Sources, Materials, Techniques

Any object is made up from a collection of materials manipulated in a certain way. A textile requires fibers; a ceramic pot certain minerals. The techniques to convert substances or materials into an object include mechanical (weaving or shaping) or chemical (fulling, firing) operations. Furthermore, certain objects require specific materials or techniques. What separates velvet from canvas, or earthenware from porcelain are the substances used in composition and the ways they are manipulated. Ultimately, how an object can be used or will be used is related to the materials of its composition and its production techniques. Velvet is not sailcloth. Porcelain is not windowglass.

> The principal view in this disquisition is to enable those, who have already learnt to draw, to make themselves easily masters of painting in any manner they may choose; by which assistance many persons of genius, who, from ignorance of the nature and use of colours, might be deterred from it, may be both induced & enabled to attempt painting successfully, and bring those talents into practice, which would be otherwise lost to the public and themselves.
>
> Robert Dossie, *The Handmaid to the Arts* (London, 1764), 1:viii.

The creation of color in or on an object is an equally specific and equally integral part of the whole. The choice and combination of materials and the interactions of those components with each other play a large part in determining what a color looks like, and how well it meets goals of beauty and durability. Eighteenth-century assumptions about color, based common knowledge about materials and methods, are reflected both in common color criteria and in general recognition of the problems of creating good color. Personal biographies—of Jacob Christian Schäffer, Antoine-Joseph Loriot, and Josiah Wedgwood, for example—highlight the range of opportunities recognized and taken by practitioners and enthusiasts, by the established academics and the hopeful virtuosos.[1] This knowledge often extended beyond the narrow range of any single craft and connections obvious to us. Basic information about the construction of objects was familiar to eighteenth-century consumers as well as to manufacturers. The curious might glean further detail from books on the arts and on artisan methods. Within even the most disparate-seeming group of objects, there were recognizable similarities in the creation of color. This information affected goals of all kinds: construction, consumption, improvement.

In this section, I outline the processes of colormaking in general and in specific contexts. I will catalog here the varieties of materials used and the ways they might be—or had to be—combined to make good color for any or all objects. This information is essential to understand these collections of materials and techniques, how they differ, and how they are similar. My purpose is to emphasize the honeycomb of connections that existed among what are often presented as isolated techniques, to look at color production and highlight the wealth of information that created ideals and provided examples. In this as in other sections, I provide links to related information found elsewhere in this work; you may find especially useful the links to artifact studies that elucidate the relationship between color and object in the creation of that object.

The Creation of Color

> It is universally agreed that an injudicious mixture of pigments, contrary in their natures, produces very disagreeable consequences; which indeed might naturally be expected from the various and dissimilar origin of the ingredients. Some are productions of the animal, others of the vegetable kingdom; fossils afford some, minerals others; some are useless without calcination, others will not bear the fire; some remain constant in their colors, and retain their proper hues; others, though brilliant at first, become after a while totally corrupted, and by their corruption injure or destroy their companions, which might otherwise have stood well. Certainly, therefore, to acquire a knowledge of the origin of any pigment may conduce very much to a happy association of it with others.
>
> *The Artist's Repository*(London, n.d. [1784]-94), 2:3.

In a very general sense, there are a series of steps common to the creation of color in all objects. Color production begins with isolation of a coloring source, some substance that might be crushed, chopped, fermented, infused, washed, filtered, distilled, or ground so that its coloring particles can be collected and concentrated. These coloring particles are then combined with other ingredients to create a coloring material. The choice of substances depends on both the coloring source (its chemistry) and the technique in which that source will be used. This coloring material is applied to a substrate (the object): it is painted or stamped on, perhaps, or the object is immersed in it. Finally, the juncture of color and object is strengthened by drying or firing. Occasionally the color might then be further altered by the application of other substances, similar or different, or through such mechanical practices as polishing, shearing, or pressing. It may be protected or altered visually by a transparent or translucent coating.

Color sources provide the essence of color; they are not specific to the type of object being colored and are only rarely employable in their natural state. Coloring materials are coloring sources made useful. The transformation from general source to more specific material can require both chemical and mechanical operations. The object to be colored is important factor in the preparation of many coloring materials, although some generic characteristics remain. The techniques that adhere color to an object are the most specific part of color production processes, as they are calibrated to the surface onto which the color is applied and to the use for which that object is intended.

Coloring Sources

Organizing Coloring Sources

One feature of eighteenth-century descriptions of color creation was placement of every color source into an order based in natural history: Color was inherently animal, vegetable, or mineral. The imposition of this classification, which appears consistently in all kinds of publications and other written descriptions, offered a shorthand for some common characteristics including characteristic uses for each class to create color in objects. Similar preparation processes might be used to isolate the coloring particles in any group. These common methods were called upon in experiments with new materials, providing both direction—they suggested initial steps in the preparation of new materials—and a point of consideration for more philosophical explanations of the results.

The natural history classification of a color was determined by its coloring particles. The creation of Turkey red , for example, involved sheep entrails, bullock's blood, and a number of other animal-derived substances. Alum was the mordant used. But Turkey red was a vegetable color, as the source of its coloring particles was madder root, a plant material. The categorization of Prussian blue as animal is a measure of the tenacity of this ordering system, persisting even after it was clear that a similar result could be obtained from other, nonanimal sources.[4]

> En général, le jaune est plus communément minéral; car le stil de grain même, est un suc fixé par les sels que je viens de nommer, ou par la craye. Le rouge vient de l'animal, & le bleu vient du végétal.
>
> Louis-Bertrand Castel, *L'Optique des couleurs* (Paris, 1740), 117.

Occasionally, the use of this animal-vegetable-mineral ordering system was a starting point for further investigation into the improvement and understanding of colormaking processes. Eighteenth-century investigators wondered about the depth of the relationship between a color and its source. Locating a correspondence between the three principal colors and the three kingdoms of the natural world seems to have been as irresistible as it was impossible to substantiate. When Louis-Bertrand Castel suggested a correlation between the three kingdoms and the three basic colors of his physical world, his models were probably ochers, cochineal, and indigo. In his lectures Peter Shaw used turmeric to represent the vegetable realm, Prussian blue the animal, and, for the mineral, purple of Cassius.[2] About 1765, Jean Hellot toyed with the idea that a correspondence between coloring source and object was needed to ensure beautiful, fast colors for textiles. John Holker responded why this could not be true: Just consider indigo, a vegetable coloring material that dyes all fibers equally well.[3]

These tests of the relationship between color sources and colored objects were an extension of information that was so well understood it was only rarely articulated: Every color source provided coloring particles that were appropriate for a specific kind of coloring technique. Permanent vitreous colors were always mineral because plant and vegetable matter could not withstand the heat of the kiln; as a result all mineral colors were believed to be the most permanent. As such, they offered an ideal; efforts to improve color could mean strategizing to adapt mineral colors to other uses, or developing a technique to give animal and vegetable coloring materials the characteristics of mineral colors. Animal colors were the next-most permanent, a deduction based as much on the reputation of some colors of antiquity as real experience. Vegetable colors were the most abundant, the most varied, the easiest to create, and the most volatile.

Animal Colors

It is more difficult to build a cohesive description of the animal colors than of either vegetable or mineral, as the catalog included substances ranging from bone to body fluids, to shells, husks or casings. Kermes red, and the shellfish and snail purples known collectively (if somewhat indiscriminately) as Tyrian purple were often-cited examples of animal colors. In the eighteenth century they were rare, and so expensive as to be virtually obsolete as commercial color sources. Cochineal was, like kermes, an insect-based color source for red. Prussian blue, occasionally used as a substitute for Tyrian purple, was animal in origin because an essential ingredient was dried blood.[5] Lac (*Coccus lacca*), a source for a varnish (shellac) as well as a textile and painting color, was a hard and glossy larval secretion that could be harvested, dissolved, and applied without loss of those desirable characteristics.[6] Bone black was collected from charred animal bones; ivory black was, similarly, charred ivory. Sepia was extracted from cuttlefish or other cephalopods. Comparatively few animal-derived colors were in regular commercial use in the eighteenth century; the most widely used were probably bone blacks, sepia, cochineal and Prussian blue.

Procedures for color extraction from animal coloring sources depended on the nature of the material as well as the specific substance. For those that were not widely available throughout Europe, or that were the specialty of a region; preparation for transshipment could include drying and sorting. To use the animal coloring source, the dried substance, either ground or whole, is soaked to release the coloring particles into a solution. After some time and perhaps the application of heat, the colored liquid is strained to separate the coloring particles from debris. This was not the case for Prussian blue, however: The task of finding a blue color in animal blood involved a laboratory-based process that depended on calcinations, mixtures, and distillations.

Vegetable Colors

A great many coloring sources are plant-derived, and coloring particles could be obtained from every component: root, bark, leaves, berries, even parasites such as oak galls. The late-eighteenth-century colormaker Constant de Massoul describes in his book on painting further divisions. Perhaps referring to Macquer's categorization of dyestuffs, he listed vegetable colors as resins such as copal,

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dragon's blood and gamboge, gums (arabic, senegal, and tragacanth), and lees, or the residues of plants. This was not commonly adopted by authors of other English, French, or German manuals of practice, however.

Vegetable sources might be made to give up their coloring parts through grinding alone; green colors traditional to manuscript illumination were produced from both iris flowers and spinach leaves in this way.[7] When the coloring material was found in a running sap—as when the color sources were roots or branches—resting stages were often recommended before grinding. Thomas Jefferson recorded that harvested madder root should be beaten to a paste after a 12-hour wait.[8] This delay would release more coloring material than merely drying and storing the whole root. The resulting paste could be thinned for immediate use or itself dried.

> Take then the root call'd in Latin *Curcurma* and in English Turmerick (which I made use of, because it was then at hand, and is among Vegetables fit for that purpose one of the most easiest to be had) and when it is beaten, put what Quantity of it you please into fair Water, adding to every pound a spoonful of as strong a *Lixivium* or solution of Potashes as you can well make, Clarifying it by Filtration before you put it to the Decocting water.
>
> Robert Boyle, "Experiment XLIX" *Experiments and Considerations Touching Colours* (1664; Reprint, New York, 1964), 370

Isolation of other vegetable colors required fermentation and repeated immersions in acidic or alkaline liquids. Processes to decompose plant matter through chemical or physical techniques had models, for both preparation and results, in indigo and woad. Heating, or the addition of fermenting agents, shortened preparation time and ensured that the greatest quantity of color was extracted. This was important, given the high cost of many coloring sources. Multiple extractions were typical, although subsequent collections were often believed to be less potent, as they contained fewer coloring particles, and might only create a shade of the original color. There are no recorded opinions that these recalcitrant molecules adhered better or less well than did the first collection, however (and however often) they might be combined.

A few plants gave different colors with multiple collections or different additives. Throughout Europe, the most familiar of these was safflower, which provided both yellows and pinks. By the eighteenth century it was no longer a significant source in the colorhouse but the connection between its colors and ideas about color change and color relationships remained strong, especially to demonstrate red-orange-yellow series of colors.

Mineral Colors

> Stuff that Spanish brown is made on is called oaker. Itt is gotten in coal pitt sows near Wakefild and a horse load is sold for 2s 6d or so. Then the burn itt and itt is called Spanish brown itt goes up to London and send down into the country wich makes itt to bee selled att great prises. The gett a deall of money bye this sortt of stuff because itt is bought in so cheap at first.

John Brearley's Notebook Vol 1 f44r. West Yorkshire Archive Service No.1444

The mineral colors include a catchall grouping of "earths" as well as manufactured colors made from such ores as cobalt, copper, manganese, mercury, and lead. The largest subgroup of earths was ochers, colors formed from iron oxides. Red, yellow, and brown colors were typical, but greens and blues derived from copper deposits were also familiar.[9] Coloring earths were native to every region of Europe, although certain districts provided especially good quality or especially desirable shades. Geographic links are often reflected in names—e.g., umber, sienna, Cologne or Kassel earth, Armenian bole, Verona green earth—that eventually transcended their local origins. Corroborating John Brearley's comment about production of Spanish brown in England is William Dyer's description of his unsuccessful effort to establish a Spanish brown manufacture in Bristol.[10]

Colors are washed; by being mixed with a proper quantity of fair water, till the water is thoroughly colored ; if the surface of it appear greasy, take off that scum, and pour the colored water into a clean bason, leaving the grosser sediment behind ; the water thus poured off, will in a little time deposit a quantity of color. This operation may be repeated till the color obtained is sufficiently pure, which appears by its fineness, and brilliancy. Mr. Sandby is said to wash Naples yellow, with milk instead of water.

The Artist's Repository(London, n.d. [1784]-94), 2:9.

Some earth colors needed only a combination of sorting, washing, and grinding to release the coloring particles. The slurry would be placed into a column-like container. Different shades or different sizes and qualities of the coloring particles separated as the ground earths and stones settled. Each layer was then carefully poured out of the container and dried. Vinegar was occasionally recommended as a washing fluid in place of water: It dissolved impurities, especially calcium carbonates, but bleached the color if used carelessly.

Other mineral coloring sources included arsenic, lead, lapis lazuli , azurite, tin, gold, and silver—each of them alone or in combination with other substances. In most cases, the work required to extract and purify the coloring material from their ores was greater than washing and sorting. In his description (1790) of the preparation of cobalt, for example, August Fürchgott Winckler, the *Bergmeister* in Zschopenthal (near Chemnitz, in Saxony) identified about 15 stages roasting, pounding, sorting, multiple separations, and calcining in the purification of cobalt ore into zaffer or other blue coloring materials.[11] Lead could be roasted to make minium, joined to antimony to make Naples yellow, to tin to make lead-tin yellows. It might be packed into jars with vinegar or grape skins to make lead white.[12] Verdigris was created from copper in a process similar to that for lead white.[13]

Coloring Particles to Coloring Materials

Once isolated from their source, coloring particles must be transformed into a workable coloring material. In these stages, the coloring material might be combined with other substances to improve durability, ease application, or enhance the color when applied to the object. As a group, coloring materials are less generic than color sources, but still not as specific as the coloring processes. The prepared coloring material might be appropriate for several different objects or uses: one such material might be used as a textile color and a painters' pigment, or for beads, glass gems, glass painting, and enameling.

Artificial, Manufactured, Chemical

> Les [couleurs] naturelles sont celles que la nature nous fournit tells qu'on les employe, simples ou rompues; les artificielles sont celles que l'art forme au moyen de feu ou de quelqu'autre agent, par l'assemblage de plusieurs ingrediens, ou par le changement que ces agens produisent sur une seule & même matiere.
>
> Antoine-Joseph Pernety, *Dictionnaire portatif de peinture*(Paris, 1757), 108.

Coloring materials, like color sources, were categorized in several ways, but here differences were linked to basic understanding of production rather than natural history. The common terms *artificial*, *manufactured*, and *chemical*—when referring to coloring materials—were clues to processing techniques in both public and specialist vocabularies. Chemical coloring materials were the result of separation and combination techniques similar to those of the laboratory workshop. Several, including massicot or giallolino, purple of Cassius , and Drebbel's red, predated the epoch. Eighteenth-century experiments increased the number of chemical colors available, and new colors included Prussian blue , Scheele's green and yellow, Brunswick green, and Turner's yellow.[14]

> King's yellow is a pure orpiment, or arsenic coloured with sulphur. . . [It] must be prepared by mixing sulphur and arsenic by sublimation, which is used for painting in oil and varnish. . .
>
> Robert Dossie, *The Handmaid to the Arts* (London, 1764), 1:90

Common manufactured colors included such pigments as king's yellow, verdigris, and lead white. Their coloring essences were often mineral. Nearly all vitreous colors and many colors for textiles were classed as manufactured and, like chemical colors, the manufactured color was a subset of the larger group of artificial colors. Artificial colors were those made by the manipulations of an artisan. All colors—except earths and certain plants that could be collected, cleaned, ground, and used—were artificial because they required manipulation to become viable coloring materials.

The nature of a coloring material was important to manufacturers and suppliers as its composition could determine who had the rights of sale. Lead white, oils, and some waxes as well as alum, tin, and oil of vitriol were used by apothecaries, drysalters, and manufacturing chemists with other specialties as well as to colormakers. In Paris, where production and distribution privileges were closely guarded, disagreements over rights of sale could continue for years. Arguments between painters' and apothecaries' guilds were especially bitter.[15] The appearance of familiar colors made in new processes provoked friction among these groups, and led to the inevitable accusations and confiscations.

Some coloring materials could be described using more than one of these terms, however. It is unclear if carbon blacks were considered manufactured or natural, for example, as they could be made deliberately or found in nature. Bitumen-based colors such as mummy were often counted as natural. Most animal and vegetable colors were manufactured, but not all mineral colors were natural. The yellow color giallolino was prepared by heating lead and tin together, occasionally with silica added to stabilize the color and deepen the shade.[16] Some published instructions for making ultramarine from lapis lazuli recommended a long process involving calcination, extraction in vinegar, mixture into a wax-resin combination, and decanting or extraction to separate the best and several less-good coloring materials.[17] Although it is possible to grind, suspend, and decant lapis lazuli, the manufactured color was believed to be better, purer, and brighter.

The Preparation of Coloring Materials

Vegetable and a few animal sources of color were converted into coloring materials known as lakes and thereby made viable for painting purposes.[18] Painters' lakes, prepared from many of the same extractions used by dyers, were made by the precipitation of coloring particles onto an absorbent base. The nature of the base medium affected the transparency of the color; lakes could be as transparent as the tinctures used to color-wash prints or the more opaque body colors or gouache. The consistent thinness of certain lakes—or, rather, the inability to turn them into stable body color—rendered them more suitable as washes or as glazes over other colors.[19] Turmeric lake is one example of a color used exclusively in this way; it is sensitive enough to the presence of acids or bases that the addition of chalk will alter the the color from bright yellow to a darker yellow-brown.

Coloring materials were often created in a range of colors from a single source. The addition of certain acids, bases, or some metals to a tincture could create a different but stable color, an effect exploited in the use of different mordants in textile dyeing. Careful heating of minerals could intensify the color, as names such as burnt sienna and burnt umber suggest.

Pigments

> *In the preparation of oil colours*, care must be taken that they be ground fine; that in putting them on the pallet, those which will not dry of themselves, be mixed with drying oil, or other driers; and that the tinged colours be mixed in as small quantities as possible.
>
> Ephraim Chambers, "Colouring, doctrine of" *Cyclopædia*(London, 1786), 1:n.p.

The creation of a painters' pigment from a coloring material generally required grinding the coloring particles in water or oil (the binder or medium). Other liquids might be added as thinners, plasticizers, or driers, depending on the characteristics of both the color source and the medium. Mechanical properties (workability) as well as visual ones were closely related to the choices of materials, and needed to be compatible with the painting technique. For oil-based paints, for example, a series of chemical reactions occur during the drying stages; the speed of the reactions depend on the media used and their proportions.[20] This in turn affects the appearance of the color when dry. Linseed and walnut oils were common recommendations for binders in the eighteenth century. Both types of oil were known for their light-reflecting properties, drying capabilities, and easy availability, and each could be purified to colorlessness. A thinner such as turpentine might be added to the coloring particle-binder mixture to improve the consistency of the color during application; a characteristic of thinners was often rapid evaporation, which meant that it hastened drying time as well. Eighteenth-century writer-practitioners recommended their cautious use however, believing that they would cause colors to yellow as they aged.

> Oil of turpentine is distilled from turpentine. It is an etherial oil which quickly exhales in the air, and if mixt with linseed, nut, or poppy oils, in flying off carries with it the more volatile part of such oils, and causes them to dry much sooner than they would otherwise.
>
> Robert Dossie, *The Handmaid to the Arts* (London, 1764), 1:161.

Coloring materials for watercolor techniques combine pigment with a small amount of a water-soluble sticky substance, such as gum arabic or sugar to promote adhesion and plasticity. Water serves as both a thinner and a vehicle. Robert Dossie described three categories of watercolor painting—miniature, the most delicate; distemper, which is coarser, uses less expensive colors in a glue or casein binder, and is appropriate for canvas hangings, ceilings, and other interior decorative painting purposes; and fresco. As a technique practiced by the Romans, fresco painting was a subject of particularly interest in the antiquity-obsessed eighteenth-century. Coloring materials for fresco were different from those used for other painting techniques: colors were ground in water and applied directly to wet plaster, which served as the binding medium, ground, and support all at once.

As a rule, watercolors dry more quickly than oils, and are more transparent. To increase the body, to make the watercolor less transparent, a chalk or other opaque source could be incorporated into the preparation. Artisans and artists looked for new additives to increase body without changing the color in the short or long term. Other additions might improve application by controlling the flow of the coloring material across the surface of the painting. Overall, as with oil painting, the goals were to make a beautiful and durable color that could be applied with ease, that dried in a reasonable period, and that behaved in predictable ways.

Most other painting techniques were variants on water- or oil-colormaking processes. Coloring particles might be ground into a varnish for vernis-Martin or other lacquer-like painting techniques. They might be mixed into a clay or chalk to make pastels, or mixed into a wax base for encaustic painting techniques.

Maniére de préparer les couleurs

Cette préparation consiste, ou à broyer la couleur avec la cire sur la pierre chaude, & de faire fondre ces cires colorées dans le vernis propre à la couleur que l'on prépare, ou à fondre la cire dans les vernis, & y ajouter la couleur.

comte de Caylus, *Mémoire sur la peinture à l'encaustique* (Geneve, 1755), 113–114.

In the eighteenth century, almost any colored substance that could be ground to an appropriate fineness and mixed into a binder was tried as a painters' color.[21] Manuscript documents as well as printed works note the regular use of substances such as finely ground colored glass and mummy, as coloring materials. The possibilities explored included attempts to convert a wide variety of what we know as waste materials into useful coloring materials. Writers and inventors often advocated special combinations of waxes and oils or of special mixtures to enhance the permanence of lake pigments. The range of experiments undertaken, and of methods advocated, make it tempting to wonder if the satiric nature of Jean-André Roquet's *L'Art nouveau de la peinture en fromage*. . . (1755), an effort to deride Jean-Jacques Bachelier's soft-wax encaustic painting technique, was lost on certain experimenters.[22] Unfortunately, there is no verifiable information for use of some exotic coloring materials put forward and, with few exceptions, we can be certain about painters' colors only when more precise records exist to confirm assumptions.[23]

Frits and Fluxes, Glazes and Enamels

Émail

L'émail est en général une matière vitrifiée, entre les parties de laquelle est distribuée une autre matière qui n'est point vitrifiée.

Pierre-Joseph Macquer, *Dictionnaire de chimie*(Paris, 1778), 1:376.

Coloring materials for glass painting and for enamels were essentially the same, created from fondant or frit combined with a metallic oxide and with substances that would stabilize the coloring material until it had melted and fused to the glass or metal surface. The coloring materials are ground in a liquid—to the consistency of buttermilk was a frequent description—and mixed with the same gums used in water-based painting were often employed to promote the temporary adhesion of coloring material, until firing made the color permanent.

Il paroît. . . qu'il faut trois choses pour faire un verre coloré.

> 1˚, Une substance qui mette la matiere vitrifiable en fusion.
>
> 2˚, Une substance qui se vitrifiant avec elle, soit de nature à retenir le phlogistique.
>
> 3˚, Une substance qui fournisse le phlogistique, & dans laquelle il soit assez fixe pour n'être pas dissipé par le feu, avant que le verre soit en fonte.
>
> Didier-François d'Arclais de Montamy, *Traité des couleurs pour la peinture*(Paris, 1765), 37.

This sounds simple enough but, as in all artisan processes, vitreous colors required considerable attention to the creation of coloring materials that would match the finer points of the substrate. The use of unique proportions of materials, and a specific firing temperature and firing time for each color was not unusual. As porcelain manufacture developed in the West during the eighteenth century, and because of the regular need to establish the quality of materials used in the colorhouse proportions and formulas of coloring materials were always subject to experiment.[24] These experiments to reformulate appear to have been more important—to individual investigators and to the production of vitreous colors in general—than the location of new color sources.[25] Josiah Wedgwood's experiment books show constant attention to such details, as do Hellot's records at Vincennes, George Berg's notebooks, and the many publications about ceramics, enamel and glassmaking that appeared throughout Europe in the eighteenth century.[26]

The *Dictionnaire des arts et métiers* (1766) outlines a typical procedure for creating the coating for ceramics or clay bodies.[27] A base, made from the ground calx of lead or fine tin, is mixed with ground white flint and tartar salts. This mixture is heated in a kiln until partially vitrified and, when cool, is broken up and ground again. The resulting powder is mixed with water or another liquid. The formula could also serve as a fondant, the medium into which one or several metallic calxes are ground to form a coloring material for use under or on the glaze.

To make coloring particles—principally metallic oxides—into the vitreous coloring materials for needed ceramics and enamels, the particles were ground with a flux, a combination of glass, sand, lead, and salts such as borax, niter, and sal gem (sodium chloride). The choice and quantity of each additive was calibrated to lower the firing temperature but still permit a glass to form. The flux could also serve as a corrective body, preventing the specks and dull surfaces that developed as lead- or arsenic-based glass corroded.

Fritting (or sintering) the coloring materials was a variation on the fluxing process. It rendered certain coloring materials insoluble and therefore appropriate for use as a glaze or ceramic color. To make a frit, an alkali source (natron, plant ash, or borax) was heated with silica. The combination, on cooling, formed a glass that was then ground and milled for use with the coloring material. Recipes often

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call for the still-hot frit to be poured onto water—the rapid temperature change created a solid mass which cracked or broke up immediately, making the grinding process easier.[28] Josiah Wedgwood noted another practical purpose for the addition of a frit to a clay mixture: When a ceramic body was constructed with a high percentage of flint (as stoneware often was), the addition of a frit made the resulting objects less likely to chip.[29]

A feature of coloring materials for certain kinds of clay bodies, including the soft-paste ceramics that were the original specialty at Vincennes was the lack of correspondence between the color as applied and the final result. Ceramic painters often worked "blind," using a chart made from the color trials as a guide. By the middle of the eighteenth century, continued experimentation with combinations of metallic oxides and fluxes led to a larger palette of colors for these and most other varieties of ceramics. The resulting colors were more appropriate for detailed scenes or for the designs of flora and fauna that were increasingly fashionable decorative elements.

The Preparation of Textile Colors

> **Colouring *and* noncolouring *drugs***.
>
> Thus the dyers distinguish their materials: the first are applicative, and communicate their colours to the matters boiled in them; or passed through them; as woad, scarlet, green, cochineal, indigo, madder, turmeric, &c.
>
> The second serve to prepare and dispose the stuffs, and other matters; and to extract the colour out of the *colouring* ingredients; as alum, salt or crystal of tartar, arsenic, realgal [sic], salt-petre, common salt, sal ammoniac, sal gemmæ, agaric, spirit of wine, bran, peas-flour, wheat, starch, lime, and ashes.
>
> Ephraim Chambers, "Colouring and noncolouring drugs" *Cyclopædia* (London, 1786), 1:n.p.

Few commercially viable colors for painting or dyeing textiles could be created with only the extracted coloring particles in a liquid form. Dyers applied other substances, generally a metallic salt such as alum, tartar, or tin, to the fibers or the dyebath to improve adherence or brightness. In modern descriptions, dyestuffs that required this preliminary application to ensure permanence are called *mordant dyes*, a term that first appeared (although not without some debate) in eighteenth-century French discussions of textile production; elsewhere they were known as noncoloring dye drugs or, more generally, assistants.[30] Other coloring assistants were added to the dye vat to enhance the color by softening the water and mellowing the yarns or cloth: bran, sumac, galls, oils, entrails, or spent dyestuffs are among the most frequently cited.[31] Soaking wool in a slightly fermented bran solution was a common initial step, believed to be comparable to the initial soapy bath that ensured complete removal of natural gums on silk.

Coloring Techniques

Securing a coloring material onto an object involves an additional complex of

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choices, with further distinctions specific to the item being colored and to its use as well as to the materials to be employed. Techniques for creating easel paintings will not successfully color cloth for clothing even if the common substrate is a textile, but neither will they necessarily provide good color for a wall or a metal sign. The preparation of the substrate, the application of a coloring material (or materials) and how it is made permanent, the tools needed for application—all of these varied. Mechanical or operational constraints and decisions existed for all objects. Efforts to understand different processes within and beyond the manufacturing communities often overlapped, with expected benefits for both the theories and the practices of color. The desire for novelty led to the examination not just of sources and materials but also techniques. .

Color on Objects—Painting

> *To prevent colors from sinking in*, take roch alum two ounces, and boil it in a pint of spring water; wet the back of the paper with a spunge dipped in the water while warm. Some use starch applied at the back. A yet stronger mixture, which will prevent the color from sinking not only on paper, but slikewise on sattin, is made, by boiling Isinglass in water, brandy, or spirit of wine, till the liquor is strong and clammy, then, after your outlines are drawn, wash them over with this solution while hot. Repeat it if wanted.
>
> *The Artist's Repository*(London, n.d. [1784]-94), 2:11.

To make a painting, apply coloring materials (source plus an appropriate medium—oil- or water-based, waxy or resinous) to a properly prepared surface. If you desire, adjust some or all of the colors through the further application of more color, perhaps a different coloring material, perhaps when the color is partially dry. Varnish all or part to add gloss, create highlights, or to protect the color. In this reduced description, instructions for fine- and decorative-art painting were virtually identical to those for industrial or "coarse" painting—coloring on houses, carriages, or ships. Yet each kind of painting involved a series of recognized techniques for creating colors on the object and so for creating that *kind*of object. A good painting had not only a beautiful and meaningful surface but also a series of underlying connections that supported that beauty and permitted its interpretation.

Painting began with the preparation of the surface to be embellished. The support should be even, absorbent, and of a shade that would enhance the colors used.[32] An abraded surface promoted adhesion of color for copper or other metal supports, and these might be sanded or roughened before priming layers were applied.[33] Oil colors on canvas might require up to half a dozen underlayers of sizing gessoes, dead colorings, and other primings. These underlayers were part of a chemical and physical package that supported the pigment-binder combinations, and affected the colors used in the making of the image.[34] To prepare a wooden support for an oil or wax-based painting, the substrate would also begin with sanding. An underlayer of varnish or wax would limit absorption of color into the wood, but otherwise, these paintings might have the same preparations as those used for paintings on cloth. For all painting supports, proper drying between each layer and before the addition of coloring materials was critical; some writers advocated up to a year's wait.

Engravings on paper that were to be embellished with water-based colors might be affixed to a firm if temporary support to prevent cockling and a light wash of gum or other sizing applied to aid color adhesion and control capillary action.

There were many variations among the coloring techniques that employed pigments, and many more were proposed by a number of eighteenth-century artists, colormen, and inventors.[35] Many of the special methods that were developed during the eighteenth century disappeared quickly: Montpetit's eludoric painting and Jean-Félix Watin's peinture d'impression, are two examples. Other methods, notably encaustic and pastel techniques, joined the standard painting repertoire.

> Tendez une toile de telle grandeur que vous souhaiterez, ensuite colez-y une feuille de papier blanc avec de l'empois très-léger. Le papier étant sec, foncez-le pour le rendre plus uni, ensuite clouez le taffetas sur le chassis : le plus commode est le demi-Florence. Qui veut faire deux originaux à la fois, mettra double taffetas, & aura soin de bien fondre & empâter son objet, & de finir le premier en huit jours, pour avoir la facilité de relever le premier sans endommager le second.
>
> La veille du jour où l'on veut peindre, on prend de l'huile que la veuve indique ou fournit : on en imbibe le taffetas avec une éponge ou du coton, le surplus on le fait tomber sur une assiette, & on laisse son chassis à plat, jusqu'au lendemain : en cas que l'on quitte son objet, qu'il soit trop sec, & que le crayon ne se fonde pas, on prend un peu d'huile que l'on passe par-dessus.
>
> "Façon de se servir du Pastel à l'huile de la Veuve Pellechet " 1767 AN O/1/1911 reel 1, #16.

Pastel colors are made by grinding pigment with chalk, in combination with water or oil and a weak binding agent that allowed the formation of the colored mass into sticks or crayons. Popular among professional and amateur artists alike, pastels provided a finished result more quickly than work in oils could, requiring fewer sittings and little or no drying time. They were more portable than oil or water colors as consistently effective color containers and watercolor cakes were late eighteenth or early nineteenth-century inventions.[36] Unlike washes or body colors, pastels offered the possibility of a wide range of effects, from oil-like impastos to delicate translucency. Pastel images were notoriously fragile, however, and a common point of invention to improve pastels was the creation of a fixative that would preserve the image and its essential physical and technical characteristics.[37]

In encaustic techniques, fire or heat is used to set, or "burn in," color and design. Under such a broad definition, all vitreous coloring materials are encaustic, a technicality exploited by Josiah Wedgwood in his vase patents of 1769.[38] As an eighteenth-century painters' technique, encaustic has been linked simultaneously to contemporary interests in a new and simplified modern style and to antiquarian efforts to revive practices of the ancient world.[39] The use of heat hinted at a painting method involving colors more permanent than those associated with common oil- or water-based methods. Encaustic pigments are incorporated into a wax, usually refined beeswax, rather than an oil or resin. The authorities most often cited—Pliny especially—did not write in sufficient detail to replicate any technique with certainty, and so the eighteenth-century encaustic-painting revival supported several rival theories. Was wax supposed to be the vehicle for the color, or was a separate layer applied to the face or reverse of the work after completion to produce a nonreflective luster and make color more permanent? This and similar questions continued to be discussed as the work of the two principal French inventors—the artist and Sèvres-based painter Jean-Jacques Bachelier and the comte de Caylus—was subjected to scrutiny and reconfiguration by others in France, England, Germany, and Italy.

Color on Objects—Vitreous Colors

> Les Peintres en Émail donnoient jusqu'ici le nom d'*Ennemies* à de certaines couleurs dont le mêlange se détruisoitt dans la fusion, ou qui bouillonnoient lorsqu'on les couchoit les unes sur les autres. Toutes celles dont on va donner la composition, n'ont aucune antipathie entr'elles se mêlent parfaitement, & ne sont point sujettes à bouillonner.
>
> Didier-François d'Arclais de Montamy, *Traité des couleurs pour la peinture* (Paris, 1765), 7–8.

Vitreous colormaking might begin with a ceramic form, a useful or decorative one, something made of soft- or hard-paste porcelain, stoneware, or earthenware. A form, once created, is dried, smoothed, fired, smoothed again, and perhaps washed: These are preparation steps that enable the clay substrate to receive colors. An initial color—occasionally the only one—is provided by a covering glaze, applied to the surface of the whole object. This substance is constructed of materials similar to the ceramic substrate: metallic oxides, frits, sand, silica, old glass. As the glaze melts in the kiln it bonds to the clay strengthening and becoming inseparable from it. This glazed object, once removed from the fire and cooled, and may then be recolored or painted upon with other coloring materials in a series of subsequent firings.

Porosity and elasticity of the support—the composition of the clay, glass, or metal used in enameling—was an important consideration in choosing the coloring materials for ceramic bodies, as they too reacted to temperature changes during firing. If the coloring material shrank more than the support cracks might form. If it shrank less, the result might be bubbling or peeling.[40] An additional requirement for good vitreous colors—glaze or painting enamels—on ceramics was an ability to withstand the predictably high heats needed to melt the coloring material and fuse it to the surface on which it lies. Too little heat, or too much, and the result would not set properly: The glaze or color might peel, craze, bubble, or devitrify. Experience-based strategies could establish the heat of the kiln during for and during firing, and tools such as Wedgwood's pyrometer added further control for the process.[41]

The composition of the fuel source was another consideration for vitreous colors. As with dyeing, manufacturers frequently used coal or peat where wood was scarce or expensive. Each fuel released different chemicals, or chemicals in different quantities, into the kiln during firing. The presence of ash and less-visible elements such as sulfur—especially but not exclusively—in coal-fired kilns required reformulations of substrates, coloring materials, coloring processes, and kiln designs. Enclosing the clay pieces in a saggar for firing could protect them from the atmosphere and could limit damage if a piece collapsed or was otherwise destroyed during firing. Experiments were also undertaken to find formulas for substrates and coloring materials that would withstand the inherent problems of firing.

Designs in Vitreous Colors

> The colours used in Enamel, are all metallic calces, mixed and melted with certain proportions of a vitreous substance, which, in the instant of fusion, discovers the colours and fixes them to the Enamelled Plate. This melted glass in Enamel, produces the same effect, that oils, gums, or glues produce in the other processes of Painting. It unites the little particles of matter, makes the adhere to the surface of the Enamel and vitrifies them with itself. When well managed, it give the colours a polish and brilliancy, that could not be produced without it.
>
> Constant de Massoul, *A Treatise on the Art of Painting*(London, 1797), 44–5.

For most vitreous painting the glazed surface or, in the case of metals, an underlayer of white enamel, served as a ground layer for the colored design. The order of color application in the building of an image depended on the temperature required to melt the coloring material sufficiently. The use of multiple firings increased the number of viable colors possible, as combinations that were more volatile could be added at lower temperatures, but added to the overall cost. Inventors of improved coloring materials and techniques for vitreous applications looked not only to new recipes but also to reordered formulas to reduce the number of firings necessary. This can be seen in the efforts to develop universal—or near-universal—fluxes, discussed by Robert Dossie in *The Handmaid to the Arts* and demonstrated by both William Peckitt and George Berg in their experiments.

> The painting with vitreous colours on glass depends entirely on the same principles as painting in enamel, and he manner of executing it is likewise the same, except that in this the transparency of the colours being indispensably requisite no substance can be used to form them but such as vitrify perfectly, since, without such vitrification, there can be no transparency.
>
> Robert Dossie, *The Handmaid to the Arts* (London, 1764), 1:364.

Other colors, particularly expensive ones, were "pounced," applied as a fine powder. In this decorating technique a mordant, usually a combination of resins and gums, was painted onto the surface of the object in the desired pattern. The coloring material, dry and finely ground, was dusted onto the area. The excess was carefully removed before final drying and firing; the mordant held the color in

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place until it had melted sufficiently and fused to the surface. The result could be a more detailed design with less waste of coloring material; this was also a technique to add colors that did not vitrify evenly under normal circumstances. Mordants were also used to apply gold or other leaf to ceramic, and the same pouncing technique was the basis for transfer-printing engraved designs onto enameled boxes and ceramic bodies.[42]

The application of slips or engobes, colored clays applied directly to the ceramic body without a covering glaze, was another important decorative technique for eighteenth-century pottery, one that more clearly illustrates the symbiotic relationship between object and decoration technique.[43] Wedgwood's encaustic ceramics, created to imitate red-figure vases, were among the most famous instances of this style. Because the substrate body had no covering glaze, it had to be denser than those that were fully glazed. This in turn required a clay mixture, more careful grinding of the ingredients and also special working, drying, and firing arrangements. As might be expected, the coloring materials had to be keyed to these differences. The application was discontinuous—neither protected nor supported by a glaze—so the coloring material had to be absorbed into the clay—deep enough to hold but not so deep that the color or pattern was lost.[44] Similar problems existed in glass painting, but encaustic ceramic production was further constrained by the three-dimensional, rather than flat, form.

A common decorative technique for clay bodies, associated especially with faience and similar soft-paste earthenwares was underglaze painting. Typical examples are the cobalt blue and white work popular throughout the eighteenth century.[45] Designs were applied directly onto the fired clay and covered with a transparent glaze for the final firing. The covering glaze layer protected the colored design from damage during use, but there was some potential for loss to the quality of the image. Capillary action could cause designs to blur irreparably in the kiln, as the painted-on colors melted into the porous biscuit. In addition, the high heat needed to form a good covering glaze limited underglaze colors to those that could withstand extreme temperatures. The traditional underglaze palette was yellow, brown, black, and blue, colors derived from iron, manganese, or cobalt. When Denis Doriot, a *fayancier* in Rouen, invented a suitable red color in 1768, that addition to the palette quickly became a specialty there.[46]

Glass and Enamel

> But Glass varies very much in quality of taking the stain. Crown Glass is the best that of the bluer tinge is of a softer nature and takes the stain deeper and that of the yellower tinge gives the yellow stain a whiter tint but the double yellow, or red, a more scarlet cast.
>
> William Peckitt, *The Principals [sic] of. . . Painting and Staining of Glass* (1793), York Museums Trust (York Art Gallery) York, England, Ms. f. 6r.

Coloring techniques for enameling and glass painting are closely related. Patterns or images are created by the application of colored glass (in solution) to a solid, usually flat surface: firing melts the glass to form a permanent color. The substrate for glass painting was glass; that for enameling was often a metal. Gold was considered best as it was non-reactive but plates of silver or copper were also common recommendations. Decorative techniques are similar to those for painted decoration on glazed ceramic surfaces, except that the substrates are more often flat or slightly convex rather than shaped. All shared the need for coordinated formulas, for the choice of coloring materials that melted at a lower temperature than the support or previously applied colors, and for finding a way to support the object in the kiln so that it would be protected from damage but fusion would not be impeded.

Glass painting held a peculiar position among artists and artisan techniques: Independent of the reputation of encaustic painting, it was frequently described as a lost art rediscovered in the eighteenth century.[47] Both the French Council of Commerce and the Society of Arts in London regularly received letters about recovered glass-painting techniques, and both were diligent about investigating presentations. It was rare that either group awarded an invention, however; the reputation of glasspainting as a lost art was simply false. Most submissions could be traced to existing information about glass and colored-glassmaking: Antonio Neri's *Arte vetraria* (1612) and its many translations; Jean Haudicquer de Blancourt's *De l'art de la verrerie* (1697); Robert Dossie's *Handmaid to the Arts* (1758), or Pierre Le Vieil's *L'Art de a peinture sur verre et de la viterie* (1774).[48]

In addition to decoration made by staining or painting glass, patterned colored glass using a technique called flashing became popular in the eighteenth century. In this technique, a layer of colored glass is fused to a substrate glass of a different color. The two are joined but visibly separate; the layers could be carved to create a two-colored design.

Flashed glass had a variety of decorative uses, and was occasionally adapted to create cameos and intaglios or carved glass medallions, similar to Wedgwood's jasperware cameos, or his copy of the Barberini vase.

Color on Objects—Dyes and Stains

If you wet a light-colored fabric in a colored substance, it will take on that color. Dry the cloth and it may retain some of the new shade. This crude example of creating color in textiles would have been as familiar in households as it was to the atelier and the laboratory. Its familiarity had a strong effect on efforts at innovation, although the creation of good, consistent color on fabric required considerable attention and more than accidental skill.

The introduction of color was either a preliminary or a mid-stage operation in the process of creating a textile. When it was added depended on the fiber type, the ability of that fiber to take color, and the kind of textile that was planned. Wool, for example, was frequently dyed before being spun to ensure an even color in cloths that required tightly spun yarns. Cotton, in contrast, was often dyed in hanks of spun yarns: wet, unspun cotton was difficult to handle. Fabrics made of any fiber might be dyed as a piece after weaving.

The Dyeing Process

> It may afford a considerable Hint. . . [to the Art of Dying], to know what change of Colours may be produc'd by the three several sorts of Salts already often mention'd (some or other of which may be procur'd in Quantity at reasonable Rates) in the Juices, Decoctions, Infusions, and (in word) the more soluble parts of Vegetables.
>
> Robert Boyle, "Experiment XXV" *Experiments and Considerations Touching Colours* (1664. reprint; New York, 1964), 257.

Typical coloring techniques for textiles or fibers began with surface preparation—sorting and cleaning, sometimes bleaching—to create a consistently-colored ground. Fibers or colors that required a mordant or assistant would be steeped in the appropriate solution, then rinsed, washed and dried: These steps might be repeated. Dyeing proper followed. The object would be added to a dyebath of water and coloring materials (both dyestuffs and assistants). The bath was heated to improve absorption and constant agitation of the fibers, yarns, or cloth promoted even coloring. More rinsing, washing, and drying followed, as might an after-treatment, such as an acidic or alkaline rinse. This would enhance—intensify or, occasionally, change—the color. A second or third dyeing might follow. Once the coloring processes were completed, the fibers could be spun, the hanks woven, or the cloth finished.

Dyeing processes might require days or weeks to produce one good color. This time would include periods between stages to fix or develop the desired color or let the fibers rest. For the highly desirable Turkey-red color on cotton, about one month was needed to complete the sixteen steps of its dye process, according to techniques published at mid-century. Knowing when each stage of the process was complete was an essential skill of the colorist, and crucial to a good result.

Dyeing, the immersion of fibers in a bath in order to give them a single, even color throughout, was not the only way to create color on fibers or fabrics. Weaving a design with colored yarns or by varying the relationship between the warp and weft were common patterning methods which I won't discuss here. Woven cloth was also colored by adding designs, in one or several colors, to the whole cloth by painting or printing. The fashion for printed textiles in eighteenth-century Europe is often connected to the printed and painted fabrics imported from China and India but these techniques were not exclusively inspired by Eastern imports and were never limited to luxury fabrics. All fabrics could be printed on or painted, and were.[49]

Printing and Painting Textiles

Textile printing and painting techniques require color to be placed at precise points on the cloth. Creating designs in this way required different colormaking formulas and application methods from other textile coloring techniques.[50] There were two critical problems: capillary action and color quality. The ability of cloth to absorb liquid and carry it along the fibers could have a disastrous effect on a design when the colored liquids used to create it were painted onto an unprepared surface. Painted fabrics destined for clothing or upholstery, though, cannot be primed as a painter's canvas is. Furthermore, these textiles are subjected to stresses and wear unknown to fine-art or decorative paintings on a rigid support. The successful creation of coloring substances for textile printing or painting, practices of increasing importance as the century progressed, required new coloring materials that would enable colormakers to solve these problems without creating new ones (altering the color unpredictably, for example, or quickly rotting the cloth).

Two textile-printing techniques became typical in eighteenth-century European manufactures. One technique involved the use of patterns cut into blocks, plates, or eventually rollers. The blocks or plates were used to introduce mordant onto the fabric in the desired pattern and the prepared cloth was then dyed according to common practices. The color adhered permanently only at the treated areas; unwanted color could be removed in a later clearing or bleaching stage. It was possible to obtain several colors from a single dyebath if different mordants were applied to the cloth.[51] Block- or roller-printed textiles were occasionally augmented with handpainting (penciling) to introduce details of color that could not be easily or permanently applied in a dye or printing process.

This textile-printing technique, like fabric-painting techniques, presented the challenge of finding an appropriate thickener for the mordant. That substance had to combine with the mordant without causing an unpredictable or uncontrollable chemical reaction. The mordant still had to penetrate the fiber—a good printed fabric, like any good dyed fabric, was colored as evenly on the reverse as on the face—but had to remain unaffected by capillary action. The mordant-thickener combination had to be water soluble, so that the residue could be easily removed. Textile-printing firms developed their own formulas, often based on a combination of starch, flour, and glues or light resins (gum arabic and gum senegal) familiar to painters and apothecaries.

Block or roller printing techniques could be used to print colors derived from many coloring materials, even those that did not need a mordant. Exceptions were indigo and woad. In the traditional, vat-prepared method, these coloring materials oxidized too quickly, creating an insoluble blue color before it was adhered to the cloth; the result was not stable. Blue colors were occasionally added in a separate stage, painted in (as "pencil blue") by hand. This was possible by altering the coloring material through the addition of orpiment, which

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slowed reaction time. But generally, because of the oxidation problem and because indigo did not need a mordant as other colors did, blue is more common in monochrome printed textiles of the period than in multicolored designs.

Monochrome printed textiles such as the blue-and-whites were usually created using resist (reserve) techniques. For this process, the portions of the cloth that will not be colored are covered with a penetrating wax, and the areas to be colored are left untreated. The fabric is dyed and the inhibitor is later removed. The procedure could be repeated to add shades or other colors. Again, the coloring operation—immersion in a vat of coloring material—remained essentially that of traditional dyeing.[52]

Changes to Processes in Eighteenth-Century Colormaking

The basic tools of color production—mills and mullers, pots, vats, and kilns—did not change significantly during the eighteenth century. Few previously unknown natural coloring sources brought into Europe at this time proved to have widespread commercial success; quercitron is the only example that comes readily to mind. Yet the lack of change to tools—an area where we often look first to assess the state of the art—does not imply a corresponding lack of innovation in sources, materials, or techniques. Change came in the methods by which sources were made into materials and in the techniques for which they were employed. While practitioners of these techniques were always aware of similarities and differences among any group of craft skills, the eighteenth century saw a deliberate turn to the examination of other production techniques for guidance or inspiration and a turn to the use of the sciences—natural history, physics, and especially chemistry—to expand and explore the repertoire of color.

One of the most obvious connections between different coloring materials can be seen in the relationship between painters' lakes and dyers' colors. Many of the same substances that dyers used as mordants stabilize and improve these painters' colors. The processes involved connections that were known and explored—directly and indirectly—before the eighteenth century. Other correspondences were equally familiar, and explored with equivalent frequency. Lead white, a common ground color and additive to pigments, was an equally basic component of glazes. Zaffer, Naples yellow, burnt sienna, and burnt umber were coloring sources or coloring materials also used as components of glaze and enamel recipes. Ocher was a common extender for glass staining, one that provided color to the stain as it was applied. The coloring techniques for enamels form a double bridge, connecting the color and patterns of ceramics to other decorative-arts objects, as the techniques used to paint with enamels called for the same skills as those used to make other kinds of miniature paintings. The connection further extends to the attempts to develop ceramic colors for other painting techniques.[53]

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> Paper Hangings are printed after the same Manner [as calico printing] and may properly be called a branch of this trade. . . Card Makers may likewise be rank'd as a Branch much allied to the Callico-Printing, as their Business is performed with Types after the same Manner; though the Youth designed to be bound to a Card Maker needs not such a Drawing Genius as the two other Trades last-mention'd.
>
> R. Campbell, *The London Tradesman* (London, 1757), 118–9.

Eighteenth-century treatises include examples of technical processes of colormaking transferred across different practices—the permutations of book printing to engraving to textile and wallpaper printing were often cited as examples to emulate. Less obviously, an eighteenth-century writer advocated that the wax used to create resist-printed textiles be closely examined and exploited in the practice of encaustic painting. It had several advantages, he claimed, including easy methods of removal.[54]

Experiments with one group of materials or methods illuminated problems of others. The assumption that this would be so was based in beliefs about connections between theories and practices. It was reflected in the often tacit acceptance of the idea that any color had a knowable system that was identifiable—if inconsistently so—through all practices. Studies of the entry of science into the workplace of eighteenth-century artisans often emphasize the advantages of experimental method—rather than the discovery of new sources, materials, or techniques—as the means whereby artisans were able to draw an essential connection between colormaking and color ideals.[55] The advantage of ordered experiment or of ordered presentations may be obvious to us now. Knowledge of other practices, connected or only similar-seeming, as a source for discoveries offered equivalent advantages. Innovations were often a response to pragmatic interests and equally pragmatic explanations of materials and techniques. For manufacturers, these interests included an increase in the effectiveness of coloring materials, assistants, and other additives; the introduction of less expensive substances; and a search for ways to change or simplify the processes of creating color in order to stabilize or reduce their cost. Trials with fewer substances or with different combinations might create some new color, as good as a familiar one, similar or different-looking. Experimentation with lowered temperatures and different fuels affected both the creation of color and the creation of objects. The change from charcoal to pit coal, for example, was one that especially required adjustment to materials, as increased quantities of sulfur vapor and of other atmospheric changes within the kiln altered both the ceramic body and the glaze. Concern for this problem was particularly strong in France during the 1780s, even though coal-fired kilns had been used to make glass in the Rouen area since the early seventeenth century. As William Sturgeon's work for the glass and ceramics industries suggests, the search in France for improved formulas continued through the 1780s, even though coal-fired kilns had been used in the Rouen region since the early seventeenth century.

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The search for new sources of color and for new techniques, increasingly carried out in the laboratory or workroom, drew inspiration from several directions. Preferences for native over imported materials led to experimentation with a wide variety of materials, with predictably varied success. The novel use of local materials was, even in successful cases, rarely the sole reason for a proposed change. The replacement of woad with indigo is an example of the (literal) intertwining of local and imported coloring sources. A more potent and more easily worked color source, indigo never completely dislodged the use of native woad in France or Germany: the two substances were often combined. Woad became an essential assistant, making the cloth supple and beautiful.

Eighteenth-century inventors, administrators and observers suggested several goals for the development of new coloring processes. Changes to techniques were often a response to a specific question or problem. How can you create a blue for printing textiles? How can water-based colors achieve more presence without losing their brilliance? Can the hardness and apparent durability of enamels be adapted to other techniques? Inquiries extended beyond the nearly pro forma assumptions that colormaking processes could be improved by an improvement in the understanding of materials, by an application of ordered knowledge about mineralogy, natural history, or chemistry. Equally fundamental to changes in the creation of color were the paired notions that color was a subject in which there were many possibilities for improvement and that suggestions for where that improvement could be sought might come from a closer look at similar or related techniques.

Some Further Thoughts

In this section, I present color as a subject of material culture divorced from objects intellectually, but not physically. It may seem, then, that I am arguing against my assertion that the process of coloring an object is integral to the object's existence not simply because the color's decorative quality makes the object more or less attractive but because the coloring processes contribute to the object's physical stability. Why, if I believe this, is it acceptable to talk about the colors in or on objects as only the results of a collection of techniques? Without this isolation of production from visual effect, and without the emphasis on a common analytical scheme among coloring practices, it is impossible to understand clearly how innovations were understood in the eighteenth century and equally difficult to see how the paths to innovations were created.

Color is one of several variables that together form an object. Like all other aspects of production, colormaking is technique-dependent; for every kind of object only certain colors can made "good enough." Any object depends on the kind of color it incorporates—depends on it not only for beauty but also for its stability and its contributions to overall value. Within many manufacturing

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practices, it was understood that the coloring layers were an embellishment that performed a physically and chemically cohesive function. This can be seen most easily in ceramics, where the addition of a covering glaze was known to strengthen the clay body and make it impermeable. The dual purpose also exists in the equation of shininess with impenetrability and completeness: this shininess is available to paintings through varnishing, and to textiles through the oiling or calendaring of cloths, or the use of glossy fibers. The physically and chemically cohesive function of color can be found in the form of the object as well, in the colored grounding layers that enhance the colors on the surface. It can be inferred from the insistence that woad or indigo be used in black dyeing to soften the other ingredients in the dyebath.[56]

It is important, therefore, to remember that colors—and so the techniques of colormaking—were inseparable from the completed object, whether a cloth, a jar, or a wall. Color was the outcome of a series of steps that formed the unique identity of the artifact. The addition of color to an object was a step in that object's production and, until undertaken and completed, the textile, pot, or painting was useless.

Notes:

Note 1: Arthur H. Cole, *The Handicrafts of France, As Recorded in the "Descriptions des arts et métiers" 1761–1788*, Kress Library of Business and Economics 8 (Boston, 1952); Nathan Fiering, "The Transatlantic Republic of Letters: A Note on the Circulation of Learned Periodicals to Early Eighteenth-Century America," *William and Mary Quarterly*, 3d ser., 33 (1976): 642–60.

Note 2: Peter Shaw, *Chemical Lectures Publickly Read at London, in the Years 1731, and 1732, and Since at Scarborough, in 1733: For the Improvement of Arts, Trades, and Natural Philosophy* (London, 1734).

Note 3: Jean Trudaine de Montigny to John Holker, "Projet de teinture l'écarlat, cramoisi et vert sur coton," November 1765, AN F/12/1330.

Note 4: See also abbé Ménon, "Mémoire sur le Bleu de Prusse par M. l'abbé Ménon Correspondant de l'Académie," *Mémoires de mathématique et de physique, présentés à l'Académie royale des Sciences, par divers sçavans, et lûs dans ses assemblées*, [*Savants étrangers*] 1 (1750): 563–72; and "Second Mémoire sur le Bleu de Prusse," *Savants étrangers*, 1 (1750): 573–92.

Note 5: Irving I. Ziderman, "Blue Thread of the Tzitzit: Was the Ancient Dye a Prussian Blue or Tyrian Purple?" *Journal of the Society of Dyers and Colourists*97 (1981): 362–364.

Note 6: Rutherford J. Gettens and George L. Stout, *Painting Materials: A Short Encyclopedia*(1942; reprint, New York, 1966), 123; Helmut Schweppe, *Handbuch der Naturfarbstoffe: Vorkommen, Verwendung, Nachweis*(Landsberg / Lech, 1992), 272–78.

Note 7: Mary P. Merrifield, *Medieval and Renaissance Treatises on the Arts of Painting* (1849; reprint, New York, 1967), 422, 658, 678, 700.

Note 8: Rita Adrosko, *Natural Dyes and Home Dyeing*(1968; reprint, New York, 1971), 21.

Note 9: Riwan Tromeur, "L'Ocre, Exactement?" *Les cahiers de Terres et Couleurs*, no. 4 (1998).

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Note 22: [Jean-André Roquet], *L'Art nouveau de la peinture en fromage, ou en ramequin, inventée pour suivre le louable projet de trouver graduellement des façons de peindre inférieures à celles qui existent* (Marolles, 1755).

Note 23: The literature on historic painting materials spans a broad range of time, geographic region, and information offered, starting with Cennino Cennini's *Libro del'arte* from the mid-fifteenth century. English-language works include Charles Lock Eastlake, *Materials for a History of Oil Painting* (London, 1847), Mary P. Merrifield, *Medieval and Renaissance Treatises on the Arts of Painting* (1849; reprint, New York, 1967), Arthur P. Laurie, *The Painter's Methods and Materials* (Philadelphia, 1926) and more recently the series sponsored by the National Gallery of Art, *Artists' Pigments: A Handbook of Their History and Characteristics*, 3 vols. (Washington, D.C., 1986–97). These constitute only a small sample.

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