A REPORT ON THE CONSERVATION
OF A PAINTING FROM THE SETTECENTO

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May 1975

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Submitted to the Faculty of Rosary College, River Forest, Illinois, in Partial Fulfillment of the Master of Fine Arts Degree.
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HISTORICAL NOTES

Benedetto Manettus from Antella (a town on the outskirts of Florence) with SS Bonifiluis, Alexis, Amadeus, Hugh, Sostenes and Buonagiunta were the seven noble young Florentines who together joined the Confraternity of the Blessed Virgin. Its seat was located at the then cathedral of Santa Reparata.

It was on August 15, 1233, during the celebration of the feast of the Assumption of the Virgin, that Mary appeared to the seven founders, inviting them to withdraw from the world to live a devoted and holy life. They eventually settled in 1234 on the slopes of Montesenario, approximately nine miles from Florence.

After a visit from Bishop Ardingo of Florence, who advised them to adopt a rule of life, they received another vision of Mary in which she told them to follow the rule of St. Augustine. In one hand she carried a black habit, "Wear this habit in memory of my seven sorrows," she said, "and continue to be faithful." In the other hand she carried a scroll on which was written, "Servants of Mary." This event took place on April 13, 1240, and from that day the group has been known as the Servites or Servants of Mary.
The church, the sacristy and the cloister are filled with numerous paintings done between the Trecento and the Novecento. Antonio Morgen, Bezzuoli and Tommaso Redi were among the artists working for Montesenario during the Novecento. To try to give a name to the artist of this particular portrait is virtually impossible.
OBSERVATIONS BEFORE CONSERVATION

The painting, (fig. 1), a portrait of St. Manettus, one of the seven founders of the Order of Montesenario, was executed in oil on canvas. The work measures 89 cm x 119.5 cm. The photomicrographs affirm the fact that the support is linen. Microscopically, linen fiber may be distinguished from cotton, with which it is most likely to be confused, by the fact that it shows joint-like cross markings and does not twist, whereas the cotton fiber shows no cross markings and does have twists (fig. 12).

The inscription reads, "B. Manettus Antellensis Ex VII Istitut Ord. Serv. 1233." 1233 is the year in which the order was founded.

The principal reason for which the surface of the painting had been reduced to such a rough and wrinkled state was the very humid atmosphere in which the painting had been kept. The colors, nearly opaque due to the almost total absorption of the varnish, had suffered a remarkable tonal drop. This was due to the oxidation of the varnish and the considerable amount of dirt on the surface (fig. 2).
The entire lower right corner was completely missing. The tear measured approximately 20x18x10 cm. Just above this, where paint was missing, traces of the ground were visible (fig. 3). These were collected for further observation along with pigment samples for the cross-sections. Along the same border there was a series of tears and holes which led one to believe that the canvas had worn away in that area (fig. 3).

Two patches appeared on the surface; both were of adhesive tape. One, elongated in form, was in the center of the crucifix (fig. 4); the other, rhomboidal in form, was to the left of the table (fig. 3). Another tear, to the left of the areas of the hands, was in the shape of an upside-down "V" (fig. 5) which presented a circular bulging area around it, certainly provoked by adhesive tape secured to the back of the tear. This patch was probably secured with an aqueous solution and after it dried it contracted, causing the bulge on the surface.

The painting showed other signs of a previous attempt at conservation. Besides the patches on the surface, which had been painted over to conceal them, there were five patches on the back of the canvas (fig. 6). Three corresponded to the two patches and the "V"-shaped tear on the front, the other two (one in the lower left corner
and the other in the upper right corner) corresponded to areas where the canvas had noticeably thinned or weakened. All the patches in question were made of canvas, with the exception of the patch shaped like a "V". All were attached with a water-soluble adhesive and were therefore easily removable.

Previous attempts had been made to clean the painting. There were areas that appeared to have been over-cleaned and scoured with the use of strong solvents, a too vigorous cleaning or a combination of both. The area around the hands and the lower part of the cloak showed noticeable signs of having been "svelato", (the removal of the final paint layer, "la velatura", that is over the preparatory color). A closer examination of the face and especially the forehead revealed inpainting done to conceal these more damaged areas (fig. 7).

The painting was not on its original stretcher. (Note Christ's left arm which extends over on the tacking edge, fig. 1.) The original stretcher was slightly larger and had a traversal across the center, the impression of which was still visible on the painting.

A series of tacking holes appeared along the very edge of the paint surface, again affirming the fact that the painting was not on its original stretcher and that
the canvas had not been secured on the tacking edge in
the traditional manner.

The paint layer and the canvas were in a state of
advanced embrittlement, although they seemed to be in
a sound condition. It was therefore safe, provided no
stress was put on the brittle canvas or paint layer, to
turn and to handle the painting.

Various cross-sections (infinitesimal parts of the
painting structure removed for microscopic analysis)
were prepared in the following manner: To 100g. of
Ceemer embedding resin was added 8cc. of hardener and
10 drops of accelerator. The mixture was then placed
in plastic cubes with a painting sample, in a position
of maximum equilibrium. After the resin had hardened,
the samples were cut and polished in such a way as to
permit an accurate reading, under the microscope, of the
various layers.

Study cross-section #1, (fig. 8), taken from the
dark grey color of the background, and note a brown
colored preparation which contains a considerable amount
of glue and only a few crystals of gesso. A darker shade
of brown also present in this layer is probably due to
an oil film. The orange-brown crystals are most likely
particles of color not ground sufficiently.
Often during the Settecento, and probably in this case, a small quantity of raw umber was introduced into the ground. This deviation from white was done purely as a matter of taste on the part of the artist to suit his particular technique. In that period the most serious defects in earlier grounds had become apparent and painters endeavored to find new techniques to obtain a satisfactory ground. Often this experimentation was the cause of ulterior damage to the painting. In fact, just an incorrect proportion in the composition of the ground could provoke the weakening of the above layers.

In this painting it is evident that the ground is of poor quality, having more glue and oil than gesso. This is one of the principal factors that contributed to the deterioration of the painting. Too much oil in a ground will not only render the pigment layer rigid but also, due to its acidity, weaken the fibers of the canvas.

In cross-section #1, (fig. 8), a dense layer of embedded grime and dirt above the dark grey color of the paint film may be noticed.

In cross-section #2, (fig. 9), taken from the red color of the coat-of-arms, the same observation may be made. In addition, however, there is a larger layer of
colletta and dirt. The colletta is from the first impregnation. This film is above and below the paint layer due to the fact that during the impregnation certain zones of dirt softened and mixed with the colletta.

Cross-section #3, (fig. 10), taken from the green color of the coat-of-arms, indicates a light green preparatory color in the paint layer above the thin ground. A segment of one of the many small perforations in the paint layer may also be seen.

In cross-section #4, (fig. 11), taken from the grey color of the cloak, there appears a dense layer of dirt above the paint film. In the ground layer there are evidences again of patches of oxidized oil.

In all the cross-sections the varnish layer is practically missing. This is due to the almost complete absorption of the varnish by the lower layers. In fact, the brown shadow present in almost every cross-section could have been provoked not only by the presence of the oxidized oil in the ground layer but also by the presence of oxidized oil in the varnish.

In order to determine what type of ground was used (linseed oil + lead white "bianca" $2\text{PbCO}_3 \cdot \text{Pb(OH)}_2$ or linseed oil + glue + gesso $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) various
microanalyses were carried out on ground samples. The test for the presence of lead was negative, while the tests for the presence of calcium and the sulfate ion were positive, and therefore it was ascertained that the ground used was composed of linseed oil + glue + gesso.

Before-treatment photographs were taken with a Sinar 4x5 format camera. The Sinar camera has a double extension bellows which permits the focusing of objects close to the lens. A ground-glass back helps in fine focusing and arranging the composition. Parallel lines on this ground glass permit the camera to correct any faulty perspective.

The first lens chosen to photograph the painting had a focal length of 130 mm, that is, the normal lens of the camera. Afterwards, a lens with a focal length of 355 mm was used in order to move the camera further away from the painting, elongate the focal length, and therefore minimize reflection. Kodak Extapan, a panchromatic film (asa 125), was adopted as a film suitable for indoor photography with artificial lighting. To achieve a uniform flat lighting two photoflood lamps were placed at a 45 degree angle from the picture to eliminate the possibility of irregular surface reflections.

* See Appendix
into the lens of the camera. In addition to an overall photograph of the painting, details were taken of the patches and missing areas. Raking light 4 was used for a total analysis, with details of the hands, to emphasize all the irregularities of the surface (fig. 13).

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4 The light beam is nearly parallel to the paint surface indicating all the dents, bulges and tears.
REPAIRING SURFACE DEFECTS BEFORE LINING

In order to eliminate the deformities in the paint layer as much as possible and to restore to the ground its adhesive strength before lining, a first consolidation was carried out using a glue mixture. This compound consisting of rabbit glue, honey, ox bile and phenic acid, a disinfectant, was diluted in water to obtain a liquid able to penetrate the various layers of the painting.

This warm consolidating compound was applied with a brush to the surface of the painting and ironed on top of a film of Melinex\(^5\) with a hot spatula at approximately 65 C. Underneath the painting another layer of Melinex was used to contain the moisture of the glue compound so as to give maximum results.

Imregnation of a painting with the glue mixture is an important process in consolidating and smoothing the paint surface. It allows the painting to regain lost elasticity which is indispensable during the lining process. Deep penetration of the adhesive reestablishes

\(^{5}\)Melinex is a polyethylene terylene material highly resistant to solvents, light and heat. It is used for its protective and insulating strength.
contact between the paint layer and the canvas. Heat is used to allow a greater penetration.

As the irregularities in the surface began to diminish, the impregnation was continued until a fairly smooth and elastic surface was obtained. At this point, the painting was ironed to remove any excess of the glue mixture, and the Helinex underneath was replaced by a sheet of absorbent paper which, with the help of a hot spatula, absorbed the excess glue through the canvas. The ironing was discontinued when the area was almost completely dry. The impregnation was repeated in those zones which showed particular resistance.

After this first impregnation, the painting was removed from its original stretcher and inlays were prepared for the missing areas on the lower border (fig. 14, 15). A sized canvas of similar weave and weight was chosen and aligned with the edge of each tear so that when cut with a scalpel, the original canvas edge would be flush with that of the inlay (fig. 16, 17). The weave and weft of each inlay were placed in the same direction as that of the original canvas and each was held down with weights. The inlays were then cut out and temporarily secured with masking tape on the back and front.
After all the inlays were in place, a protective operation called "facing" was carried out. On the surface of the painting a layer of Japanese paper was applied with a wax-resin compound and a brush (fig. 18). The wax-resin quickly penetrates the Japanese paper and secures it to the surface. Facing is essential because it protects the painting from the destructive results of various surface tensions that may result during the lining. In the areas where the canvas was torn, additional pieces of Japanese paper were applied to lend extra strength to the paper in those zones (fig. 19).

The wax-resin used for facing is liquid and is the same as that used for the impregnation and lining of a painting. It is made by melting fourteen parts of beeswax together with one part of elemi resin and four parts of dammar resin. The only difference in the preparation of wax-resin for the facing is the use of dammar varnish instead of dammar resin, to render the mixture liquid at room temperature and easily spreadable. The wax-resin used for impregnation and lining is solid at room temperature and has a very good holding power up to 40 C. The mixture is kept from becoming brittle by the plasticizing effects of the elemi.
After the wax-resin had dried, the painting was turned over and secured with staples on a wooden plane. The back was then scraped with a scalpel to remove any dirt or obstructive knots in the canvas which could have damaging effects during the lining. A very fine sandpaper was used where necessary. After the back had been scraped, the canvas became much more flexible and easier to handle. At this point, the painting was turned face up and a second impregnation, this time with wax-resin, was carried out. This was done, first of all, to correct any further irregularities that might still exist, for example in the area of the hands where the paint surface was quite wrinkled and along the center of the painting which showed the impression of a transverse bar; secondly, to weatherproof the surface allowing the paste to penetrate at a more controllable rate. The wax-resin was applied directly through the Japanese paper with a circular motion to encourage its penetration (fig. 20).

After the consolidation with wax-resin, the painting was turned over and again secured to the wooden plane. In order to have a completely intact surface with no missing canvas, picture putty was used to fill
in the holes too small to accommodate an inlay (fig. 21). Picture putty is used as a filler and is made up of three parts of gesso, an inert substance which gives bulk; four parts of colophony, a soft resin residue from the distillation of turpentine, which resists humidity; and one-half part of wax for stability and impermeability. A small quantity of pigment is added to obtain a color close to the preparatory color of the missing area. A picture putty colored raw umber/Cassel earth was used. It was also applied in the holes left by the tacks of the previous stretcher. Various shaped spatulas, with the aid of heat, were used to model the putty (fig. 22).

At this point, the masking tape on the back of the inlays was removed because the strength of the wax-resin was sufficient to hold the canvas in place. The painting was now ready to be lined.
THE LINING

A stretcher on which the painting would be lined was chosen with inside measurements of 120cm x 138cm. A hemp canvas which was slightly heavier and more tightly woven than the original canvas was chosen to help correct any deformities in the original canvas. The canvas was pulled tightly over the stretcher and secured with staples. It was then soaked with water and left to dry. It is usually necessary to repeat this procedure until the canvas is completely tired, that is, when it no longer manifests a tendency to expand and contract and can be considered insusceptible to further influences of water. After each wetting and drying, the canvas had relaxed quite a bit. After the final stretching, which was very taut and the weft and weave were as perpendicular as possible, the canvas was sized with a warm diluted glue compound. This is the same compound as was used in the first impregnation. It is applied with a brush, making sure it penetrates well and beyond the staples. This treatment prevents the lining adhesive from being too absorbed by the new canvas, slightly waterproofing it.
In the case of this painting three different adhesives could have been used: wax-resin, animal glue/vegetable paste, or vegetable paste alone.

Usually a wax-resin adhesive is chosen for lining when a painting indicates a great sensitivity to moisture. The wax, as it melts from an iron of about 65 C., is applied to the new canvas and then to the back of the painting. The two surfaces are then pressed together and ironed, with a sheet of Melinex on top and underneath, and as the wax cools the two surfaces become well secured together. This method of lining is more rapid than with the aqueous adhesives but in some cases it is not advisable because of a tonal drop often encountered, especially in paintings with a light-colored ground.

The animal glue/vegetable paste adhesive (for one square meter) is made up of approximately 75g. of wheat flour and 75g. of rye flour, both of which give bulk to the mixture; 600g. of water; 50g. of animal glue (for example rabbit glue) which gives strength and adhesiveness; 25g. of linseed (suspended in a gauze sack in water until a gelatinous liquid is obtained); syrup (honey or molasses) which absorbs humidity, rendering hydroscopic the animal glue and also maintaining the elasticity of the glue; 25g. of Venice Turpentine which gives back
to the canvas and the colors the oil substances which they have lost with time; a few drops of ox bile which allows the animal glue to adhere well and is also an emulsifier of fat; and finally a few drops of disinfectant (alum or phenic acid) which are added to discourage the growth of micro-organisms which attack the animal glue.

The vegetable paste (usually flour paste) which comes commercially prepared with a disinfectant already added to it (in this case formalin), was chosen for the lining because it was not necessary to use the other more complex compounds. Since the painting had been consolidated twice, first with the glue compound and then with the wax-resin, it had acquired the necessary elasticity and impermeability during the lining process, and therefore a simple vegetable paste adhesive would be sufficient at this stage of restoration.

A table was prepared with several layers of newspaper, and an iron was set at 60°C. The paste was spread on the back of the new canvas with a spatula, then smoothed with a comb-like metal plate, so that it could be evenly distributed between the fibers of the canvas. After a few minutes, when the canvas began to pull, the paste was applied to the back of the original canvas in the
same manner. The two surfaces were then placed together and firmly secured by rubbing with a soft cloth from the center toward the outer edges. The sides of the painting were lifted to allow air to escape. After the two surfaces were well pressed together, the ironing began again from the center outward. A few layers of newspaper were placed between the iron and the protective facing.

After about forty minutes, the painting was leaned up to dry for fifteen minutes and the wet newspapers underneath were changed. The ironing was continued for another two and one-half hours, with intervals to change the newspapers and allow the painting to dry. When the painting was sufficiently dried, the ironing was stopped and the painting was leaned up. As the new canvas dried it gently pulled the original canvas with it, smoothing all the irregularities in the paint surface.

The following day the facing was removed with the help of petroleum spirits. At this point the painting was ready to be cleaned.
CLEANING

The dirt was principally made up of the old varnish which had oxidized (it was probably a fatty varnish) and superficial dust. Often in the past fatty varnishes (resins, volatile essences and oil), even though they were flexible, had proven to be permeable and not very resistant to aqueous vapors. Often, therefore, a small quantity of oleo-resin (or balsams – semi-liquid secretions from trees containing a mixture of resinous substances and essential oils) was added to the varnish.

Beginning in the Settecento, it became very popular to add to the varnish and to the pigments small quantities of Copaiba Balsam, Peru Balsam, Canada Balsam, Venice Turpentine or Strasbourg Turpentine (olio d'abezzo). These balsams give considerable protection but when they auto-oxidize they can cause the colors to become opaque.

It is very possible that a balsam was added to the varnish of this painting contributing to the darkening of its colors.

Oil present in varnish undergoes a characteristic
chemical change which causes its drying and its yellow-
ing. Delineating the drying process of linseed oil (used in most varnishes) will better explain this mechanism.

Linseed oil and in general all oils contain at least 50% of polyunsaturated (several double bonds) fatty acids. Linseed oil contains linolenic acid, linoleic acid, oleic acid and stearic acid. The drying process takes place at the double bonds in two steps: oxidation and polymerization.

The mechanism of oxidation takes place in two periods.
1. Induction Period. In this period there is little change in the nature of the oil. It is believed that the reason for this is the presence of anti-oxidizing impurities or because there is a need for an accumulation of material before the second part of the oxidation can take place. 2. Autoxidation Period. During this period a rapid change takes place in the chemical-physical properties. There is an increase in the viscosity, the density, the index of refraction and absorption of ultraviolet and infrared radiation. The increase in these chemical-physical properties is characteristic in the formation peroxide, oxyhydrogen, carboxyl and polymer bonds. Linseed oil absorbs air first slowly
(2-3 days) then rapidly (20, 30 days).

\[
\text{[CH}_3\text{-(CH}_2\text{)}_4\text{-CH=CH-CH}_2\text{-CH=CH-(CH}_2\text{)}_7\text{-COO]}_3 \text{ C}_3\text{H}_5 \rightarrow \text{O}_2
\]

Trilinoleina

\[
\{\text{...CH - C - CH...CH - CH...}\} \text{ C}_3\text{H}_5
\]

peroxide compound

This seems to be the most important substance in a film of linseed oil that gives strength and transparency to the film.

The reaction of oxidation continues until more complex compounds are formed, for example, by way of crossed bonds between molecules until a typical structure of cross-linked polymers is formed. (The product of this reaction is a plastic, linoleum - linseed oil oxidized to the maximum degree.)
Linseed oil, and in general all oils, have a tendency to become yellow with time or when kept in the dark. Humidity and the catalyzing effects of various metallic ions in some pigments bring about the same result. The yellowing seems to be caused by impurities and most of all by the degree of insaturation (number of double bonds); it is not caused by acidity. In fact, polymerization obtained in the laboratory (inert atmosphere, N₂, CO₂) brings about a slight yellowing.

The cleaning was begun on the lining stretcher (fig. 23) and the first solvent chosen was dimethyl formamide diluted in xilene (1:3). Dimethyl formamide \( \text{H-C-N}^\text{CH₃} \) is a slightly alkaline organic compound. Derived from ammonia and its corresponding acid, it is the only liquid of the amides and because of its alkalinity it is capable of dissolving an oil film. Petroleum spirits was used to neutralize the dimethyl formamide. In certain areas, for example the forehead (fig. 24), where previous inpainting was difficult to remove, dimethyl formamide and xilene (1:2) was used. At times it was necessary to use pure dimethyl formamide with the help of a scalpel.

Before the cleaning was terminated, the painting was removed from the lining stretcher and secured to
its permanent stretcher. This stretcher had been varnished in advance with bitumen (fig. 25). A protective adhesive tape was secured over the tacking edge, and after this the cleaning was brought to an end (fig. 26, 27, 28).

The painting was then varnished using dammar and mastic varnish (1:1). With the painting in a horizontal position, the varnish was applied with a brush. A circular motion was used to allow the varnish to penetrate and nurture the painting. After the varnish had dried, the inlays and missing areas were re-examined. Picture putty was used to obtain an omogeneous surface (fig. 29). A scalpel and spatula, where necessary, were used with heat to model the putty. The space between the inlays and the surface of the painting were filled in with picture putty and on the surface of the inlays picture putty was applied to create a surface texture similar to that of the painting.

Inpainting was carried out with varnish colors for restoration from the company Maimeri. Dammar varnish and xilene were used as medium and diluent, respectively. In certain areas, especially around the inlays, it was necessary to use powdered fiberglass and ground colors to obtain more height and a granular surface that would coincide with that of the painting.
The areas that required a considerable amount of inpainting were the inlays and the face, where a total reconstruction of the left eyebrow was necessary (fig. 30). In addition, there were very small areas where the original color had fallen and where the dirt had caused a too-pronounced craqueleur. The areas which corresponded to the patch in the center of the crucifix also required a considerable amount of inpainting.

After the inpainting was completed, a final varnish was applied. The same dammar/mastic mixture used for the first varnishing was again employed, but this time it was applied with a sprayer.

When the painting had dried, after-treatment photographs were taken with a Nikormat (50 mm) camera (fig. 31, 32).

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6A pattern of fracture lines due to desiccation that usually penetrate the varnish layer, the paint film layer and the ground.
Fig. 2. The picture surface before conservation - photographed with raking light
Fig. 3. Missing areas on the lower border and patch on the paint surface.
Fig. 4. Patch in the center of the crucifix
Fig. 5 Tear on the paint surface surrounded by a bulge
Fig. 6. Reverse of the painting before treatment
Fig. 7. Detail of face before treatment showing inpainting on forehead and dust on beard.
Fig. 8. Cross-section #1

Fig. 9. Cross-section #2

Fig. 10. Cross-section #3
Fig. 11 Cross-section #4.

Fig. 12. Micro-photograph of linen fiber. Note the characteristic joint-like crossings. The slide was prepared in the following manner: the fiber was washed in NaOH, rinsed, then colored with methyl blue, then placed on the slide for observation.
Fig. 13 Detail of the surface in the area of the hands (raking light)
Fig. 14. Missing angle on the lower border

Fig. 15. Detail of holes on the lower border
Fig. 16. Inlay for the lower border

Fig. 17. Inlays for holes on lower border
Fig. 18. Application of facing with wax-resin

Fig. 19. Japanese paper applied with wax-resin
Fig. 20. Impregnation with wax-resin
Fig. 21. Filling in perforations with picture putty

Fig. 22. Smoothing picture putty with a spatula
Fig. 23. Detail of face partially cleaned
Fig. 24. Test cleaning after lining
Fig. 26. Test cleaning after lining
Fig. 24. Central portion of the face not cleaned
Fig. 28. Cleaning with a scalpel

Fig. 29. Applying picture putty to the inlays
Fig. 30. Detail of the face after treatment with the reconstruction of the left eyebrow
Fig. 31. Detail of the surface in the area of the hands after treatment (raking light)
Fig. 32. The painting after treatment
APPENDIX

MICROCHEMICAL ANALYSES

Tests executed on ground samples

Test for the presence of lead, Pb$^{++}$

- sample treated with HCl, dil. ---- no reaction
- sample treated with HNO$_3$ + HCl ---- no reaction
- sample treated with NaOH ---- no reaction

Result: Negative

Test for the presence of calcium, Ca$^{++}$

- sample in solution with HCl, dil.
- observation ---- presence of fine white needles piled in a cone

Result: Positive

Test for the presence of the sulfate ion, SO$_4^{-2}$

- sample in solution with HCl + BaCl$_2$, dil.
- observation ---- presence of a white precipitate that results insoluble in H$^+$, OH$^-$, and H$_2$O

Result: Positive

Conclusion:

CaSO$_4$ · 2H$_2$O, gesso, present in the ground
BIBLIOGRAPHY


