

OBSERVATIONS ON THE USE OF FRESCO
PAINTING IN MODERN BUILDINGS

by

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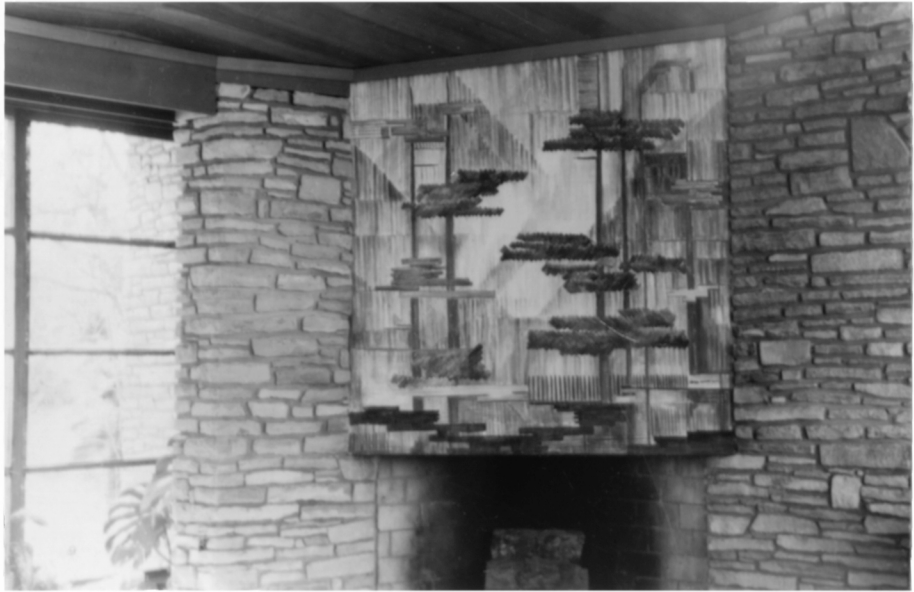
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SCOPE

The steps taken in the selection of a design for a specific wall area and the execution of that design in fresco is the subject of this paper. A tabulation of some of the characteristics observed in the experimental plaster mixtures is included -as is a listing of the pigments used in the fresco. Beyond a brief tracing of the origins of fresco, this paper does not include discussion of historical works, nor does it consider mural decoration other than buon fresco.¹

It was believed that a valid investigation might be made by means of a problem involving the actual design and execution of a mural in fresco. The results of this work are given in this paper.

¹Of the several means by which mural decorations may be executed, the term "buon fresco" has traditionally been used in connection with painting on freshly prepared plaster with pigments ground in water. Other methods include "fresco secco" in which the painting is executed on dry plaster with colors ground in water, with a ground-wash of lime water to bind the colors to the wall; "tempera" in which the colors are bound to the surface by the use of such vehicles as egg yolk, various gums, or casein; oil painting, either painted directly on the wall or on canvas which is later cemented to the wall; miscellaneous methods using as binding agents certain silicates, resins, or waxes.

INTRODUCTION

Origins of Fresco

From the earliest times man has attempted to modify or to mould his environment to his pleasure. In this he differs from the other animals who seem, generally, to have reached their limits in this direction with the lining of a burrow with down, moss, or similar materials.

Even before he had learned to erect permanent shelter for himself, man had begun his restless attack on his surroundings by scratching or painting those marvelous pictures of animals and symbols which made a dwelling of the animal lair. For whatever purpose the unknown artists created these pictures (and we shall never know with certainty whether they were created for magic or for pleasure) he there began to make his surroundings serve needs other than physical.

With increased knowledge of the materials of the world around him came greater strides in the alteration of man's surroundings. Layers of mud daubed on the face of rough stonework improved its weather resistance, but more importantly, the appearance of the rock was refined.

The date of the discovery of lime for use in plaster is lost in the dusts of time. Likewise unknown is the period in which man learned to color plaster by smearing its wet surface with pigments. It was, apparently, a well developed craft and art as long ago as the late Minoan period in Greece.

According to Mayer, the finest examples of this early Greek fresco were uncovered by excavations at Knossos.¹ These were painted with native earths -yellow ochre, a red oxide, a red made by burning the yellow ochre, a mineral black apparently made from shale, and a blue Egyptian frit. Greens were made by mixing the blue and yellow.

At one period, most of the interior walls were plastered and frescoed -even those of common dwellings. Expert plasterers and mural painters, the Minoans appear to have changed the decorations from time to time -perhaps in the spirit in which wallpaper in houses is changed today.

Plaster was employed not only as decoration, but as a stucco or protective coating on soft building stone. For this, marble dust and sand were used in the mixture for undercoats or for coarse exteriors, but the finest decorative surfaces received only a coat of pure plaster.

No examples of Hellenic Greek frescoes are known to exist; but their general character can be inferred from pottery and sculpture of the period. How strange it seems that no frescoes should survive from this period when an unbroken series stretches afterward from Etruria, thru Pompeii, Rome, Byzantium, the masters of the Renaissance, to the works of the present.

¹Ralph Mayer, *The Artist's Handbook*, p.262

General Requirements for a Mural Design

To form an integral part of contemporary architecture (or, for that matter, the architecture of any period) a fresco should do the following:

1. Contribute color harmonies which compliment and strengthen the architectural character of the space in which it is used.
2. Be consistently "mural" in its composition and color, i.e. it must not destroy the character of the wall, nor should it appear as a decorative element added to the wall.
3. Use subject matter which, like the color and composition, is fitting for the character and uses of the room.

Other requirements for a mural design can be listed,¹ but these three are sufficient for a discussion of the problem of determining the suitability of fresco for modern interiors or to design a fresco for a specific wall.

¹"The technical requirements for a mural are similar to those for oil or tempera easel pictures, and in addition these:

1. It must be absolutely permanent under the conditions to which it is exposed for the life of the building--these include the necessary cleaning or washing which is periodically given to walls.

2. It should present a dead flat (matt) finish so that it may be viewed from all angles without undue glare or reflections as one gets from an oil or varnish surface.

3. The design of the picture must be laid out with the understanding that the spectator is ambulatory rather than stationed at an arbitrary fixed point, as in the viewing of easel paintings.

4. The painting must have a mural quality--a very definite but somewhat intangible character which includes certain

Of these, the first two are largely self-explanatory. The third requirement merits discussion.

The choice of subject matter for a modern fresco is, perhaps, a more difficult problem for the painter than that which confronted his earlier counterpart. Symbolism, which until now has played a leading role, is of limited help--except for those murals designed for use in buildings of industrial, governmental, or religious character. Gone, too, from the contemporary scene are the compositions based on allusions to classic mythology which formed the backbone of mural art in past times. (The myths of certain politico-economic ideologies are the basis for some work, but these are of minor importance in the overall picture.)

Contemporary systems of religion have no need for the watchful guardian painted on a wall, have no hosts of spirits to be placated or celebrated. These religions promise to supply all needs in a future world and thus make it unnecessary for the painter to provide the images which will accompany the

degree of appropriateness to the architecture and function of the room; if it is to be painted in a completed building, it must be planned to fit into the architectural design rather than give the impression of being a surface ornament.

Proceeding along these lines, our definition runs into aesthetics, which is beyond the scope of our present account. The means of accomplishment are as many as there are schools of artistic thought. A familiar admonition is to maintain the two-dimensional or plane surface feeling of the work as a whole: subjects, whether pictorial or decorative, may be presented in full perspective or recession but not so as to create "holes" in the wall....."

Ralph Mayer, *The Artist's Handbook*, p. 256.

dead to the next world. All this has taken from the mural painter a fruitful source of material which was ready-made for the painter of ancient times.

The scenes of everyday life, recorded on freshly plastered walls by the painters of Etruria, or Mycenae, or Pompeii, were pictorial reporting as well as decoration. Today, this reporting is done in smothering profusion by the ever-present eye of the camera.

However, it should not be imagined that the devices of symbolism, of realism, of mirroring everyday life--or even of allegory--are completely unavailable to the modern mural painter. It is rather that the ceaseless changes in human activities with their attendant effect on taste and fashion (O tempora! O mores!) have made these devices less useful. Symbolism is not dead.

What then are the avenues open to the mural painter of today? Is the field so proscribed that there is little room for the skillful exercise of his talents? If so many potentials are either unsuitable or passé, what then remains?

Since the dawn of man's graphic efforts, painters have made use of abstraction (and its sister--conventionalization) at the same time that they were strenuously holding a mirror to the face of nature. Islamic art, for example, is based entirely on such a conception. The laws of the religion forbid the realistic representation of any living thing. The beautiful and intricate patterns in buildings in Spain erected during the Moorish occupation are brilliant examples of this influence.

The emergence of the several schools of French painting since the turn of the century has brought about the use and study of the abstract and non-objective painting for its own sake. These studies, largely in the form of easel paintings, have had such a profound influence that many of the principles of composition developed in them are now counted among the tools which a mural painter uses in the pursuit of his profession.

SOLUTION OF A SELECTED PROBLEM IN FRESCO

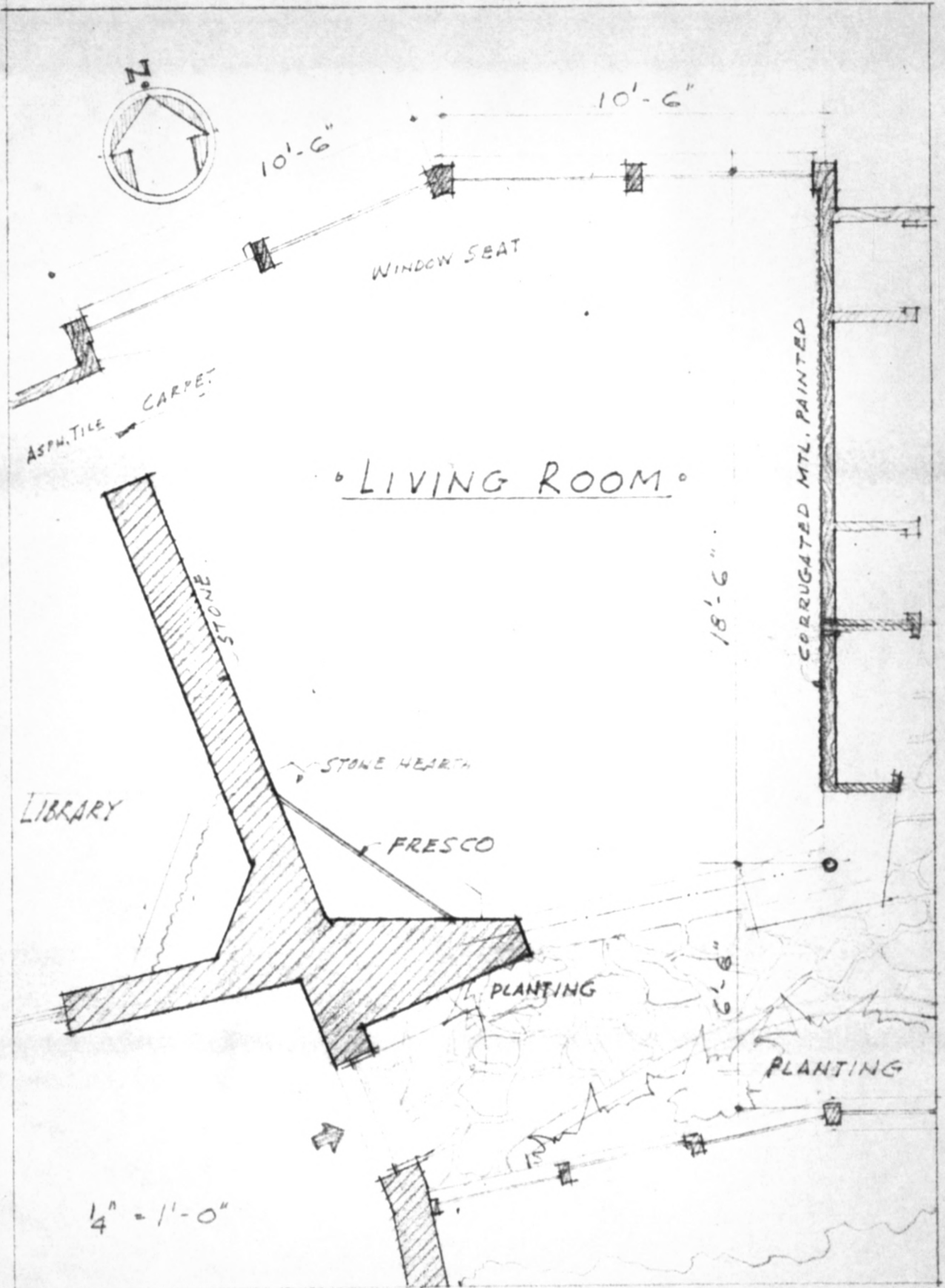
The Site

The wall chosen for study was a trapezoidal area having a base of 5'-10" and sides of 5'-6" and 6'-0" above the fireplace in the living room of a residence in Manhattan, Kansas. As shown by the plan (Plate I) the room is a pentagonal shaped areas with windows entirely across the two northern sides. Stone walls of random, coursed, ledge limestone flank the fresco wall. A sloping ceiling of warm toned wood (Philippine mahogany) cuts across the top of the fresco; the lower edge is bounded by the steel angle of the fireplace opening. A rich green, rough-textured carpet and a corrugated wall painted a green similar to that of the carpet, but deepened and slightly greyed, complete the room enclosure.

From the northern windows, a splendid distant view of the Blue River valley may be seen beyond the well-clipped shoulder of the hills forming part of a golf course. To the south, a wall of glass stands between the protected indoor

EXPLANATION OF PLATE I

Plan of Living Room showing location of Fireplace.
Mural is painted on the wall above the fireplace.



planting of subtropical foliage (oleander, gardenia, azelea, ricinus communis, philodendron pertussin, avocado) and the grass and trees outside.

Light from the north windows floods the wall with a somewhat bluish light while the direct sunlight from the south (in winter) is predominately warm as it falls on the floor in front of the fireplace. Because of the angle of the fireplace walls, no southern light reaches the fresco directly.

The completed fresco is shown in the frontispiece.

Development of the Design

Preliminary consideration of suitable subject matter for this fresco revealed the following:

1. Naturalistic material, in addition to being of questionable "mural" character, would be unable to compete with the genuine article so strongly present in both the interior planting and the view thru the north windows.
2. No strong indications for significant symbols.
3. No marked preferences of the owner as to motifs to be used.

With the field of operations thus relatively wide open, studies were begun at small scale to produce thematic material from which the final design could be made. Preliminary sketches are shown in the illustrations which follow. The originals were at a scale of $1\frac{1}{2}'' = 1'-0''$ and were executed in colored pencil or in watercolor.



Fig. 1

The study shown in Fig. 1 is a composition of overlapping triangular areas in shades of green, brown, and yellow with accents of blues and reds. Although this composition is not without interest and achieves a fairly satisfactory unity by the superimposition of the areas and colors, in the final selection it was discarded because the composition had a strong tendency to stray outside the frame - appearing to be a fragment of a larger all-over design.

In Fig. 2, a line composition of circular and diagonal shapes suggestive of animal and vegetable forms, the colors of the original are ocher, red-brown, blue-green, yellow-green, with accents of medium red. The background area (largest in the composition) was white. This study was

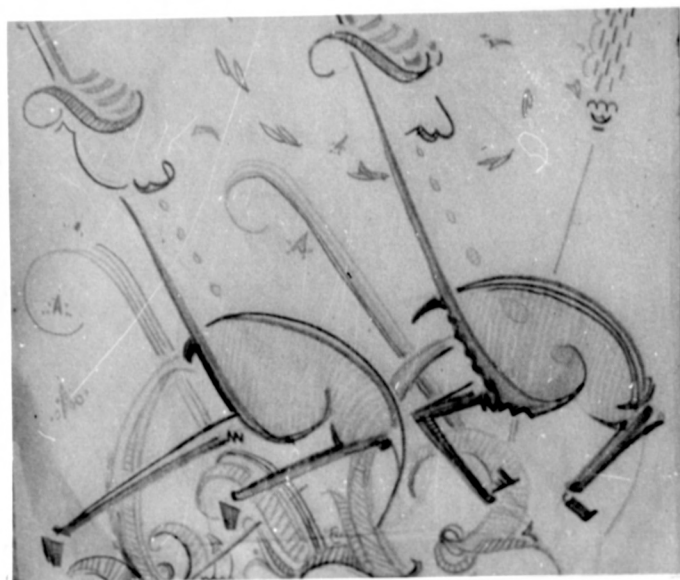


Fig. 2

eliminated because it was felt that the "scale" of the composition was too small and that it, too, had a sense of being a fragment of a continuing composition. This latter defect was in large part a result of the very strong and swift movement to the left coupled with a counter movement to the right which, instead of cancelling, seemed to add.¹

It was also felt that the colors, with the large white area, were not as well matched as they might be with the rest of the room.

¹The effect is somewhat similar to that observed from a moving train window, in which the apparent forward motion of objects on the horizon increases the seeming rearward speed of nearer objects, thus heightening the sense of speed experienced by the observer.

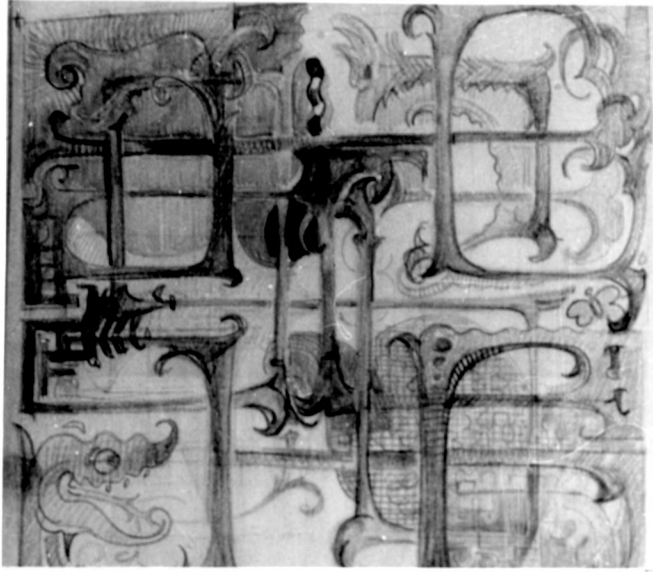


Fig. 3

Strong horizontals and verticals in the composition of No. 3 echoed the elements of the room structure and at the same time minimized the effect of the slightly sloping upper edge of the fresco. Unfortunately, this study was completely out of scale, its forms being those better suited to an illuminated manuscript or a bookplate.

The "sequence of action" motifs in Fig. 4, depicting the steps in getting fuel for the fireplace directly below the fresco had the virtue of being immediately and peculiarly related to the wall and the room in which the painting was to be placed. However, it was felt that this story, retold each time a viewer entered the room, might not "wear" well under the forces of everyday residential living. In a

commercial atmosphere, such as the reception room of a lumber company, a meeting room of a hotel or a restaurant, or any place where the occupants would not be so intimately in contact with the composition, this study might have possibilities and be worth further development.

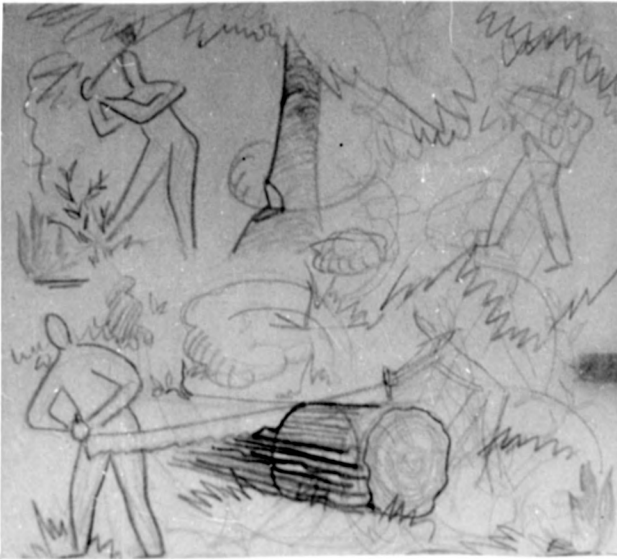


Fig. 4



Fig. 5

Diagonal movements, with angular intersections suggesting human heads, and a patchwork of bright, clear colors mark the study shown in Fig. 5. Somewhat related to Fig. 1 in composition and having the same weakness of being not confined definitely within the space, it still offered possibilities. The placement of the areas of color and their angular configuration could be varied to aid in unifying the composition. The fact that it was possible to read this design as an interlocking series of blanketed Indians was considered to be

neither a detriment nor an asset. The colors of the sketch are spotty, but this was felt to be not beyond the possibility of final resolution. This sketch was later studied at large scale before discarding it in favor of the final solution.



Fig. 6



Fig. 7

Figure 6 and the incomplete Fig. 7 are based on circular motifs and thus in no way parallel or echo the structural elements of the room. This divergence is not, in itself, a fault. Many times such a contrast is a means of arriving at a powerful effect, but in these two studies it produces only a loose and sloppy result. This may be in part due to the choice of subject matter.



Fig. 8

Interrupted verticals and horizontals form the basis of the composition in Fig. 8, which has much to be commended. This non-continuous line is characteristic of the random, coursed fieldstone of the walls so that there is a good unity with the areas on either side. Unfortunately, the composition was not at rest within the space and exhibited the same weakness noted in Fig. 1 of appearing to be a fragment of a larger and continuing composition. This, together with a "nervousness" in other parts of the design, led to its elimination although certain features of the horizontals and verticals were incorporated in the final design.

In the study shown in Fig. 9, the attempt to reduce the "nervousness" of the preceding design by making smaller the total number of compositional elements had the opposite effect.



Fig. 9

The scale has now become that of drapery or other cloth patterns and the shape of the light areas (other colored in the sketch) has an explosive quality far different from that which was sought.

An attempt was made in Fig. 10 to achieve a more quiet composition by reducing the design to a single figure in a relaxed pose against a uniformly textured background. By contrast with some of the previous studies, this design achieves a unity and calm which are quite desirable in a living room. Its relatively static qualities are the result of the elimination of complexities of composition. The eye grasps the main lines quickly and follows them easily. Such a composition lends itself to further refinement and study



Fig. 10

because the small number of component parts reduces the interaction of each element. As a result, a change in one area can be studied almost independently.

This study was eliminated from consideration, however, because of the motif (which would probably become tiresome); and because of the heaviness of the color in the background.

Interlacing circles and diagonals form the basis of the design shown in Fig. 11, which keeps its movements well within the limits of the space. The colors echo strongly the rug and the corrugated wall, but the scale is that of a textile print or embroidery.



Fig. 11

The rectilinear composition in Fig. 12 had a calm unity which was a relief after the frenzied designs which preceded it. The colors of ocher, warm grayed green, burnt sienna, cerulean blue, and vermillion, were well keyed to the room.

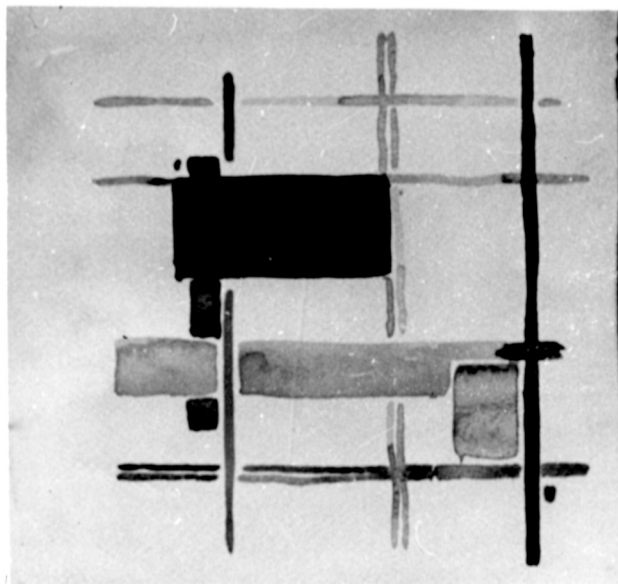


Fig. 12

However, where many of the previous studies had many mobile elements which rendered them unsuitable, this sketch was too stiff and unexciting.



Fig. 13

Figure 13 is a study based on the general arrangement of Fig. 12. Here, in the same colors, is a livelier composition which is largely a pattern of light and dark areas having shapes which may be associated with natural forms. This indirect echo of plant forms helps to tie the wall to its surroundings without mimicing them. The flowing brush strokes of the sketch were not sufficiently in keeping with the "mural" character desired, so further study in a more abstract vein was made.

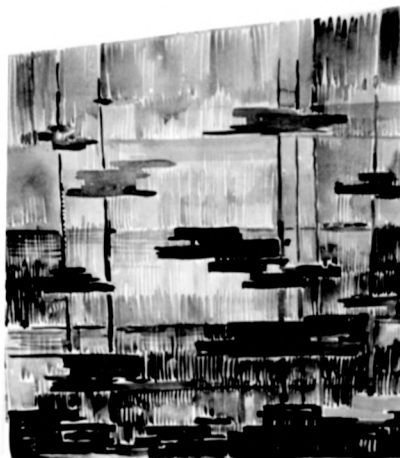


Fig. 14

In Fig. 14, the final small sketch for the fresco, the rectilinear composition of Fig. 12 has been combined with the natural derivations of Fig. 13 and executed with a formalized pattern of brush strokes. The colors, which run from light ochre and red-browns at the top and sides to blue-black and blue at the bottom, were chosen to be in concord with the colors of the room and to recognize the very real fact that the area of the fireplace opening is essentially a black one and that any small amounts of smoke escaping from the fireplace would affect the grey and blue and black portion at the bottom of the composition less than if it were painted in lighter values.

This design successfully combines the qualities previously listed as essential to the proper integration of the painting with the architecture. Its colors echo and compliment

those of the structure and furnishings of the room; the interacting areas of color, although suggesting planes of varying depth in space, remain flat and well within the character of the wall surface; by abstraction the subject matter is such that it makes no jarring note with the room, as the shapes and colors are suggestive of the natural forms so abundant both inside and outside the house.

From the color sketch in Fig. 14, the study proceeded to full size studies in color, executed on paper fastened directly over the space on which the fresco was to appear.

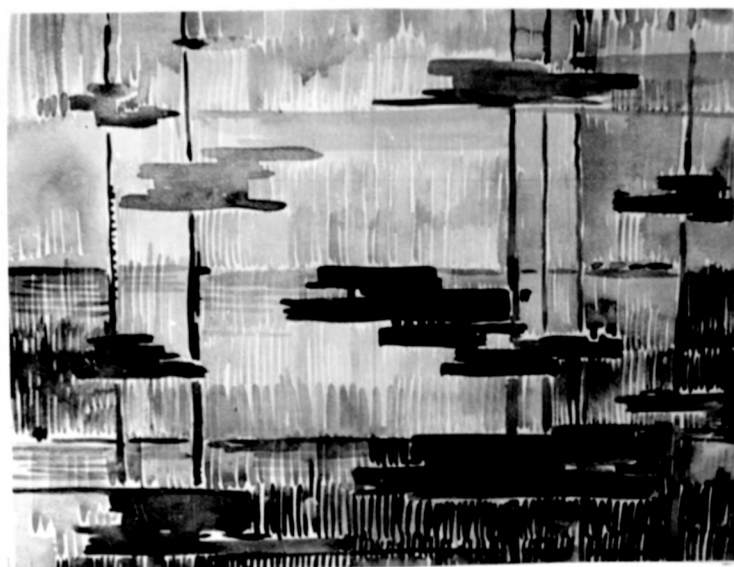


Fig. 15

These studies, part of one of which is shown in Fig. 15, permitted more detailed study of each part of the composition. Experiments with brushwork and refinements of color relationships were undertaken which would have been difficult to accomplish at the smaller scale.

It will be noticed that in the final studies at full size that the foliage-like green areas have been broken up into a network of diagonal brushstrokes of varying and broken color. The formalized vertical passages in the background of the original sketch have been retained, but modified to an overlapping composition of diagonals which strengthens the brush work of the green areas and at the same time echoes a diagonal pattern in the transoms of the windows which face the mural. In the fresco as finally executed, these diagonal areas in the background strongly suggest the play of sunlight coming thru the windows at either side of the living room.

In suggesting the play of sunlight by the arrangement of diagonal areas of color the essential plane quality of the wall is preserved, in that the painting in itself makes no attempt to portray linear perspective. Rather, the more subtle effects of aerial perspective are used. The series of overlapping and intersecting areas, whose colors range from light, clear yellow to a smoky blue-grey or blue-violet, permit the spectator to make his own assignment of position in space to each of the color areas. This assignment is, of course, quided by the values of the composition, but it is also influenced and colored by the range of each viewer's experiences. Thus, the mural becomes a somewhat personal interpretation to each person who enters the room.

Materials of Fresco

Lime. Basically, fresco is extremely simple. Plaster, a wet mixture of calcium hydroxide and sand or other aggregate is spread evenly over the surface of a wall (or ceiling). As water evaporates from the mass it is replaced by carbon dioxide from the air. This combines with the lime chemically to form calcium carbonate--the same compound as marble, limestone, and chalk. Pigments painted on the surface of this mass are absorbed in the outer layer of calcium hydroxide and as it becomes calcium carbonate the pigment particles are firmly and permanently in the hardening plaster of the wall.

But, as is so frequently the case, this simple process has become surrounded with a great body of mystic rules, prohibitions and directions. Writers on the subject, from Pliny to Mayer, have detailed the steps minutely. Many of these accounts are but recipe recitations of men whose technical training did not permit them to make an accurate sifting of the "facts" about which they wrote. As a result of this, a current impression among present day artists is that painting on wet plaster is a mysterious and difficult art, tolerable in a day when life was less hurried and lengthy procedures the rule, but ill suited to the methods of today.

With such a background of mysticism (not lessened by the knowledge that some of the world's masterpieces were executed in this medium) writers on the subject, and artists working in fresco, have tended to repeat the methods of the past and to ignore possible changes which might come from

improved sources of materials or from improved conditions in the structures in which the fresco is to be placed.

Illustrative of this are the statements made by Professor Max Doerner, of the Munich Academy of Fine Arts, in his authoritative work "Materials of the Artist".¹ In this he describes the qualities required for the materials of fresco in a carefully detailed fashion, but from the standpoint of materials as known and available in Bavaria in 1933!²

Professor Doerner writes, "The best lime is that which has been burned over wood fires, because, if coal has been used the lime is likely to absorb sulphuric acid and partially turn to gypsum."³ This statement, undoubtedly valid in Europe, has less meaning here where natural gas is an almost universal industrial fuel.

In this same work is found,

The slaked lime which thru addition of water has become fairly liquid is allowed to run into a pit. Impurities there settle to the bottom. This process of purification should not be shortened.....Experienced fresco painters have always insisted that lime should

¹Max Doerner, Materials of the Artist, Harcourt, Brace and Co., 1934, p. 432

²In the translator's preface to the English translation of the fifth edition, Eugen Neuhaus gives a clue to the common habit of clinging to and working from the old ways when he writes, ".....As a final preparation toward the translation of this uniquely useful and authoritative book, I accepted an invitation from Professor Doerner to visit him at his country residence at Wessling in upper Bavaria. The delightful days spent in the primitive environment of a small and picturesque village..." The italics are this author's!

³Ibid., p. 268.

ripen in the pit; at least two years is a minimum.¹

American industrial processes manufacture lime which is uniformly pure and this renders the pit unnecessary for such purposes. Developments in the methods of producing lime make it possible now to prepare and store only enough plaster for a day's work.

Lime for plaster is made by heating limestone (or marble) strongly. This "burning" decomposes the calcium carbonate (CaCO_3), liberating carbon dioxide (CO_2), a gas, and leaving calcium oxide or quicklime (CaO). This caustic solid, when combined with water forms calcium hydroxide ($\text{Ca}(\text{OH})_2$) and is accompanied by the liberation of much heat.

When approximately twice the amount of water theoretically necessary to hydrate the calcium oxide completely is added, the result is a stiff, white, plastic mass. This is known as "lime putty". The processes now employed by American manufacturers produce a fine powder which, unlike the old lump quicklime mentioned by writers on the subject, will produce a highly plastic and workable putty with only overnight soaking.

Manufacturers also prepare a quicklime which is ready for use immediately upon mixing with water and cooling. However, their literature implies that this lime should be used only when insufficient time (overnight) is not available to prepare the regular variety.

¹Max Doerner, *Materials of the Artist*, p. 269.

Thus it would seem that this material need not be considered for fresco, regardless of its properties. The time required in the preparation of the design for the fresco would make such speed completely unnecessary.

As it is probable that the plastic qualities of the lime putty may improve with a certain amount of aging, because of more uniform dispersion of water in the mass and, perhaps, because of improved colloidal properties, it would seem that preparation of lime putty in quantity sufficient for the job might well be made at the time design sketches are started. This represents a considerable reduction in the two-year minimum aging suggested in the literature.

Modern manufacturers also produce ready-slaked lime by combining it with the exact amount of water (usually in the form of steam) to produce complete hydration. This dry, fluffy powder, sold under the designation "Hydrated Lime", is unsuitable for fresco plaster because it has no plastic qualities and will not set tightly to the wall.

In the literature, much attention is given to the preparation of the lime (often in a tone which suggests that the artist should burn his own). The suitability of pigments for use with plaster is also well discussed. Descriptions are common of the action of the lime in recombining with carbon dioxide, from the air, to form calcium carbonate crystals with the consequent binding of the pigment to the wall in a permanent and insoluble way. But no references were found which bear upon the proportion of calcium carbonate crystals in the

total mass actually necessary to bind the pigment to the wall.

That this minimum proportion is of some importance is hinted at in the unanimous reference to the bad effects caused by gypsum (calcium sulphate) in the plaster. Doerner¹ suggests that up to 5 percent gypsum is not harmful--indicating that perhaps all of the lime carbonate crystals are not needed to bind the color into the plaster.

An investigation of the minimum requirements of calcium carbonate crystals needed is beyond the scope of this paper, but if undertaken, could prove of considerable use to painters. Should subsequent investigation show that only a portion of the calcium carbonate crystals are needed to fix the color, then fresco painting can be brought more closely in line with present-day plastering practice which employs approximately 25 percent gauging plaster, made of gypsum, along with the lime putty to produce a satisfactory, hard surfaced plaster.

The lime putty used in the test panels was prepared from "Veri-fat" hydrated finishing lime produced by the Certainteed Corporation.

Sand and Other Aggregate. Aggregates are granular mineral products added to the plaster for the purpose of reducing the shrinkage in the lime putty which occurs with the evaporation of water from the plaster. In ancient times aggregates were chiefly silicious sands, limestone dust, and marble dust. Modern techniques include these plus light weight aggregates made by heating certain shales and volcanic

¹Max Doerner, *Materials of the Artist*, p. 268.

rocks to expand their bulk and then grinding them to suitable fineness.

The aggregate used in the sample panels was from the following sources:

1. A brownish, sharp grained, moderately fine sand obtained by a local producer from deposits in the Kansas River and/or Blue River. This sand was sifted thru a 16 mesh screen before use.

2. A clear, white, round grained sand having extremely uniform particle size, known as "Ottawa Sand".

3. Ground limestone, which was sifted thru a 16 mesh screen, was obtained from a local stone plant. This plant works limestones from local ledges and also from Onaga, and Silverdale, Kansas, and from Bedford, Indiana. Thus the ground limestone used may have contained material from any or all of these sources. The chips were angular, generally having been produced by the chipping operations performed in dressing building stones to the proper size. The slight differences in color of the limestones was not thought to have any measurable effect on the plaster mixtures in which they were used.

4. Perlite, an aggregate of white, spherical granules, is produced from a glassy mineral of volcanic origin. By heating to 1500° F., the base mineral is tremendously expanded to produce hollow granules weighing approximately seven pounds per cubic foot.

The perlite used in the test panels was produced by Panacolite Perlite Inc., Kansas City, Kansas.

Pigments. Pigments for fresco painting must be unaffected the action of the lime. Thus the palette has a much more limited range than that which may be employed in the other media. In general, only the natural pigments (earth colors) can be counted on to resist the strongly caustic action of the wet plaster, although a limited number of metallic compounds have proved to be entirely safe. The palette employed in these studies is as follows:

Light Red Oxide	(Red iron oxide)
Cadmium Red, Light	(Cadmium selenide co-precipitated with barium)
Cadmium Yellow, Light	(Cadmium sulfide)
Yellow Ocher	(Yellow oxide of iron)
Raw Sienna	(Natural yellow earth)
Burnt Sienna	(Calcined yellow earth)
Burnt Umber	(Calcined brown earth)
Cobalt Oxide	(Cobalt-aluminum oxide)
Viridian	(Chromium oxide, transparent)
Lamp Black	(Amorphous carbon)
Pthalocyanine Green	(Chlorinated copper phthalocyanine)
Terre Verte	(Natural green earth)

The pigments used were those manufactured by Permanent Pigments, Inc. or by Windsor and Newton, Ltd. Tube colors made for watercolor painting were used as this form was readily obtainable, convenient, and easily mixed. The vehicle in which these pigments were ground--distilled water, glycerin, dextrin, and vegetable gum--will produce no deleterious effects in conjunction with the lime.

PREPARATION OF TEST PANELS

A series of panels 16"x48" was prepared using varying proportions of lime, gauging plaster, sand and ground lime-

stone in order to investigate the painting qualities or "feel", the paint retention behavior, and (within the limits of the time available) the durability of each.

The base of each panel was a slab of gypsum plaster $3/8$ inch thick, enclosed in a grey paper covering. Known in the building trade as "Rock Lath", these slabs are meant to be nailed to the framework of the building and to serve as a base for plaster in place of wood or metal lath. The paper covering serves to reinforce the gypsum plaster and to provide a uniform "suction" which keys the plaster tightly to the wall.

Over this base the various plaster mixtures were spread with a flat steel trowel to a thickness of approximately $3/8$ inch. When the surface of the plaster had set sufficiently so that it would just retain the imprint of a sharp instrument the design was traced upon it by placing a paper cartoon of the design over the face of the plaster and tracing thru it with a non-metallic stylus. The depressed line thus formed in the surface of the plaster served as an adequate guide for the application of the colors of the design.

None of the panels presented a surface upon which it was impossible to paint. Those mixtures containing only hydrated lime and gauging plaster tended to be more absorptive, making brushwork more difficult as the changes in the amount of moisture in the brush as it moved across the surface was clearly evident in the finished color. These mixtures also had poor binding of the colors to the surface.

The final fresco was painted on a plaster mixture like that of panel No. 11. The slightly rough surface of this panel had a paintability similar to that of fine watercolor paper. It was absorptive, but not blotter-thirsty; the color spread evenly and with great luminosity; deep toned portions of the painting remained clear.

Panel No. 10 displayed all of these desirable qualities to almost the same degree as No. 11, with the exception that the brownish grains of sand made the plaster slightly less brilliantly white.

Table I gives the proportions of each ingredient used, together with some significant qualities of each.

METHOD OF PAINTING A FRESCO

The nature of true fresco painting demands that the painting be carried out in the plaster while it is still wet. With the drying of the plaster comes the chemical change which produces the calcium carbonate crystals necessary to bind the colors to the wall. Thus the work of painting may progress only so long as sufficient moisture is in the plaster. When the plaster has dried to the point at which the color "pulls" the painting must stop and any plaster not yet painted must be scraped from the wall.

This "pulling" is felt because dry plaster is more porous than wet plaster, so that such a surface appears to the painter to be "pulling" the paint from the brush. The length of time from the placement of the plaster on the wall to the moment

when it has "set" to a state where it can no longer be painted will vary with the thickness of the plaster coats, the water bearing capacity of the finish plaster coat, and the temperature and humidity of the air. Only as much plaster is spread on the wall as it is possible to paint before it becomes too dry. Any plaster remaining unpainted is cut away from the wall. The succeeding areas are carefully joined to the work just finished.

Thus the design must not only be prepared to fit the wall area, but it should also permit division into daily work sections. Insofar as possible, these divisions should occur along the boundary between the light and dark areas of the design for in this way they become less noticeable.

Work was begun in the upper left hand corner of the design. An area approximately 24 inches wide was plastered across the top of the panel and smoothed to a plane surface with a minimum of troweling. The experimental panels showed that a more responsive painting surface with a long painting time was produced by the least amount of troweling consistent with securing a plane surface.

A full size tracing of the final design was made on heavy, transparent paper and stapled to a wood strip across the top of the panel. When the plaster was sufficiently set, the tracing was unrolled and dropped over the face of the plaster. A moderately sharp pencil of a color other than that of the tracing (so that it could readily be seen when all parts of the design were traced) was used to incise the

outline of the design in the surface of the wet plaster by pressing thru the thickness of the paper. The tracing paper was then rolled up, secured to the ceiling with pressure-sensitive cellulose tape, and painting begun.

The standard method of procedure begins the plastering in the upper left-hand corner of the area, proceeding completely across the top before moving downward. This sequence makes plastering and painting operations somewhat easier and eliminates the dangers of dripping on or spattering freshly painted work while performing subsequent operations.

By the exercise of great care, work with which the artist is dissatisfied may be removed and replastered and repainted. Figure 16 shows such an area removed from the center of the



Fig. 16

design before replastering. Dissatisfaction with the brushwork in this area, as compared to the rest of the painting, caused its removal and repainting.

The surface from which the plaster was cut was thoroly wet before beginning the final application of plaster. Care was taken to prevent excess water from running down the surface which had already been painted. This was done so that particles of lime, not yet carbonated, would not be carried over the face of the colors below to become deposited and to form a white film of calcium carbonate.

Fresco painting differs from other painting techniques in several respects. The great luminosity of the plaster surface encourages the application of the pigments in thin layers--a practice which the literature describes as improving the binding of the colors in the calcium carbonate film. In this respect the technique is on common ground with watercolor painting. The surface of the damp plaster is greatly different, however, from watercolor paper. It is more absorptive, with each brush stroke sinking into the surface. This makes washes, in the watercolor sense, next to impossible.

The absorption has sharply defined limits. Altho painting must be done with a fully charged brush, care must be taken to avoid presenting too large an amount of water to the surface of the plaster. If this occurs, the absorption point of the plaster is quickly reached; it refuses more water; and a rivulet of color courses down the face of the plaster. This immediately sinks in and becomes quite difficult

to remove or to alter in subsequent painting.

The habits of manipulating the pigment as used in oil painting are of little use in fresco, as is also the use of the graded watercolor wash. The absorption of the surface and the clarity of the brush stroke makes both of these techniques unsuitable. Underpainting, broadly and flatly done, is highly useful, and the optical effects of broken color may be employed at every stage of painting.

The broad horizontal areas of deep green in the completed fresco (Fig. 17) employed both underpainting and broken color to assist in achieving a vibrant effect. The lower, serrated edges were first hatched in cadmium red, light, with strokes approximately 1 inch long, $1/8$ to $3/8$ inch wide and spaced

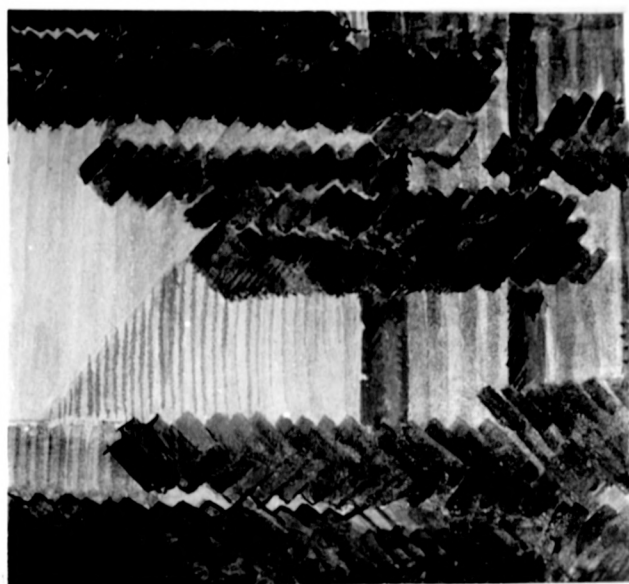


Fig. 17

approximately the same distance apart. This hatching was directed from the upper left to the lower right.

Over this, running diagonally from the upper right to the lower left, a second series of hatching of the same weight (painted with the same round sable brush) was placed in a middle deep tone of cobalt blue. Not too much attention was paid to confining the cross hatching exactly to the serrated outline of the area. These alternating and crossing stripes of color produced a grey effect which was at the same time lively.

The surrounding background areas were now painted, using a flat sable brush $3/4$ inch wide. Strokes the width of the brush and in lengths varying with the requirements of the design, were laid on, using color lightly but freely blended on the palette. This mixing of color on the surface of the wall (in a manner somewhat similar to the blending of color on the paper in watercolor) gave to these strokes the same effects of vibrancy which occur in the darker passages where underpainting is employed. These parallel strokes were carried down into the areas which had been cross hatched as underpainting for the dark green areas.

With the flat sable brush well charged with color, the dark green areas were then carefully painted, this time staying more closely to the incised guide outline. In charging the brush, it was filled with water and then swirled in the Pthalocyanine Green, then in the Burnt Umber (or Yellow Ocher, or Burnt Sienna or, perhaps, Cobalt Blue) after which it was transferred to the plaster. No attempt was made to mix

the pigments any more than that which would normally result from the motion of the brush in picking up the second color or the third color. In this way the mixing of the colors also occurred on the surface of the plaster giving a richer and more brilliant effect.

Local accents of deeper color were finally added with a round sable brush to complete the painting. No painting or strengthening of highlights was done, the watercolor procedure of using the white of the ground for highlights being followed. It was felt that this tended to preserve the plane of the wall to a greater degree than would be the case if a greater range of modeling values had been employed. Also, the white of the plaster ground is as brilliant as any subsequent application could be.

Use of the plaster ground as the white of highlights or for producing light color values has technical advantages for the painter in addition to those relating to the clarity and brilliance of the color. By working in this way, the differences in color and value which exist between the wet and dry states of the pigments are minimized and the artist is able to proceed with his work with more assurance as to the harmonious color and value relationships of the finished work.

When lime putty (the best white pigment for use in fresco) is mixed with other colors, the combination is generally much deeper in tone when wet than when the lime has set and dried. If not carefully and properly allowed for in the application of the color to the fresco, the result upon drying of the plaster can easily be disastrous to the over-all harmony of the design.

CONCLUSION

Fresco painting, with its clear, clean color, is well suited to or adaptable to the requirements of modern buildings. No other medium possesses the rare combination of high luminosity and nearly complete absence of surface sheen. This quality is of tremendous importance in view of the large areas of glass so regularly employed in every type of building erected today. This flood of light, bouncing and glittering from reflective surfaces, such as those of oil painting or mosaic, impairs the artistic composition and degrades its colors and is genuinely irritating to occupants of the room. In the fresco described in this paper, the strong, oblique light falling on it would have made any other surface than a dead matte one of doubtful value.

Many objections to the use of fresco which have been made in the past have been invalidated by progress in materials manufacture and in building construction. Better control of the processes of manufacturing all of the materials of fresco has removed many of the uncertainties which heretofore have surrounded the final outcome of the painting. Improvements in construction, changes in the types of fuels and in the methods of burning them, have so altered the atmosphere within modern buildings that many of the fresco destroying conditions no longer exist.

The technical demands on the artist working in fresco, although different in many respects, are no greater than those imposed by any of the media of artistic expression.

The greatest single restriction imposed on the painter by the nature of fresco is not really a restriction in the truest sense. The relatively limited time available for working on the plaster, as contrasted to the endless days in which an oil painting can be worked and reworked, merely insures that the painter must have made practically all of the artistic decisions of his design before he begins to paint. Fresco permits of little in the way of "ad lib" performances.

Removal of the aura of mystery from the processes of fresco painting and discard of the heroic role so long assigned to it should do much to encourage a greater use of this beautiful medium of artistic expression.





Table 1. Painting quality and other characteristics of thirty experimental plaster panels.

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Panel	Ingredients	Surface	Shrinkage	Paintability	Color Quality	Water Resistance
1	2 hydrated lime 1 gauging plaster	hard, smooth		fair	good	poor
2	1/2 lime putty 1 gauging plaster	hard, smooth		fair	somewhat dull	adequate
3	pure lime putty	hard, smooth	excessive, scaled from panel	good	clear, bright, luminous	good
4	1 lime putty 3 limestone dust	moderately hard, smooth	many cracks	fair, sensitive to water in brush	dull, grey tone	adequate
5	1 lime putty 3 Blue River sand	soft, smooth		good	clear, somewhat greyed	adequate
6,7,8	3 hydrated lime 1 gauging plaster	hard, smooth, very white		absorptive	dark tones muddy	poor
9	3 lime putty 1 gauging plaster	hard, smooth		fair	fair	adequate
10	1/2 lime putty 1 Blue River sand 1 gauging plaster	hard, slightly rough		good, takes color evenly	luminous, slightly off-white	adequate
11	1 lime putty 1/2 Ottawa sand 3 hydrated lime 1 gauging plaster	hard, eggshell finish very white		excellent	brilliantly luminous, dark colors clear	good
12	1 hydrated lime 2 Ottawa sand 1 white portland lime wash	hard, sandy		good	good	poor
13	2 hydrated lime 2 Ottawa sand 1 white portland lime wash	hard, smooth	some cracks	good	luminous	poor
14	3 hydrated lime 2 Ottawa sand 1 white portland lime wash	hard, smooth	many cracks	good	good	poor
15	1 lime putty 2 Ottawa sand 2 gauging plaster 1 perlite	hard, moderately smooth		very good	luminous	adequate
16	3 lime putty 3 Ottawa sand 1 gauging plaster 3 Perlite	hard, sandy		good	slightly dull	adequate
17	3 lime putty 1/2 Ottawa sand 1 gauging plaster	hard, smooth		good	luminous	good
18	2 lime putty 2 Ottawa sand 1 gauging plaster 2 Perlite	hard, rough		good	good	good
19	3 lime putty 6 Ottawa sand 1 gauging plaster	hard, smooth	some cracks	good	good	good
20	3 lime putty 3 Ottawa sand 1 gauging plaster 6 Perlite	hard, rough	some cracks	stayed wet too long	slightly lightened tones	poor
21	3 lime putty 5 Ottawa sand 1 gauging plaster 2 1/2 Perlite 1 hydrated lime	hard, sandy		good	good	adequate
22	3 lime putty 3 Ottawa sand 1 gauging plaster 3 Perlite	hard, smooth	many cracks	good	good	adequate
23	2 lime putty 2 Ottawa sand 1 gauging plaster 1 Perlite	hard, sandy		good, held moisture well	good	good
24	3 lime putty 3 Perlite 1 gauging plaster	hard, rough		good, held moisture	good	good
25	2 lime putty 3 Perlite 2 white portland	hard, moderately smooth		good, held moisture	good	adequate
26	2 lime putty 3 Perlite 1 white portland	hard, rough		good, held moisture	very good	good
27	1 white portland 2 Ottawa sand lime wash	moderately hard, smooth		fair	dull	good
28	1 white portland 3 Perlite	hard, smooth		fair	dull	partial
29	1 lime putty 1 Perlite 1 gauging plaster	hard, moderately smooth		good	bright	good
30	3 lime putty 6 perlite 1 gauging plaster	hard, smooth		good, held moisture well	good	good

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REFERENCES

- Doerner, Max.
Materials of the Artist. New York: Harcourt Brace and
Co., 1938.
- Hiler, Hilare.
Painter's Pocket Book. New York: Harcourt Brace and
Co., n. d.
- Gettens, Rutherford J., and George L. Stout.
Painting Materials. New York: Van Nostrand Co., 1942.
- Mayer, Ralph.
The Artist's Handbook of Materials and Techniques.
New York: Viking Co., 1940.

OBSERVATIONS ON THE USE OF FRESCO
PAINTING IN MODERN BUILDINGS

by

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Fresco painting, although an historically important decorative medium, has fallen into comparative disuse in modern times partly because the aura of mystery and difficulty which surrounds the practise of the art has discouraged many painters from using it.

True fresco painting is a method in which pigments are incorporated in the surface of freshly prepared and spread lime plaster. The plaster hardens by losing moisture and by absorbing carbon dioxide from the air. In this process the plaster becomes a mass of calcium carbonate crystals which bind the pigment particles firmly and insolubly to the wall. Although the range of pigments which can be employed is limited to those which can withstand the highly caustic lime, the clarity and brilliance obtainable are of a quality which is scarcely found with any other medium.

A series of experimental panels using varying proportions of ingredients was prepared to explore the qualities of each. These tests, in part, preceeded the development and execution of a design for a specific wall. This procedure was considered to be a satisfactory method by which to determine the merits and the difficulties of fresco painting for use in modern buildings.

It was felt that many of the difficulties which, in earlier times, accompanied the execution of a fresco have been removed by improvements in the manufacture of the raw materials and by changes in the interior climate of the structure in which the fresco is to be placed.

The experiments undertaken with varying proportions of lime, gypsum plaster, sand and other aggregates, show that satisfactory results are obtainable with the use of mixtures which are in line with current plastering techniques. These commonly employ gypsum plaster (in the ratio of one part to three parts) together with the lime plaster.

The gypsum, which has no power to bind the colors to the wall when used alone, did not seem to affect the waterfastness of the painting unless the proportion of lime became too small. Varying proportions of lime and gypsum made little change in the clarity and brilliance of the colors.

Color clarity was, however, affected by the choice of aggregate. Those aggregates having little or no color such as "Ottawa sand" or "perlite" produced a more sparkling result than that obtained by the use of greyish limestone dust or brown colored sand.

Through the development of a design and the execution of a fresco for a specific wall it is demonstrated that the techniques of painting in wet plaster are not greatly different from those regularly a part of the equipment of every artist. Such limitations as are imposed by the necessity to work only in the fresh plaster actually produce a freshness which is rarely obtained in other media.

The freshness of execution demanded by fresco and the clarity of color produced by this medium, together with the complete lack of surface glare, makes fresco well suited for use in modern buildings and worthy of wider employment.

Recognition that fresco is a medium of artistic expression no more difficult than any other could do much to restore this decorative process to a place in modern painting in modern buildings.

