Old Master Painting Technique

An Introduction to the Research of Living Craft

by

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Part I: New Versus Old

I often get e-mails asking how to reconcile older painting practice, such as the material in the De Mayerne Manuscript, or the findings in the National Gallery Technical Bulletins, with the general run of modern, usually academic, recommendations. This conundrum occurs because the two systems are irreconcilably different. Modern writing on the craft has tended towards oversimplification. This is possibly due to the academic origin of the modern approach—the system must work for college students using commercial materials. In the older method, the painter starts from scratch and develops a relationship with the materials: the process creates the product. In the modern method the painter purchases commodities and manipulates them: the products determine the process. The justification is that the products are "right," typically sanctified by science. The conclusions of this "science," however, are simplistic in relation to the painter's experience of the craft, because the craft is more diverse in its combination and manipulation of materials than the laboratory can comprehend. Materials are never tested in context, this would be incredibly complicated and expensive. What value are isolated conclusions when materials are never used in isolation? Science tests "linseed oil," but where was the flax grown, at what point was it harvested, how was the seed pressed, and, most importantly, how has the oil been subsequently processed? Painters have always known these questions to be important. From the older point of view, there is no such thing as "linseed oil," this concept is both too abstract and too vague. There is only the behavior of the specific oils one knows through years of experience. As a result of a naturally deeper awareness of the materials, painters often end up questioning "science," which "science" finds absurd: painters have proven themselves once again to be irrational: end of discussion.

But this commercial-academic "science" is not real science. Genuine empiricism is aware that any definition of truth is relative, it is simply what we know up to now. The occasional dogmatism one encounters is best viewed in this light. Observation and experiential research provide great tools, but they must be willing to acknowledge that diverse situations may well lead to diverse conclusions. Insistence on a rote approach to the process and materials results in false certainty; the physical or visceral aspects of the craft are subjugated to a static set of rules. This can be compared to what happens when a great novel is made into a Hollywood movie: much is lost.

On the other hand technical art history is aware of the complexity of the materials situation. The "Art in the Making" series by London's National Gallery provides a great example of this, as does "Seeing Through Paintings", by Kirsch and Levenson, and anything by Joyce Townsend or Leslie Carlyle. This discipline is aware that the older way is not particularly complex, it simply springs from a different set of root assumptions about the craft. These are much more logical than "alchemical" – the use of that word in this context is usually well-meant but probably inaccurate past the earliest painters. The cumulative day-to-day experience of the craftsperson and the traditions that were handed down within the master-apprentice system created a vast body of functional knowledge. This level of hands-on experience is unavailable to the modern method. It is therefore logical that most modern writers have tried so hard to make the older method go away: it is, by definition, non-existent. But the older method will never go away. because it involves the painter with the materials in the moment. This ongoing dialogue is the fundamental key to a more evolved technical practice, which can have a significant effect on the quality of the work itself.

Part II: Hand Refined Linseed Oil

There have been many theories over the centuries about the "secrets of the Old Masters." But all claims to have found the magical potion have subsequently been disproved, and modern technical art history has shown through decades of research that the materials of older painting are straightforward on the surface. However, if we look underneath the surface, we find that many materials have morphed over the centuries to the point that they no longer resemble their historical relatives. Such is the case with the complex material called, almost always too casually, linseed oil.

The 20th century produced a simplified painting system based on various combinations of damar varnish, turpentine, and stand oil. But the research by the National Gallery in their yearly Technical Bulletins published since 1980 shows that, prior to the 19th century, there is no such thing as global use of resin the paint film. In fact, resin in older painting is principally limited to "small amounts of pine resin", and use is quite sporadic, primarily as a way to get a specific pigment to dry more quickly.

A detailed investigation of this subject would require a book of its own. However, the NGTB research analysis does suggest three distinct general patterns of medium use in older painting. These can be broadly termed early, middle, and late, but it is more accurate to call them egg-oil, oil dominant, and resin-oil. The earliest pattern involves a combination of oil and egg as the medium for the paint, and is coming to be more widely known for earlier painting. It also now appears that, as late as the 16th century, Lotto made a complex *tempera grassa* medium. The oil dominant pattern begins in the 15th century and features many paintings made with oil alone, some with heat-bodied oil, and some with an addition of "a little pine resin" or egg as well. The use of resin or egg in the this approach is not global, but is reserved for a specific colour or passage. A small amount of added resin such as silver fir or larch balsam gives the oil slightly more set and drag, making edges cleaner, and could be used without additional solvent. But the pattern of resin use is complex. Early Flemish painting often uses resin to help a red lake glaze to dry (NGTB 18). Yet, in the samples analyzed from *The Arnolfini Portrait* (1434), the green uses resin (and the pigment is not "copper resinate," copper acetate ground in resin to seal it) while the red lake does not. The use of heat-bodied oil also suggests the possible use of litharge or white lead as a drier, but the presence or absence of these cannot be detected. The oil based system continues through the 17th and 18th centuries: both Jan Steen and Canaletto use heat-bodied linseed oil and no resin (NGTB 19). Research "suspects" – stated in *Rubens Unveilea*, (2012) by Nico Van Hout and Arnout Balis – that the rheology of Ruben's paint was influenced by an addition of egg white. A noticeable change is Rembrandt's use of chalk, and ground calcite as a medium ingredient for Velásquez. It is worth noting that these painters, in their search for ingredients to increase an element of thixotropic adhesion globally in the system, chose ingredients other than resins. While this approach may seem simple on the surface, the following sections show that the oil can be modified to many different behaviors, that "a small amount of pine resin" can also be implemented in a variety of ways, and that the addition of calcium carbonate to the system creates an entirely new dimension.

The resin-oil medium pattern is more varied in terms of materials, and more individualized from painter to painter. It also features the global use of resin in the paint in certain cases, and more in the way of "lost secrets" medium experimentation that led to technical issues. The oil-dominant pattern does extend through 19th century usage, however. Analysis of Impressionist paintings suggests very little use of even simple resin preparations, Constable's *The Hay Wain* (1821) was painted with heat-bodied linseed oil and used heat-bodied walnut oil for the white (NGTB 19). On the other hand, this is also the era of the notorious mastic gel, lead acetate, and various experiments involving copaiba balsam and gum elemi, and Constable's late work has been shown to contain the traditional sequestering trio of beeswax, resin, and egg. Later in the century, amber varnish has a brief heyday in England, and, apparently starting in Germany, use of damar begins. While much of what was done in the 19th century worked, the fallout from more complex "nostrums" led to the simplified 20th century approach to the medium.

The Oil

The traditional oils for painting were long thought to be linseed oil in the colder north and Spain, and walnut oil in Italy, but recent research has revealed a more general use of both than was previously known. This is aligned with research which suggests a highly developed trade network for painting materials throughout Europe even by the 14th century. Poppy oil began to be used in Holland in the 17th century and is associated with floral specialists. Linseed oil can dry the fastest, but also has the most potential to yellow: the De Mayerne Manuscript has many recipes designed to improve linseed oil, the painter's opinions recorded there are generally in favor of walnut oil, although Van Dyck prefers linseed oil. Poppy oil is slow drying, the least yellowing of the traditional oils, but can wrinkle if too much is used in a layer. Walnut oil can provide a happy medium, especially if used in a climate that is warm and dry, but walnut oil does not lend itself naturally to more bravura or broken-surface paint application the way linseed oil does. This can, however, be changed by using a denser medium. Both safflower oil and sunflower oil – refined, nearly colourless – can also be used for painting. While they are non-yellowing, they are also very slow drying. Small additions of these can be used for colours that otherwise dry quickly in the tube, or in an oil medium to extend the open time, allowing for a single alla prima layer to continue over many days. Commercial safflower or walnut oils which dry surprisingly quickly do so because they have added driers.

The debate about the best oil to use for painting has gone on for centuries. This makes sense when one realizes the extent to which older painters knew and trusted the specific type of oil with which they worked, this obviously became "the best." Much is sometimes made of the film strength of linseed oil versus walnut oil, but most Italian Renaissance paintings were made with walnut oil, and are still with us. Much is also made of the potential of linseed oil to yellow, based on the experience in the 20th century with hot-pressed oils coupled with the generally debilitated craft of the period. While the availability of cold-pressed, highly refined linseed oil has solved the overt darkening issue, this oil is so refined that it does not tend to dry well, a period of four or five days is common in tests. However, an organic cold-pressed oil, hand refined using the method below, will dry in one or two days and only yellow to the extent of walnut oil, less if aged in the traditional manner in the light. It is important to look not only at the type of oil, but at its original quality, and how it has been subsequently processed: printed remarks about "the oil" seldom take any of this into account, and can therefore be misleading. Walnut oil is naturally better suited to finer or thinner painting, linseed oil to working with more force, but each can be modified somewhat towards the other quality. All this being said, the best oil for a given painter may well be the one of highest and most predictable quality which is readily and reliably available.

Paint Film Basics

Plant oils are very complex chemically: dense tomes are written about edible oil chemistry, and there is no such thing as a generic "oil" molecule. Rather, oil is made up of quite large molecules called triglycerides which have various, also large, water soluble fatty acids loosely attached to them. Fatty acids are better known now as Omega-3, Omega-6, etcetera, for their positive role in human nutrition. The variety of the fatty acid make-up is what makes one oil dry differently from another. The proportion of linolenic (Omega 3) and linoleic (Omega 6) acids in walnut and linseed oil, for example, is different, linseed having significantly more linolenic acid than walnut. Linolenic acid is the most chemically reactive of the group, making linseed oil the faster drier, but also the oil most likely to yellow over time due to byproducts of the polymerization process. Only the triglycerides polymerize, or "dry," the fatty acids do not. Refining the oil removes a miscellany of impurities and reduces the fatty acid content significantly, making the same thickness of paint film that much stronger and less likely to yellow. Polymerization is a complex reaction with atmospheric oxygen which takes place over very long periods of time; even linseed oil which has been dry for months and is safe to paint over will still be polymerizing for years to come. Oxygen, in conjunction with heat and sunlight, has the potential to eventually desiccate the oil altogether. If the paint film is thin, or underbound through the use of solvent, this can begin to happen in a matter of decades. If the paint film is thick, uses preheated oil, or is protected by a varnish layer, this process can be slowed for many centuries. However, thicker oil can have more of a tendency to yellow, and is best used with moderation no matter how good the oil is. Creating a working balance here is a matter of knowing the behavior of one's materials relatively well. This happens naturally in practice as nothing is more important than knowing at what point, or under what conditions, a thick or viscous final layer of paint may darken on drying.

Raw oil alone is quite thin, and, especially when used with solvent as a medium, may not make a strong enough paint film to adequately withstand the attack of oxygen over time. Oil paint thinned with solvent in the manner of watercolour thinned with water does not tend to hold up well. This is especially true if the painting is never varnished. The premature aging of many 20th century paintings made with the somewhat misguided conceptual purity of paint alone attests to this. The hot-pressed, alkali-refined oil of mid-20th century American commercial paint is relatively volatile with regard to its drying characteristics, and the most likely to darken; so-called "artist's" linseed oil from this period can be so hopeless that it forms a dark brown, soft gum instead of hardening. When reading the comments of writers on what they term linseed oil, it is important to take the time period into account. Also, the words "linseed oil" in these cases typically refer to the readily available commercial oil of the period. For most of the 20th century, this was not even a cold-pressed oil. One of Laurie's early texts mentions refining the oil and gives a method, after this no 20th century text in English goes into refining the oil at all.

Commercial paint always uses new, raw oil. While the paint appears to be "rich" and, of course, "buttery," these qualities are from additives. Given the nature of commercial paint, a medium is virtually necessary to enhance the longevity and character of the paint, as well as to keep the paint from drying down in layers, the dreaded "sinking in."

When a resin is added to a paint film, much more complexity occurs in the aging process. This is especially true of a spirit-resin type medium such as damar, a balsam, or mastic. The use of resin in oil paint is arguably ancient, going back to its origin as a decorative outdoor paint. Paint made with boiled oil and a hard resin varnish such as copal or sandarac would last much longer outdoors. However, the necessity for the paint to maintain its true colour over time was not as dire. Warnings about the overuse of resin causing brittleness and ultimate darkening in the paint film have been coming from scholars and conservators for many decades. It is important to always formulate a paint film with the absolute minimum amount of resin if using resin should prove helpful or unavoidable. Research into paint films that are centuries old (NGTB) indicates that small amounts of resin can be used safely. This is logical because the behavior of the stronger oil component then remains dominant during the aging of the paint film.

The traditional alternative to using resins is a paint film which relies on a somewhat thicker, preheated oil and possibly a mineral addition as well, such as chalk, calcite, or silica, all of which have been found in older paintings. The thicker vehicle allows the pigment particles to float, and helps keep the action of oxygen at bay by sealing the surface of the painting more effectively. The stone dusts allow the exploration of many different types of paint rheology and viscosity, and, in the case of the calcium carbonates, create a stronger paint film over time. That this system works well over time is demonstrated by the condition of most Rembrandt paintings, noted consistently by scholars and conservators as unusually good in spite of what they have often been through in over four centuries.

Chemically, the yellowing of linseed oil occurs as a by-product of the polymerization process. Conjugated unsaturated hydroperoxides are converted into conjugated unsaturated ketones, which can then produce long-chain polyenes with a yellow colour. If the hydroperoxides are reduced, or eliminated, this process can be curtailed before it begins. "Semi heat-bodied oil" is often found in older paintings in the NGTB research. A study done titled *Long-Term Behavior of Oil-Based Varnishes and Paints, Fate of Hydroperoxides in Drying Oils* by Jacky Mallgol, Jean-Luc Gardette, and Jaques Lemaire of the Laboratoire de Photochimie Molculaire et Macromoléculaire at Universite Blaise Pascal (JAOCS, vol. 77, no. 3 (2000)) shows the way in which a specific amount of heat (from 25°C to 120°C) applied to linseed oil first generates, then eliminates, the hydroperoxide population of the oil. The amount of hydroperoxides generated, and the amount of time to both create them and eliminate them, decreases with greater amounts of heat. According to the study, (done with a commercially refined linseed oil provided by Pebeo), at 25°C hydroperoxides peak at 600 hours, then have declined markedly by 1200 hours. This amounts to three months storage at slightly above average room temperature, and might well be approximated by a temperate zone summer in a south facing windowsill. At 120°C hydroperoxides peak at one hour, and are eliminated at ten hours. Extrapolation based on the other temperatures involved suggests that at 150°C hydroperoxides would peak at half an hour, then by eliminated after four hours. This provides a set of working guidelines for minimizing this problem, and helps explain both the historical preference for "old" oil, and for storing oil in the light for long periods of time. On drying, a film of hand refined organic (HRO) linseed oil aged in the light for three years does not yellow to a perceptible degree after eight months. The simple combination of a high quality, non-invasively refined oil with preheating or prolonged aging in the light may be a primary factor in the relative non-yellowing of older Low Country painting made with linseed oil. The oil forms a stronger paint film, is inherently more resistant to humidity, and does not yellow perceptibly over time.

Linseed Oil

While linseed oil has a recent reputation for yellowing, the linseed oil of Van Eyck, and of the Dutch painters of the 17th century has yellowed relatively little, if at all. Discussions about the generic behavior of linseed oil are confusing, because there are many different types of linseed oil. The focal issue is not the plant of origin, but the way the oil has been processed and refined. Quality here is paramount. While painters are always attracted to pale oil, the colour the oil starts out is not important, this is fugitive. If darkening occurs it is through the creation of hydroperoxides during polymerization: the "drying" which occurs through interaction with oxygen. It is possible to make an oil colourless using bleaching clay, as is consistently done with commercial oils, but this does not mean the oil will remain colourless over time. Wehlte points out thatit is natural to be drawn to the lightest oil, but a lighter oil may dry darker due to the way it has been processed. Cold-pressed linseed oil is considered more generally reliable than hot-pressed or alkali-refined linseed oil. But even if the oil is cold-pressed, there are variables. Factors such as growing climate, ripeness of the seeds when harvested, and the care which has been taken to exclude other seeds from the oil are all mentioned by Wehlte. When reading about test results on linseed oil, it is important to find out as much as possible about the oil with which the tests began, and how it was or wasn't processed. Using a quality cold-pressed, refined commercial linseed oil will alleviate much yellowing potential. This can be purchased from many of the older or higher quality paint manufacturers. It is at least moderately expensive, but typically yellows minimally. However, this is at the price of a faster drying rate, because this oil has been so totally refined.

The thoroughness of the refining process also results in this oil losing much of the rheological potential inherent in linseed oil. It is safe, but has also been effectively stripped of its personality. With any commercial cold-pressed oil, the elements of the process are both involved and unknown outside the trade. This is an area where it is beneficial to be patient and do yellowing tests, as some of these oils will prove better than others. A show of technical responsibility is becoming a more prevalent as a marketing strategy, but may or may not in fact have a quality oil to back it up.

While the older texts contain endless different recipes for refining linseed oil to make it less yellowing, painters will occasionally become interested in unrefined linseed oil on the theory that it is somehow more pure or original, or that, in an era devoted to over-refining natural products, unrefined must be better. The long term problem is that the fatty acids in the oil do not polymerize, and become more acidic over time. An oil from which the fatty acids have been removed will produce a stronger paint film which is also less acidic and less reactive to the great potential issue of atmospheric moisture over time.

Experience has shown hand-refined linseed oil to be capable of a variety of rheologies and behaviors that modern linseed oil simply cannot emulate. This may explain why the "lost secret" has always been thought to be something outside the loop of well-known materials. The actual secret may have been hidden in plain sight all along in the oil itself. To refine linseed oil by any one of several traditional refining methods, please download Refining Linseed Oil.

Part III: Optical Colour Separation

Transparent, Translucent, Opaque

Older painting consistently uses a system of enhanced optical contrast based on transparent darks, translucent midtones, and opaque highlights. This method was later codified and taught in the European academies, but begins to change in the early 19th century as more emphasis is placed on naturalism. Impressionism discarded the use of transparency, and, in the 20th century, the opacity of titanium white made it both counter-intuitive and difficult to achieve. The original system exploits the fact that darker transparent colours made with a viscous medium have a physical recessive depth, while lighter opaque colours, often featuring impasto, appear closer to the viewer. Older paintings were often begun in warm, transparent paint, with opaque higher values then placed on top of transparent darker ones. Further layers begin transparently, lowering the value structure, before move towards opacity again in the lighter values.

In the work of painters who used calcium carbonate – chalk, calcite, or marble dust – another level occurs. By making lighter values using calcium carbonate instead of white, many different translucent values can be obtained that are different both optically and chromatically than the same value made with white. This method allows even a limited earth colour palette to generate a system of highly evolved value and temperature relationships by mixing colour with an awareness of the opposite optical effects of transparency and the various degrees of opacity created by white. In this situation, both the sense of colour, and the sense of dimension, are enhanced using a minimum number of pigments to accentuate an overall chromatic unity.

This system, moving from transparent to translucent to opaque as the values go from dark to light, and also within a given value itself, creates a maximum illusion of depth with a minimum number of colours by organizing the painting around the great optical warmth of transparent paint relative to the optical coolness of any paint mixed with white. This way of working typically also involves the use of cool and warm grays as intermediaries. Subsequent layers of the painting continue in the same manner, often working from an overall warmth towards light which is cool. A simple way to begin to work with this type of painting is to concentrate the use of white into the upper quarter or so of the value scale, and to use a combination of calcium carbonate and a second triad of primaries that are lighter and at least somewhat opaque to make temperature shifts in the midtones. This method is not required to make either light or art, but an understanding of it allows another technical dimension: the logical manipulation of the optical qualities of the paint. The apogee of this technique historically occurs in the later work of Rembrandt.

Traditional Axes of Colour Behavior

Partly in response to a need to conserve costly materials, partly as a way of organizing complex compositions in an underpainting, and partly because the effect was pleasing to the period, older painters made use of value, temperature, and the optical qualities of the paint more fully than is typical with 20th century painting. Exploration of the effects made possible via the optical condition of the paint – transparent, translucent, opaque – is often eradicated in modern painting practice by the use of uncut titanium white. The white of older painting was lead white, and this could be cut with chalk or calcite for even more transparency. It requires more finesse to control an optical system with titanium white – which is ten times more opaque than lead white – and especially when it is used in a spontaneous mixing system. The approach of modern painting to colour may have been determined, to a large extent unconsciously, by the strength of titanium white, and the need for brilliant pigments that can stand up to it.

In the later work of Titian, and more famously in later Rembrandt paintings, another axis comes into play as well, that of organized, low-relief impasto. This is typically used with incredible skill to delineate the architecture of the human face, but paintings such as *The Jewish Bride* (c.1665), show it being used with a unique, bravura forethought to depict clothing as well. This gives four axes, or dimensions, which tend to act in parallel in older painting:

- **Dark to light**
- **Transparent to opaque**
- **Warm to cool (with possible shifts within each value)**
- **Smooth to broken (impastoed) paint**

These axes can be accessed most readily using the traditional materials, lead white and chalk or calcite, but the behavior of titanium white can be altered enough with *The Putty Medium* (section 5.25) to be effective as well. *Optical Colour Separation* (section 6.15) and *The Predimensional Palette* (section 6.17.5) are helpful for developing this more physically active look in the paint.

Optical Colour Separation

Paintings from the 17th century often exhibit a technique for maximizing the chromatic contrast available from a palette composed simply of relatively low chroma earth colours, black, and white. This technique can be seen in an especially evolved way in close-ups of later Rembrandt portraits. It involves using optically different types of colour in specific areas of each value to augment the painting's sense of dimension while maintaining a limited palette. This creates more of a sense of dimension in all values, but is especially useful for keeping higher values from losing depth and becoming visually flat or pasty.

In the first pass, the colours – typically a low chroma palette such as yellow ochre, raw sienna, Venetian or Mars red, burnt sienna, and black – are used without white. The lighter values of these colours are made by simply adding the bodied but translucent chalk putty medium. The first pass is somewhat darker than the ultimate goal, acknowledging that some lightening will occur from subsequent values mixed with white. This is then followed, after drying or wet-in-wet if the medium permits, by a cool, thin, more or less opaque layer. The cool layer may be initially made using only black and white, although at first this gives the painting the somewhat jarring effect of sudden dimensionality where it has been placed. This appears to be the general method, for example, used in a painting such as Rembrandt's *Stormy Landscape* (c.1638), which may be an example of a general Dutch method for beginning work during the period: the complex pattern of warm-cool interaction is established with a minimum number of colours, creating a convincing three-dimensional atmosphere for the local colour to follow. If used wet-in-wet, the rheology of the chalk putty medium allows a significant degree of control over how much these distinct warm and cool layers remain separate or blend together through different levels of pressure with the brush. As such, a great deal of development can occur in one extended layer of paint while keeping colour, value, and temperature relatively clean or discrete. The third pass on the painting again returns to warm and transparent colour, the fourth pass to cool and opaque, this time using colours other than black with white.

A good image for how this method operates is again a pendulum that moves back and forth between the poles of dark, warm, and transparent, and light, cool, and opaque. The method juxtaposes opposite types of colour: warm-transparent, and cool-opaque. Balancing these in the dimensional envelope is the fundamental technical goal of the painting. Bright midtone areas of colour are typically downplayed, even sacrificed, for the greater physical and psychological presence possible from more closely orchestrated value and temperature relationships. It is interesting to note the differences created by layering and impasto technique in this case. The earlier *Portrait of Jan Six*(1654) uses a bold red, gold, and black colour scheme similar to *The Jewish Bride* (c.1665), but the later painting features brighter, yet also much more texturally and chromatically detailed colour and an overall calligraphic technique based on the many layers, coupled with Rembrandt's advanced ability to accentuate temperature within a limited palette.

The eye perceives greater chroma and distinction between warm and cool tones as a result of this technique. This is especially true in the higher values, where light colours made with putty contrast both optically and in terms of temperature with light colours made with white. Yet, in spite of the strong colour dynamics available using this method, unusual chromatic harmony can be achieved because the palette is kept as simple as possible.

Optical Colour Exercises

These exercises are designed to develop facility with the putty medium, and provide a way to understand the basic principle often found in older painting: colour deployed with awareness of the optical temperature shift between a given value of a colour made with, or without, white.

Black & White: The Paradox of Optical Colour

This method illustrates how to manipulate the movement from transparent dark paint to opaque light paint that is so basic to 17th century painting practice. A limited palette develops more variety of chromatic expression through this method by capitalizing on optical shifts in temperature as the values change. If the logic of arranging optical temperature within value to enhance dimension is understood, the addition of colour to the system does not cause confusion. The eye has a reference for how the system appears at each stage as it develops on the canvas.

Begin by placing a small amount of both black and white paint on the palette. Take most of each and cut it with putty, 1:1. Then take half of each of these, and again cut with putty, 1:1. Do this three more times, so that there are six dilutions of both black and white, ranging from full strength to a ratio of 1:32. Place extra putty on the palette for further dilution. Begin the image first in the lightest black (a translucent gray) using no white. Continue through the values in the transparent blacks from light to dark, allowing the study to become somewhat darker in overall value than ultimately intended. Then clean the brush, or select a new one, and add the most dilute white. This is logical at the beginning of the cool midtones, or for cool reflections in the darker shadows. Even this dilute white creates a dramatic optical "jump" in context with the relatively warm, transparent grays. The pressure of the brush also makes a difference in terms of the temperature shift, more pressure meaning more blending and less shift. Slowly move up through the white dilutions from weak to strong, integrating warm (transparent) and cool (opaque) values through neutral (translucent) ones. Three distinct "colours" of gray can be differentiated. Integrating these is the first step towards augmenting colour via the optical quality of the paint. Note the way the eye reads transparency as shadow, and the way any value containing white comes forward relative to its proportion of white. The principle of optical colour separation is not necessary to make paintings, but does offer maximum colour perception within the inherent harmony of a limited palette.

Perennial Triad & White (The Tetrachromatikón)

The above exercise can be extended to colour using the ancient combination of yellow ochre and red earth with black and white. This illustrates how much apparent colour a limited palette is capable of generating when used with the putty medium. The point is to create alternative higher chroma areas by making them using the putty medium instead of white, and alternative lower chroma areas by including a very small amount of white. This method gives access to greater control of temperature in any value, but is especially apparent in higher values, through juxtaposing transparent or translucent application – warmer, no white – with more opaque application – cooler, with white.

Modifying Colour

A given colour can be modified five basic ways:

Colour mixed with colour: An uncut colour is called a **hue**. This is hue-to-hue mixing. As a type, hues are relatively warm even if made with cool colours. Colours that are less than ninety degrees apart make more vivid hues than colours that are more than ninety degrees apart. As colours approach one hundred eighty degrees apart, they begin to make a chromatic neutral hue. Hues advance in the picture plane unless they are relatively neutral.

Colour mixed with white: These are technically called **tints**, sometimes **pastels,** and are the coolest colour type. Tints advance in the picture plane.

Colour mixed with black: Technically **shades**, these are surprisingly warm even though approaching neutral. Shades recede in the picture plane.

Colour mixed with gray: Technically **tones**, these are cool relative to hues, but less than colours mixed with white. Tones can advance or recede depending on value and context.

Colour mixed with medium: If the pigment is transparent, this creates a glaze. Transparent or translucent colour is the warmest type, advancing or receding according to value.

Modern colour mixing tends to follow the spontaneous Impressionist model. In this system, there are two options, or chromatic types of mixing: colours are mixed with one another, making both brighter colours and neutrals, or colours are mixed with white. Painters in the 17th Century tended to follow a more complex model incorporating all five options listed above. This model creates an extremely subtle dimensional illusion from a minimum number of pigments, as we see in the work of Rembrandt, Murillo, and Velásquez. Historically, there are also painters who used certain aspects of the complete system in order to emphasize midtone colour more effectively.

This is the system of painters as various as Van Eyck, Fra Angelico, Lotto, Manet, Sargent, and Degas. A period of conscious exploration of all five options – which are much easier to see than to think about – quickly opens the doorway to achieving more apparent colour from fewer pigments on the palette once the relative temperature of the various modifications – their logical place in the value structure – becomes intuitive.

The Natural Neutral

Because any daylight scene is composed of relationships between red, yellow, and blue, with a single light-shadow axis, each scene also contains a natural neutral tone – the gray of the day – that can be used alone or to modify the other colours on the palette. The natural neutral is made from a combination of red, yellow, and blue keyed to the subject matter, and is most versatile if it is transparent. It can be made from the colour of the light mixed with the colour of the shadows, but can also be chosen based on what the painter sees, or can be exactly neutral. This introduces a specific or key neutral tint, and is helpful in situations where more detailed premixing is precluded. This approach is also helpful for beginning students, who find it difficult to be patient with premixing, but appreciate that the natural neutral makes midtone colour appear more vivid and unified. Exaggerating the natural neutral, either through more chroma or simply more presence, leads to the Mancini or Bouguereau style of midtone integration in a matrix of noticeable or stylish grays.

Part IV: Chalk and Other Mineral Modifiers

Older painting practice contains many interesting technical surprises. Next to the craft of the oil, the use of stone dust as an extender, brightener, stabilizer, and varied surface creator is at once both the most prosaic and the most profound. Different minerals have been used in the past to make pigments more translucent or to raise the value of a colour without making it markedly cooler in the manner of white. Painters tend to think of extenders as part of lower grade paint, therefore as something to avoid, but their use in older painting was functional both optically and technically. Early examples are Raphael's use of manganese-bearing ground glass in the imprimatura layer and the paint (National Gallery Technical Bulletin 25), the recent discovery of ground silica (quartzite) used for making glass in Venice as an extender in the work of Lotto, and the ground glass itself in various colours in the work of Tintoretto. In the 17th century, ground chalk is found in the work of Rembrandt, and to a lesser extent, Vermeer, and ground calcite is found in the work of Velásquez. The various materials do have different intrinsic behaviors, but are all also adaptable through shifts in proportion, or by incorporating other ingredients. While this territory is fascinating, exploration of it has yet to yield the penultimate philosopher's stone dust. As with other aspects of the craft, much depends on the scale and style involved, and the painter's intentions. The materials are different, but since Velásquez used ground calcite, Rembrandt used ground chalk, and the Venetians used ground glass or silica pebbles, the difference isn't one of quality, but of personal working preference, or perhaps simply availability, coupled with a given material's working character. While variety exists, this area is equally about developing greater awareness of the materials through experience.

Chalk is a natural calcium carbonate made up of the discarded shells – coccoliths – of ancient microscopic marine creatures. Natural chalks behave slightly differently in use depending on their composition, degree of compression, and how finely they are ground. Chalks tend to have a slight colour in oil from grey to beige, this is not typically an issue in working. (Note that the material called Bologna chalk is not calcium carbonate, but calcium sulphate, and is best avoided as a paint additive.) If the purest colour is necessary, say for emphasis on more pure midtone colour in translucent applications, the lightest chalk becomes more critical, the lightest natural chalk in oil is the Kremer Stone Chalk, 58162. Alternatively, a fine calcium carbonate made from marble or limestone is almost pure white and a bit more opaque in oil, while also being less sticky. However, all natural forms of calcium carbonate tend to inhibit yellowing in the oil. Chalk is absorbent, and translucent. Unless the oil is aged, it gives the putty a significant glutinous body and the ability to make impastoed or broken surfaces readily. Most chalk is quite fine, and the finer chalks, such as the Champagne chalk used for pastels, have a long, stringy, and more adhesive quality in new, the behavior becoming more gelatinous as the oil is aged in the light. Chalk is associated with the late, broader style of Rembrandt, but is also found in the work of Chardin, and in several of the paint samples from *Girl With A Pearl Earring* (c. 1665) analyzed in *Vermeer Studies* (1998), and in the work of Cezanne. While the active, broken surface potential of a putty-type medium is obvious, chalk can easily be incorporated into a smooth surface style as a way to create slightly more body and adhesion with a technically reliable oil medium.

Ground **calcite** is not made from optical calcite crystals, but is the name given to a crystalline, non-absorbent, and relatively large particle (approx. 20µ for the Kremer 58720) calcium carbonate that exhibits a much different working behavior than chalk. If made with thin oil, a calcite putty is translucent, tends to slump and level, and benefits from being mulled to give the mixture more cohesion. The rheology of this medium can also be altered by using heat-bodied linseed oil, as detected consistently in the analysis of Velásquez paint samples (NGTB 19). An oil heated for four hours to 150°C has enough body to effectively float the calcite particles, but this can also be engineered with sun oil or studio oil added to thinner oil. This increases the thickness of the paint and relative elasticity or *boing*. Of the putty family, this medium has a unique rheology, sliding in a slightly granular manner as though on miniature ball-bearings, but also stopping abruptly. It exhibits little of the adhesive or glutinous quality of a chalk putty. As such, a calcite putty tends towards lower, more even relief and edges which break cleanly but raggedly. This behavior is easily seen in close-ups of Velásquez paintings. Although consummately skilled, the painter is also capitalizing on the medium's natural way of working. An energetic style of brushwork with repeated edge attenuation is the calcite putty's strength; this medium is not as conducive to fine work at a small scale unless mulled. In a mixture, calcite provides a way to balance chalk with more mobility. It is also useful for the underpainting of finer work to provide a slight internal grip for future layers, and need not, in this case, be mulled.

Marble dust is semi-crystalline and the Fredrix brand is widely available as a gesso additive, making it an easy material with which to begin. Typically pure white and quite fine, it is more glutinous than calcite, not as adhesive as chalk, and more opaque than either. Even coarse marble dust is more adhesive than fine calcite.

There are many forms of natural **calcium carbonate** available as well, often made from limestone, the geological precursor to marble, sometimes also called **whiting**. (Limestone is sometimes marketed as chalk, since both are calcium carbonates, but they are quite different materials in use.) Used for the building trades, or for pottery, these tend to be quite white, relatively fine, and less adhesive but more opaque than chalk. They are available in large bags at low prices. Man-made **precipitated chalk** is also available. This is very light, and makes an adhesive white putty with little body and a very fine working character, but may yellow – testing is advised.

More gritty forms of **silica** such as fine aquarium sand can be used in a lean underpainting putty to help maintain subsequent adhesion. Kremer also has many grades of pure quartz sand. In the NGTB research there are many examples of coarser materials used in underlayers. Silica from pottery supply sources is typically 200 to 400 mesh and makes a beige putty similar in working character to marble dust. Very fine **glass beads** are also available, at 0-50µ these make a short mid-gray putty otherwise similar to calcite. An underpainting putty can also incorporate **ground leaded glass** when available. An interesting material in this family is very fine **cristobalite**, a high-temperature variety of quartz. At 7µ it makes a translucent white putty with a long but gelatinous or mobile quality. This is a step towards the behavior of **fumed silica**, which essentially dissolves into the oil, forming a gel of any consistency that produces a lubricating effect in a putty even in small amounts. While the calcium carbonates tend to accelerate drying, silica tends to be neutral or retard drying slightly. Using hand-refined organic linseed oil, this is not an issue. Any ground silica in dry form presents a long-term respiratory hazard and should always be handled wearing a serious particle mask.

Another interesting traditional additive is **bone ash,** an organic complex that is principally calcium phosphate, and often mentioned as a drier in the oldest texts. A small amount acts as a thickener, making it potentially the original material used in this way, and its mildly alkaline nature helps the paint film remain less acidic over time. It also tends to make a putty formula relax or slide, making it more mobile unless a separate thickening agent is added. This can be helpful when fine tuning a putty formula, or for diminishing the adhesiveness of a thicker oil.

Colloidal Clay is often used as an additive in commercial paint, a minute amount of a colloidal clay such as attapulgite or bentonite creates a more thixotropic putty. These clays are not ever that light in colour, however, and darken the putty even in small amounts. The lightest bentonite is marketed as Bentonlite in the pottery trade.

The early 20th century system of extenders is covered in *Paint Making and Colour Grinding* (1913) by Charles Uebele. It is important to note, though, that barium sulphate, commonly used in cadmium pigments in the 20th century, does cause the oil to yellow in tests and is therefore not a general purpose extender. Similarly, magnesium carbonate, while more gelatinous and translucent than chalk, also causes yellowing in an unpigmented test. Kaolin has also been reported to darken significantly.

Part V: The Art of Black, and the Worlds of Gray

The Art of Black

Is black a "good" colour, or a "bad" colour? Is black optional, necessary, or even crucial? The answer may be different depending on the home century of one's colour perception. Contemporary prejudice against black is often theoretical, or derived from confusion about how to use it effectively. From the perspective of gaining access to older colour schemes, learning first to use black as a type of blue, then integrating warm and cool gray values into the mixing system, offer tremendous potential as techniques. Black has also been used as a means of enhancing the perception of colour: even earth colours become vivid in context with grays. Fitting those grays smoothly into the envelope is an art, but there are many evolved examples of this art from the history of painting. In relation to light, physicists often say that black is not a colour. But for painters, working with the completely different optics of pigments, black *is* a colour. The injunction against black can be problematic because black is the most logical optical partner, and hence, tamer, of white. This is illustrated by the inspired simplicity of the Greek *tetrachromatikón*, and in countless ways in older painting. While black is commonly used to enhance visual drama, close-up images of older paintings often reveal a network of cool gray values woven loosely over a warmer colour of approximately the same value to create an optical vibration. This is part of the general older system of using warm and cool colours separately, for different passes on the painting, with cool-lighter following warm-darker.

However, this can be taken further in terms of integration. In *The Young Beggar* (c.1650), Murillo demonstrates the virtuoso use of a limited earth colour palette with an amazing variety of grays integrated by temperature, but used for both local colours and for cool reflections. This type of integration is intrinsic to Hammershøi, and can be seen in simplified ways in a variety of 19th century paintings such as *El Jaleo* (1882) by Sargent, or *The Ice Skater* (1898) by Anders Zorn. Overall warmer in tone, *The Forge of Vulcan* (1630) by Velásquez uses grays in a similar but more blended way. The 19th century French atelier method of integrating black into the envelope through gray can be seen in *Frédéric Bazille at his Easel* (1867) by Renoir, and in the elegant first version of *The Oyster Gatherers of Cancale* (1878) by Sargent, although this painting contains blue pigments as well. Sargent studied with Carolus-Duran, whose less formal paintings, such as *Portrait of Édouard Manet* (1880), illustrate his teaching principle of integrating grays over transparent warm tones.

While fundamental to older practice, in more recent painting the use of black is an art whose principles are typically learned incrementally. The work of Manet himself provides an example of this in practice. In early paintings, especially if they are executed alla prima, there are sometimes instances where the gray leaves the dimensional field and becomes noticeable in places as a form of flatness in the picture plane. But by *Luncheon in the Studio* (1868), Manet has solved the spatial issue: the interaction of the specific compositional planes is in fact the technical subject of the painting. By the time of *A Bar at the Folies-Bergère* (1882), spacial and chromatic relationships have both become masterful. The colours are set off by a shimmering, integrated matrix of black, white, and multiple varieties of lavender and gray reflected in the equivocal "distance" of the mirror. Here Manet illustrates black integrated into a brighter palette, the principles of Impressionism synthesized with the 17th century approach to black and white as a team.

While Manet studied Velásquez, this method of framing colour in black and white was also developed – although in an entirely different manner – by Rembrandt in such portraits as *Agatha Bas* (1641). A general feature of older painting practice is the dramatic pairing of black with white in order to make even earth colours that much more focal and vibrant. This is often employed in Dutch painting through clothing, or the dramatic checkerboard of a tiled floor, and is used by Vermeer for the painter's dramatic outfit as well in *The Art of Painting* (c. 1666).

At this point, the colours available are so extensive and reasonable that black can be left out, and pairs of opposite colours substituted. Using natural ultramarine in a shadow would have been inconceivable for a Renaissance painter, but it is straightforward to do now in combination with burnt sienna. Another way of approaching this is through a foundation triad of transparent primaries that are used to create a dark chromatic neutral. This produces an enhanced perception of harmony from a minimum number of pigments. Still, black has a unique character, a remarkably varied history, and offers the simplest way to balance white through the integration of grays.

The Worlds of Gray

As a term, gray is used for many different things, and this can cause confusion in implementing the three types of gray effectively. Because all colours are relative to context, the use of these types is based not only on their component pigments, but on where they are placed, and how they are integrated. Grays are typically based on black and white until the mid-19th century, when less expensive and more reliable pigments make the use of chromatic grays mixed from opposite colours viable as well. Black and white based **simple grays** are typically cool, and can appear literally blue in context with warm transparent earth colours. The strength of these grays is their distinctiveness, but this also means that they must be carefully integrated into the midtone structure to create a consistent illusion. This begins in fresco cycles made with earth pigments, was explored thoroughly by Rembrandt, and is a feature of Titian's more realistic work. The juxtaposition of a dark, warm, transparent underpainting with cool gray overpainting is a foundation of the way colour is used in the Low Countries in the 17th century. If the black is genuine ivory black, the grays are on the purple or even lavender side, as in the Rembrandt's *Self Portrait with Plumed Beret* of 1629. Before the 19th century, black and white based grays are most often made warmer with earth colours, but vermilion is sometimes used in the 18th century. The combination of black, white, and vermilion with earth colours is often a feature of English portraiture of this period.

An early **chromatic gray** combination is vermilion and Prussian blue, this is seen in both French and Italian painting later in the 18th century. The combination of cobalt or cerulean blue and vermilion becomes important in the 19th century first to Corot, then to Impressionism. Once synthetic ultramarine is produced in 1826, it is often combined with burnt Sienna for grays that can be made warm, cool, or neutral for daylight. The cold grays made from viridian and rose madder are often used for reflections by Sargent. The strength of chromatic grays is the ease with which they can be integrated into the chromatic architecture of the illusion.

More complex gray structures emerge when black and white are mixed with higher chroma pigments to make **compound grays**. A finely tuned tension between shimmering blue grays and midtone colour is often a feature 19th century French academic painting. The interaction of midtone colour with a specific structure of grays reaches a technical apogee in painters such as Mancini, who explored it in a variety of semi-tonalist ways using stone colours or a warm lavender gray, and Bouguereau, whose approach involved a highly refined blending of midtone hues with blue grays throughout the value structure, resulting in a trademark “celestial” refulgence for the entire painting.

Grays are used in four ways: as colours in their own right, such as for stones or overcast skies, as the vehicle for the envelope of a day or a room, as a form of tonalist filter used to establish a specific chromatic mood, and, within the triadic structure of shadow, midtone, and highlight, as reflections, the highlights occurring within lower values. This gives gray many possible functions in realism, and several possible positions in the chromatic architecture of the painting. It is important, when considering how grays have been implemented, to look at their purpose within the painter's intentions. Especially in situations where there are both gray objects and a gray shadow-reflection structure, unusual figure-ground interplay can occur, as in Murillo's *Beggar Boy.* Use of this becomes more conscious and systematic in 19th century French academic painting; an example being the interaction between the gray geese and their gray shadows in *Children Feeding Geese* (1881) by Julien Dupré. This painting mixes simplified bright midtones with a strong, consistent cold gray shadow structure reminiscent of the bright overcast of a cool Spring day. The puzzle of the lively, milling geese the children are feeding gives a predictable genre scene the disarming technical focus of a detailed chromatic pun.

The most fully chromatic, therefore most genuinely realistic, gray structure is possible if the grays are made from a triad of red, yellow and blue pigments. This can be set up various ways depending on the style of the work. Ideally, these pigments would also be transparent, allowing them to function as the transparent shadow structure as well. The pigments most often used to illustrate this in colour theory are quinacradone rose, phthalo blue, and a translucent primary yellow: the process triad. While this triad works in theory, it tends towards an unsettling combination of the lyrical and mechanical in practice unless mixed with great precision. An alternative, more painterly combination of pigments for use in natural daylight painting is Pyrol red, ultramarine blue, and transparent Mars yellow. A more developed shadow and gray structure creates the most multidimensional potential for the diversity of colour to be fully integrated throughout the formal structure of shadow, midtone, and highlight, but it does involve premixing, or relatively precise spontaneous mixing.

Part VI: Fat Over Lean

The first technical principle of modern painting practice is that painting always proceeds from "leaner" layers with less oil to "fatter" layers with more or richer oil. Painting this way assures that each layer adheres well to the layer beneath it, and that the paint film develops less internal tension on polymerizing fully over time, minimizing one source of surface cracks. This principle is correct in theory, but how it goes into practice is worth comment, both in terms of how consensus painting materials have recently developed, and how paintings were originally made, with handmade materials.

As far as long term cracking is concerned, the use of the generally accepted substrate of stretched canvas presents an inherent issue. If stretched canvas is used, the paint film needs to be engineered for maximum flexibility and the canvas needs to be protected from moisture in some way from the back. This at least helps minimize the potential for expansion and contraction through humidity changes. Laurie goes into this problem and technical solutions for it in significant detail. Current conservations strategies on this vary and can be researched, but tend to use some kind of panel insert system for the back of the painting. This can also be extended to protecting the canvas itself from moisture through a coat of a relatively flexible and hydrophobic size such as PVA, although the flexibility of any material will diminish over time. Given the fact that it is now possible to make dimensionally stable panels that are also relatively lightweight in larger sizes, while, on the other hand, larger stretchers are necessarily more complex and therefore expensive, this way of working is recommended if possible.

With regard to adhesion, it is important for underlayers to dry matte. It is possible, on panels, to grind the underpainting back between layers, removing any supernatant oil and opening up the surface for the next layer. Underpainting layers can be made leaner with solvent , or matte with an addition of a form of calcium carbonate to the paint. More gritty aggregates can also be used in larger scale work to add an internal tooth to the work, in consonance with early practice.

It is often stated that alla prima is exempt from the fat over lean rule because it is simply one layer. This is true, and can be pushed to significant extremes, as long as the same materials are used throughout the layer. If, however, one medium is used to start, and a faster drying or leaner medium is put over it, even though both are wet when applied – in "one layer," – subsequent wrinkling can occur when the whole layer dries. It is not, in this case, a matter of the relative richness, or "fatness" of the paint, but of potential discrepancy between two paints drying at different rates. This is possible even using the chalk putty medium, for example, if both mediums are on the dense side, making the layers themselves relatively discrete. If complex or dense alla prima application is the goal, the underpaint is still made leaner and faster-drying.

The fat over lean principle is not specifically part of any older text, although it is often stated that underlayers should dry matte. The fat over lean focus of 20^{th} century texts may well have occurred because the quality of the linseed oil used for painting for most of the 20^{th} century, especially in America, was not high. Linseed oil, as has been shown, is capable of a great range of behaviors depending on how it is processed. Technical art history has demonstrated conclusively that it is possible to make non-yellowing linseed oil. Experience with cold-pressed linseed oil refined in various older ways has shown it to be non-yellowing, especially so when aged in the light. The hot pressed, alkali refined linseed oil of the early to mid-20^{th} century, however, had a definite tendency to yellow, and is relatively volatile, surface drying in a way that makes wrinkling likely if such an oil were used liberally on a large canvas. As such, the 20^{th} century system in print is typically quite cautious about "the oil." However, the quality of oil in general use has improved, and a high quality, refined, cold-pressed oil, both in the paint and as a medium, makes a significant difference. Going further and using the type of oil that was the foundation of older painting – an organic, cold-pressed oil that has been hand refined – creates the next level of non-yellowing behavior, film strength and stability, especially when using linseed oil with any form of calcium carbonate. Relative to the behavior of commercial tube paint alone, the strength and stability of this system in use needs to be experienced to be believed.

A problem often encountered with the modern academic system in use, lack of saturation, sinking in or drying down of subsequent layers, is traceable to painting in too lean a manner, for too long. However, it is logical to paint lean, or rely on a resin medium, if the oil itself has been repeatedly shown to be suspect, and this is what it was for at least the first half of the 20^{th} century. But this is exactly where the older oil technology – epitomized by the behavior of the various hand refined linseed oils – fundamentally changes the way the system both behaves and ages. In order for the paint to dry with luminosity in alla prima work, or later layers of indirect work, the medium must contain a percentage of resin or a pre-polymerized oil. This also suspends the pigment particles so they remain more dispersed, allowing more light to enter and refract. As indicated by the general run of the National Gallery Technical Bulletin research into the materials of older practice, a high quality pre-polymerized oil is preferable to resin for this purpose in the long run because it is less likely to become brittle and yellow. In spite of the famous reference to resin in the

Strasbourg Manuscript, in spite of tremendous interest in resins in the 19th century as the "lost secret of the Old Masters," there is still no evidence of the global use of a resin by any major oil painter of the 15th to 17th century era. (Although an exception is probably the complex tempera grassa medium of Lotto, which recent research has shown contains egg, oil, and resin.)

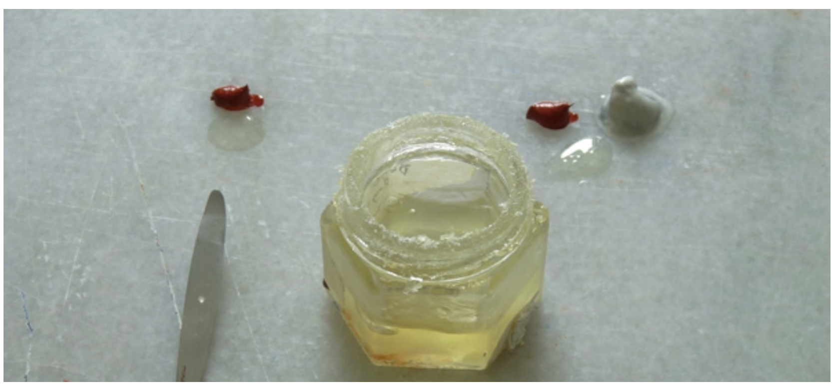
Fat over lean remains valid as a principle within the context of the older system based on a cold-pressed, hand refined oil, especially with regard to the adhesion of paint layers in indirect work. However, it is less crucial or more forgiving if the system itself is based on higher quality oil, especially the more stable hand refined oil. The De Mayerne Manuscript is thorough in terms of discussing diverse aspects of the craft, and contains many entries on how to make linseed oil non-yellowing or quicker drying. Yet, in contrast to the extensive discussion of paint film issues in a 20th century text such as Ralph Mayer's *The Artist's Handbook of Materials and Techniques* (1940-1991), De Mayerne contains no references to paint wrinkling or cracking, or on how to avoid this. (Conversely, there is no discussion of hand-refined oil in Mayer.) Given the much higher quality of the oil in use, this may not have been an issue at the time. Experience with the hand refined linseed oil system (see Appendix I) has confirmed this in practice. If a calcium carbonate is used, another level of long term physical and chemical stability can be achieved for the paint film. Even small additions of egg yolk also enhance stability and brightness, although the use of egg yolk is safest over time on panels.

Part VII: Oil to Oil Thixotropy

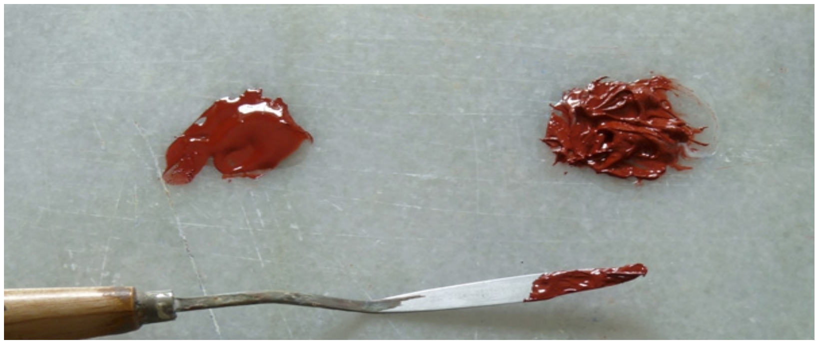
I explored thixotropy over a period of ten years as part of an exploration of older painting technique based on the research findings of current technical art history such as *The National Gallery Technical Bulletins*, or *The Artist's Assistant* by Dr. Leslie Carlyle. For the first five years I worked with an addition of hard resin varnish or egg yolk, but in the last five years, after reading the findings of the *Rembrandt* book in the National Gallery's *Art in the Making* series, I concentrated on producing the same reaction using oil and chalk alone. As this effect is less well-known, it is the focus of the example given here.

The paint used for this is handmade, using refined – washed with water, sand, and salt – walnut oil that is then preheated to 150 C° for one hour. The pigment was a medium red earth from Kama Pigments in Montreal called "salmon." The reaction works for all pigments, although some – such as green earth – seize more firmly than others. The reaction is less well defined with commercial paint, sometimes working a little bit, sometimes not at all. The reaction works with either walnut or linseed oil as the base for the paint.

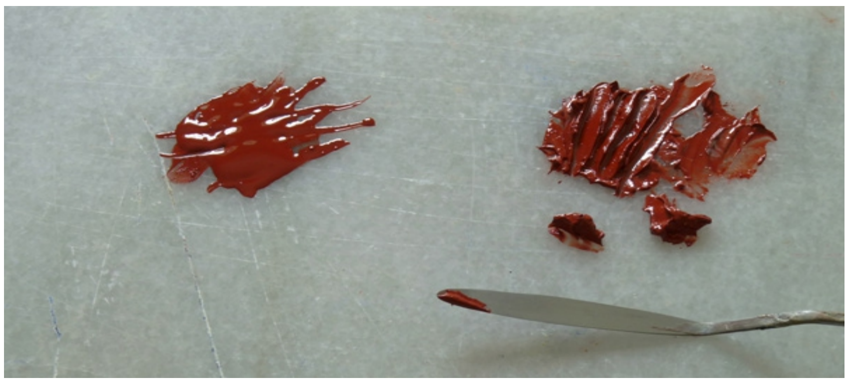
Two types of paint are possible with this reaction, one beginning with paint which has been previously cut with an oil and chalk putty medium, the other with paint which has not.



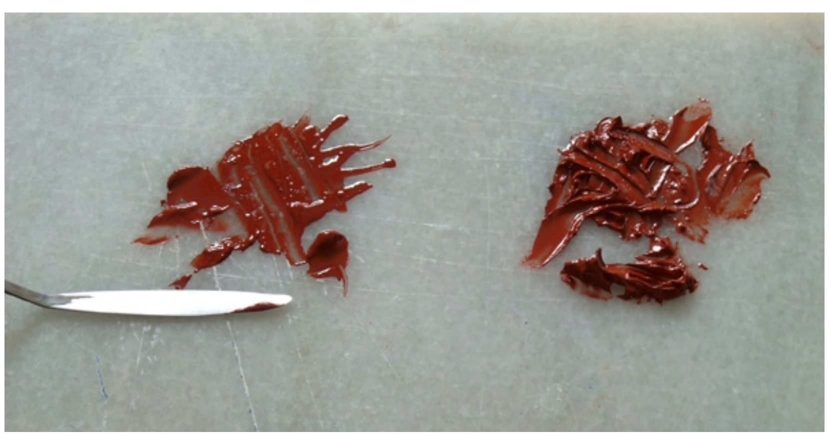
The seizing reaction is created by the introduction of a small amount of thickened oil to the paint. This oil is an organic, cold-pressed linseed oil that has been refined by the water, sand and salt method, then thickened in a thin layer in an open glass tray in the studio. Up to a certain thickness of oil, there is a moderate reaction. But, after this, the thicker the oil, the more pronounced the reaction. Thus, the thickness of the paint can be adjusted depending on the thickness of the modifying oil.



When the thick oil is mixed with the paint, the reaction begins. It is typically faster with the paint cut with chalk putty.



After a few minutes, the chalk putty paint is significantly firmer, will make separate chunks, while the straight paint is just beginning to thicken.



After a few more minutes, both samples of paint continue to tighten slightly.

But overnight, the paint without putty also tightens significantly.

The putty itself will tighten to a near solid over time. The sample on the left is the original putty, the sample on the right has been modified for twenty-four hours, and is so dense that it might be worked with a sacrificial bristle brush, but not a softer hair brush.

Another working consistency is supplied by paint cut with putty, but without thicker oil added. This can be used to modify the seizing reaction, either before or during work. This sample of paint was cut with a larger proportion of putty. Note the lightening of the value and brightening of the color without the coldness and opacity associated with any white pigment.

The paint can also be modified at any time with a moderate thickness of hand-refined linseed oil to loosen it, or any form of calcium carbonate to tighten it again.

This method offers a broad range of working rheologies from a limited, readily available, and highly reliable set of materials. Paint which is applied using this reaction will continue to seize on the painting, making it possible to paint over it, or into it, depending on the timing, and the type and pressure of the brush. Painting done using any form of hand refined linseed oil also dries relatively quickly, a day or two is typical depending on application and studio temperature.

This non-Newtonian, oil-to-oil reaction offers a possible solution to the puzzle of how older painters were able to make a decidedly thixotropic paint without recourse to lead salts or resins. More information about the materials involved in this example can be found in Living Craft. To refine linseed oil by any one of several traditional refining methods, please download Refining Linseed Oil. For any questions about this material, please e-mail me.