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30. Inpainting and Design Compensation

Inpainting is the addition of appropriate media to fills, repairs, and areas of loss in a work of art or artifact. The intent is to suggest the continuity of image and/or background, to create the illusion of wholeness, and to minimize the distraction of losses. This chapter will deal primarily with the compensation of image loss with references made to the preparation of fills or inserts, alternatives to inpainting, disguising of stains, etc. (See AIC/BPG/PCC 26. Filling of Losses, 1987.)

30.1 Purpose

To restore visual integrity by compensating losses of media, or in some cases support, without compromising original intent or materials.

30.2 Factors to Consider

30.2.1 Ethical Considerations

- A. The decision to inpaint is made in consultation with the curator, custodian, owner, dealer, or artist/creator. It is important that the conservator inform the custodian or owner of the limitations and possible consequences of inpainting as well as the potential for aesthetic improvement.(RGC)
- B. Some conservators consider inpainting not to be a genuine and necessary component of conservation and that it is even a questionable aspect of restoration since the line between reconstruction and forgery or deception can be very ambiguous.
- C. Issue of reversibility: The new draft of the AIC Code of Ethics states under Compensation for Loss (#23) that "... such compensation should be reversible." On original artifacts, every effort should be made to inpaint in a reversible manner, recognizing that this is not always possible given the relatively simple structure of works of art on paper. Few, if any inpainting materials are completely reversible, especially since many inpainting media become increasingly insoluble with time. Inpainting on an original surface, therefore may become a permanent part of its structure.(IB) For example, pastel pigments can become permanently embedded in paper fibers; watercolors can be absorbed easily by soft-sized papers; coated papers may not withstand the manipulation necessary to remove dry or wet inpainting materials without harming the surface; etc. Exercising restraint is essential due to the inherently intractable and relatively non-reversible nature of compensation on paper.(JB) Application of an isolating layer may improve reversibility, as may using as thin and non-penetrating a layer of media as possible.
- D. There is general agreement amongst conservators that inpainting and reconstructions are restricted to damaged or inserted areas, and should not be used to intentionally alter the original or existing character of a work of art. Inpainting to strengthen a weak impression or signature is not considered to be appropriate.
- E. Disguising damage may interfere with interpreting an artifact whether for historical or artistic information, or for condition assessment during resale of an artifact.

- F. Every effort should be made to render inpainting detectable by common examination methods (examination with microscopes, ultraviolet light, raking and specular light, radiography, etc.). Inpainting with the same media as found in the object may interfere with detectability of inpainting, but is considered by some conservators to be unavoidable, especially in cases where it produces the best results. Use of different pigments than those found in the object may increase detectability.
- G. Documentation, written and photographic, is especially important since inpainting on paper objects is not always removable or easily detectable. Documentation should include exact location of inpainting and the media and technique of application. Photographs taken before compensation and inpainting are particularly critical.
- H. Consultation with the artist may be desirable in some cases, in particular regarding materials, techniques, and artistic impressions. There may be cases in which the artist is asked to repair his/her own work. Some regard inpainting by an artist less problematic, ethically, than inpainting by a conservator. It is important that the artist understand the ethical principles underlying compensation. Also, it is incumbent on the conservator to inform the custodian or owner that the nature and value of the artwork can be altered by an artist's proclivity to enhance his/her former work rather than to simply restore it. (RGC) It may be helpful to explain to the custodian/owner and artist that the skills required for inpainting differ than the painting skills used to create a work of art.

30.2.2 Determining Justification for Inpainting

- A. Owner (institution, collector, dealer, etc.): A range of opinions exists on the part of all owners and custodians (and conservators) about the justification for and degree of inpainting. Most people judge the merits and limitations of inpainting on a case-by-case basis. (Factors of resale are often an issue in conservation retouching of objects from private collections. PV)
- B. Type of object (historical artifact or fine art): Works of art tend to be inpainted more often than are historical artifacts because aesthetics are more essential to the appreciation of an art object and less critical in a historical artifact. (DDM)
- C. Degree of distraction of losses, etc. which may compromise appreciation of artifact: Location (margin versus image), severity, and number of areas to be inpainted, should be considered as well as scale of damage or loss relative to the whole object. Also, size of the object and viewing distance affect choices.

The degree of damage may render the object unexhibitable if left untreated, e.g., an extensive scratch which reads white against the colorful background of a watercolor. In this case, the conservator and custodian should evaluate the ramifications of not compensating the disfiguring loss since the alternative is to not exhibit or enjoy the object. (ECL)

The object may be so physically damaged that time-consuming inpainting may be inappropriate. (CB)

- D. What may first appear as "losses" may actually be a result of an artist's working method or historically significant corrections or alterations. In addition, losses caused by use or wear may be an important determinant of the value of an artifact.(HM) Compensation of these "losses" would not be appropriate.
1. Examples of inappropriate compensation of an artist's or creator's working methods: inpainting interruptions in design caused by an artist's vigorous technique or erasures; compensating gouges made as erasures or changes in a composer's manuscript(AS); filling pin holes in paper documenting earlier placement of collage pieces; compensating fragmentary studio or outdoor sketches or studies, never intended to be "finished"; retouching or concealing disfiguring stains or marks that may have historical or sociological significance (e.g., oil deposits from artist's studio transferred onto working drawings; preparatory grid lines used for enlargement of the composition onto a mural or painting).(JB)
 2. Example: An artifact was historically disfigured when eyes of the sitter were scratched out as a political statement. Inpainting would depend upon whether the original piece or the act of violation is considered more important.(DvdR)
- E. In some cases prior inpainting and repairs may be a significant part of the history of the object, but are distracting. The removed parts can be retained in a file, but there is no guarantee records, etc. will be passed on during resale.(JW) Though undoing prior restoration may present more wear and tear on the object than merited by small improvement in appearance.(BF)
- F. In some cases attempts to inpaint may be more distracting than the loss or stain itself. Inpainting dark-colored damages with a lighter, opaque medium will in most cases result in a noticeable mark.(IB,ECL) However, it is a judgement call depending upon the object because sometimes the result is less noticeable than the original mark.
- G. Cost-effectiveness: Sometimes meticulous color matching is not a cost-effective use of the conservator's time if one is attempting to service the conservation and preservation needs of a large collection.(SB)

30.2.3 Determining Degree of Compensation

- A. Degree of compensation will vary according to object, collection, and custodian. After the decision to inpaint has been made, consider degree of compensation: general toning versus exact color match, reconstruction of missing design versus simply matching background color, and sympathetic, but detectable, versus more extensive compensation. Type and extent of inpainting should be discussed and agreed upon by owner or custodian and conservator.
- B. Viewing conditions (taking into account the size of object and viewing distance), matting and framing, and lighting should be considered during inpainting.
1. Low light levels in many exhibition spaces may lessen amount of inpainting necessary to achieve visual unity. However, in a study collection objects are often viewed unframed, mats are lifted, and thus are subject to closer scrutiny.(JW)

2. It is important to evaluate matting options. Areas covered by a window mat may not require inpainting. One might consider placing an object with losses on a sympathetically toned sheet instead of filling and toning losses on the object.(TKM)
- C. Reconstruction of missing design may be considered more appropriate and common if working on an insert rather than on the original.
- D. In cases where compensation is done on the original, the conservator should practice restraint. One or two dots of color may be all that is required to restore continuity of design. Addition of "soiling" to the edge of a fill may integrate the edge loss into the sheet.(JW)

30.2.4 Physical Characteristics of Artifact

Close examination and identification of physical characteristics of the media and support are important in order to match or approximate them during inpainting.

- A. **Support:** Absorbency, color, texture, presence of coating, general condition, etc. See AIC/BPG/PCC 4. Support Problems, 1990. For example, determining the degree of absorbency of the support will dictate the amount and strength of an isolating layer required to increase reversibility of inpainting. In many cases, approximating the surface texture of the support may be as important as getting an exact color match during compensation.
- B. **Media:** General composition (binders, pigments, etc.), color, surface gloss, friability, texture, thickness of application, etc. See AIC/BPG/PCC 3. Media Problems, 1985. Note subtle characteristics of media when selecting and manipulating inpainting materials.
- C. **Damage:** Nature of damage (abrasion of top paper fibers, superficial loss of support, loss of design, scratch in media or coating), location of losses (margin vs. image), extent and number of losses, etc.

30.2.5 Chemical Composition and Characteristics of Inpainting Materials

- A. **Characteristics of Inpainting Materials:** Physical form (stick, pencil, powder, liquid), presence of binder and additives, viscosity, solubility (carrier solvent), translucency/opacity, friability, surface gloss, general covering power of pigment or media, ease of control during application, etc. See listing of specific media in 30.3.3 and 30.3.4.

All inpainting materials are comprised of a coloring agent, which may require a carrier on which to cast the color, and a binder which adheres the coloring material both to itself and to the artwork support. Some coloring agents may be derived from organic dyes, which may be cast directly onto the paper support, using the white of the paper fiber for reflection of light and color. Other coloring agents may be organic dyes cast onto an inert transparent particle, resulting in pigment that requires binder to adhere to the support. Pigments, both organic and inorganic, generally require some binder to facilitate adhesion. Due to the toothy or textural quality of many paper surfaces, coloring agents with little or no binder may be applied directly to the paper, holding by friction contact.(JB)

- B. **Durability:** Natural aging characteristics (i.e., yellowing, cracking), sensitivity to abrasion, etc. may affect choice of inpainting materials.
- C. **Reversibility (Solubility):** Media which may have a water or organic solvent carrier during application may not be soluble in the same solvent upon drying. (For instance, acrylic dispersion paints are water-borne, but are not water-soluble when the film has dried.) Also, many media become increasingly insoluble or intractable with time.
- D. **Light Stability** (See 30.5.1 Stability for discussion of lightfastness ratings.) Light stability of pigments and dyes vary. In general, inorganic pigments are less susceptible to fading than organic pigments and dyes.

Differential aging of the original versus additions is always a likely possibility. Repairs may differ in light stability than the original, resulting in lighter or darker inpainting than original media over time.(IB)

E. Effects of Inpainting Materials on Artifact

1. Some pigments contain transition metals which sensitize cellulose to oxidative reactions catalyzed by light and moisture. Sensitizing compounds/pigments include titanium dioxide, zinc sulfide, zinc oxide (found in zinc or Chinese white), and copper greens. (AIC/BPG/PCC 3. Media Problems, 1985, 2) "These oxidizing species can accelerate the fading of several dyes and pigments when mixed together with zinc oxide." (Daniels, 1990, 236) A halo of discoloration in the paper may be observed surrounding the pigment.
2. Oil paints are rarely used for inpainting on unprepared paper due to staining of the cellulose by the oil binder.
3. Media in the artifact may be sensitive to accidental contact with the liquid carrier of some inpainting materials. For example, red chalk, pastels, and certain kinds of crayons permanently darken upon wetting with water or organic solvents.
4. Friable inpainting materials can be transferred and smudged unintentionally, and subsequently can be difficult to remove.

- F. Consideration of Effects of Subsequent Treatments (i.e., Washing) on Inpainting:** Works on paper may be subjected to wet treatment at some point and previous inpainting on fills, if not recognized as such, could bleed producing an irreversible mess. Therefore, the deliberate use of "permanent" (i.e., water-insoluble) materials may be justified on fills, only.(ECL)

30.2.6 Considerations During Inpainting

- A. **Metamerism:** Metamerism is the phenomenon in which "two colors that match each other under one kind of illumination (daylight, fluorescent tube, tungsten bulb) differ from each other when seen under another light source. The main cause of metameric pairs is a difference in the coloring ingredients of which the substance is composed. For example, one paint may contain a single pigment, the other a mixture. Other factors may be variations in gloss, surface texture, and ratio of pigment to binder." (Mayer, 1985, 629)

The more simple the mixture, the less chance for pronounced metamerism of the resultant color.

- B. Lighting:** View the object and inpainting in a variety of light sources and angles (i.e., raking, specular and normal illuminations), to evaluate color, surface gloss, and texture.

Avoid inpainting under certain quartz or halogen lamps which may be characterized by a strong or excessive pink, yellow, blue or green coloration. If fluorescent lamps are used in combination with other inpainting light sources, be sure to select bulbs with relatively balanced wavelength spectra, a high color rendering index (e.g., CRI equal to or greater than 88), and ultraviolet light shielding (factory applied absorptive coating or fitted with absorbing shields).(JB)

When inpainting, consideration of lighting conditions to be used during display may lessen the chance of problems with metamerism. Generally, for objects in private collections, inpaint using tungsten and daylight; for institutions, inpaint using lighting source found in exhibition areas.(DM) However, attempting to match lighting conditions during inpainting to anticipated gallery or viewing lighting may overlook subsequent display conditions as ownership or exhibition location changes.(RGC)

- C. Orientation of Object:** An object can be inpainted in a horizontal or vertical position. If working on a table, the object should occasionally be viewed vertically as this is the orientation in which it will typically be displayed. View the object from all sides and angles, vary the viewing distance, and periodically use magnification.
- D. Matting:** Inpainting while the artwork is placed on a mat of appropriate color may be helpful in achieving a good color match due to translucency of the paper support and influence of the surrounding mat color. Sometimes mat color can be adjusted or locally toned to avoid inpainting the object.
- E. Use of Reproductions to Help Reconstruct Losses:** Existing documentation (i.e., pre-damage photographs, photocopies), facsimiles, other impressions of prints, and copies after the original may aid the conservator in reconstructing areas of loss in design or support. The new computer imaging programs can help conservators and custodians determine how much compensation is acceptable.(JW)

30.3 Materials and Equipment: Materials listed below can be purchased at art supply stores or through art and conservation supply catalogs. Note that any of the brand-name materials listed below, especially those of complex composition, may be altered by the manufacturer at any time.(IB) Lists of manufacturers and brands are only partial and do not represent an endorsement. Also see AIC/BPG/PCC 3. Media Problems.

30.3.1 Sizing and Isolating Layer Materials: The following materials can be used to size insert papers or can act as local isolating layers for inpainting. See AIC/BPG/PCC 46. Adhesives.

- A. **Wheat Starch Paste**
- B. **Cellulose Ethers** (primarily methyl cellulose, but also sodium carboxymethyl cellulose, hydroxypropyl cellulose, and ethyl hydroxy ethylcellulose).
 Consider viscosity grade and concentration appropriate for type of paper, i.e. shorter chain polymers penetrate while longer chain methyl celluloses form films on paper surface.(LHP) For a discussion of stability see Feller and Wilt, 1990.
- C. **Gelatin and Parchment Size**
- D. **Acrylic Resins and Emulsions**
- E. **Polyvinyl Acetate Resins and Emulsions**

30.3.2 **Pigments**(See AIC/BPG/PCC 3. Media Problems, Feller 1986, Gettens and Stout 1966, Gottsegen 1987, Mayer 1985, and Wehlte 1982 for description of individual pigments.)

Pigments are described as organic (vegetable, animal or synthetic in origin) or inorganic (mineral, earth or synthetic in origin) particles which do not dissolve, but remain dispersed in a liquid. (Dyes are in solution.) Lakes are pigments made by precipitating an organic color or dye onto an inorganic base. Particle size is dependent upon grinding and pigment type. Powdered pigments can be applied dry or mixed with binders.

In dry form, the toxic aspects of pigments are more easily transmitted and absorbed by the human system; therefore, special caution should be observed in handling dry pigments.(RGC)

Dry artists' pigments are manufactured and/or distributed by Winsor & Newton, Kremer Pigments, Daniel Smith, Conservation Materials, Ltd., Schmincke, Old Holland, Sennelier, etc. Pigments are available from manufacturers and through art supply stores.

- A. **White (and/or Inert) Pigments (JB)**: The classic Chinese (zinc oxide) white and titanium (dioxide) white, typically found in watercolor inpainting palettes, are in many instances too brilliant and opaque for paper inpainting, where the media and support are often warm, semi-transparent and inherently less brilliant. Other white pigments may be mixed with cellulose gums (methyl cellulose and carboxymethyl cellulose), other gums or resins to produce more effective watercolor inpaints.

Calcium carbonate whites such as chalk (whiting), marble white (ground marble) or oyster shell white (ground from mollusk shells) will provide softer, warmer, more transparent whites that will be closer in value to paper and media tones. Gypsum (calcium sulphate) may also be useful, particularly if a gesso underlayer needs to be reconstructed; however, it is not an ideal white pigment due to its low refractive index, its absorptive nature, and its affinity for water.

White china clay (kaolin, white bole) has a wonderfully warm and soft optical quality, that reads more naturally than zinc or titanium whites. Inpaints

containing kaolin (frequently added as a filler in clay-coated and other papers) may be burnished after application and drying to align the clay platelets and provide increased surface uniformity and sheen. When adding kaolin to inpaints, moderation is advised and additional medium is recommended; paints comprised primarily of kaolin pigment with insufficient binder have poor adhesion and may crumble and/or spawl.

- B. Extenders, Fillers, and Matting/Flatting Agents (JB):** The conservator is encouraged to study and explore the use of inert fillers and matting or flatting agents used extensively by the paint formulation industry. Examples of particles that may have applications for paper inpainting are silicas (natural and fumed), glass balloons, talc, kaolin, alumina, and so on. For an introduction to the properties and applications of these paint modifiers, refer to bibliography entry under Federation of Societies for Coatings and Technology.
- C. "Natural" Pigments, Pigments with Low Tinting Strength, and Gritty Pigments (JB):** The eye adjusts easily to pigments of natural derivation (i.e., natural iron earths) or pigments of low tinting strength, which can be added in tiny amounts to produce very subtle color shifts in inpainting, enabling great control. For some toning or inpainting situations, a pigment may be selected not as much for its color as for its individual appearance or configuration. For instance, charcoal black has large, splintery particles that stand out visually and produce a wonderfully gritty effect, very different from the uniform black produced by ivory black. Viridian, silicas (available in a wide range of mesh sizes, natural and synthesized), green earth, certain iron oxide earths, and Van Dyke brown (the latter not especially stable or permanent) have visibly gritty particles and may be effective for certain inpainting effects. To gain the benefit of the pigment grit, one must begin with pure pigments, rather than paints where the pigment grit has been negated by extensive grinding.
- D. Specialty Pigments (JB)**
1. Interference, iridescent, pearlescent or lustrous pigments: Nacreous pigments comprised of tiny mica platelets coated with thin films of titanium dioxide, and/or iron oxide or other pigment, to form a wide range of luster, "metallic" (emulating shades of metals such as gold, silver, bronze, copper, etc.) or color effects. These pigments are essential for matching iridescent or pearlescent colors appearing in modern prints and acrylic dispersion paints on paper. With good stability and lightfastness, pearlescent pigments are excellent substitutes for pigments made from metal flakes, which oxidize and tarnish. The pure pigment may be mixed with the medium of choice or mixed into other paints as needed. Refer to literature and samples from: Mearl Corporation (Mearlin Luster Pigments), 217 N. Highland Ave., Ossing, NY 10562, 915-736-3300, 800-253-8605 (fax); and EM Industries (Afflair Pearl Lustre Pigments), Plastics & Coatings Group, 5 Skyline Drive, Hawthorne, NY 10532, 914-592-4660.
 2. Fluorescent pigments: Known under the trade name "Day-Glo", these brilliant modern pigments are found in silkscreen or other prints from the 1960's to the present. Available in approximately ten colors, these pigments contain

dyes that absorb invisible and near visible ultraviolet light, giving off a glowing emission of a longer wavelength than that absorbed. With exposure to light and aging, these pigments lose their fluorescent strength and the dye component may fade as well; nonetheless, Day-Glo's are indispensable for replicating the effect of Day-Glo paints used on artifacts by Pop and other artists. For literature and samples contact: Day-Glo Color Corp., 4515 St. Clair Ave., Cleveland, OH 44103, 800-289-3294.

3. **Metallic pigments:** Bronze, aluminum, and other flake metal powder pigments are reactive and not recommended for most paper compensation applications as they readily tarnish, turn dark brown-green, and can interact with paper and/or metal.
4. **Gold powder and/or gold leaf:** Powdered true gold (either commercially prepared, or prepared in the conservation studio by grinding scraps of gold leaf) is inert and may be mixed with a binder of choice (e.g., gelatin in water or Acryloid B-72 in solvent). Gold powder, and/or continuous gold leaf, are indispensable for accurately matching true gold found on artifacts. To produce gold powders in a wide range of colors, select desired shade of gold leaf; add leaf to a honey-water slurry and grind with a mortar and pestle; rinse with water, pour into a tall jar and allow gold to settle; decant rinse water, rinse and allow to settle again; decant water and allow gold powder residue to dry. Note, however, that the use of true gold to compensate gold losses may make it difficult to distinguish restorations from original.

30.3.3 Compressed Stick and Pencil Colors

- A. **Charcoal:** Made by carbonizing wood sticks and composed of grey-black splintery particles. Available as vine or compressed charcoal sticks, or in pencil form. No binder is present in charcoal sticks. (Jirat-Wasiutynski, 1990, 122-4) Some pencils, such as Conté brand charcoal pencils, may contain additives such as waxes, clay, and finely ground pigments.

Working characteristics: Charcoal can be blended depending upon degree of hardness; vine charcoal sticks are fairly friable. Vine charcoals often tend toward a warm brown-black, and cover less well than compressed charcoal sticks, which are usually a bluer black.(CF) A brushable black paste can be made when charcoal particles are mixed with methyl cellulose.(CH)

- B. **Graphite:** Manufacturing process of synthetic graphite leads is basically the same as when first developed in 1794 - graphite powder is mixed with fine clays, dried, and then fired. Historically, antimony, spermaceti and other waxes, shellac, rosins, gums, and at times lamp black were added. (Watrous, 1957, 142) Graphite is available in stick, pencil, and powder forms. Hardness of stick or pencil varies with proportion of graphite to clay; "waxes or fatty oils are frequently used to impregnate rods to improve smoothness of marks". (Newman, 1980, 33-34) Degree of hardness ratings: H hard, HB medium, and B soft; numbers, in ascending order, designate higher degree of hardness or softness within appropriate category.

Working characteristics: Graphite can be blended depending upon degree of hardness. Appears shiny and slightly iridescent. Tone and metallic sheen are controlled by graphite hardness and application technique. Softer forms of graphite can be smudged or transferred if heavily applied.

C. Chalks: Natural and fabricated black, white, red, and brown chalks.

Natural chalks: Black chalk's principal ingredients are carbon and clay. White chalk is composed of calcite (calcium carbonate); however, another chalk not often found is soapstone, a variety of talc (hydrous silicate of magnesium). (Watrous, 1957, 106,108) Red chalk contains iron oxide from the mineral hematite and clay; presence of clay increases softness. Today natural chalks are rarely available in stores.

Fabricated chalks: Traditionally contained a binder of gum tragacanth; cellulose ethers often are used today. See 30.3.3.E Pastel sticks.

Working characteristics: Chalks are blendable and may smudge or transfer if heavily applied. Can be difficult to control in stick form when inpainting small areas. Chalks can be applied dry or wet with brush, etc. or mixed with binders.

D. Conté Crayons: Made of compressed pigments and binder; are grease-free and harder than pastels. Colored pigments or dyes appear to be added to obtain various shades of greys. Sanguine crayons have a kaolin base containing red iron oxide (Daniel Smith Inc. catalog).

Working characteristics: Conté crayons feel slightly brittle yet waxy compared to charcoal, chalk or pastel. They are somewhat blendable, but are more resistant to gentle smudging than pastels. Although, generally matte in appearance, they are more shiny than pastels.

Reversibility: Conté crayons tend to be more difficult to remove from paper than some other dry media possibly due to clay component and relatively fine particle size.(DDM)

E. Pastel Sticks: Composed of pigments, aqueous binder, and fillers. Binder was traditionally a vegetable gum (often gum tragacanth) or proteinaceous glue; today methyl cellulose or similar cellulose gums are used. Clay, plaster of Paris, kaolin, alabaster, zinc and titanium whites, silica, and aluminum are added as fillers to obtain tints and give body to the sticks. Fungicides may be added because pastels are susceptible to mold growth; however, synthetic binders, such as methyl cellulose, are less vulnerable. (Ellis, 1987, 85) Light stability is dependent upon pigments or dyes found in particular pastel sticks - most light-stable colors tend to be inorganic pigments; least stable tend to be organic pigments. Pastel sticks are sold in three grades - soft (most common), medium, and hard.

Working characteristics: Pastels are blendable, but can be easily smudged or transferred if heavily applied. Are generally matte. Can be difficult to control in stick form on small losses. Pastels may be applied dry with brushes, absorbent tips, etc. or mixed with binders. Ground pastel can be applied with wet brush, then burnished or texturized afterwards.(RA)

Common brands / manufacturers: Rowney soft pastels (England), Schmincke soft pastels (Germany), Rembrandt soft pastels by Talens (Holland), Sennelier soft pastels (France), Grumbacher soft pastels, Lefranc & Bourgeois pastels (France), Girault soft pastels, and Conté Color Crayons.

- F. **Pastel Pencils:** Composed of pigments mixed with binder, fillers, and other components. See 30.3.3.E Pastel sticks.

Working characteristics: Pastel pencils are blendable, appear matte, and are more controllable than pastel sticks. Water and organic solvent sensitivity depends upon brand and color composition of each pencil.

1. Carb-Othello colored pastel pencils, manufactured by Schwan-Stabilo: Composed of 2.5% water-soluble cellulosic binder (added for durability), 70% mineral compounds (responsible for chalky character of these pencils), 10-30% organic and inorganic pigments, 2% metallic soaps, and 1% preservative. (Norris, 1993 draft, 11)
2. Conté Pastel Pencils: Leads of pastel pencils harder than pastel sticks (product literature). Seem to be more friable than Carb-Othello.

- G. **Colored Pencils:** Contain organic and inorganic pigments, fillers (clays or talc), cellulose ether binders, and wax. Proportions may vary greatly among brands. Cheaper versions contain less pigment and more wax, and are softer and have inherently lower color strength. (Owen, 1985, 58)

Working characteristics: Colored pencils are blendable, but not overly friable; however, they can transfer if applied heavily. May appear more glossy on application than pastel pencils, especially on soft papers. This can be avoided by repeated light application of pencil versus a single heavy application. (PV) Water and solvent sensitivity depend upon brand and color composition of pencil and amount of liquid present. Will transfer if heavily applied and not coated or fixed. Can be used directly or mixed with binders. Can be applied dry and then brushed over with mineral spirits, etc. to achieve a wash effect. Harder pencils can scratch the surface of some papers to which they are applied.

Reversibility: Colored pencils can be reduced partially by eraser. They tend to be more difficult to remove after having been applied wet. Use of isolating layer increases reversibility by eraser or damp swab.

Stability: There is great concern for light stability of colored pencils: "In general, earth colors (including grays) exhibit excellent to very good lightfastness. Blues, greens and often yellows, however, are very inconsistent varying significantly in stability from one manufacturer to another. Finally, the violets, reds, oranges, and pale tints are often problematic and most susceptible to significant fading upon exposure to light." (Norris, 1993 draft, 12-13) Lightfastness of lake pigments (e.g., purple magenta and dark violet) is poor. Manufacturers often vary pigments and dyes, so the conservator should test each individual pencil for lightfastness. ASTM and pencil manufacturers are working on quality standards and labelling to be adopted in the near future. After testing, the National Artists Equity Association concluded that half of the

pencils in any manufacturer's line fade significantly and no one brand is clearly superior to the others.

High wax content of some colored pencils increases the possibility of formation of bloom upon exposure to high relative humidity when media is thickly or heavily applied. (Norris, 1993 draft, 14)

1. Berol Prismacolor pencils: Composed of methyl cellulose binder, kaolin and bentonite clays (for additional strength), 20-30% wax, and are heavily pigmented with both inorganic and organic pigments. High pigment concentration results in good covering power. (Norris, 1993 draft, 12) Berol also manufactures Verithin colored pencils which are harder, less creamy, and slightly more erasable than Prismacolor pencils.
2. Derwent Studio pencils, manufactured by Rexel Cumberland in Great Britain: Composed of natural clay filler, hydroxypropyl-cellulose binder, and organic and inorganic pigments. Hardness is controlled by the addition of wax (about 15%). Manufacturer will provide lightfastness chart that includes rating system based upon the British Standard Blue Wool Scale (BS 1006) Method of measuring colorfastness to light. (Norris, 1993 draft, 12)

- H. Colored Water-soluble Pencils and Crayons:** Some colored pencils and crayons are made with water-soluble binders and dyes. These tend to be more commonly used for toning inserts than for inpainting directly on artifacts. If used for inpainting, water sensitivity of pencil or crayon could preclude subsequent water treatments due to possible bleeding.

Working characteristics: Water-soluble pencils and crayons are similar to other colored pencils. In addition, they may be applied dry and then gone over with a wet brush, or dipped into water and applied damp.

Reversibility: If applied dry, these pencils and crayons can be reduced partially with eraser, but are more irreversible if applied wet.

1. Derwent Watercolor pencils, manufactured by Rexel Cumberland in Great Britain: Made with water-soluble dyes. Fuchsia, bluish red, and purple colors are especially fugitive. (National Artists Equity, 1993, 1)
 2. Derwent Water-soluble Sketching Pencils: Similar in appearance to graphite with unaided eye; however, under the microscope, seem to contain both graphite and black pigment or dye.
 3. Caran d'Ache Neocolor II water-soluble crayons and soft pencils: Made in Switzerland.
 4. Holbein water-soluble soft pastels.
- I. Other Pencils:** Conté black sketching pencils (Pierre Noire pencils, Carbon pencils, Special Carbon): Made of waxes, clay, and finely ground pigments (carbon black and lamp black). Powdered ingredients are mixed with water and several plasticizing agents, and then dried. Carbon pencils are more dense and shiny than Pierre Noire pencils. (product literature)

Working characteristics: These sketching pencils are somewhat blendable and water-soluble. See 30.3.3.H Colored Water - Soluble Pencils and Crayons.

- J. **Crayons:** Crayons are described as drawing materials containing oily, waxy or greasy components or combinations of water-soluble and fatty binders. They are used infrequently for inpainting directly on objects due to limited reversibility.
1. Lithographic crayons: May contain lamp black, wax, tallow, spermaceti, soap, and shellac. (Watrous, 1957, 120; and Mayer) Available in range of softness.
 2. Oil pastels and sticks: May contain oils (linseed or vegetable), waxes, and pigments.
 3. Wax crayons

30.3.4 Wet Media

A. Pan or Tube Watercolors and Gouaches

Watercolors contain pigments dispersed in water and gum arabic, vegetable gums, or dextrin; and may include plasticizer (such as hydromel or sugar water), glycerine to keep paint moist, wetting agent, and preservative. (Mayer, 1981, 426) Gouaches contain the same ingredients as tube watercolors, except they include more pigment and an inert, such as blanc fixe, to produce a matte surface and opacity. Lithopone, composed of zinc sulfide with barium sulfate and titanium dioxide, is found in some contemporary water-based paints, such as poster colors and cheap watercolors. (Gettens and Stout, 1966, 125; SB)

Special note: Modern watercolor and gouache may differ from traditional paints. Check the product label carefully. For instance, some products with "gouache" in the title actually contain an acrylic component.

Working characteristics: Watercolor and gouache can be diluted with water and applied directly or mixed with other binders, solvents, and media. Either a transparent or an opaque appearance is possible depending upon dilution and application, pigment type, or mixture components. Gloss can be adjusted with addition of other binders. When toning fills, increased penetration and evenness of tone can be achieved by adding glycerine as a wetting agent.(BF)

Reversibility: Watercolor and gouache may be reduced with damp swabs depending upon age and penetration of the inpainting layer into the paper, as well as the paint composition. Reversibility increases with application of an isolating layer or addition of a resoluble binder, e.g., methyl cellulose.

Stability: In watercolors, the pigments are not protected by excess binder as in oil or acrylic paints and therefore, are more vulnerable to light and pollutants. Also, they tend to be applied in thin films exposing pigments to increased exposure and subsequent damage. References on the stability of pigments and watercolor paints are ASTM D5067 Standard Specification for Artists' Watercolor Paints and The Wilcox Guide to the Best Watercolor Paints by Michael Wilcox. Manufacturers may change components so conservators may need to test individual paints for lightfastness.

1. Manufacturers include: Winsor & Newton, Grumbacher, Schmincke, Rowney, Lefranc & Bourgeois, etc.
2. Winsor & Newton Brilliant Watercolors: Watercolor liquids sold in bottles; manufactured from dyes and have limited lightfastness. (product literature)

3. **Photographic retouching paints** (e.g., Marabu Retouch Set, Schmincke Positive Retouching Colors): These are essentially watercolor or gouache paints composed of pigments bound with gum arabic, dextrin or "sugary substance". Colors are available in matte and glossy and appear somewhat opaque when applied. (Norris, 1993 Draft, 11 / 12) Some conservators suspect that dyes may be mixed with pigments for certain colors.
- B. Extract from Boiled Discolored Paper:** Prepared by soaking or cooking old, discolored paper scraps in water and evaporating the liquid. pH can be adjusted with calcium or magnesium compounds. The residue can be remoistened with water similar to pan watercolors. (Perkinson, 1984, 110) Extract was tested at the Smithsonian Institution in 1977 / 78 at request of Katherine Eirk and found to contain short-chain sugars from degradation of sizing and cellulose.(JW) Some conservators have reservations because the extract may be acidic and possibly harmful to the paper substrate over time, and because of unknown light stability and reversibility. Thus, while useful for inserts, it may not be appropriate for application onto original.(LHP) Mold growth was found on distillate "cake" even after initial and repeated washing of paper scraps to remove adhesives.(ECL)
- C. Drawing Inks:** Composed of finely ground pigments or dyes dispersed in aqueous binder with a wetting agent and preservative. India and sumi inks are carbon-based; some fountain and felt-tip pen inks are dye-based. Binders of water-resistant inks contain shellac or rosin combined with borax. (Watrous, 1957, 69) Black waterproof inks usually are composed of carbon black pigment in a colloidal solution of shellac soap (or synthetic resin); chromatic waterproof inks contain pigments, chiefly organic, in the same formulation, or aqueous anionic or cationic dyes in shellac solution. (Bredereck, 1988, 115) Inks tend to be glossier than watercolors.
 1. Winsor & Newton Drawing Inks: Pigments (black, white, gold, and silver inks) or dyes (all colored inks) in shellac. (product literature)
 2. Higgins India Ink: Waterproof black ink by A.W. Faber-Castell.
- D. Printing Inks:** Printing inks can be diluted with organic solvents and applied with a fine brush to bridge areas of design loss in printed areas.(PV)
- E. Acrylic Resin Paints:** Contain pigments in acrylic resin(s). Used frequently by paintings and objects conservators. Dilution with solvents required for translucent effects. Tend to remain soluble in organic solvents. Can be modified with acrylic resins.
 1. Lefranc & Bourgeois Restoration Colors (recently renamed Charbonell Restoration Colors): Pigments preselected for lightfastness. Bound in resin mixture of isobutyl methacrylate in cyclohexanone. By combining resins, working properties result in greater flexibility, increased gloss, and less yellowing. Remain soluble in benzene. (Norris, 1993 draft, 18)
 2. Magna Bocour: Manufacturer recently went out of business. Remains soluble in xylene and toluene. (Norris, 1993 draft, 18)
- F. Acrylic Dispersion Paints:** Composed of pigments in acrylic polymer or copolymer dispersion of acrylic acid, methacrylic acid or acrylonitrile.

(Sometimes termed latex, acrylic latex or polymer emulsion paint.) (Norris, 1993, 16) Acrylic dispersion paints may contain additives including plasticizers, anti-foaming agents, thickeners, fungicides, wetting agents, etc. Labels often list pigment(s) present and lightfastness rating. Acrylic dispersions are most often used to tone inserts and lining papers.

Working characteristics: Acrylic dispersion paints can be thinned with water for application, but when dry are water resistant. Tend to appear opaque unless diluted. Can be "fattened" with unpigmented acrylic medium for glazing or shinier effects.(CF) Acrylic matte or gel medium may be mixed with or applied over areas of retouching to match surface gloss.(PV)

Stability and reversibility: Yellowing of the acrylic emulsion binder may occur, although this may not be a function of binder degradation. At early stages of aging, acrylic dispersions are soluble in acetone, benzene, alcohol, and toluene. Later, "stronger" organic solvents may be required to swell the paint film. (Norris, 1993, 16-17)

1. Brands include: Liquitex Acrylic Artist Color, Winsor & Newton Artists' Acrylic Colour, Golden Artist Colors, etc. Liquitex and Golden paints are formulated with Rhoplex acrylic dispersion binder modified with general additives.
2. Winsor & Newton Liquid Acrylic Color: Pigments in an alkali soluble acrylic solution (Winsor & Newton product literature). These are transparent colors with a consistency similar to ink. Are diluted with water, but are water resistant upon drying. Reversibility and light stability unknown.
3. Turner Acryl Gouache: Contains an acrylic emulsion which makes paint more resistant to water than gouache, but paint dries to a matte surface similar to Turner's Design Gouache. (National Artists Equity, Winter 1994, 3)

G. **Vinyl Paints:** Composed of pigments in vinyl-based binder. They are slightly to readily reversible in ethanol. Very good for retouching matte screenprint surfaces such as those found in Andy Warhol prints. Brand name: Flasche by Lefranc & Bourgeois. (PV)

H. **Dyes:** For description of dyes used in retouching photographs see AIC/Photographic Materials Group Conservation Catalog, Inpainting of Historic Photographic Prints, Norris, 1993 draft.

30.3.5 Other Media

- A. **Colored Waxes:** Pigments ground in microcrystalline wax can be used as toned filling material or as inpainting media; especially good for filling losses in serigraphs and clay-coated papers. Applied warm and cleaned up with benzene; can be burnished to match sheen.(HK)
- B. **Dry Cellulose Powder:** Whatman cellulose powder available from Fisher Scientific. Microcrystalline cellulose (FLUKA) has a smaller particle size than alpha cellulose powder.(LHP) Cellulose powder has been used for filling small superficial losses in paper support or along tears, and for covering dirty tear edges, abraded areas, etc. Powder, originally white, can be "toned" by heating on a hot plate, periodically stirring the powder to get even darkening of color.

Range of colors from beige to brown can be obtained by adjusting heat and time. (See 30.4.9.A Use of Paper Fibers or Cellulose Powder for notes on application.)

Cellulose powder deteriorated by heating or roasting can release discoloration when wet, can change tonal value, and can cause staining. (DDM) Burned cellulose should be washed to prevent bleeding of tone, via paste or cellulose ethers, into original. (BF)

30.3.6 Additional Binders or Coating Materials

Additional materials can be added to inpainting media to act as a binder for dry pigments or pastels, to adjust solubility and thus reversibility, to alter viscosity, and to adjust gloss. Coatings may be applied over inpainting to seal media or adjust gloss. See AIC/BPG/PCC 46. Adhesives for description of characteristics, stability, and preparation of the following materials.

- A. **Cellulose Ethers**
- B. **Gelatin**
- C. **Gums:** Historically used by artists, but not generally used by conservators because of tendency to crack when heavily applied. May be used to attempt to match gloss of original gum coating.
- D. **Acrylic Resins**
- E. **Acrylic Dispersions:** Liquitex Acrylic Gloss Medium and Varnish, acrylic dispersion adhesives (Rhoplex, Plextol, Lascaux, etc.).
- F. **Polyvinyl Acetate Resins**
- G. **Wax or Paraffin:** Can be mixed with heptane and applied to surface, then burnished or texturized as appropriate. Reversible with heptane. (RA)
- H. **Wondersol:** "Often used by photographic 'retouchers' in an airbrush to 'seal' each layer of retouching, or added to gouache to assist in its flow. According to manufacturer, Retouch Methods, Inc., Wondersol consists of gum arabic, methanol, water, and a preservative Moldall. Everything goes into suspension and the mixture is allowed to settle for six months. Undissolved gum arabic is skimmed off the top of the solution before it is packaged in a plastic jar fitted with an eyedropper lid. This material may be considered to increase gloss on finished inpainting." (Norris, 1993 draft, 13; HM)
- I. **Aquapasto:** Is a soft translucent gel which contains gum arabic and silica, and when mixed with watercolor or gouache enables thicker layers of paint. Full impasto is best achieved with two or more applications, rather than one thick application. Manufactured by Winsor & Newton. (product literature)

30.3.7 Tools and Supplies

- A. **Application Tools:** Cotton swabs, blotters, sponge pastel blenders, erasers (manual and motorized), wooden skewers, cotton, tortillions and stumps, polyester film (Mylar), toothpicks, absorbent dental tips (Healthco), air brush, drafting masks.

- B. **Brushes:** Large mop watercolor brushes for preparing inserts, fine point (00-0000) sable brushes, stipple or blender brushes. Small stipple brushes can be created by cutting off the ends of pointed watercolor brushes. Caution should be taken not to wet ferrule of brushes with mouth as some pigments may be toxic.(PV)
- C. **Palettes and Mixing Equipment:** Ground glass, unglazed ceramic dishes, sandpaper, aluminum pans, beakers, small pieces of glass or plexiglas, disposable paper palettes, plastic pans.
- D. **General Tools:** Hair dryer, knife or scalpels, microscope, magnifiers. Dremel tool or other precision grinding tool can be invaluable for shaping and sharpening knives and scalpels to be more fitted for special use.(RGC)
- E. **Burnishing Tools:** Bone folders, small Teflon spatulas, agates, curved dental tools, fingernail, cotton swabs, polyester web, Japanese tissue.

30.4 Treatment Variations

30.4.1 Technical Considerations

- A. **Order of Treatment Procedures:** Inpainting is one of the last procedures to be carried out during treatment of an object. Wet treatments, stain removal, etc. should be undertaken before inpainting. If flattening is the final procedure, the object should be humidified and dried so as not to disturb inpainting.
- B. **General Working Tips:** During treatment, review inpainting in several lighting situations (incandescent, natural, fluorescent; specular, raking, normal) and in both horizontal and vertical positions. Step away many times so visual considerations are fresh. Test on extra material from insert or similar paper. With translucent papers and repairs, consider what the work of art will be against (e.g., mat board); color of mat will affect color of support and insert. Also see 30.2.6 Considerations During Inpainting.

Objects which are lined using a stretch drying technique (such as with "Dacron", plexiglas, karibari board, etc.) may be more easily inpainted if the object remains under restraint, especially where much moisture is needed.(TKM)

- C. **Pretreatment of Area:** Pretreatment of the area to be inpainted can determine whether results are successful. Ensure that the texture, relative gloss or matte appearance, planar conformity, etc. correspond prior to applying color. Color match or approximation will not be successful if the underlying structure is not matched.(AD)
 1. Set down lifted fibers in abraded areas with moisture or adhesive (wheat starch paste, methyl cellulose, methyl cellulose/ carboxy methyl cellulose mix, gelatin, etc.).
 2. Damages (such as gouges) or irregular surfaces may need to be filled with paper fibers, cellulose powder, or other appropriate material before inpainting.
 3. Edges of original at tears and losses should be thoroughly cleaned before filling.(TKM)

4. Textures can be created on an insert paper using a variety of tools. Also, small pieces of glass, plexiglas, felts, etc., even wooden surfaces, can be used to "print" textures on fills (for instance wood texture in Japanese print); this is best done before the fill is cut and placed.(JW)

D. Color Matching (AD)

1. Err on the side of slightly lighter and cooler than surrounding color.
2. Relationship of warm-to-cool color matching is very important. Often building up a color by mixing (e.g., a cool blue with yellow to create a green) will be more successful than directly applying a single color.
3. One can create a color that will read as "dark" but not be as harsh as black by mixing dark blues, brown or red with black.
4. To lighten a black, keep the color warm and lighten gradually by adding raw sienna or a yellow oxide as an alternative to adding a white, which tends to make the black go cool and bluish.(JB)
5. Build up several layers of the same or different colors to simulate the complexity of the artifact, rather than an obviously single color application. Also, gradually adding layers aids color approximation.(IB)
6. A blotter with a hole cut in the center can be placed over the color field to be matched to permit viewing without distraction from adjacent colors.(JW)

- E. Use of Complementary Colors (DDM):** When toning an insert paper to match the base paper tone, it is often advisable to work using the principle of complementary colors. Utilizing complementary color pairs when selecting the color to apply gives one the ability to significantly alter the resulting color using very little amounts of toning medium. Keeping toning medium to a minimum helps maintain the translucent quality which is so important in replicating a convincing paper tone. For example, if a paper is becoming orange-brown, instead of adding a darker brown to compensate, add a very thin wash of a blue (or terre verte). An extremely small amount of blue is all that is required to neutralize the orange tone and the resulting color appears more natural and less like a painted surface.

F. General Notes on Color Application

1. Consider stippling in several different tones so the eye does not settle on and discriminate the inpainted area from the artifact.(AD)
2. Do not overwork the area as colors can become muddy and less convincing.
3. Selectively blotting a freshly applied aqueous compensation with Kimwipe tissue will lessen an overly thick and opaque application and help to create a color field that is less flat and artificial looking.(CH)
4. Consider adding "fox marks", "flyspecks", and "soiling" to an insert so that it blends better with the original support. Stains, abrasions, and other signs of wear in the artifact which have been interrupted by a loss can be simulated in the insert.(CF)
5. To compensate losses in which the edge of the original is discolored, best results may be achieved by toning the insert to match the paper rather than the staining, and then blending the edge color slightly.(TKM)

6. Adjust translucency of fills on an thin object using acrylics on reverse; tone front with watercolors, etc.(TKM)
7. If inpainting black lines on an off-white support (e.g., in the case of an engraving), be sure to match tone of support on insert before adding lines. It is essential to get the basic match correct before detail is added.(CB)

30.4.2 Application of Isolating Layer or Size

The presence of an isolating layer or size prevents absorption of wet media by paper fibers, reduces embedding of powdered pigments, and provides a distinct layer to allow easier removal of inpainting materials. Thin layers of methyl cellulose, other cellulose ethers, gelatin, etc. may be applied locally to the object in areas to be inpainted and allowed to dry before inpainting. In some cases, it may be necessary to build up the coating by applying several thin layers. Insert papers may be immersed in size solution or coated by brush. Consider stability and reversibility of isolating layer since some materials can be difficult to remove entirely. Consider also the potential darkening and planar distortions of the support when using water-based materials.(CF)

Japanese paper fills can be surface sized with 1-5% gelatin to receive color more evenly and absorb less.(BF)

30.4.3 Application of Dry Materials

- A. **Dry Media in Stick Form:** Pastels, charcoal, crayons, etc. can be applied directly; however, because of their chunky form and often friable nature, they tend to be applied in powdered form using brushes, etc. (See 30.4.3.C Crumbled Dry Media). In stick form, they are used more often for toning inserts where they are applied directly and then blended with fingertips, swabs, brushes or stumps. Application tools/ sticks can be formed to a point using knives or sandpaper.

Drawbacks: Pastels, chalks, etc. are often too crumbly and uncontrollable in stick form for inpainting small losses. If applied heavily, they may require coating to prevent accidental smearing or transfer. One must keep in mind, however, that coating, particularly in the case of pastels, may alter the colors causing darkening and / or a shift in hue.(RGC) Pastels may tend to gather at edges of losses and be subsequently difficult to remove.(AS)

- B. **Dry Media in Pencil Form** (pastel, colored, charcoal, and graphite pencils): Pencil media can be applied directly to losses and inserts. Are easy to apply, controllable, and blendable. Colored pencils are fairly containable, do not penetrate into paper, and can be burnished to a high gloss. Sensitivity to water and organic solvents is dependent on type, brand, and specific color composition of pencil.

Drawbacks: A continuous layer may be difficult to achieve depending upon pencil type and texture of paper substrate; may need to combine pencils with other media (e.g., watercolors) to increase coverage and density. Smudging or transfer of these media may be problematic; if applied heavily, may require coating to prevent transfer, though coating may darken color. Pencils with hard points may scratch and damage the paper support, and will easily

burnish paper texture. Color pencils may impart an undesired gloss to the paper surface.(IB)

C. Crumbled Dry Media:

1. Dry application: Crumbled pastel sticks, scraped colored pencils, and dry pigments can be mixed in a container or on a palette, sheet of sandpaper, or paper/blotter to form powders of the desired color. Palette made of ground glass or masking tape strip on glass provides for slight tooth without losing all color into absorbent blotter.(JW) The mixture is applied with pointed or stipple brushes, absorbent tips (Healthco), swabs, stumps, blotter tips, toothpicks, etc. Excess powder can be removed with swabs or brushes, dry or moistened, or can be picked up with kneaded erasers.

Drawbacks: Smudging of media may be problematic depending upon application. Some papers may be too slick for dry media unless the media are rubbed into paper substrate or applied wet or with binder. Some papers may be too pulpy or soft to withstand manipulation of applicator.(DDM)

2. Dry application: (AD) Locally "humidify" or moisten area so dry media can be held while it is being manipulated and not smudge adjacent areas. (Note that the paper is not wet.) Alternatively, apply a thin layer of methyl cellulose or gelatin to the area. Stipple on color in a series of thin coats using a pointed or stipple brush. Burnish with Japanese tissue (Uda) or Hollytex, and cover with a weight until dry. Repeat until color and density is appropriate. A final thin layer of methyl cellulose or gelatin may be applied, but generally is not necessary.
3. Wet application: Pastels, dry pigments, and powdery colored and graphite pencils can be mixed with a damp brush, water, ethanol, or binders such as methyl cellulose, gelatin, acrylic resin or dispersion, polyvinyl acetate resin, etc. Better color buildup may be achieved with wet application than when powdered media are applied dry. Variations in gloss depend on the type and amount of binder.

Powdered pastel colors can be also easily blended in wet condition to achieve a particular tone. Check dried color first before application. Useful for inpainting small blemishes on pastel paintings. Addition of small quantity of ethanol to pigment mixture will facilitate transfer of pigments onto support (especially when pigments will not adhere to the paper well). Working with ethanol as a carrier facilitates color mixing and application, and inpainting dries quickly. Be aware of danger of wicking water/ethanol into surrounding areas. Check ethanol compatibility of pigments.

- D. **Wet Application of Colored Pencils:** Water-soluble colored pencils can be applied dry and then brushed over with water, or the tip dipped in water and applied damp for ease of application and to achieve intense color.(HK) Colored pencils can be applied similarly using mineral spirits, etc. instead of water.

30.4.4 Application of Wet Media

- A. **General Techniques:** The following techniques can be used for toning inserts as well as for inpainting.

1. Watercolors, inks, and other paints may be diluted with appropriate solvents and applied directly with small brushes. Applying wet media with a fairly dry brush by touching the brush on blotting paper may prevent wicking of media by paper substrate.
2. To achieve continuous flat tones, first spray or brush with water the area to be treated. This will prevent the formation of hard edges. Then apply watercolor.(AD)
3. Stipple brushes can be used to create patterns as found in spatter or crayon lithographs. Also, a stiff brush loaded with color which is flicked onto the toned fill simulates a stipple effect.(HK)
4. Wet inpainting media can be selectively picked up with dry or moistened blotter tip or swabs to soften or blend toning. Erasers can be used to lighten watercolor when already dry. Care should be taken not to alter the original surface when working directly on an object.
5. Wet media, such as acrylic emulsion paints and watercolors, change color when dry.
6. Reversibility of wet media is increased by the presence of an isolating layer and/or by the addition of a large molecule resoluble gum, such as methyl cellulose or carboxymethyl cellulose.

B. Notes on Watercolor and Gouache

1. Considerations relating to transparency of watercolor pigments: Organic pigments tend to be transparent, inorganic pigments from metals tend to be opaque. However, some transparent colors have high tinting strengths and can stain the paper and overpower underlying colors (e.g., alizarin crimson has high staining power). (Weingrod, 1991, 15) Opacity may be more easily achieved with gouaches than with repeated layering of transparent watercolors.
2. Watercolors can be applied in a single layer or in several layers utilizing the transparent nature of some pigments to create a third color.
A hair-dryer can be used to dry watercolor stippling as it is applied to effectively build up layers of tones and to prevent lifting of underlying paint layers. Also, this technique prevents the formation of tide lines.(AD)
3. It may be difficult to achieve dense or dark passages by layering watercolor washes due to tendency of previous layers to be picked-up by damp brush. Acrylics can be layered more successfully.
4. Some watercolor pigments "settle out" when mixed in dilute solutions. Frequent stirring helps maintain a well-blended mixture.
5. Cellulose ethers, gelatin or gum arabic can be added to watercolors to increase viscosity, alter gloss, and improve handling. Gum arabic, if thickly applied, may crack. Gloss can be adjusted by the proportion and choice of cellulose gum (e.g., carboxymethyl cellulose tends to have less gloss than methyl cellulose).(JB)
6. Pastels or kaolin may be added to watercolors to increase matte appearance.

7. Alternating layers of colored pencils and watercolors have been used to build up dark or opaque passages, and to simulate some printing inks.

C. Extract from Old Papers: Can be used like pan watercolors. May be mixed with watercolors to make a color look "old".(JW)

D. Notes on Acrylic Paints

1. Acrylics (aqueous dispersion-based or solvent-resin based) may be used for inpainting oil on paper, imitating heavy-bodied screenprint or lithographic inks, and inpainting losses on water-sensitive (tempera block-print) historic wallpapers. One may also choose to use non-aqueous media, such as solvent-based resin acrylics (Lefranc & Bourgeois or Magna) for compensations that will "hold" (won't travel or bleed) on artwork to receive aqueous treatment. Adjust surface characteristics by the addition of more medium (glossy or matte), the addition of dry pigments (to absorb excess medium present in prepared paints), or by the addition of small amounts of matting or flattening agents (e.g., silica). Matting agents should be added sparingly as excessive amounts will result in a greying or chalking of the color.(JB)
2. Acrylics can be layered more successfully than watercolors. Apply many thin layers, allowing each layer to dry first.(AD)
3. Acrylics can change color when dry and tend to appear opaque unless thinned with water.

E. Adjusting Diluent (JB): Behavior and handling of inpainting media can be modified by adjusting the diluent formulation. For watercolor media, acetone may be added to replace a portion of the water in the diluent (i.e., 20% to 60%) to produce paints with speedier evaporation and less tendency to travel. For solvent-resin acrylics, slow evaporating solvents, such as xylene, may be used for long working times; speedier mixtures, incorporating benzene and acetone (or toluene, although to be avoided for its noxiousness) will produce faster evaporating inpaint. Faster evaporating mixes may be helpful for brush recreation of crisp, "high-standing" printed intaglio ink lines.

30.4.5 Notes on Toning Inserts

- A.** Flat tones on large inserts may be achieved before final shaping and attachment to the object by using an airbrush with diluted watercolors, acrylic paints, inks, etc. Areas not to be toned can be masked. Practice is required to control dripping and unwanted spray from airbrush. Also, splatter effect on lithographs can be simulated using airbrush.
- B.** Background color of inserts may be painted with one type of media while the design may be drawn with another. Acrylics can be used for basic tone or background color on fills or inserts; then watercolors can be used for design or to make final color adjustments without disturbing the bottom layer.(ECL, CM) Alternatively, watercolors may be used for background toning, and then acrylics (aqueous or solvent based) may be used for inpainting design on top or for adjusting touches.(JB)

- C. On fill paper, alternate warm (red to yellow) and cool (blue to green) tones in light washes, drying between applications, to match the color of darkened older papers. Create shades of grey and brown or tone down a color using its complementary color in light washes or mixed together.(SB)
- D. After toning a large piece of paper from which smaller inserts are going to be formed, be sure to tone the edges of the fills before adhering them in place. Otherwise, lighter edges may be visible. When toning insert edges be cautious because they will generally be more absorbent, and hence will become darker than the sized surface of the paper.(CB)
- E. When fill is to be toned after adhering, apply paste to reverse of object, not to fill, in order to avoid getting an area on fill that resists toning. After fill is adhered in place, work in a drier manner or do not apply color to the edge of the juncture of fill and object; dot in edge last.(BF)
- F. A barrier line at edge of fill using paste, methyl cellulose, benzine or xylene, or Acryloid B-72 can be created if original paper is soft and bleeding from fill is a problem.(BF)
- G. For cast paper pulp inserts, pulp can be mixed with watercolor or diluted acrylic paint in blender and cast on the suction table to achieve very subtle tints.(CH)

30.4.6 Mechanical Alteration of Inpainted Surface

- A. **Increasing Surface Gloss:** An inpainted area or insert paper can be burnished with the tip of a bone folder, teflon spatula, stainless steel dental tool, or agate directly rubbed on the surface or with a barrier of polyester web, slick paper (i.e. silicone release paper, gampi tissue), polyester film, etc. to increase gloss. Buffing with cotton pad or swabs may also increase gloss. Burnishing is often accompanied by a decrease in surface texture which may or may not be desirable.
- B. **Decreasing Surface Gloss:** Insert paper may be abraded with sandpaper to create mottled or matte appearance. New, very fine sandpapers on Mylar are invaluable, but one should be careful if working near original surface.(JW) A very light application of pastel pigments may achieve a similar effect.(IB) Microcrystalline wax also decreases gloss.(JW)

See 30.3.2.B Extenders, Fillers and Flattening Agents for discussion of microballoons, silica, chalk, etc.

- C. **Creation of Texture:** Insert can be modified by moistening its surface, and using tools such as dental tools or dull knives to create various effects, e.g., dimples, incised lines, felt textures, platemarks or other embossments, etc.(CM)

30.4.7 Application of Coatings: To increase gloss or simulate a coating, inpainting can be coated with gelatin, methyl cellulose, gum arabic, acrylic resin or emulsion, microcrystalline wax, etc. Caution should be exercised, since application of coating may disturb or lift inpainting. Coating can be burnished to increase gloss.

- A. **Acrylic Resins:** Acryloid B-72 resin or Winton varnish will give inserts a higher degree of gloss than possible with methyl cellulose. These can be applied over a variety of media depending upon solvent sensitivity.(CM)

- B. **Wax or Paraffin:** Waxes can be mixed with heptane and coated onto surface. Burnish to create gloss or texturize with sandpaper, pressure and polyester web, or scalpel. Can mix with powdered pigments to create matte surface.(RA)
- C. **Achieving High Gloss:** If high gloss is required on insert paper, silicone release Mylar can be placed on coating while wet and the area put under weight until dry. Especially effective with Liquitex acrylic medium or acrylic dispersion adhesives (i.e., Rhoplex, Plextol). If necessary, repeat to get even gloss. This technique may be problematic if used directly on an object as coating material may seep beyond the desired area when heavily applied.

30.4.8 Removal of Inpainting

- A. **Erasers:** White vinyl, gum, and kneaded rubber erasers can be used to pick up dry media and lighten dried watercolors. However, pigment particles may remain in the interstices of the paper substrate.

Smearing and/or driving of pigments into fiber interstices must be avoided. Careful cleaning of eraser surface, and use of light dabbing - not rubbing - motion with first application of eraser may help to improve control. Oil transferred from hands to kneaded rubber eraser may be transferred to color surface making ultimate removal more difficult.(RGC)
- B. **Wet Removal:** Swabs dampened with water or an appropriate solvent can be used to remove watercolors and other paints. Area can be wet with water or solvents, and the inpainting lifted off with filter paper, blotters, or Japanese paper. Presence of an isolating layer will improve ability to remove inpainting. Moisture may "set" inpainting materials into the paper. Very quick application of fresh blotter to moistened area can reduce moisture penetration and limit problem of setting colors into paper.(RGC) Abrasion or disturbance of paper surface may occur during wet removal, so caution must be exercised.(CB)
- C. **Mechanical Removal:** In some cases, one may be able to gently scrape off inpainting with scalpels and pick up the particles with a kneaded eraser. This technique may cause less embedding of inpainting media into the paper than removal with moisture.
- D. **Removal of Colored Pencils:** Colored pencils can partially be reduced with eraser, scalpel, etc. Damp swabs may be used to partially lift off colored pencil, however, too much moisture may set colors or cause bleeding of media. Removal is most effective when an isolating layer or size is present. However, if heavily applied or applied wet, colored pencils can be difficult to remove. Be aware that some colored pencils are soluble in water, while some are sensitive to organic solvents, and others may be affected by both.
- E. **Pastel Removal:** In many cases, pastel or chalk particles can be picked up with the dampened tip of a small brush. A very controlled "particle by particle" removal is possible if a microscope is used.(CH)

30.4.9 Alternatives to Inpainting

- A. **Use of Paper Fibers or Cellulose Powder:** Paper fibers or cellulose powder may be used to disguise stains, the grey edge of tears, etc., and to fill gouges,

superficial losses in paper support, gaps from sprung tears, etc. in preparation for inpainting. Note that sprung tears can frequently be rejoined by partially humidifying the surrounding paper to expand it. Resulting planar distortions, if they occur, can often be evened out by subsequent weighting.(IB)

1. Paper fibers, teased from either Western or Japanese papers and toned to match support or media, can be adhered with methyl cellulose or wheat starch paste.
2. Cellulose powder can be "toned" to match support color by heating powder on a hot plate. (See 30.3.5.B. Dry Cellulose Powder.) Pre-toned dry cellulose powder is blended on a blotter until it is dispersed and the color is matched to the artifact. It is important to blend and disperse the powder so that it is not lumpy. Either locally humidify, moisten, or apply methyl cellulose or gelatin to the area to be treated. Stipple in dry cellulose in a thin layer. Burnish into place and allow to completely dry. Repeat procedure until the color and density is appropriate.(AD)

Alternatively, mix cellulose powder with methyl cellulose before application; ensures neat, even application. Excess can be shaved with a scalpel after drying.(IB)

Cellulose powder can be picked up and applied with fine-tipped tweezers which may save time. Good results may be obtained by sizing the surface of cellulose powder fills with thin methyl cellulose and applying watercolor on top to enhance or improve the end result. Burnishing with flat Teflon spatula aids adhesion but does not result in polished surface.(YS)

A mixture of dry pigments and/or watercolor and microcellulose powder can be applied with a brush and painted into gaps from tears or silverfish damages. Repeat until desired color and thickness is achieved.(LHP)

- B. **Overlays:** Inserts or overlays may be used to cover stains or reconstruct design where inpainting may not be successful or desirable. In some cases, these may be more reversible than inpainting. However, there is no guarantee that the color of the overlay will remain matched to that of the paper support after aging.
 1. Thin Japanese tissue papers and thinned Western papers can be toned and adhered to the original in some cases, thereby avoiding direct application of media.(IB) Some conservators take this approach where a stain cannot be reduced, yet is truly disfiguring, since it may be both more effective and more reversible than covering with media.(ECL)
 2. In some cases, inserts may be made from photocopies on archival paper, or hand-copies from reproductions may be used to compensate design losses. Archival photocopies or laser prints can be used for temporary, reversible fills reintegrating an area of loss for exhibition.(PV) Photocopies can be made onto old papers, Mylar, etc.; however, avoid getting plastics caught in the machines as they may present a fire hazard.(JW) Caution - poor quality electrostatic photocopies may smudge or deposit particles on original.(BF)
 3. Custom-mixed paper pulp discs can be made and then used for inserts or overlays. See AIC/BPG/PCC 26. Filling of Losses, 1987.

- C. **Toned Supports:** Mat board beneath loss can be toned with watercolors, or toned inserts can be adhered to the mat to visually compensate for losses. The combination of toned and white mat board (or paper inserts) can visually integrate discolored and unaffected areas of a fairly translucent paper, thereby delaying or avoiding treatment (i.e., stain removal, washing, or inpainting).

30.4.10 Tips for Reproducing Certain Colors or Media

- A. **Serigraph Ink:** Pigments ground in microcrystalline wax are very good for filling chip losses in serigraphs and clay-coated papers; areas can be burnished to match sheen.(HK) Acrylic or polyvinyl acetate paints have been used to replicate screen inks.
- B. **Mezzotint Prints:** Dry black pigment mixed with methyl cellulose can be used to simulate very thick printing ink in mezzotints.(DDM)
- C. **Photogravures:** Charcoal mixed with methyl cellulose is good for touching up photogravures.(CH)
- D. **Gouache:** Pastel pigments may be applied with a wet brush to replicate matte gouache in small areas. Superficial scratches in gouache can be gone over lightly with a damp brush to restore original surface characteristics instead of inpainting.

30.4.11 Tips for Reducing or Covering Stains

The amount of anticipated reduction of the visual strength of a stain should be considered as should its dimension. The degree of subtle application of inpainting media is important.(DDM) Some stains may be successfully diminished, but in other cases inpainting may be more distracting than the appearance of the original stain or damage.

- A. Several layers of stippled watercolor tones may be applied to form an opaque base covering the stain. Pastel on top of watercolor integrates and provides convincing paper texture.(AD)
- B. When applied wet, pastels can be very effective in disguising stains; use pastels lighter than stain and tone to match surrounding color with glaze of watercolor. (TKM)
- C. Disguising with paper fibers or temporary inserts may be options. See 30.4.8 Removal of Inpainting and 30.4.9. Alternatives to Inpainting.

30.5 Special Considerations

30.5.1 Stability (Lightfastness) Rating of Some Commonly Used Pigments

- A. **ASTM (American Society for Testing and Materials)** classifies the following pigments as having excellent lightfastness (category 1): burnt sienna, burnt umber, raw sienna, raw umber, Prussian blue, cerulean blue, cobalt blue, ultramarine blue, ivory black, lamp black, terre verte, viridian, yellow ochre, most cadmium pigments, red oxide, Chinese white.
- B. **Manufacturers' Classifications:** For example, Winsor & Newton classifies all its paints in terms of permanence judging them on durability and lightfastness in

under glass, are exposed to ordinary daylight, damp, and atmospheric pollutants for a number of years. (See product literature.) Classification designations (AA extremely permanent through C fugitive) are marked on the paint tube. Some of the pigments classified as category 1 by ASTM are marked only as class A by Winsor & Newton: cadmium reds and yellows, ultramarine blue, and Prussian blue.

- C. **Published Guides:** The Wilcox Guide to the Best Watercolor Paints gives descriptions of pigments, paints, and particular manufacturers' products. Wilcox rates each tube of paint based upon reliability, suitability, and quality. ASTM lightfastness classifications also given. Since Wilcox's definitions are not clearly explained, take care when interpreting ratings of paints.
- D. **Testing Lightfastness:** One can test lightfastness by applying materials to paper, covering one side with black paper or board, then exposing samples to light. British Blue Wool Standard can be incorporated into test in order to estimate amount of light exposure and fading. (Weingrod, 1992, 19)

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5/31/94

9th Edition

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