Mural Paints: Current and Future Formulations

Mark Golden

The Getty Conservation Institute

The Getty Conservation Institute
1200 Getty Center Drive, Suite 700
Los Angeles, CA 90049-1684
Telephone (310) 440-7325
Fax (310) 440-7702
Email gciweb@getty.edu
www.getty.edu/conservation

The Getty Conservation Institute works internationally to advance conservation and to enhance and encourage the preservation and understanding of the visual arts in all of their dimensions—objects, collections, architecture, and sites. The Institute serves the conservation community through scientific research; education and training; field projects; and the dissemination of the results of both its work and the work of others in the field. In all its endeavors, the Institute is committed to addressing unanswered questions and to promoting the highest possible standards of conservation practice.

The Institute is a program of the J. Paul Getty Trust, an international cultural and philanthropic institution devoted to the visual arts and the humanities that includes an art museum as well as programs for education, scholarship, and conservation.

Preface

The following essay was originally presented at “Mural Painting and Conservation in the Americas,” a two-day symposium sponsored by the Getty Research Institute and the Getty Conservation Institute, May 16–17, 2003, at the Getty Center in Los Angeles.

At this event, a cross-disciplinary roster of art historians, conservators, and artists discussed the social, artistic, and political dimensions of murals, the value they hold for different constituencies, and the rationale and conservation techniques for ensuring their long-term survival.

The views expressed in this essay are those of the author and do not represent the views of the J. Paul Getty Trust.

In preparing my introductory remarks, I was reminded of the writings of Jose Gutierrez, who was among the first to truly explain and advance the new technologies emerging in the 1930s. Gutierrez, in his treatise *From Fresco to Plastics*, recognized that new automobiles were being painted with the new Duco pyroxylene (nitrocellulose) paints. He reasoned that if oil paints were more permanent than the new synthetic paints, then why weren't the manufacturers, who were looking for the most durable coatings, painting the cars with artist oils? He and many others embraced the early paints and the promise of the new science and technology. Hopefully, we can begin to provide some rigor to help validate some of his assumptions relating to the possibilities of at least one modern synthetic coating.

In the evaluation process of most products, we would consider over fifty years of satisfactory service as quite adequate to be able to define a product as a true quality performer—we might even say *venerable*.

For acrylic artist paints, we realize that fifty years is a mere drop in the paint bucket. Compared to materials used by artists over the millennia, including stone, glass, and bronze, acrylics have only performed 1 or 2 percent of their required service life. We can even add the relatively modern materials of egg tempera and linseed oil, and we still have materials that have performed at only 3 to 5 percent of their service life so far.

As acrylic artist paint manufacturers, we are constantly asked to compare the durability of our materials to time-tested alternatives, and we often find ourselves falling short of this mission and having to rely on artificially accelerated aging results and on the suggested mechanics of photochemical, photolytic, or heat- and moisture-induced changes. As we begin to create a rigorous assessment protocol for outdoor murals, I believe we have a unique opportunity to create a real testing paradigm that will allow us to use real aging to understand the unique virtues of these acrylic dispersion and solution resins.

Industry for years had been extolling the virtues of these new synthetic coatings and films made from the acrylic family of polymers. It was suggested that these materials were extremely resistant to light-induced changes and that their incredible flexibility was an important feature in creating a coating that could follow the movements of substrates, such as wood or natural fibers, that would eventually crack more rigid films.

Starting in the mid-1950s, Robert Feller presented data—from a field other than the chemical industry—which gave at least a partial nod to the durability of acrylic polymers. Feller was looking at these films for potential varnish systems—including polymers of isoamyl methacrylate, butyl methacrylate (BMA) and methyl methacrylate (MMA), and ethyl acrylate (EA)—although he was still skeptical as to the durability of these polymers, noting that the acrylics differed dramatically in their solubility after accelerated aging. He did recognize that these "polymethacrylates have been shown to be highly resistant to deterioration at normal temperatures and may provide a very viable system for a permanent (yet questionably removable) coating" (Robert L. Feller, Nathan Stolow, and Elizabeth H. Jones, *On Picture Varnishes and Their Solvents* [Washington, D.C.: National Gallery of Art, 1985], p. 133).

The work by Paul Whitmore—continuing the work Feller had begun many years earlier at the Carnegie Mellon Research Institute—looked at the durability of Liquitex polymer medium under artificial aging. He concluded that the acrylic failed under his testing involving ultraviolet B (UVB) artificial aging. But he suggested, almost as an aside, that when the same films were tested under ultraviolet A (UVA), the portion of the spectrum from 320 through 400 nanometers, he found that the acrylic polymers' tensile strength was still considerable, even when the materials were subjected to a dose of UVA equivalent to the exposure of five thousand years in a museum. He described their photochemical stability as "remarkable" (Paul M. Whitmore and Val G. Colaluca, "The Natural and Accelerated Aging of an Acrylic Artists' Medium," *Studies in Conservation* 40 (1995): 51–64).

Although industry recognized the significant attribute of these softer acrylics to elongate and bridge gaps and cracks in substrates, work by Marion Mecklenburg showed that cold causes the stiffening of acrylic dispersion colors beginning at temperatures even as high as 52°F. This figure varied with the nature of the pigment used. Mecklenburg demonstrated, however, that under normal temperatures, the aged acrylic free films he cast showed extraordinary flexibility. While this work is important to the understanding of issues in moving artwork, many people in the art community took his work to mean that acrylics might crack spontaneously when subjected to cold. We hope to dispel this rumor.

Besides their suggested durability as an art material, acrylics provide exceptional ease of use and the versatility to lend themselves to a wide range of painting styles, techniques, and substrates. They have created whole new areas of expression. Because many of these acrylic solution- and dispersion-type acrylics were developed for exterior use, they have naturally become the material of choice for many mural artists. Acrylics form a semipermeable membrane that allows water vapor to pass through; thus, they avoid the tendency of other, less-permeable films to pop off when vapor pressure overcomes the adhesive forces. They have become the coating of choice on cementitious substrates, as well as on various wood and fiberboard products. If prepared adequately, acrylic will also perform on acrylic plastic sheets and polycarbonate. Acrylics have also been used successfully on aluminum and galvanized metal.

The various categories of acrylic have been thoroughly covered in significant depth by many authors, including Tom Learner and Jo Crook, so excuse me when I refer to these materials simply as acrylics. When it is important to our discussion, I will note when I am referring to solution acrylics as opposed to the dispersion acrylics, which are commonly called acrylic latex or acrylic emulsions.

Outdoor murals executed on site are usually painted on cementitious materials. According to Rohm and Haas, the world's premier acrylic producer, dispersion acrylics such as Rhoplex AC-33 (an MMA/EA polymer) have been offered for over four decades for adhesion to cementitious materials, including brick, cement shingles, mortar, and cinder block, as well as exterior wood.

Acrylics perform on these cementitious surfaces because of their exterior durability, their good adhesion to these alkaline substrates (especially when they are fresh), and their permeability to water vapor. Clearly, use of oils or alkyds on these alkaline surfaces is not appropriate because of the possible saponification of these coatings, especially when the surfaces are new. Even vinyl emulsions would be suspect, due to the combination of alkalinity and water, which is capable of hydrolyzing these systems.

The dispersion acrylics have been shown to outperform other systems in outdoor testing conditions on wood as well. Research conducted by the U.S. Department of Agriculture Forestry Service over the last twenty years has shown the superiority of the acrylic dispersion coatings over alkyd and oil coatings. Their studies, published in the *Forest Products Journal,* have shown that two coats of an acrylic latex over an alkyd primer on a wood treated with a water preservative outlasted all other systems. Some of these acrylic systems performed for over ten years without failure.

Our research and work within the conservation community have allowed us to explore and share in detail the most significant issues for acrylic paintings. Some of these issues are mitigated by use of rigid mural supports, yet others are much more severe in the outdoor environment. The most significant problem with acrylic dispersion polymers in use outdoors is also a concern for conservators of traditional paintings. This problem is the potential deterioration of the acrylic when it is subjected to intense UV radiation. We understand the mechanics of degradation of the acrylate polymer to be one of chain scission, or a breaking of the long polymers into shorter chains. We also understand the potential for cross-linking in the methacrylates or stiffening over time of the acrylics. Both of these reactions can happen simultaneously in the emulsion acrylic in outdoor settings.

The acrylics' ability to elongate and move with their substrate to resist cracking also yields a soft surface at temperatures above 60°F. Because of their tackiness at room temperature, they attract dirt and airborne pollution quite easily. As film forming continues to occur for the acrylic for months, even when it is applied in thin layers, it is possible for layers of dust to actually be embedded in the film. In mural applications subject to changing weather conditions, it is necessary for the coating system to set sufficiently very early on, to allow it to perform until it is completely cured.

The acrylics' permeability, while allowing for water vapor to pass through, also creates a significant potential issue for the dried film. Water-miscible pollutants can also pass through the film and could potentially be trapped within the painting surface. Porosity of paint in an artwork has implications for conservation.

Although acrylics are a complex system of binder, pigment, and additives, including surfactants, cosolvents, ammonia and ammonium salts, thickeners, and defoamers, the most critical defining properties of the paint to a mural's success are the binder, pigment load and type, and the drying conditions, as well as the incredibly diverse and changing environment of the mural. The water-miscible components, although of great importance to the stability of the acrylic painting (especially works housed indoors), become significant only for an understanding of the changes that occur as these materials are leached out of the painting and potentially washed away. A consortium of institutions, including the Getty, the National Gallery in Washington, D.C., and the Tate, are currently conducting work in this area. Work within the coatings industry suggests that it is best when these fugitive and potentially harmful components are washed out early in a film's life.

I'd like to present to you some informal reviews from conversations with artists whom we've had the privilege to work with on some significant mural projects, as well as present data from some of our accelerated aging work. I'd also like to discuss how this process of collaboration continues to create new possibilities.

Our first significant mural project, in 1983, was for the artist Archie Rand (Figures 1–3). He was commissioned to paint a series of seven murals on the theme of Creation on the walls of the Michlalah–Jerusalem College for Women in Israel. The challenging factor relating to these murals (besides their orientation to the south, exposed to the full force of the hot sun of the Middle East) was that they were to be painted on a newly polished marble surface. Having received several samples of the marble to be used on the project, we were immediately aware of the issue of friability of this material. First we developed an acid-etching system to create a tooth on the marble, and then we created a silane coupling tying coat to assist the adhesion of

Figure 1 Archie Rand, *The Seven Days of Creation: Day One,* 1984. Acrylic with silane coupling coat on prepared marble, approx. 13 x 17 ft. Michlalah–Jerusalem College for Women, Jerusalem, Israel. Reproduced courtesy of the artist.

Figure 2 Archie Rand, *The Seven Days of Creation: Day Three,* 1984. Acrylic with silane coupling coat on prepared marble, approx. 13 x 17 ft. Michlalah–Jerusalem College for Women, Jerusalem, Israel. Reproduced courtesy of the artist.

Figure 3 Archie Rand, *The Seven Days of Creation: Day Six,* 1984. Acrylic with silane coupling coat on prepared marble, approx. 13 x 17 ft. Michlalah–Jerusalem College for Women, Jerusalem, Israel. Reproduced courtesy of the artist.

the subsequent coats of dispersion acrylic. Although one would not expect significant sites that would allow for adhesion of a silane coupling material to marble, we were able to show clear improvements in adhesion.

We also incorporated harder acrylic dispersion polymer and a polymer that offered greater adhesion to chalky surfaces. Finally, the murals were coated with our mineral spirit–borne acrylic solution polymer based on isobutyl and n-butyl methacrylate. We suggested that this be reapplied as the murals aged.

When we look back at the Michlalah murals, we learn from Rand that the yellows have significantly blanched, while the blues and reds have remained reasonably brilliant. The artist has remarked that while the colors have dulled somewhat from the effect of the driving sand, the mural remains cohesive aesthetically. Because the surfaces have not been inspected in detail, we do not know if cracking exists in the films. No loss of material has been reported to date. We had recommended the use of Hansa yellow (PY 74) for increased lightfastness, but given the lack of rain in the region, we might have performed better in the yellows with the cadmiums, which we typically remove from consideration because of the reaction to moisture and UV radiation. We currently recommend for yellow our titanate yellow for the greatest color retention outdoors. The murals have not been revarnished to date.

A second important mural project we had the opportunity to participate on was for the mural *West and North* by Norman Yates, located at the Faculty of Education Building of the University of Alberta, Edmonton, completed in 1987 (Figure 4). Although the title is *West and North*, the mural faces north. It consists of 202 four-by-eight-foot medium density overlaid (MDO) plywood panels, constructed of Douglas fir plywood with a face of Crezon (phenolic) resin fiber hardboard surface. Yates collaborated with the Canadian Conservation Institute, as well as with the Canadian National Research Council. Yates's unique system for attachment of the mural actually withstood a tornado during construction. Yates first coated the surface with two coats of alkyd primer—first a slow- and then a fast-drying one—then applied a leafing aluminum coating on the edges to reduce the potential for water swelling or delamination of the MDO plywood.

Figure 4 Norman Edward Yates, *West and North,* 1987. Acrylic on alkyd-primed MDO plywood, 67 x 138 ft. Faculty of Education Building, University of Alberta, Edmonton, Canada. Reproduced by permission of the University of Alberta Art and Artifact Collection, Museums and Collections Services, University of Alberta.

The colors included Hansa yellow medium, naphthol red, cobalt and phthalo blues, anthraquinone blue, titanium white, Mars black, and the earth colors. The mural was clearcoated with an acrylic based on MMA and BMA. Finally, a top coat of Golden Mineral Spirit Acrylic (MSA) Varnish with a then-new system of UV absorbers and stabilizers was added.

The most important development to come from this project was our first use of tinuvins to improve the degree of protection of the varnish. I had the opportunity to hear René de la Rie talk about his work to potentially improve the durability of damar varnishes. We hoped that by incorporating the tinuvins, they would also help protect the work itself, by (1) protecting the integrity of the varnish, and (2) reducing the level of UV absorbed into the paint layer. It was recommended by Ciba Geigy, the manufacturer of the tinuvins, that the UV absorber and the hindered amine light stabilizer, when used together, had a synergistic effect.

On recent inspection, the work shows no observable blistering or checking. Yates reports that the mural looks very bright and beautiful, with no fading or loss of energy. To date, this sixteen-year-old mural, which is inspected every two years, has not required any work on the surface.

We have subsequently pursued some accelerated aging, looking at both our polymer medium and our titanium dioxide white. The data from our QUV accelerated-weathering testing booth (Q-Panel Co.) when UVA sources were used certainly confirmed some significant value from the use of the tinuvins. Notice the over-45% reduction in color change in both the titanium dioxide and the polymer medium formula. We have also conducted numerous tests showing the ability of our solution acrylic varnish—our MSA Varnish with UVLS (ultraviolet light stabilizers)—to dramatically reduce the color fading of fugitive pencils, markers, dyes, fluorescent colors, and computer inks.

After conducting a nine-month exterior exposure in upstate New York, we found less significant protection from these tinuvin-containing coatings. The white continued to show some protective support, but the polymer medium no longer exhibited the same protection from color change.

The most promising data, interestingly enough, seemed to center around the blues. Under accelerated UVA tests, the colors consistently showed some improvement; when we then included the results of the exterior exposure conducted at our facility, we no longer saw the same improvement in the UV-protected coatings. Clearly the tinuvins are not the one silver bullet for protecting murals.

In long-term studies we did find a protective effect both from the tinuvins and, more particularly outdoors, from the solution acrylics we call our MSA colors. This finding led to a collaboration with the artist Knox Martin in 1999, in his repainting of his 1970 work *Venus* on the Bayview Correctional Facility, on the north corner of West Twentieth Street and Eleventh Avenue in New York (Figure 5). The mural was originally painted with acrylic house paint. For this project I suggested to Martin that we use our MSA colors. These colors have been used in significant indoor murals by Frank Stella and by Roy Lichtenstein. These acrylics have shown during long-term exterior exposures in south Florida to be among some of the most durable of any acrylic polymer we have worked with. We custom-mixed each color to Martin's specifications for color and consistency. We look forward to watching this mural gain in years but remain fresh and vibrant in color.

Figure 5 Knox Martin, *Venus* (detail), originally painted in 1970, repainted in 1999. Mineral spirit acrylic (MSA) colors on brick, approx. 90 x 35 ft. Bayview Correctional Facility, West Twentieth Street and Eleventh Avenue, New York. Reproduced courtesy of the artist. *Photo:* Jim Walsh.

Long Term

Over the years we have worked with hundreds of artists doing murals around the world. Outdoor murals give us a unique opportunity to examine real accelerated aging of coatings. In the multiple unusual environments that the paints are subjected to, we might find additional answers to traditional issues of acrylic paint conservation—for example, watching the effects of the leaching of surfactants and other water-miscible materials from the films, or understanding dirt retention in these coatings. We are confident that a review of the performance of these murals will lead to a greater understanding of the unique contributions of pigment types and loads, as well as unique combinations of acrylic monomers to create materials that might be specific to the location and conditions the mural will be subjected to. Finally, we are grateful to the many talented artists who have allowed us to explore new and unique uses of these acrylic coatings, which will someday, I hope, achieve a status among the best of our beloved tools of art.

Mark Golden

Mark Golden is CEO and cofounder, with his father, Sam Golden, of Golden Artist Colors. The company has been working directly with artists to create art-supply products for over twenty-two years. The original staff consisted of four people in a cow barn on the elder Golden's property in rural upstate New York. Today Golden Artist Colors has over one hundred employees who make products for professional artists worldwide. Golden also produces custom materials for artists, conservators, and museums—including seven lines of acrylics and hundreds of unique mediums and products for the industry.