin in order that they become rigid. The cut edges of the fibreglass cloth were filed smooth with a metal file. Powdered pigments added to polyester resin were applied to the projections and any exposed fibreglass cloth (between the sections of glass which were irregular after firing). This provided a continuity of color scheme on all exposed areas when the work was hung.

Under the previously specified firing conditions the

opal glass lost the dull, hard quality and came to have a highly glazed surface and increased transparency. The copper foil, the opal glass, and the sheets of clear glass fused, forming one piece. The foil changed color, reacting chemically with the pigments in the opal glass and oxidizing from the heat treatment. Color in the opal glass was considerably intensified in most cases with some colors actually changing as in the case of some yellows which became brown.

As the title suggests the subject of this work is a figure, part of a reclining figure, and the color blue is prominent in the composition. However, the blue is not as prominent in the figure itself, as in the surrounding area. While there are linear aspects the work was developed in terms of color masses defining the abstracted figure and adjacent areas. As the figure was abstracted so was the rectangular space encompassing it; the eight pieces were arranged to suggest but not complete the form.

Assemblage #1 represents a different approach in the design procedure, one in which the design developed as the work developed, rather than following a preliminary drawing as did Blue Figure. This work, Assemblage #1, began with the selecting of various shapes and sizes of single strength window glass and placing on these pieces smaller pieces of colored glass. The colors were arranged on the clear glass in such manner that there would be in certain areas a

concentration of one color and in others a blending of colors. These arrangements were placed in the kiln and fired to cone 06, requiring approximately ten hours to mature. In the case of each arrangement there was a fusion of the colored glass and the base of clear glass into one piece, with a blending of colors where the small pieces of different colored glasses were in close proximity.

Whereas in the previous work, Blue Figure, the copper foil around the edges of the sheets had maintained the original shape with only slight irregularities, in Assemblage #1 the molten glass was free to flow within the limitation of the flat bed of powdered flint. Consequently, with the glass having reached a high degree of fluidity none of the pieces retained their original shape.

After coming from the kiln the pieces were arranged on a framed panel of one-fourth inch plywood and, at this time, areas of the plywood to be given a textured surface were indicated by drawing. Placement of the glass pieces was indicated and they were removed in order that the plywood surface be treated. Textured areas were achieved by applying a coat of enamel and sprinkling, while still tacky, with sand. After the enamel had become dry the excess sand was removed and the entire panel and frame painted. The glass pieces were replaced as designed and secured by means of a polymer resin adhesive. While it is generally difficult to get an adhesive to cling securely to the non-porous surface of glass the firing on the bed of powdered flint

gave the slightly roughened under surface that permitted the adhesive to grasp and hold the glass securely.

This work is non-objective, concerned primarily with achieving carefully controlled relationships in color and form. In firing, the element of chance entered into the color organization within a given piece but control was exerted in selection of color prior to firing and in selecting only those fired pieces which related to each other in accord with the desire of the artist. The intermixing color in the glass forms is contrasted by the precisely designed foundation.

Plants in Red Forest followed the general pattern of development in construction of Blue Figure. Rectangles of the clear glass of varying dimensions were arranged over a drawing on paper, leaving some areas uncovered. The edges of the glass sheets were surrounded by coils of clay varying in diameter from one-fourth inch to three-eighths inch. Somewhat smaller coils were placed on the glass along the lines of the drawing beneath. When the clay had begun to dry, slightly short of the leather hard stage, the surface was finished by scraping. When the clay on top of the glass had become dry it had to be glued in place until it became fused in place in the kiln. The glue used was a polymer resin adhesive. Areas of the drawing not covered by glass were covered by a layer of clay approximately the same

thickness as the clay bands around the edges of the glass pieces. Referring to test pieces glass was selected for applying color to the various areas on the sheets of clear glass, again using small pieces of the colored glass. Within each area outlined by the copper foil in Blue Figure only one color was used. For Plants in Red Forest the method of using color was altered so that there were changes in color within the areas, sometimes sufficiently separated by distance so as not to blend and at others, a fusion of two or more colors. In addition to colored glass certain areas were sprinkled lightly with small particles of copper foil. Both clay and glass sections were fired to cone 06.

The sections were then arranged according to the original design and placed face down on a flat surface. As described previously, three layers of polyester resin and fibreglass cloth were applied to the back of the work. When the final layer had hardened the work was turned over and a mixture of sand and polyester resin was applied lightly over the clay section surfaces and packed in spaces between sections. In this instance the sand and resin mixture serves the dual purpose of having structural significance in the sense of providing a mortar and aesthetic significance by providing, subjectively, a link between glass and clay and thus enhancing the expressive quality of the whole. A further link between the glass and clay was furnished by covering the entire piece with a coating of the resin. The resin will adhere to a glazed surface but since it cannot

penetrate the glass it is in need of a supporting material if used over large areas. The support in this case was furnished by sprinkling number eighteen reflective glass beads over the surface before the resin dried.

The static horizontal and vertical scheme is relieved by the curved lines of clay on the glass and flowing quality of the color within sharply defined areas.

For Ordonnance #4 single strength window glass was cut into rectangles. On these were placed pieces of colored glass and strips and bits of copper foil. These rectangles were fired as before but to a temperature of cone 08.

A three-eighths inch plywood panel was prepared by painting with mat finish oil base paint. Only mental sketching of the arrangement was done prior to firing so that it was at this stage in the construction that the precise design was developed on the panel. Since the firing temperature was lower the rectangles of glass retained generally the original shape with only a rounding of corners. While the edges of the pieces of colored glass fused with the base glass, they too, retained their shape. After working out the desired arrangement of the glass sections they were secured to the panel with a polymer resin adhesive.

One-inch cubes of wood were spaced at random along the edges of the back of the panel to provide a slight projection from the surface on which the work would be hung.

The work required a greater suggestion of depth than that provided by the plywood panel. The cubes of wood were painted to correspond with the panel.

Ordonnance #4 represents an arrangement seeking balance in relationships; not a static balance but one suggestive of constant, but controlled, activity. Arrangement of the glass rectangles was carried out with respect to the locating of adjacent pieces and to the whole of the glass pieces, and the rectangle formed by the glass to the rectangle of the wood foundation.

Glass pieces for Assemblage #2 were prepared in the same manner as for Assemblage #1. The support, however, was prepared from quite a different material. Over a rectangular wooden stretcher fibreglass cloth was tacked and was sealed and made rigid by treatment with polyester resin. The surface of this foundation was treated by covering part of it with a mixture of sand and polyester resin and the remainder with a mixture of the resin and sized particles of the mineral pyrophyllite. Use of this particular mineral was determined by the color of the particles and the suggestion, in keeping with glass, of translucency after treatment with the resin. The design of the foundation, in terms of areas of sand texture and gravel texture, was worked out with the arrangement of the fired glass pieces. The adhesive for attaching the glass was the polyester resin. The entire

work was then coated with a layer of the resin. The frame was of a light colored wood, left in its natural color and sealed with the same resin.

Statements of purpose given for Assemblage #1 apply to this work also. The color design differs in this respect: there is closer harmony of colors between the glass and the supporting material, color variety being present largely by accents within the glass pieces.

Circumfluent has a foundation of fibreglass cloth and polyester resin on a panel of wallboard, the surface of which had been treated with a mixture of resin and white powdered pigment. The application of pigment to the board before covering with the cloth was done in order to give a light surface and yet allow the natural appearance of the cloth to be a part of the character of the work. The glass preparation was the same as for Ordonnance #4 with the exception that the firing temperature was cone 09. This difference in temperature provided for a definite difference in the appearance of the glass. The clear glass base for Circumfluent developed a higher degree of translucency as a result of the particular time and temperature of the firing process. In addition, while the color pieces were adequately fused with the base there was generally a sharper line of demarcation between the two. The degree of fusion, of course, depended upon the chemical composition of the colored

glasses and their reactions with the clear glass.

After arranging the glass pieces on the foundation and securing with polyester resin, mixtures of powdered pigment and resin were applied by brushing and rubbing onto particular areas of the foundation. Framing of this piece was in wood painted with resin and pigment in a color suitable to the color design of the work.

Circumfluent displays more obvious suggestion of movement within the picture space than any other work discussed up to this point. This is achieved by the spacing and directional arrangement of the glass as well as the manner of application of pigment and resin. The relatively subduing effect of the color is offset by the lively spatial arrangement. Precise orderliness found in earlier works is less apparent here.

Circumorbital is constructed of small chunks of green glass, copper foil, and polyester resin. Copper foil was glued to a one-fourth inch plywood panel, and treated with an amorphous design done by driving the point of a nail through the foil and removing it, leaving a hole. Resin was applied to certain areas of the surface. The next step in development was applying the variously sized chunks of glass to the surface with the resin as the bonding agent. Application of the glass ranged from sparse scattering to masses built up considerably above the surface. The area of greatest

concentration is not only three dimensional in fact but has an immediate impact on the observer of possessing this quality. Surface treatment of the copper was carried further by scratching into it a definite pattern by use of steel wool; and areas were treated by dabbing with a cloth saturated in the resin. Framing of this piece consisted of strips of wood covered with copper foil and attached to the panel with the frame flush with the surface of the panel.

It must be pointed out here that the entire surface of the copper is not covered by resin or any other material to protect it from exposure to the atmosphere. Therefore, with the passage of time there will be a gradual change in the color of the exposed copper. From the beginning of the work this fact was recognized and influenced the choice of color of glass used. The exposed portions were intentionally left as such.

Color and material for this work was selected on the basis of what would prove essential to the most complete expression possible and yet manage to eliminate the superfluous.

For Red Chicken a one-fourth inch plywood panel was painted with powdered pigment ground in polyester resin. While the surface was still tacky it was covered with a sheet of rice paper. On this foundation, designing was carried out using three different glasses, in color and in

condition. The red glass was flash glass, which is a sheet of clear glass covered by a thin layer of the colored glass. This particular glass was chosen not for its being a flash glass but for the quality of color available in the glass. It was cut into pieces measuring up to roughly three-eighths inch square. The yellow glass was used in small chunks as received from the manufacturer. For the blue glass, sheet stained glass was hammered between layers of heavy brown paper and the finer sized particles separated by sifting through a wire screen. The glass was attached to the surface of the panel in most cases by polyester resin applied with a medicine dropper after the pieces were in place. The exception to this was in the area of blue at the top, in which case that part of the surface to be covered was brushed with the resin and sprinkled with the fine particles of glass. After the composition was completed the entire surface of the work was coated with resin encasing the glass pieces in a continuous film secured to the panel.

Red Chicken displays a highly suggestive use of the glass, in color as well as texture. The work is limited in color but these limitations are overcome by variations within the three colors. This is partially due to the pigment quality, but more to the concentration of pigment, dependent on size of glass piece. The amount of light absorption is directly proportional to the concentration of pigment. With regard to the flash glass there is a

readily observable difference between placing the flash side next to or away from the panel surface.

APPENDIX I

Pyrometric Cone Temperature Equivalents

The following table gives a schedule of Orton Standard Pyrometric large cone numbers and equivalent temperatures:

Cone Number	Rate of Temperature Increase per Hour	
	108°F.	270°F.
010	1629°F.	1641°F.
09	1679	1693
08	1733	1751
07	1783	1803
06	1816	1830
05	1888	1915
04	1922	1940
03	1987	2014

The above table is a portion, applicable to the present study, of one published by the Edward Orton (Jr.) Ceramic Foundation, 1445 Summit Street, Columbus 1, Ohio. The temperature equivalents given are only approximate for the work discussed in this paper since the actual rate of firing did not coincide with either temperature rate given.

APPENDIX II

Use of Polyester Resin

The polyester resin is available in various compositions. Those used in this work are Super Bonding Coat, Procoat, and Finish Coat, all products of Fibre Glass-Evercoat Company, Inc. In all cases Super Bonding Coat is used as the first coating and either Procoat or Finish Coat for the final coating. Intermediate layers may be any one of the three. Powdered pigments may be satisfactorily added to the resins if ground into the resin in a mortar.

Finish Coat gives a mat surface and Procoat a glossy surface. Often the Procoat on an impenetrable surface, such as glass, will remain slightly tacky long after the normal drying time (thirty to forty minutes at 77° Fahrenheit). In this case the Finish Coat may be diluted by adding an equal amount of solvent, Resin Kleener, and the resulting mixture will dry with a glossy surface.

For cleaning the resin from tools and equipment a strong solution of household detergent in water may be used. The detergent solution proved to be more effective than the resin solvent. More detailed instructions may be obtained from the local source of supply or the manufacturer.

BIBLIOGRAPHY

Books

Scholes, Samuel R. Modern Glass Practice. Chicago: Industrial Publications, Inc., 1946.

Sowers, Robert. The Lost Art. New York: George Wittenborn, Inc., 1954.

Periodicals

Cherry, Herman. "Joseph Meert: Experiments in Stained Glass," Craft Horizons, XVI (March/April, 1956), 14-17.

Ostuni, Peter. "A New Technique in Stained Glass," Craft Horizons, XIV (March, 1954), 34-36.

Reports

Fibreglass-Evercoat Instructions for Boat Covering. Cincinnati, Ohio: Fibre Glass-Evercoat Company, Inc.

Fibreglass-Evercoat Instructions. Cincinnati, Ohio: Fibre Glass-Evercoat Company, form FE-120.

Orton Standard Pyrometric Cones: Temperature Equivalents. Columbus, Ohio: The Edward Orton (Jr.) Ceramic Foundation [1954].