A Review of Varnish Application Fundamentals *

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This session is about studio practices, our experiences with materials and methods, and the results we achieve -- both positive and negative. Perhaps there are no lessons better learned than those learned from direct experience. Two maxims come to mind regarding varnish application. The first is Paintings Conservator Joyce Hill Stoner's recommendation, "*If the system works, don't monkey with it!*" She was describing a wonderful sixteen year old Chiron sprayer at the Winterthur Museum that, although "gooped up", produced beautiful results as long as nobody fooled with it. The second timeless maxim comes from the late Professor Rostislov Hlopoff, esteemed Professor of Objects Conservation at the Cooperstown Graduate Program. I can still hear him admonishing his students (in a heavy Russian accent), "*Oh my dears, how many times I ask myself, how many times ruined, ruined because I tried to do too much and didn't stop when I was ahead. I beg of you, please don't do it! Believe your beloved Professor when he tells you 'Better is the enemy of Good*".

Today is a good day to ask ourselves, "how many times ruined"? Is there a conservator who has not experienced reticulation (orange peeling) of that one more application of varnish, necessitating the removal of all varnish and weeks of exhaustive inpainting? We can all agree that there is much to be said for getting to know one's repertoire of materials and techniques intimately, knowing when and how to proceed, and knowing exactly when and how to stop. Let's look at some of our experiences and procedures relating to varnish.

Because the topic of varnish application is so voluminous, I will only be touching upon selected principles, focusing upon the handling and studio aspects. Readers are referred to conservation and manufacturer technical literature for further discussions. For a lucid primer illustrating basic concepts of varnish application, Louis Pomerantz's book *Is Your Contemporary Painting More Temporary Than You Think?* (Chicago, 1962) is an excellent starting point. The text *On Picture Varnishes and Their Solvents* by Feller, Stolow and Jones (Washington, D.C., 1985) elucidates varnish formulation and behavior in great depth and is a superb work for repeated reference. C.V. Horie's *Materials for Conservation. Organic Consolidants, Adhesives and Coatings.* (London: Butterworths, 1987) is an excellent companion volume, also including Teas solubility charts for a variety of polymers. More recent findings and contributions appear in the IIC Preprints, 1990 Brussels Congress, *Cleaning, Retouching and Coatings*, (London) and in selected articles in IIC's *Studies in Conservation* (London) and AIC Bulletins, *Preprints*, and *Postprints* (Washington, D.C.) In addition, the series of informative booklets from the Federation of Societies for Coatings Technology, *Federation Series on Coatings Technology* and the *New Series on Coatings Technology* (Blue Bell [formerly Philadelphia] PA: FSCT, 1973 - present) offer introductory material on varnishes and paints as used in the coatings industries.

VARNISH APPLICATION PRINCIPLES

Every varnish scenario has the following components or variables: RESIN, SOLVENT, ADDITIVES, APPLICATION SYSTEM, ENVIRONMENT, & THE UNIQUE CHARACTER OF THE PAINTING TO BE VARNISHED. For each subcategory there are further variables, making the subject of varnish application extremely complex and challenging. For the painting conservator concerned with the full scope of varnish effects, varnishing a picture is not, as much of the world may think, simply a matter of taking a solution out of a jar and brushing it on.

* Presented to conservators at the Paintings Specialty Group at the Annual Meeting of the American Institute for Conservation, Buffalo, NY June 1992.

Looking at the first component, the RESIN or primary non-volatile component of varnish, one observes physical properties that are directly linked to performance properties. For the most part, resins may be grouped or characterized according to the class (painting conservators being interested primarily in thermoplastic polymers) and size of the resin. Individual resin structures may be referred to as small, moderate, or large in molecule size. It helps to visualize a particular resin alongside other resins, to compare its size, behavior and properties. Feller's three dimensional chart *Key Physical Properties of Thermoplastic Resins* [Figure 1 in Feller, *Problems in the Investigation of Picture Varnishes* [in IIC, Conservation of Paintings and the Graphic Arts. Preprints of the Lisbon Congress 1972. London: IIC, 1972. pp. 201-205.] is an invaluable resource for this purpose, comparing sward hardness, solubility grade and viscosity grade of familiar thermoplastic resins. Observations from practical handling, studio experimentation, and natural aging confirm theoretical and laboratory induced predictions. While there are occasional exceptions, definite generalizations can be made that hold true for many varnish resins.

Typically, SMALL molecule resins have a low viscosity, are easy to handle, have good to excellent wetting properties, have a low initial solubility (dissolve in mild aliphatic/aromatic solvents), produce good gloss, may have a low glass temperature (resulting in cold flow or tackiness), tend to be brittle, have poor abrasion and fracture resistance, are susceptible to moisture and bloom, discolor with age, and may require increasingly aromatic and polar solvents to remove.

Conversely, LARGE molecule resin varnishes have a high viscosity, may be difficult to handle, may level and wet only moderately well, usually initially require more aromatic or polar solvents to dissolve, have greater plasticity, are more elastic and scuff resistant, gray upon aging, and while moisture resistant, can behave like a skin, that may on occasional instances delaminate with aging.

In addition to molecular weight, characteristics of resins include: solvency parameters, volatility, flash point, evaporation characteristics, surface tension, odor, and toxicity.

Conservators desire the best properties of all resin worlds. Frequently, traditional paintings are given a preliminary varnish of a small molecule resin to fully 'wet' and saturate the paint. Upon completion of filling, inpainting and additional varnishing, the painting may be given a thin application of a larger molecule varnish to provide enhanced 'skin-like' protection to the exposed outer surface. An alternate practice is to combine resins in solution, to produce a hybrid product; Binney & Smith's Soluvar® Picture Varnish or Golden MSA Varnish® are examples of such combinations. Getting two (or more) resins to work well together in solution and in film forming requires very special solvent blending and formulation, feats not easily achieved. An ideal would be to have resin structures designed and fabricated specifically for conservation picture varnish use. Conservators and conservation scientists have not explored these realms to their fullest potential, frontiers that may hold promise for the future.

FORMULATION AND DILUTIONS

A language problem, a veritable Tower of Babel, exists when conservators compare varnish formulations. Each practitioner has a favorite way of visualizing, preparing and describing varnishes. When assessing recipes and concentrations of solids, it is very important to ascertain the method of solution computation. Specifically, is the percentage of resin-to-diluent in a varnish solution a ratio of: 1) Volume/Volume (v/v), 2) Weight/Volume (w/v) or 3) Weight/Weight (w/w)? A 10% solution of a resin in a solvent computed in one manner, will be very different from a 10% solution formulated in another manner.

Conservators may also become confused when diluting an existing varnish solution. The math can get complicated, so it is handy to display a

copy of Pearson's Square for simplifying dilution calculations near the solutions workbench. This formula and examples of its use appear in Harold Plenderleith's, Conservation of Antiquities and Works of Art, Oxford 1966 . p. 349.

Oftentimes, varnish solutions are like porridge at the Three Little Bears' house. One frequently hears, "*My varnish is too thick*...", "*My varnish is too thin* ...", and every once in a while, "*My varnish is just right!*" For each resin, there is ideal ratio of solids to solvent for favorable viscosity and handling. For instance, Paraloid B-72 works well as a brush varnish in concentrations from 10% to 15% solids (w/v); spray varnish concentrations have to be lower, e.g. concentrations from 5% to 8% (w/v). With a smaller molecule resin, such as dammar, solids can be higher, such as 12 to 20% for a brush varnish and 6 to 14% (w/v) for a spray solution.

A thick varnish solution produces high gloss, good filling and saturation, but may not flow well due to the high viscosity of the solution. By contrast, a thin varnish solution produces a lower gloss and is easy flowing (due to the low viscosity). If excessively thin, however, the fluid can flow through a painting structure soaking and impregnating the canvas reverse. The particular painting structure under consideration is very important, since each picture has its own unique absorbency or non-absorbency of varnish.

SOLVENTS

Complicating things further, the behavior and handling properties of a resin may change depending upon the SOLVENT selected for solution. First and foremost, the solvent(s) chosen must fall within the ideal solubility parameter range for the resin under consideration. Next, the evaporation rate of the solvent will have a major effect on the handling. If a solvent is too fast evaporating, there will not be enough working time, resulting in dragging and brush marks, or if spraying, stringiness or granularity. If excessively fast, condensation of moisture may occur on the cooled painting surface, producing a milky finish. Conversely, if the solvent is too slow, excessive running or creep may occur, or lower layers may become swollen or may actually move, resulting in reticulation throughout.

Conservators often varnish with individual pure solvents, e.g., 100% xylenes, or 100% toluene, so that they may predict the exact behavior of a particular solution. At times, less-than-ideal solvents may be used, such as turpentine, because an effective replacement providing the same working properties may require a complicated mixture of solvents. For varnish formulation, mixtures of a variety of solvents can be highly effective, approaching the swelling and solution of the resin from numerous solubility directions, and allowing more evaporation control, extended manipulation time, and improved film forming. The paint and varnish formulation industries use solvent mixtures to great advantage; conservators and conservation scientists need to research more sophisticated solvent mixtures for improved resin formulations for conservation.

Classification, solubility parameters, evaporation rates, toxicity, flammability, and other statistics are displayed in Shell Chemical Company's helpful Organic Solvent Properties Chart (available from Regional Offices in Atlanta, Chicago, Cleveland, Houston, Los Angeles and West Orange, NJ.). This chart is a must for every conservation studio!

ADDITIVES

Additives include ultraviolet absorbers, ultraviolet inhibitors, flatting agents and other substances. Recent research indicates that the life span of selected resins, particularly the smaller molecular weight types, are extended with the judicious addition of small (but critical) concentrations of ultraviolet absorbers or stabilizers. René de la Rie describes the tip of pre-diluting the stabilizer fluid to facilitate addition of the correct amount of stabilizer to a freshly prepared varnish solution. (see de la Rié, *Hals-Stabilized Damar Varnish*, AIC News, Jan. 1992, p.16. Hypodermic needle cartridges, with

numbered cc and ml demarcations, work nicely for accurate measurement of small quantities of fluid additives.

Siliceous pigments and other transparent or semi-transparent particle matting agents are frequently added to proprietary resin solutions to produce "matte" varnishes. These varnishes produce a satiny low sheen that hides a wealth of ills, but also can spell death to the color and luminosity of a painting. The same particles that produce the matte finish act as a colloidal veil, killing the character of the paint. I am not a fan of "matte" varnishes and my preference is to achieve matting by control of the varnish application, not by adding clouding particles. If to be used, "matte" varnishes should be used sparingly. Since matte varnishes usually contain a considerable amount of matting agent, diluting the "matte" varnish with the equivalent clear varnish product can produce an adequate, less extreme result. The addition of a small quantity of wax, either to the final varnish, or in an application on top of a fully set final varnish, is another surface modifying technique, often associated with "European" restoration traditions. For varnishes resistant to aliphatic hydrocarbon solvents, wax may be removed and then reapplied without dissolving the varnish, similar to rewaxing a table-top. Of course, there is the concern for the physical polishing action required to buff a wax polish. And there is always a certain dirt-collecting potential inherent with semi-soft wax surfaces.

Whether additives are added to a varnish or not, it is essential to filter every prepared varnish solution through very fine mesh sieves (e.g., the wide-mouth funnel sieves available from Binks Manufacturing Company) prior to application.

BRUSH VARNISHING

Brush varnishing is the classic method of varnish application and is ideal for the preliminary saturation and sealing-off of paint surfaces that are to receive varnishing in the "traditional" (a continuous, wetting coat of resin) manner. Because the varnish is moved about the painting surface by physical manipulation, brush varnishing (or padding, if a pad or textile wad applicator is used) allows for repeated feeding of lean or leached areas and filling of interstices to produce a continuous saturating coating with minimum specular reflection.

The technique I use for brush varnishing proceeds as follows. A varnish solution of appropriate viscosity is prepared and then transferred to a low profile, wide-mouth, weighty (tip-proof) vessel. The vessel is filled with only a shallow volume of varnish, so that the solution will wet only the lower tip of the brush (1/4 to 1/3 the total length of the bristles). Preferences for varnish brushes vary considerably. Some (the author included) prefer small, bright bristle brushes, 1 to 2-1/2 inches in width. Others prefer larger brushes, 3 to 5 inches wide. The behavior of the brush will vary depending upon the length of the bristles and the thickness of the bristle pack and ferrule. Short bristle, thick brushes are able to move thicker, more viscous varnish solutions, and are suited for physical working of the varnish, such as pushing the varnish into crevices, or matting down the varnish with continued brushing as the varnish sets up. Long bristle, thin brushes work nicely with lower viscosity solutions, enabling the varnish to flow through and past the bristles, filling interstices and leaving a smoother, more level finish.

Smaller pictures are usually brush varnished lying flat to prevent sag; larger paintings generally require upright application. Prior to proceeding, a varnish application strategy must be determined. For this, the boundaries to be covered with each brush dip of solution need to be envisioned. At times, the varnish is applied in overlapping parallel rows, edge-to-edge across a canvas. Other times, varnish is applied in square or rectangular sections, following a grid of overlapping regions. Still other times, varnish is applied in free-form sections, following compositional features or outlines. Many conservators use a combination of these approaches, depending upon the picture, the varnish solution and considerations unique to each treatment.

Before dipping and brushing, estimate the amount of coverage possible for even distribution with each dip. When proceeding, always place the loaded (remember, only partially) brush in the middle of the section to be covered. The solution is then spread out until evenly saturating the entire section. The next dip is placed in the center of the next area to be covered, not directly adjacent to the previously varnished area. After filling the present section, the still wet application is often finished with quickly brushed, low angle strokes, lightly overlapping the wet varnish across the transition edge where it meets the previously applied, partially set varnish field. The painting is varnished thus, going from section to section until complete.

When sufficient brushing time is possible, the varnishing may be finished with continuous light strokes across the entire length of the painting, using the same varnish brush without dipping again into the varnish solution, or finishing with a clean, thin bristle brush. My preference is to finish with strokes beginning from the bottom of the canvas, moving to the top. This can help to fill the undersides of the weave or impasto strokes, reducing banding, shadows and specular reflection (since paintings are lit mostly from above). Mark Leonard (IIC, Cleaning, Retouching and Coatings, London, pp. 174-176) describes the technique of picking up excess varnish with clean badger hair blender brushes so that a satiny, thin varnish film remains.

SPRAY VARNISHING

Spray application of varnish enables great control of the quantity, gloss and uniformity of the resin deposited. A major benefit of spray varnishes is that they may be applied without direct contact with, and physical disruption of, the painting surface. Instances where this is crucial are where paintings have friable or flaking paint, requiring introduction of a consolidating resin or varnish; or paintings with recently applied (or in-progress) retouchings, that would be altered or removed with the action of brush varnishing. For contemporary paintings, spray application is also used for the uniform introduction of extremely dilute resin solutions, where the "varnish" serves not as a surface modifier but primarily as a thin protective fixative or consolidant in an otherwise open and "unvarnished"-looking paint layer.

Many conservators favor a hybrid technique. A preliminary saturating coat of varnish is applied by brush, followed by successive, thinly built-up finishing spray applications of varnish.

Most spray systems depend upon compressed or accelerated flow air to draw, atomize and disperse a varnish solution. The type of spray system and equipment has a major effect upon the results. The most elemental is the atomizer, using either lung or hand-pump air pressure and Bernoulli suction to draw a solution up a tube, dispersing it into a spray. This method has largely been abandoned due to superior systems of atomization available. Small aerosol spray packs, powered by disposable propellant cans, also operate by external mixing and can be convenient for small jobs or on-site work. However, the atomizing mechanism remains primitive (the coarsely sprayed varnish may require brushing out) and some of the propellant compounds used for pressurization present environmental biohazards.

Electric compressors compress air to elevated pressures, and are rated for the CFM or cubic feet per minute they can deliver at a given PSI or pressure per square inch. The compressed air is frequently forwarded to an air reservoir tank, from which even flow of pressurized air is possible for a sustained spraying period. In the process of being compressed, the air is chilled and the relative humidity level increases dramatically. A moisture and oil filter trap, an air pressure gauge, and an air regulator are placed on-line to condition the air before it reaches the spray apparatus and artwork.

Airbrush sprayers require low volumes of air flow (1 to 2.5 CFM) at pressures of 15 to 30 PSI, and are suited to small scale or detail work. Due to the fineness of the spray head and needle assemblies, airbrushes enable very fine atomizing of low volumes of varnish solution and great

control of the build-up and specific area being covered. While ideal for localized toning or building of varnish, they are not practical for large pictures where banding may result. For most painting spray applications, an industrial spray gun provides the capacity and capability needed for a variety of varnish techniques. Spray guns require a minimum of 2.5 CFM to typically 4.0 CFM or higher; and a working pressure of 20 to 40 PSI. The gun and needle head housing may be small, medium or large and it is beneficial to have more than one spray head assembly to suit the requirements of different treatments. In addition to the size of the spray head, fineness of atomization and pattern of spray options, the type of air mix and type of solution feed vary tremendously. Other factors that affect spray results are the amount of air movement in the spray booth or outdoor setting (for those who spray out-of-doors), and the ambient temperature and humidity conditions. It is important to observe the weather and air conditions in your locale prior to commencing with any resin coating application. For example, on a cold or humid day, the amount of air (CFM) and pressure (PSI) must be increased as varnishes would otherwise be slow to dry. Conversely, on a warm or dry day the amount of air and pressure must be decreased to allow sufficient film forming before the solvent evaporates.

Always pre-test spray settings and solutions on scraps of board or discarded X-ray film or mylar sheet, to observe the handling and forming of the varnish before attempting to spray any art. Once adjustments are made, spraying is begun at a far corner of the painting, continuing across the surface in an uninterrupted linear pass. Constant distance is maintained (e.g., 10 - 14 inches) and spraying proceeds past the outer edge of the painting, where a turn in direction takes place for the next, slightly overlapping, parallel pass of varnish. Spraying continues in this manner until the entire surface is covered. For subsequent varnish applications, the spray orientation may be switched by 90 degrees (e.g., horizontal passes for the first coat, vertical for the second, and so on) to ensure uniform distribution.

An important precaution is never to spray a picture first thing in the morning fresh out of cold storage. Allow the painting (and studio) to warm up. For certain paintings, it is actually beneficial to gently pre-warm the painting surface, particularly oils on non-absorptive hard surfaces, such as metal (copper or tin) or wooden panels (wood, laminate or hardboard). Also, on a cold day, one might carefully warm the varnish solution in a *bain Marie* (warm water bath). Precaution must be taken that there be no open flames, active heating or hot elements in conjunction with open varnish in the studio. Always preheat the water prior to opening the varnish, remove the pot of water from the heating source and shut the heat, and then perform the warming in an explosion-proof spray booth or vacuum hood. Carefully warm the varnish solution in a covered metal spray container, with the cover seal left slightly open to prevent vapor pressure build-up. Another tip is to place a slightly larger cardboard behind the painting, extending beyond the outer edges of the picture. This will slow down the evaporation and improve glossing at the edges, which often dry before the wetter center of the painting has had a chance to set.

Because of frustrations with traditional air compressor-spray gun equipment that has been either inadequate, very lavish but not appropriate for their purposes, not understood or properly maintained, or the scene of many an unhappy coatings disaster, a number of conservators have switched to and prefer the Chiron SG90E blower and PN2 Spray Gun (available from American Distributors, 3085 54th St., San Diego, CA 92105) or similar type unit (available from W.W. Grainger Inc., locations nationwide), which use a low pressure, high volume air flow, warming the air before mixing it with the varnish. Warm air spraying reduces ambient moisture and improves film-forming properties, and the low pressure will generally produce less over spray. The lightweight air pump pack (working like a canister vacuum, only in reverse) can be worn on the operator's back, handy for large paintings where one has to cover a lot of territory.

MANIPULATION OF VARNISH AFTER APPLICATION

It is important to remember that there are actually a number of stages of drying within an applied varnish film, which progress from the first few minutes of rapid evaporation of solvent and preliminary setting of the film, to the gradual curing and hardening that takes place in successive days, weeks and months. The degree of solvent retention and 'set' at any given time in the life of a recently applied varnish must be judged and taken into consideration when any manipulation of the surface is attempted.

Manipulation of the varnish immediately following application (as it is setting up and drying) enables a diverse range of effects. One technique for dulling down a fresh varnish is to rub down the just-set surface with a fine sponge or a pad of silk cloth (wrapped around a cotton ball) wet with deionized water. The aqueous interface with the still somewhat solvent-swollen varnish, results in a falling out of the uppermost resin from solution, accelerating set-up and producing a soft satin finish. Conversely, if greater gloss and luminosity is desired, a just-varnished painting surface can be warmed gently with the radiant heat of a photographic or work lamp (preferably one encased behind a protective lens; no studio explosions, please!). The elevated temperature drops the viscosity of the solution, drives off any entrapped moisture and improves varnish film forming and clarity. Obviously, with either of these manipulations, great care must be taken, being sure that the painting under consideration is sturdy and can withstand short-term exposure to moisture or heat.

Some adjustments of varnish configuration can be performed after a varnish is fully cured. In fact, hard varnishes can be polished, hopefully very carefully, with super fine abrasive compounds, reducing gloss, film thickness or undesirable features such as entrapped linters or reticulation craters. Abrasive polishing is sometimes performed with 0000 steel wool, but in many instances is most successfully performed with a very fine alumina or silica compound. The rubbing compound is first dispersed in a lubricating solution of deionized water, then applied on a soft, damp cotton cloth. After polishing, the surface is thoroughly rinsed with deionized water-dampened cotton wool, followed by thorough drying. Lastly, the painting is given a thin finishing spray of varnish to reform and resaturate the surface. This technique, requiring great caution and not for every painting (a substantial base varnish must be present to protect the paint from abrasion and to prevent foreign matter from entering cracks or interstices), can produce remarkable results with smooth surfaced, unforgiving pictures, such as panel paintings.

VARNISH SITUATIONS AND SOLUTIONS:

SOAKING OR SINKING-IN
Situation: The varnish is sinking-in and is not adequately saturating or glossing the paint.
Solution: The varnish solution is either too low in solids concentration, or too slow evaporating a solvent is being used. Increase the resin concentration substantially, and use a faster evaporating solvent mixture. Successive thin spray applications of isolating varnish may be required, alternating varnishes with slightly differing (and thus isolating) resin solubilities. Localized building of varnish and gloss may also be needed.

Note: Sinking-in is not always a problem and may actually be desired. For example, with lean, 20th Century paintings, one may wish to introduce a small quantity of varnish as a consolidant or pigment saturator, producing minimum surface build-up or alteration of sheen. In such instances, low resin concentrations (2 to 4%) dissolved in slow evaporating solvents can be effective.

EXCESSIVE GLOSS
Situation: The varnish is excessively glossy and possibly too thick.
Solution: First wait several weeks to see if the picture dulls down by itself. The coating may be

retaining solvent and may still be relatively swollen and shiny. If not the case, the surface may be dulled down by manipulation (polishing with wet silk or gentle abrasive), or dulled by varnishing with a highly aerated, dilute resin spray. In certain instances, excessive gloss may be brought down with a solvent spray outside of the solubility of the resin; this is described in an earlier Bernstein Studio Tip (AIC, Paintings Specialty Group Postprints, 1989, p.8). In the future, control glossing before it occurs by applying thinner varnish applications with lower resin concentrations, faster evaporating solvents and higher air pressure and atomization.

STRINGINESS
Situation: The concentration of solids in the varnish solution is too high for this resin, the solvent too fast evaporating, the solvent may not be the correct solubility parameter for the resin, and/or the air pressure and quantity settings may be too high.
Solution: Add more solvent to reduce the concentration of solids, add a slower evaporating solvent or a solvent of more appropriate solubility parameter, and reduce air pressure and quantity settings as appropriate.

FOREIGN MATTER
Situation: Cotton linters or foreign matter (brush hairs, grit, etc.) have become entrapped in the varnish.
Solution: There are two options. The first is to remove the foreign matter immediately, while the varnish is still very fluid and forgiving. Remove matter with micro tweezers or point of a needle or scalpel. Alternatively, wait until significantly later, when the varnish has fully set. The foreign matter can then be readily removed mechanically, with minimal disruption to the surrounding finish. Any slight break in the coating can be restored locally by dotting with a viscous solution of varnish on the tip of a fine point brush.

MILKINESS
Situation: The varnish has a slightly cloudy or milky appearance due to moisture entrapment. The ambient humidity was too high, or the solvent was too fast evaporating resulting in condensation of moisture at the painting surface.
Solution: A slightly milky or cloudy spray coating can be clarified by warming the painting surface slightly (with lamps or warm air blowers) to drive off the moisture; or by spraying with a slower evaporating, more polar solvent, to act as a bridge, grabbing and releasing the moisture trapped in the film. Don't spray varnish on humid days, or if in a high humidity environment, add small amounts of slow evaporating, polar solvent to the varnish formulation.

GRANULARITY
Situation: A sprayed varnish has dried in the air before reaching the painting surface. The environment may be very dry, the solvent may be too fast evaporating, and/or the CFM air pressure and quantity settings of the sprayer may be too high.
Solution: Use a slower evaporating solvent mix, reduce the CFM air pressure and air quantity settings on the sprayer; possibly increase the concentration of resin solids.

BANDING
Situation: Alternate shiny and matte horizontal or vertical bands appear in the sprayed varnish. There is insufficient 'wet time' between rows of varnish application; the solvent mixture is too fast evaporating, the weather is too warm and/or dry, the air pressure and quantity settings are too high, the spray width pattern at the spray head is too narrow, and/or the spray booth air flow may be too high.
Solution: Use a wider spray width pattern setting on the spray head, increase the distance of the spray head from the painting (by 2 to 6 inches), use a slower evaporating solvent mixture, reduce the air pressure and quantity of the spray system, and reduce the air flow setting of the spray booth (if possible).

SURFACE TENSION PROBLEMS: RETICULATION
Situation: A surface tension problem is taking place between a new varnish application and previously applied varnish, causing movement of either the upper layer, the lower layer or both.

The varnish solution is too thick or too thin, holding too much solvent or allowing solvent to travel; and/or the solvent used is too slow evaporating, the solvent used is too non-polar, the weather may be too cold and/or too humid, the painting may be too cold or non-absorptive, and/or the air pressure and quantity settings may be too low.

Solution: Never spray on excessively cold or humid days. Instead of heavy or wet applications of varnish, apply multiple thin, almost dry sprays, increasing air pressure and flow, and the evaporation rate of the solvent. Trace additions of polar solvents to the varnish mixture may assist in bridging conflicting surface tensions. If reticulation has already taken place, a varnish reduction or polishing treatment may be required.

INPAINTING OVER READILY RESOLUBLE VARNISHES

Many conservators relate difficulties or disasters when inpainting over readily resoluble varnish coatings, such as resins Laropal K80, Arkon P90 or Regalrez 1094. In these instances, the solvent in the inpainting medium causes the underlying varnish to swell, creep and move, forming tide or crater lines. When this occurs, the brush is usually holding too much paint and solvent. To correct this, try using a smaller size brush, e.g. drop from size 2 to size 1 or 0; or from size 1 to size 0 or 00. I prefer to dot on the color with the point of the brush, not stroke on the color with potentially disruptive lateral or vertical movement.

Also, the inpainting solvent may be staying on the structure too long, or may be too close in solubility to the underlying varnish causing it to redissolve and travel. Try adjusting the diluent formulation, replacing slow evaporating solvents with faster evaporating equivalents; and experiment with solvent additives that weaken the solvency of the mix, or approach the solubility from a very different place (e.g., alcohols). As an alternative, a thin spray application of a larger molecule or differing solubility isolating varnish may be applied over the base varnish, shielding it (partially) from the inpainting solvents.

CONCLUSION

This introduction only scratches the surface (pun intended) of a topic critical to painting appearance and preservation. Hopefully, this Paintings Specialty Group Session will encourage follow-up sessions directed to the practical discussion of picture varnishing. And don't forget to watch "*What's happening to the weather in your part of the country today*"!

BIBLIOGRAPHY: VARNISH APPLICATION FUNDAMENTALS

De la Rie, E. René and Christopher McGlinchey. *New Synthetic Resins for Picture Varnishes.* [IIC, Preprints of the 1990 Brussels Congress, Cleaning, Retouching and Coatings, London: IIC, 1990. pp. 168-173.

_____ *Stabilized Damar Picture Varnish.* Studies in Conservation. London: IIC. 34:137.

Federation of Societies for Coatings Technology, Federation Series on Coatings Technology [27 Units available] and New Series on Coatings Technology [20 Units available]. Blue Bell, PA (formerly in Philadelphia): FSCT, 1973-present.

Feller, Stolow and Jones, On Picture Varnishes and Their Solvents. Washington, D.C.:National Gallery of Art, 1985.

Horie, C.V. Materials for Conservation. Organic Consolidants, Adhesives and Coatings. London: Butterworths, 1987.

IIC, Preprints of the 1990 Brussels Congress, Cleaning, Retouching and Coatings, [Edited by J.S. Mills and P. Smith]. London: IIC, 1990.

IIC, Conservation of Paintings and the Graphic Arts. Preprints of Contributions to the Lisbon Congress 1972. London: IIC, 1972.

Pomerantz, Louis, Is Your Contemporary Painting More Temporary Than you Think? Chicago: International Book Co., 1962.

Leonard, Mark. *Some Observations on the Use and Appearance of Two New Synthetic Resins for Picture Varnishes.* [in IIC, Preprints of the 1990 Brussels Congress, Cleaning, Retouching and Coatings, London:IIC, 1990. pp. 174-176.

Paintings Specialty Group of the AIC. Painting Conservation Catalog Volume 1: Varnishes and Surface Coatings. Wendy Samet, Compiler. Wash, D.C. American Institute for Conservation, 1998. 330 pp.

UNESCO. The Conservation of Cultural Property. *Appendix: Synthetic Materials Used in the Conservation of Cultural Property.* [Revised by Toracca]. Paris:UNESCO, 1968. pp. 303 - 335.