Art Authentication Using Non-destructive Techniques

An Honors Thesis (ID 499)

by

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Terms used that may not be familiar are printed in boldface and explained in the glossary following the text.

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INTRODUCTION

From its 14th-century beginnings in Italy to its end in the 1600s, the Renaissance was marked by the revival of the classical spirit and expressed by the burgeoning of art, literature, and science. During this time, the other-worldly, spiritual focus of the Middle Ages gave way to a passion for the present life. Men appreciated beauty and delighted in their own genius, and art began to reflect this earthy new attitude. Its focus shifted away from the pious call to holiness that typified Medieval works and approached a more humanistic, accessible style. In Medieval times, realistic depictions were not essential to convey ideas about the afterlife, but the Renaissance, in its concern for the present world, demanded a more realistic style. Art began to move away from the two-dimensional look of Medieval works and to strive for the impression of three dimensionality. Even in religious paintings, which had the purpose of directing one's thoughts toward the next life, great care was taken to achieve the human and believable look of this earth, true to Renaissance ideals. Realistic rendering techniques such as linear and atmospheric perspective, sfumato, and chiaroscuro were perfected, and the use of color became important, resulting in the development of higher quality materials, allowing deeper, richer hues.

Such progress attested to the fact that interest in art was flourishing during this time, the age of artist Giovanni Bellini (c.1430-1516), and no longer were the Church and the governing bodies the only sources of commissions. Art was becoming accessible
to the common man, and people began to purchase small works for
their own homes. Bellini, who had done some very large altarpieces,
also did many smaller sized paintings of the Madonna and Child for
private use. He did several variations of this subject, and so many
more were wanted that works were also produced by apprentices who
worked from sketches done by Bellini.

This method of using apprentices to help lighten the work load
and keep up with demand worked well for the master and was quite
typical of the quatrocento. In "mass producing" works under his
direction, Bellini "succeeded in so popularizing [his] manner in
Venice and its subject cities that it became the dominant style." ¹

Considering the important position in art history that is
assigned to Bellini, very little is known about him and his work.
In the 1400s, Giovanni Bellini was an active artist, working along
with his father, Jacopo, and his brother, Gentile, in Venice where
they operated a studio. Both his father and brother were skillful
artists, and his cousin Leonardo Bellini was a painter of
miniatures, but it was Giovanni who most firmly secured the fame of
the family name.

He began his career under the direction of his father, then
shared a studio with brother Gentile. His first signed and dated
painting appeared in 1487, but he was almost certainly painting by
1455. ² His early work was heavily influenced by his father and by
his sister's husband, Andrea Mantegna, an important artist of
northern Italy. Soon, however, he went beyond mere imitation,
developing his own style.

Judging from the look of his paintings, Bellini kept abreast of
advances in his field, developing his drawings away from mere imitation of his father and brother-in-law and switching to the new oil-based paints that were developed about this time. Says art historian Frederick Hartt, "Giovanni must have been using a medium containing some oil; it is difficult to see how he could have obtained such effects in any other way. Recent [1979] investigations have disclosed that he was also using varnish in which a certain amount of color was dissolved, not only for glazing effects but also for some actual painting." The varnish was most likely some type of oil resin since dammar and solvent types of mastic varnishes have only been available in the last few hundred years. This is obviously not an exhaustive account of his working methods, and perhaps even less is known about the man himself. Even his birthdate is shrouded in mystery. He was born, perhaps illegitimately, between 1426 and 1433 (depending upon whose estimate is accepted). Robertson claims the date to be 1431, and roughly 1430 seems to be generally accepted. Bellini died on November 29, 1516, after an active artistic career that spanned at least 60 years. This rough sketch of the master's life represents nearly all the major facts known about him. It is a vague picture, yet Hartt seems to feel he understands Bellini well enough to claim that he would have liked his position of "unknown genius": "It is in keeping with Bellini's character which was in the last analysis poetic, that we possess so little exact information about him." Hartt paints a romantic image of an unfathomable Bellini charmed by his own mysteriousness, but the image is not acceptable to researchers. Learning more, however, is a difficult task. Study
of legal documents of the period yields very little of value, and Bellini's paintings themselves are often hard to trace. A good part of the difficulty is caused by the studio method of production. Often no distinction was made between autograph works and paintings by studio help. It was common for all works produced in Bellini's shop to be signed with the master's name regardless of whether he had actually had a hand in their execution. 7

The problems with this technique haunt those of us who come later. Is there any way to determine authorship of a painting now, 500 years after the fact? This is the problem tackled in this research, which makes use of a particular Bellinesque work of art.

In the Ball State Art Gallery collection, there is a Madonna and Child (in the original Italian, Madonna che Tiene il Bambino in Piedi), c. 1490, from the workshop of Giovanni Bellini. There is some question as to whether the painting was done by apprentices or by Bellini himself. Professional infrared photographs of the work reveal a cluster of berries, possibly cherries that are invisible to the naked eye, which sees only the spray of flowers that appears there today. This discovery raises some interesting questions. The cherries-to-flowers switch may suggest a compositional change that appears to have come at the hand of the master himself. Could this indicate that the picture is an original Bellini rather than a studio copy of a Bellini drawing executed by an apprentice?

Scientific methods were applied in an attempt to answer such questions. In the hopes that photos could provide new visual evidence, pictures were taken utilizing radiation from various parts of the electromagnetic spectrum.
Visible light spans wavelengths of about 400 to 700 nanometers, and it is this portion with which we are familiar. Infrared lies beyond the visible red, in the 700-9000 nm range. It is not visible to the unaided eye, but it has proven to be particularly useful as a non-destructive tool of authentication because film can be sensitized to it. Only the infrared region from 700 to 900 nm, however, can be easily recorded on film [see Diagram 1]. Infrared radiation was used to photograph the painting.

INFRARED

Theory: Electromagnetic radiation can be used in conjunction with infrared-sensitive film to produce an image not visible to the eye. The IR rays can penetrate the paint and varnish layers and reflect from charcoal underdrawings, making the paint "vanish" and revealing the hidden image beneath. IR photography is a record of luminescence. Bombarding a surface with EM radiation causes excitation and stimulates energy emission from the surface, also in the form of EM waves. This induced light emission is called luminescence, which is broken down into two types. One is fluorescence, or luminescence that lasts only a very short time (10 to the negative 8 seconds) after stimulating radiation is removed.

Phosphorescence is the second type of luminescence and describes luminescence that lasts well after the excitation source has been discontinued.

It is luminescence of the fluorescence type that was used here to make a visual record of the painting. Photos were also taken
THE SPECTRUM

DIAGRAM 1
(Eastman Kodak, p. 2)
using reflected IR.

In fluorescing IR, the light sources are encased in blue-green filters which absorb IR radiation, and the camera lens is filtered to absorb all visible light. By this method, IR wavelengths do not hit the subject, and all IR that reaches the plane of the film in the camera is then a result of fluorescence excited by wavelengths that were allowed to travel from the light source [see Diagram 2A]. Since different material compositions fluoresce at different rates, an image can be formed that is often quite unlike the one visible to the eye.

In reflectance, the second method used, the IR wavelengths are allowed to pass from the light source to the picture. Any luminescence these cause will travel to the camera and be recorded on film. Any of the original IR radiation reflected from the subject surface and traveling to the camera will also be recorded [see Diagram 2B]. The top layers of paint and varnish are transparent to IR, and the IR is reflected from drawing under the visible surface.

To aid in the formation of an entirely IR-formed image, both light source and/or camera lens can be filtered to screen out visible light. Here, red filters were used to block violet and blue visible light. Various filtering methods were used to determine the means to record the best image. Three methods were tried, each eliminating progressively more of the visible light until in the third setup, all visible light was blocked.

Photography by IR can be done with a standard 35 mm SLR camera in a manner very similar to typical visible-light photography, but
KEY

DIAGRAM 2
(Gibson, p. 46)

A. Emission method

B. Reflection method
some adjustments must be made. Infrared-sensitized film is needed. Only one type of 35 mm IR film is generally available. Since it is so sensitive to a range of wavelengths, it must be loaded in total darkness so IR radiation does not penetrate at the felt-lined magazine slots and fog film. Film can be stored for up to several months if kept under the right conditions. It should be stored at or below 55 degrees Farenheit and should be allowed to stand in room temperature for two hours before use if refrigerated, four to 6 hours if it was in a freezer. This prevents moisture condensation on cold film.

The film is sensitized to respond to infrared wavelengths but also responds to visible violet, blue, and red light as well as some ultraviolet wavelengths, so it is necessary to filter out unwanted radiation. In general, blue-green filters are used on the light source to absorb IR radiation, and a glass opaque filter over the camera lens blocks all visible light.

The focal point of IR radiation is not the same as that of visible light, but closer to the camera. For this reason, one should focus on the nearest edge of the subject. At infinity focus for visible light, an average correction of .25 percent of the focal length is added to the lens-to-film distance. This means basically that the focal point should be brought slightly in front of the object. In general, this is adequate adjustment to produce good pictures. For photographing a painting, however, which is too flat to have any real "near edge," the .25 percent focal length correction should be made. It may be easiest, however, simply to use a lens marked for IR focusing. Most good lenses have this feature.
It is simply a red index mark. The subject should be brought into sharp focus while the lens is unfiltered. The distance that appears opposite the normal index mark should then be moved so it is opposite the red infrared index mark. The focal point has now been adjusted somewhat nearer for infrared, and filters can be attached and the subject photographed.\textsuperscript{12}

It should be kept in mind, however, that even when focused correctly, IR photos are not as sharp as panchromatic ones: "Since lens aberrations have been corrected for panchromatic photography, the anastigmatism is not as perfect in the IR."\textsuperscript{13} Lateral scattering also reduces image resolution, resulting in the "soft" image that characterizes IR photos.

Normal photoflood lights were used here, but electronic flash units can also be used. Exposure time, however, must be experimented with because IR films are not given an ASA (film "speed") rating since the exposure depends on the light source. A very general ASA rating of 64 is estimated for Kodak High Speed Infrared Film when used under tungsten lighting.\textsuperscript{14} This, however, is an estimate only. The addition of filters will lengthen exposure times and lens-to-subject distance will vary them also. It is best to shoot a test roll or at least to bracket exposures.

SESSION I: INFRARED

APPARATUS: 35 mm camera, filters (gelatin and glass) for camera and lights, two tungsten photoflood lights with barn doors and diffusion screens, infrared film, tripod, yardstick

PROCEDURE:
1. SET UP: Set lights at roughly a 45 degree angle to painting and four feet high. Put camera on four-foot tripod (even with
A 7 feet
B 5 feet
C 5 feet
painting's center). Keep lights behind camera to avoid glare [see
Diag. #3].

2. FLUORESCENCE: Shoot 11 photos at f-5.6.
   filters
   on lights: Kodak gelatin filters numbers 877 (Medium Blue Green) and
   858 (Light Green Blue). These block infrared radiation.
   on camera: the "reds": Kodak gelatin filters numbers 828 (Follies
   Pink), 819 (Orange-Amber), and 806 (Medium Lemon) which block
   visible light.
   exposures (in seconds)
   1/60, 1/30, 1/15, 1/8, 1/4, 1/2, 1, 2, 4, 6, 8

   filters
   on lights: the reds
   on camera: 1 Orange-Amber and 1 Medium Lemon (which block visible
   light)
   exposures
   1/125, 1/60, 1/30, 1/15, 1/8, 1/4, 1/2, 1, 2

   B. REDUCED VISIBLE: Shoot 8 photos at f-4.
   filters
   on lights: 2 sets of reds
   on camera: 2 Orange-Ambers, 2 Medium Lemons
   lighting
   Because of technical difficulties, only one light was used in 2B
   and 3C.
   exposures
   1/60, 1/30, 1/15, 1/8, 1/4, 1/2, 1, 2

   C. NO VISIBLE: Shoot remaining film at f-4.
   filters
   on light: 2 sets reds
   on camera: infrared glass filter (which transmits only IR)
   exposures
   1/125, 1/60, 1/30, 1/15, 1/8

The same basic shooting arrangement was repeated (Session II)
with the addition of polarizing filters to achieve a clearer image.
Polarizing filters greatly increase exposure times, so it is
necessary to be aware of filter factors in judging exposure times.

SESSION II: Polarized Infrared

APPARATUS: camera, filters (IR glass, polarizers for camera and
lights, and colored gelatin filters), IR film, tripod, two tungsten
photoflood lights with barn doors and diffusions screens, tripods
for lights, extension cord, yardstick

1. SET UP: Place lights at roughly a 45 degree angle to the
painting and even with center of painting, polarizers in front of lights, camera on tripod at four feet

2. CALIBRATE POLARIZERS: Set up lights, turn one off and shine one on painting to produce a reflection (put a piece of glass in front of picture for a more visible reflection). Turn polarized filter on camera until reflection cancels. Then turn that light off and the other light on. Leave camera filter alone; turn the filter over lighted lamp until reflection cancels. Then the light is polarized. Shoot with IR set up like that of SESSION I. Turn off ALL lights but the polarized ones.

3. A. Focus, adjusting for infrared. (Focus normally without a filter. Distance that appears opposite normal index mark should then be moved to the red index mark for infrared. Attach filter and shoot. Remember, even with lens focused correctly, IR photos are not as sharp as panchromatic ones.) Take a normal photo for comparison using no filters. Record f-stop, exposure time, and (eventually) negative number.

   2. From this step on, use the IR glass filter over lens and camera-mounted polarizer. For this part, read light meter at f-4, and set exposure as it ought to be when the filter factors are taken into consideration. Light meter, however, is only as reliable as your ASA guess is good.

   Recommended ASA Settings For Tungsten Light:

   No filters: ASA 200
   With Kodak Wratten filters 25, 29, 70, or 89B: ASA 125
   Kodak filter 87 or 88A: ASA 64
   Kodak filter 87C(visually opaque): ASA 25

   Filter factors: IR glass filter: double exposure time
                  Polarizing filter: 2.5 X or increase f-stop by 1 1/3

   TURN OUT GALLERY LIGHTS, only polarizing filters on lights.
   Shoot 5 pictures in range of exposure times determined above.
   Record shutter speed, f-stop, and (after film is developed) negative number.

   C. Camera filters: IR glass & polarizers (same as in B)
      Lights filters: all the reds (3) & polarizers
      f-2.0
      shoot exposures 1/15, 1/8, 1/4, 1/2, 1, 2, 3
      record negative numbers

   D. Camera filters: same as in part B
      lights filters: only 2 of the reds (I used Orange-Amber and Medium Yellow)
      f-2.0
      exposures 1/8, 1/4, 1/2, 1
      record negative numbers

   E. Camera filters: same
      Lights filters: Medium Blue Green and Light Green Blue
      f-2.0
      exposures: 1/8, 1/4, 1/2, 1, 2, 3
      record negative numbers

   F. CLOSE UPS OF CHERRIES AREA Move the camera in and record new camera distance and new lights distance. Camera
filters remain the same.
Lights filters: the reds and polarizers
f-2.0
exposures: 1/8, 1/4, 1/2, 1, 2, 3
record negative numbers

G. MORE CLOSE UPS, changing only the filters on the lights:
lights filters: Medium Blue Green, Light Green Blue, and polarizers
f-2.0
exposures: 1/8, 1/4, 1/2, 1, 2, 3
record negative numbers

Keep in mind that "polarizing filters in general are low in their polarization of IR." Special IR polarizers can be purchased, but were not available for this shooting session.

One detail photo was chosen for computer colorization.
The Artron computer graphics software enables a slide, photo, video frame, or drawn image to be altered, either with the "draw" function, which allows drawing directly on the computer image, or the "paint" function. This function allows an image to be categorized into a range of grays, and then a color may be arbitrarily assigned to any gray. This method sometimes establishes good contrast and hence a better view of suspect areas [see Photographs section].

ULTRAVIOLET

In the interest of thoroughness, the painting was also subjected to ultraviolet photography. Ultraviolet wavelengths are shorter than visible light wavelengths and lie just beyond the violet end of the spectrum at 10 to 400 nm [see Diagram 1]. As with IR, these wavelengths are invisible but may be captured on film.

Ultraviolet radiation is generally broken down into four
categories. Longwave UV lies just beyond visible violet (from 400 to 320nm). Normal glass will transmit these waves, and it is here in the longwave UV that photographs are generally taken.

The middle UV spans a range from 320 to 280nm. A band within this range (295-320nm) causes tanning in human skin, but a normal glass camera lenses will not transmit in this range. To shoot middle UV photographs, a special quartz lens is needed.

Shortwave UV continues the progression into shorter wavelengths; these are from 280 down to 200nm. "Sunburn" damage to the eyes will result from a look into a light source emitting in the shortwave range.

The fourth category is vacuum UV which includes the remainder of the UV, from 200 down to 10 nm, which is the upper limit of X rays. These wavelengths are present in sunlight but are absorbed by the atmosphere, so they are generally only detected in the vacuum environment of space.17

Since the camera used here is fitted with a glass lens, not quartz, only the longwave UV could be used for taking photographs.

Unlike the IR photography case, normal panchromatic film can be used to take UV photos because the silver halide crystals contained in all photographic emulsions are naturally sensitive to UV radiation. Therefore, normal Pan-X, Plus-X, or Tri-X films are suitable as well as easily obtainable and inexpensive. But since these are also sensitive to visible wavelengths, the key to obtaining a wholly UV image lies in the filtering. The simplest means of allowing only UV radiation to reach the film plate involves the use of a Kodak 18A filter or its equivalent. This filter blocks
all visible wavelengths, allowing only UV to pass.

The light source, too, is a consideration. A source which emits a large percentage of longwave UV radiation is desired. Sunlight is an obvious choice since it emits a sufficient amount of the desired wavelength, and it can be used as the source on dry, sunny days. Indoor lighting is always more easily controlled, and therefore preferable, and a must for photographing unstable subjects like art objects. There are several indoor sources that can work (electronic flash lamps, arc lamps, mercury vapor lamps), but perhaps the simplest choice is fluorescent tubes, or "black lights." These can be bought in four-foot lengths that are convenient for illuminating large areas. Electricity discharges through the gas in the blacklight tube, causing it to ionize and give off electromagnetic radiation in the green, blue, and UV ranges. The tube's insides are coated with a shortwave absorbing phosphor. Longwave UV and some visible light are emitted, and it is then only necessary to filter these latter out to obtain a completely UV-generated image.

To take the photographs, there are a few more necessary bits of information: film speed and focusing methods. There is no set ASA rating for UV film. The film is assigned an ASA rating by the manufacturer, but it is meant as a reference number for visible light only, not UV radiation. Ultraviolet ASA is a matter of guess work, though film speed is generally much slower. For example, ASA 400 film drops to roughly ASA 10 when used for UV photography. Exposure times for UV are generally much longer, and filter factors should be considered. Short of shooting a test roll, there is no
exact way to determine ASA. A good guess and bracketing exposures will usually remedy this problem.

As with IR, the UV focal point is not the same as the visual focal point. Whereas the IR focal point is somewhat nearer the camera than the visible focal point, the UV focal point is somewhat farther away from it. To achieve sharp UV focus, one can focus visually, then decrease lens aperture to increase depth of field. 35mm cameras generally have lenses with short focal lengths, and a decrease of aperture at least two f-stops below wide open will generally focus the UV image. 20

In my experiments, I used this focusing method and also tried putting an index mark on the focusing ring that was as far from the center mark as the IR index mark but in the opposite direction.

Below is the procedure followed for the UV photos (Session III). The session was repeated using a Kodak 18A filter over the camera lens (Session IV). This filter bars all visible light from the film but allows UV to penetrate, creating an entirely ultraviolet-formed image. To compensate for the decrease in electromagnetic radiation that penetrates the filter, exposure times had to be lengthened. The 18A is assigned no filter factor by the manufacturer, but a polarizing filter has a 2.5X filter factor and an 18A blocks more than a polarizer. I guessed it to be roughly 3X and used a range of exposures with good results.

SESSIONS III and IV: longwave ultraviolet

APPARATUS: 35 mm camera, Pan-X black and white film (here, ASA 400), blacklight source, tripod, light tables, extension cord, Kodak UV filter 18A, filter frame, and adapter ring

NOTES: Ultraviolet ASA is a matter of guesswork. Twenty is my
camera's lowest setting, so I set ASA to 20 and then kept in mind adjustments should leave light meter needle pointing toward the "+
" direction. UV exposures are generally much longer than visible exposures.
Focal lengths are shorter than visible focal lengths (opposite of IR
pictures).
UV pictures are generally low contrast; develop for high contrast to compensate.
When shooting, turn off all lights except the UV sources.

1. MEASUREMENTS: Set up like the previous two shooting sessions
and take position measurements of light-to-picture and camera-to-
picture distance.

2. FULL-SIZE SHOTS:
A. Focus visually, then increase f-stop (bigger number, more
depth of field) by two stops or more. Shoot 6 photos. Record
negative number, exposure time, and f-stop of each photo.

B. Focus visually, turn focus ring to tape mark, shoot six
pictures, recording the same information. (The tape mark
represented my estimate of the index mark necessary for proper
focusing of UV waves. I set it the same distance from the center
line as the IR index mark, but in the opposite direction.)

3. Repeat I above using a close up of the cherries area as subject.
Record the same information for pictures shot by the two focusing
methods.

4. Repeat I above using a close up of the upper right corner (the
suspicious arc area) as subject. Record information.

5. If there is extra film, shoot more close ups of the cherries
area and full shots at different exposure times or f-stops. Record
information.

ANALYSIS

The ultraviolet photographs provided little useful information.
The image on the canvas surface barely shows, and the photos are
obscured by the heavy varnish, revealing only surface damage which
is considerable [see Photographs section]. But the infrared photos
suggest evidence which doesn't allow us to dismiss this painting
as the work of a Bellini apprentice with a clear conscience. While
the present painting shows a spray of flowers, the infrareds suggest there was once a cluster of berries, probably cherries, above the flowers.

If Bellini painted the picture, it is quite possible he may have drawn in the fruit as he had in many other similar compositions [see Figures 1 and 2], changed his mind and painted instead the flowers that we see there today. If an apprentice were painting the work from sketches and directions given by Bellini, he may not have had the freedom of working through ideas for compositional elements, but would make a faithful copy of the design already set for him, painting in flowers without question. Or possibly the painting was completed (by Bellini or an apprentice) and sold to a new owner who then had repainting done to it, concealing the cherries and adding the flowers. Overpainting has occurred in other areas of the painting, and painting a picture to "match" others in a collection was not an uncommon practice during the Renaissance. Or Bellini could have worked on it, changed the cherries, then had an apprentice finish it.

I believe the painting contained the cherries (visible or not) by the time it left the studio. X rays of the work show that certain areas including the cherries show outlines in fine, white lines. "Presumably, these lines originally were grooves incised in the gesso, done perhaps when the cartoon was transferred to the panel," perhaps via some form of pounce bag technique. This transfer could have been done by Bellini or an apprentice, but the fact that the cherry outlines are incised rules out the possibility of some later owner painting the cherries. They were the intent of
FIGURE 1

(Heinemann, Plate LXXV a)

**FIGURE 2**

(Heinemann, Plate LXXII)
the original artist.

Historical documentation on the painting itself yields little. Records were found to be incomplete. Ball State has had the picture on permanent loan from the Ball Foundation since January 17, 1951. It received the work from E. Arthur Ball, who in turn purchased the work from the Wildenstein Galleries. This organization was established in 1875 in Paris by Nathan Wildenstein. Son Georges, director of the Gazette des Beaux Arts since 1929, took over the gallery in 1934. He was acting president until 1959, and now his son Daniel operates the gallery which has expanded to include branches in New York, London, and Buenos Aires as well as Paris.

Ball State's painting came into New York via Paris and bears three Paris customs stamps. It is not known, however, when or from whom the Wildensteins received the painting, or even which Wildenstein obtained it, although Fritz Heinemann mentions that the painting was in Wildenstein's possession in 1930. However, the painting is referred to by Berenson in a letter to the Wildenstein Galleries in 1928, so it is probable that they were in possession of the painting by the middle of 1928 at the latest. The only other name mentioned in the provenance is that of the Comtesse Ducroq. This name is unverified and no dates are connected with it. The provenance is fairly unhelpful.

Neither is mention of the painting likely to be found in books. More common is coverage of the sister painting to Ball State's [see Figure 3]. This painting is at the Glasgow Museum and Art Gallery in Scotland. Correspondence was established with the Assistant Keeper of Fine Art there. Comparisons will certainly be necessary for any

FIGURE 3

(Heinemann, Plate LXXVIII a)
real decision on the authenticity. At least one important art connoisseur accepts the Ball State version as authentic. Bernard Berenson, in a letter to the Wildenstein Galleries dated June 1, 1928, said,

The composition is well known to me, and I am acquainted with other versions of it...The picture is an autograph work by Giovanni Bellini painted about 1490. [It is not known when or where he examined the painting to make this decision.] The words 'Zuan Bellino' are scarcely a signature but as good as, for they must have been put there, as I pledge from the style of the letters, about 1510, certainly within the life of the master. By that time, he was already so famous that the owner would have thought it worthwhile to put the name on the panel."26

Although Berenson is well respected, some doubt his motives in verifying the authenticity of paintings. A report done recently at the Glasgow Museums and Art Galleries states probably quite rightfully that "it is general knowledge that art historians were often quite willing to provide such documents [authenticating paintings] for art dealers for quite small sums of money."27

The report goes on, however, to quote from the diary of Mary Berenson a section that addresses this matter. It relates the story of Berenson's rejection of an offer of money in exchange for "certain attributions," and Ms. Berenson states that her husband would not "be classed with Gronau, van Hadeln, and Venture and the rest who exchange attestations for bank notes."28

This speaks well of Berenson, though it must be noted that he did work for Wildenstein's. Whether his statement that the Ball State version is an original work is an honest one can only be a matter of speculation. There seems to be no good evidence that Berenson was "bought," but it is a possibility that can't quite be
eliminated.

It is interesting, however, to find Gronau listed in Ms. Berenson's diary among those who would sell attestations. He wrote a glowing testimonial to the authenticity of the Glasgow Bellini.29

What, then, can be said of Ball State's *Madonna & Child*? The historical documentation available on the work is inconclusive at best, arguable or contradictory at worst. The provenance is vague, and, given available resources, the picture's whereabouts seem untraceable before 1930, leaving about 400 years of the painting's existence unaccounted for. To add to our confusion, some historians aware of the work descredit it as a Bellini, Heinemmann can't be sure,30 and Berenson names it autograph.31

Heinemann lists in his book nineteen variations of the original Bellini composition. Some of these were done by the master and some by his apprentices.

Of the nineteen versions, I have seen photographs of only four, two of which are definitely attributed to others [see Figures 4 and 5]. Of the 19, Heinemmann attributes most of them to assistants. There are two, however, which he seems in doubt about: the Glasgow's, which he comments on as very clean but probably authentic ("molto pulito, ma probabilmente autentico"32), and the Ball State painting, about which he says, "the original is not known to me" (a rather surprising statement as he is familiar with the Glasgow painting and believes it to be authentic). He also is unsure about the authenticity of Ball State's version, asking whether it could be original ("e originia?") then saying that perhaps its rather square dimensions contest its authenticity.
FIGURE 4
(Heinemann, p. 348, 388; 36c)
FIGURE 5

(Heinemann, p. 360, 403;36r)
It measures 67.3cm x 54 (26 1/2 in x 21 1/4). Glasgow's is 75cm x 52 (28 3/8 x 20 1/2 in). The Glasgow is 7 7/8" longer than wide, and Ball State's is 5 1/4" longer than wide, leaving only a 2 5/8" difference between the two. This hardly seems to me to be grounds for dismissing it as inauthentic.

Perhaps of more significance would be the dates of the works. Glasgow dates its piece at 1475, whereas Heinemann only says it is not painted after 1489. Ball State's is dated at approximately 1490, at which time Bellini would have been in the 5th decade of his career. So the two paintings could be separated by anything from one to 15 years if these dates were both indeed correct, or the Ball State work could predate the Glasgow piece if the 1490 date is off by as little as one year. Even if Ball State's is the later piece, it is not necessarily a copy of the earlier one as Bellini was known to rework a particular problem years after his first version, sometimes rethinking the image and bringing it to a slightly different conclusion.

It has been suggested that the Ball State version's inclusion of a landscape lessens the intensity of the scene between Mother and Child, and this flaw could not have come from the hand of Bellini. On the other hand, the painting exhibits a subtle tension between this world and the next that epitomizes the sense of balance so important during the Renaissance. The Virgin and Child are physically distanced from the world of man (represented by the landscape in the distance and the ledge that separates the two figures from the viewer), yet masterfully humanized by their three dimensionality and playful, even endearing, poses. The Christ Child playfully dangles flowers on a
string as His Mother watches patiently, yet her face is somber, as if she understands what future Fate has in store for her Child. This knowing expression serves as another link to the next life, beautifully balancing the painting. The presence of a garland in the landscape is interesting and does not seem to be a common characteristic of Bellini, yet the device has been used at least once in other works of his [see Figure 6].

Analysis, however, is hampered by the condition of the painting. At approximately 500 years of age, the work is dirty, and there is a thick patina of varnish that is subject to blush and blooming. An inspection report tells of the painting's condition: Scattered black spots in X rays and IR photographs "do not have the character of flaked losses and may indicate damage by some corrosive agent or perhaps by fire...The IR photograph[es] show...damage which has been covered by retouching." This retouching was not always done with utmost care, it seems. As we read further, we find that in "the proper right hand of the Child and possibly in the proper right hand of the Virgin also, there is a disagreement in the drawing...This indicates a minor revision, probably by a restorer."  

It should be noted that a thorough cleaning can make an appreciable difference, as the Glasgow Museum and Art Galleries can well appreciate because its Bellini "had become so disfigured by dirt and repaint as to be attributed to a pupil."  

The Ball State painting is scheduled to undergo complete technical analysis under a grant from the Institute of Museum Services in Washington, D.C., and doubtless no conclusion can be made responsibly without the information from this report and photographs.
of the Glasgow Bellini.
FIGURE 6

(Heinemann, p. 23, 21:11)
APPENDIX A

DEVELOPING NEGATIVES
(with all due credit to Larry Graham)

Needed: thermometer, tank with cap and reel, trays, chemicals (D-76, stop bath, fixer, Hypo Clear, Photo Flo), timer, clothespins, scissors, funnel, graduated cylinder

1. Put chemicals in temperature-regulating tray to cool to 68 degrees
2. Arrange developing tank, reel, cover, and scissors so you can find them in the dark
3. Turn out lights; make sure room has no light leaks (door jam, etc.)
4. Remove film from camera in total darkness
5. Put film on reel (practice with exposed film first)
6. Put reel in tank and cover
7. Pour in D-76 for 11 minutes at 68 degrees or D-19 for 6 minutes
   Agitate every 30 seconds. Pour developer back in container.
8. In the same manner, use
   a. stop bath for 30 seconds,
   b. fixer for 5-10 minutes (Rapid Fixer 2-4 min)
   c. wash with water 30 seconds
   d. Hypo Clear 1-2 minutes
   e. wash 5 minutes in running water
   f. Photo Flo 1 minute or so (optional)
9. Remove film from reel, run it between fingers to remove excess water
10. Dry dust free

Steps 8c-8f may be replaced with a 20-30 minute wash in water.
APPENDIX B
PRINTING CONTACT SHEETS
(Swedlund, p.197)

NEEDED: contact printer, printing paper, chemicals (Dektol dilute, stop bath, fixer, Hypo Clear), trays, timer

1. Make test strips for exposure time
2. Clean dust from negatives
3. Open back of proofer (contact printer) and be sure glass is clean
4. Put negatives on glass, emulsion side up. Turn out lights; use safelight
5. Put paper emulsion side down in proofer
6. Replace proofer back; lock in position
7. Turn proofer over and expose
8. Develop strips as instructed in Appendix C.
APPENDIX C
PRINTING FROM NEGATIVES
(from the handouts of Larry Graham)

NEEDED: printing paper, easel, chemicals (Dektol dilute, stop bath, fixer, Hypo Clear), focus finder, negative holder, timer, trays, tape, paint brush for dusting

1. Set trays in this order: a. Dektol  b. stop bath  c. fixer  d. Hypo Clear  Turn on safe light; turn off lights
2. Tape negative in holder, put in enlarger, turn enlarger on
3. Dust negative
4. Focus and compose image on easel
5. Turn off enlarger; on easel, place test so it covers a sample of dark and light image areas
6. Expose gradually for a series of short exposures
7. Develop 90 seconds, drain 10 seconds
8. Stop bath 30 seconds, drain 10
9. Fix 3 minutes (after 2 minutes, lights can be turned on)
10. Choose best exposure; set timer for that exposure time
11. Redust and refocus negative if necessary
12. Expose full sheet; dodge and burn if necessary
13. Develop as in steps 7-9, then
14. Wash at least 20 minutes in water
15. Dry completely (face down on belt if using the dryer)
GLOSSARY OF TERMS

ANASTIGMATISM: Not astigmatic; in particular, a lens that's been corrected for astigmatism

ASA: For American Standards Association, which evolved a system designed to rate the speed or light sensitivity of photographic materials (Swedlund, p. 399)

BURNING: Printing technique for allowing restricted areas of an image to receive longer exposure while the rest of the print is shielded (Swedlund, p. 399)

BLOOMING: The clouding of varnish with age

BLUSH: Term applied to lacquers when they become partially opaque, cloudy, or translucent upon application or drying

BRACKETING: As a margin for error, the technique of making, in addition to a normal exposure, several exposures both over and under the normal (Swedlund, p.399)

CHIAROSCURO: In painting or drawing, the treatment and use of light and dark, especially the gradation of light that produces the effect of three-dimensional form (Hartt, p. 977)

DAMMAR: A common spirit varnish

DODGING: Technique of lightening part of the image in a print by shielding that section during the exposure of the printing paper (Swedlund, p. 401)

FILTER FACTOR: The number by which correct exposure without filtration must be multiplied in order to maintain the same effective exposure with a filter. The factor increases exposure to compensate for the light withheld by the filter (Swedlund, p. 401).

FOCAL LENGTH: The distance from the lens to the plane of focus when the lens is focused at infinity (Swedlund, p.401)

INFINITY FOCUS: The area farthest from the camera in which objects are rendered by the lens in sharp focus. This usually begins at 40 or 50 feet in front of the camera and continues into the distance as far as 300 yards. Infinity focusing derives from the phenomenon of light rays seeming to travel parallel to each other over great distances rather than at angles to one another, as over short distances (Swedlund, p. 402).

MASTIC: A common spirit varnish

OIL VARNISH: One of the two general classifications of varnish (the other is spirit varnish). Oil varnish dries mainly by chemical change and is less solvent than spirit varnish.

PANCHROMATIC: Sensitive to the wavelengths for all colors in the visible spectrum (Swedlund, p. 403)

PATINA: Often used as a general term for yellowed varnish layers that form over and obscure an object

PERSPECTIVE: Formula for projecting an illusion of three-dimensionality onto a flat surface

ATMOSPHERIC: Creates the illusion of distance by blurring of contours and the diminution of color intensity

LINEAR: All parallel lines converge on a single point on the horizon known as the vanishing point, and associated objects are rendered smaller the farther from the viewer they are intended to seem (Hartt, p.981)

POUNCE-BAG TECHNIQUE: Early copying technique in which principal
features of a painting were initially defined by pin pricking a sheet-overlay; then the pattern was transferred to a new panel by dusting the perforations with charcoal dust (Fleming, p. 35).

QUATROCENTO: Fifteenth century in Italian art
SFUMATO: A smoke-like haziness that subtly softens outlines in paintings (Gardner, p. 982)
SLR (SINGLE-LENS REFLEX) CAMERA: A camera that has a built-in movable mirror at an angle to reflect the light from the scene through the taking lens and pentaprism to a viewing screen. When the shutter release is pressed, the mirror flips up, allowing the light to pass through and expose the film (Swedlund, p. 401).
SOLVENT VARNISH: Varnish that can usually be removed with solvents. Synonymous with spirit varnish
SPIRIT VARNISH: Varnish made "from resins that are directly soluble in volatile solvents such as turpentine or white spirit, and that on evaporation of the solvent leave behind a film of resin having ... desired qualities" such as protective coating, gloss finish, etc. (Eastman Kodak, 1972, p. 177)
ENDNOTES


5. Robertson, p. 11.


18. Eastman Kodak, 1972, p. 3.


22. Accession form, Ball State University.


31. Berenson.

32. Heinemann, cat. no. 36h, p. 9.

33. Hamilton, p. 54.

34. Heinemann, cat. no. 36h, p. 9.

35. Hamilton, p. 38.


37. Buck, p. 2.

38. Hamilton, p. 27.
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Martens, Charles R., ed. Technology of Paints, Varnishes, and


PHOTOGRAPHS

Printing Data

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Help with questions about filters or other equipment is available by calling the Kodak toll-free information number: 1-800-242-2424.