Cultures of Sciences, Cultures of Technology

Begin with the rhetoric. Or rather, begin with the rhetorical devices that accompany the presentation of new materials or new ideas during the eighteenth century. Even limited, as we are, to what the record can tell us, these devices reveal a great deal about the attitudes, ideas, and assumptions that comprised the cultures of technologies and of sciences in Europe. This is not because differences highlight the person or people behind every petition, book, article, or letter. Instead, we see from their conventions the breadth of a unified culture, a sameness that makes it possible to suggest a Europe that was clusters of regions and industries with common interests even as we also view its discrete groups of nations or of occupations. Critical to this unified culture are notions of enlightenment and of enlightened behavior for individuals and societies.

Any formal presentation, whether a social introduction, a petition for a patent or a letter of commendation, requires formalized language. The rhetoric may incorporate one or several set pieces. Recognizing the formal structures used by eighteenth-century inventors aids our understanding on several levels. The presentation offers clues to the ways an inventor (or author) comprehends the significance of the novelty, and its—and the inventors own—place in the world of invention, trade and ideas. At the same time, these forms provide an opening into eighteenth-century culture and its broader goals. From these introductions, we can see the persisting themes in the science and technology of eighteenth-century Europe, whether those themes are defined closely, as novelties and improvements for trade, or more conceptually, as concerns for public life and one's place within it.

> Sir, the effect is this; I through the help of divine goodness by great expence study & experiments for the space of above nine years have fundamentaly found out improved and brought to perfection in all its parts the art of painting and staining in glass scripture history coats of arms and other designs of the like kind, so much as could reasonably be expected to any one in that space of time and being yet not thirty years of age, performances in which if thought agreeable I will make bold to show to the society when thought proper, and if I am thought worthy from thence of some mark of encouragement to compensate for the said indefatigable endeavours, I will still endeavour to promote the same as much as layeth in me.
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> William Peckett [sic] to the Society of Arts, dated York, 4th February 1760, [R]SA Guard Book PR.GE/110/11/8.

Consider the rhetorical devices accompanying discovery, invention, and novelty in technologies or sciences. These set pieces often declared the costs of the long work and careful experiment. Study, development, and perfection all take time—six, twenty, or a less precise "many" years—and often considerable outlay of money. These descriptions assure the reader of the inventor's personal involvement. For the immediately accepted or immediately rejected inventions—the very good and the very bad—claims of years of study and

experiment to achieve perfection has no verifiable meaning. Only when an innovation is contested or when there is a reason to query the presenter more closely about the discovery itself do we learn more. In William Peckitt's case, his project was not taken up by the Society of Arts, but he continued to work on his collection of recipes to paint and stain glass for another three decades.

A subset of this rhetorical description of time expended is an account of the origins of the interest leading to the invention or discovery. Some petitioners sought novelty while others had it thrust upon them: Discovery could be the outcome of a deliberate search or an accident turned to advantage although, by the middle of the eighteenth century, the latter had become rare. Serendipity was better controlled; the new and useful were expected outcomes of chemical analysis and rational experimentation, even those that began as accidents. The pigment known as Scheele's green developed from that chemist's experiments with arsenic. The theoretical foundations of James Turner's patent yellow color (a by-product of the industrial production of soda) had been suggested by Torbern Bergman a decade earlier.[1]

> Mr. Gordon, from natural appearances upon a vegetable substance plentifully produced in the Grampian Hills, was lead to think that a dying or colouring ware might be thence obtained. After many experiments, and much application, Mr. Gordon had the pleasure of producing a dye ware, which answered all the purposes to which archel (sic) was applied.
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> Further trials evinced that the new material might be, in a certain degree, substituted for indigo, and cochineal. The proportions were soon ascertained with precision; the new article saved one third of indigo in striking the various shades of blue and purple on silk and cotton; and one fourth of cochineal in every case where that high-priced article was necessary, scarlets and high pinks excepted.
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> To this new invented dye Mr. Gordon gave the appellation of *Cudbear*, from his own Christian name.
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> *Memorial of Mr. Cuthbert Gordon Relative to the Discovery and Use of Cudbear and Other Dying Wares*, (n.p., n.d.[1784]), 3.

An inventor's rhetoric might highlight his or her search for the presented novelty as an effort to solve a known or perceived problem. Cuthbert Gordon credits the development of cudbear in this way; he claimed to find a plentiful source for a certain lichen and, knowing that the purple colors it made are easily destroyed by light, set himself to find a stabilization method. Similarly, Jean-Baptiste Pont's descriptions of his inspiration for finding a more efficient dye extraction process was, he claimed, based on knowledge of the high cost of cochineal. Other petitions—Johann Carl Barth's for a privilege in Saxony to produce a blue dye from lacmus, for instance—do not mention the discovery process at all but concentrate instead on the economic advantage of the production method and the deliberation that its reworking demanded.[2]

Recovery of lost arts or attempts to forge connections to antiquity is another rhetorical device, and one that appears often in eighteenth century petitions for

acknowledgement of discoveries. Examination of an object, a color, a technique often included investigation of its history. Petitions described this as groundwork to the discovery; it emphasized the idea that something familiar is made new, or remade. Danielle Rice describes one use of this device in her work on the revival of encaustic painting techniques that began about mid-century in Europe.[3] In this case, she found that tensions between modernism and the meaning of posterity were expressed through obsessions with antiquity and its arts. There were other rhetorical uses for antiquity, or for ancient techniques. Josiah Wedgwood's Etruscan vases, for example, articulated a similar obsession with the ancient world. Through their form and decoration, they offered an unspoken statement of taste and culture for both maker and owner.

> Weil mine Umstände nicht so beschaffen sind, daß ich von diesen Farben weder einigen Nutzen ziehen, noch auch, wegen anderweitiger Arbeit, die Versuche in behörigem Zusammenhange fortsetzen kann; so habe ich schon vorlangst verschiedenen Freunden geschrieben, wie ich wünschte, daß jemand, gegen Ersetzung aufgewandter Mühe und Kosten, mit der Sache gedient ware. Weil ich aber nachher mehr und mehr von demjenigen entdeckt, dessen ich in obigem gedacht habe, und eine kleine Belohnung nicht übrig hoch schatze; so bin ich entschlossen, die Versuche nach Möglichkeit fortzusetzen.
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> Gottfried Michael Kortum, *Neue Versuche der Färbekunst* (Breslau, 1749), 20.

In this section I will describe and connect ideas implied by the actions this rhetoric introduced. The combinations of ideas and actions were adopted by many inventors and authors in the eighteenth century, but the context was not always the same. I will sketch some interests and activities that followed the rhetoric, and reconstruct paths between them. I will then situate color and colormaking as a subject and a model within the relevant aspects of society, in particular the enmeshed cultures of technology and the sciences.

Concerns about Progress and Improvement

> For, in proportion as the principles of any science are unknown or misconceived, the advancement of the arts, and manufactures which depend on them, must, of course, be impeded; for, without those guides, neither much addition or any improvement, is to be expected. But when scientific principles are disclosed to the artist, he is enabled to draw, from those original sources, an ample store of useful inventions, by which this art is enriched; and thus, the speculative sciences, by their extension to practical purposes, become objects of great public utility.
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> George Adams, "Mr. Delaval's Account of the Permanent Colours of Opake Bodies," in *Lectures on Natural and Experimental Philosophy* (London, 1794), 2:410–411.

Several themes bind the variations in modern descriptions of the eighteenth-century Enlightenment. Changes in social and cultural underpinnings encouraged examination of many subjects, including politics, economics, and social life. Ancient wisdoms, like ancient arts, were reconsidered and reconfigured. Common highlights include explorations of new forms of social interaction, new approaches to moral or political economies, and a variety of new working relationships. Also enfolded into the notion of enlightenment were

positive ideas about "progress" and "improvement," related terms that echoed in many endeavors. For eighteenth-century enlightened investigators, close study of any topic would surely lead to greater understanding. That understanding would spark recognition of a path to improvement. Improvement would yield progress. Progress, once recognized and acclaimed, would inspire further improvement, achieved through continued or related studies. Ultimately, all aspects of society—people, ideas, objects—might advance, though not, it is important to remember, equally so everywhere.

Belief in the existence of an enlightened world implied support for these paired concepts of progress and improvement, as both a means and an end. Their subtleties differentiated the age from the past, even when the past was used as a model. The advance of a culture was not measured by its ability to inhabit some former golden age but rather to study the surrounding worlds—the natural and the manufactured, and including those of the past—to form a new one. Furthermore, the opportunities implied by this feedback system were open. The sources that could be called upon were as large and as diverse as the world, and they were input at variable points or times. The immediate surroundings of any person, however determined, offered many sites from which improvement could be launched. The accompanying perceptions of an enlightened world that valued progress and improvement in all corners encouraged individual participation in public life, including personal assessments of its condition and efforts to remedy its problems. Trust in the cycle of progress and improvement underlay writing about economy, about art, about society itself, as well as about the sciences and technology.

The urge to locate improvements and to perceive their adoption as progress is significant only when the prevailing worldview recognizes a problem or problems to be solved. That trait has roots in traditional philosophical and religious concerns, but its expression during the eighteenth century expanded and changed. The problems of the world entered daily life in new ways—through the life cycle of moths, the desirability of a national banking system, the condition of public thoroughfares. The inherently problematic nature of the world was not presented as an invariable statement of condition but rather with recognition—quite often posed literally, as questions—that a solution did exist.

The information that encouraged recognition of problems within the world supported solutions from many sources. An investigator might interpret (or, from our vantage point, misinterpret) classical texts, books, periodical reports, and publications sponsored by private or public institutions. Solutions might come from exchanges of information between people, in lectures, meetings, apprenticeships, or observations of work. Inspiration came from other evidence of progress: new objects, new ideas, novelties. Studies were instigated by the real and imagined work of contemporaries and predecessors, by observation and

personal experience. Efforts to improve and to stimulate progress could focus on internal or external changes, and they could be called on to maintain or enhance the reputations of a nation, a region, a discipline, an individual. Acknowledging, and attempting to solve, the problems that retarded improvement or progress in any discipline created an enlightened framework around personal activity, and it intensified roles within a community and in the larger society. Projects did not need to be large-scale, and so ties between a contribution to progress and improvement of public life was approachable to those who might consider the greater issues of the epoch to be beyond their depth.

Changing Attitudes toward Commerce

> How many people ruin themselves by laying out money on trinkets of frivolous utility? What pleases these lovers of toys is not so much the utility, as the aptness of the machines which are fitted to promote it. All their pockets are stuffed with little conveniencies. They contrive new pockets, unknown in the clothes of other people, in order to carry a greater number.
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> Adam Smith, *The Theory of Moral Sentiments,* 4th ed. (London, 1774), 266.

Another cornerstone of eighteenth-century experience is the role of commerce as a source for debate and action. Increased trade, increased production, and the corresponding need for raw materials were forces in the alterations to eighteenth-century manufacturing practices. The desire for these changes fostered discussions about work, about luxury, about the state. If progress and improvement suggested desirable increases in goods as well as knowledge, the real and abstract problems of economies were an appropriate topic for institutional investigation and support.

Changes to commodities were as important to eighteenth-century commerce as the development of tools would later be to the implementation of new scales of production. In recognition of their importance to economics and taste, the mechanical arts that literally make up certain types of commodities—objects—benefited from enlightened beliefs and from beliefs about enlightenment. The number of associations devoted to trade and improvement grew throughout the century in all Europe; their interests in improving or increasing exports confirms this awareness. The ongoing exchange of information about practices is another outcome of this same desire. The gamut of artisan concerns, from plowing to enamel painting, were collected, examined, and published, often treated to the same cycles of progress and improvement applied elsewhere. Proper investigation of a trade might require learning techniques as well as learning about them. While only a few people who set out to study, experiment, and broadcast their discoveries were explicit about a desire to participate in enlightened public life, or in "the Enlightenment," many more demonstrate an absorption of the cultural tenets of that notion and express this in accompanying rhetorical gestures.

The Role of Technology as an Aspect of the Goals for Commerce and

Improvement

One longstanding method in the history of technology looks for certain milestones—such as the introduction of factory-like production levels, divisions of labor, and shifts to investments in capital—to identify the maturing industries of the eighteenth century. Progress is identified with the increased economic output and ever greater efficiencies typical of the nineteenth century: The eighteenth century is best understood as a series of long and parallel runways used to land the scientific revolutions of the seventeenth century and launch the technological ones in the nineteenth.[4] The curious nature of eighteenth-century technology is best expressed through case studies of isolated, often heroic anomalies.

These are persistent views but, in the last three decades, historians have regularly countered them. Assessing the place of science in technologies or of technology more generally during the eighteenth century now requires less a dissection of the intellectual prowess and persuasive capabilities of a few men than it does understanding a confluence of available ideas. The larger-than-life figures are not made small, but we can better place their significance, knowing how typical were their interests and concerns. Still, internalist views that emphasize action by one or a few "giants," individuals or firms, and see accomplishments of the eighteenth century in terms of their effect on the nineteenth have been difficult to shake outside the discipline.

The desire for improved tools of all kinds, and their subsequent development, was a recognized and recognizable part of the culture of the eighteenth century. The origins for core events in the history of its technology—whether Hargreaves's spinning jenny, Boulton and Watt's collaboration, the development of national monetary systems, the transfer of iron and textile technologies from Britain to France, or the ubiquity of Justi's economic policies—have been pushed earlier into, and occasionally outside, the eighteenth century, and correlatives have been found in many places. We can locate beginnings in the sixteenth- and seventeenth-century import and distribution of cotton, porcelain, or other foreign luxuries to Europe, in the spread of Venetian glassmaking techniques beyond the Veneto, and in assumptions by guilds, merchants and others about the more-than-local distribution of a large number of other products.[5] We recognize an eighteenth century that is more complicated and less detached, and in which that assessment is visible in attitudes toward the development and use of technology in its many forms.

J'ai travaillé dès ma jeunesse chez le Sieur le François fils, qui à la vérité fut peu curieux de perfectionner cette manufacture [des papiers soufflés et des toiles soufflées], parce que telle qu'elle étoit elle lui procuroit le plus grand débit. Sur la fin de ses jours j'achetai de lui les fonds de cette manufacture, & j'ose dire que par des recherches & des essais multipliés j'ai le bonheur de la porter à un point bien supérieur à celui où les Sieurs le François l'avoient portée.

Tierce, "Lettre sur l'Invention des Papiers Soufflés & des Toiles Soufflées," *Journal œconomique*

(February 1756): 94.

As a result, we now add considerably more activity in eighteenth-century artisan, manufacturing, and intellectual communities to our lists of the markers of industrialization. We can connect these activities to what we know about contemporary interest in public life, including its vibrant and sustained scientific activity as a means and an end. Continuing examination of art and artisan practices by insiders and outsiders, and the contribution of new techniques or new equipment that was frequently the result, demonstrated a commitment to enlightened behavior, one that might be driven by personal or occupational motives. Participation ranged from abstract expressions of concern for trade to concrete recommendations, based on personal experiment and assessment, about processes. Manifestations could be as formal and institutionalized as an improvement society or as informal as private discussions and individual experimental programs. Consideration of the motives for these many different engagements adds to our understanding both of the rhetoric of inclusion that encouraged participation and of the technological inventions or developments themselves.

A New Role for the Sciences

The expanded place of the sciences in public and private life is another significant theme in our understanding of eighteenth-century actions and ideas. Exhortations to learn the book of nature and a belief in its uniform behavior, long familiar, combined with faith in the value of knowledge to give an often amorphous idea of the sciences some specific targets. The sciences provided exemplary systems, as visible as the animal, vegetable, and mineral kingdoms and as invisible as the laws of motion or mathematics. Ongoing efforts to find the inherent order of the natural world took on broader relevance as examples from its corner were rallied to explain artificial or manufactured realms: Almost anything could be *made* scientific. The range of purposes behind the study of chemistry demonstrates the coexistent possibilities. Its operational and philosophical aspects might be called on, in varying proportion, to explain procedures in a laboratory or at a factory. Discussions of the chemical nature of an object or of an operation could focus on measurement, or affinity, or combinations of salts with other essences. Other scientific topics, such as mechanics and mineralogy, shared its widespread uses and illustrate the pervasiveness of the notion of scientific culture throughout Europe in the eighteenth century.[6]

Furthermore, one might choose to invoke rational order, observation, and experiment—scientific approaches, all—in the study of man, the past, aesthetics, or almost anything else. One portion of the dialogue about the sciences within eighteenth-century public culture addressed their value and place in artisan practices. We see this in the efforts by artisans and others to adapt the sciences into practices. We see it in the discussion of technological subjects in

general-interest and other publications. For many of its students, the juxtaposition of the sciences or of scientific ideas to arts and trades identified the rational structure underlying their investigation, and secured it within an eighteenth-century social and cultural universe that extended beyond the atelier, the manufacture, and corporate life.

Communal Activities

Eighteenth-century discourse about improvement as a benefit to humanity and society locates its place in daily life through the enhancement of trade, industry, art, literature, philosophy. Knowledge should flow from and into all human endeavors; it should take advantage of and be available to the full span of populations. Within regular expressions of support for knowledge, the glorification of things scientific appears in approaches to study, experiment, and communication about recognized problems.[7] Posing a question based in science or technology, discussing it, and experimenting to finding solutions gave a purpose to interactions that heightened the reputation of those involved, whether apprentice or master, academic or amateur. Such discussions highlight our need to consider eighteenth-century assumptions about the appropriate places to disseminate information.

The ideals of common knowledge were supported by a multitude of formal and informal connections among people and among institutions. The role of nationally-based academies—of sciences, of fine arts, of letters—as eighteenth-century communities dedicated to the dissemination of information is obvious. The existence of the French academies, the Royal Society, and the Berlin Academy, the examples of efforts to create similar institutions elsewhere, and for other disciplines—all point to the recognized benefits of acquiring knowledge within a communal setting. Provincial centers further served the growing public interest in and perceived need for information as they helped to extend personal enthusiasms to the public good.[8] Guilds or merchant communities offered their members opportunities to embrace the same goals.

The values of progress and improvement may have been common to all groups, but different communities played different roles in the effort to embrace them. Members of the academies—especially the scientific societies—often undertook administrative tasks in accordance with their official interests or relevant personal experience. Corporate or occupation-oriented presentations were more concerned with the dissemination of new information than with its creation.[9] Coffeehouse gatherings, voluntary societies to promote arts, trades, or manufactures, and other formal or informal groups dedicated to science, economic improvements, fine arts, politics, and other subjects promoted the ideal of shared knowledge. Such groups might offer members further investigative opportunities and serve as an outlet for avocational as well as occupational interests. Occasionally, what

began as private gatherings became larger, more firmly established, provincial societies.[10] In other situations, one or a few enthusiastic participants often sustained group activity so that, when this key person ceased to attend, organized discussion or experiment stopped too.[11]

> Each member on admission [should] choose some particular subject, either in Natural History, Husbandry, Agriculture [or] Gardening, or some species of Manufacture, or other branch of improvement, and make it his business by reading what hath been printed on that subject, by conversing with them that make it their profession, or by making their own experiments, to make himself Master thereof, and to report in writing the best account they can get by experiment or enquiry relating thereto, …
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> From the regulations of the Royal Dublin Society, ca. 1731, quoted in Desmond Clarke, *Thomas Prior 1681–1751, Founder of the Royal Dublin Society* (Dublin, 1951), 28–9.

Within and among all these groups, a multitude of formal and informal connections met expressions of interest in knowledge, progress, and improvement. Whether open to all or restricted by occupation, reputation, or other criteria, the local and national associations dedicated to the furtherance of knowledge filled multiple roles, encouraging and adjudicating within a social setting.[12] They held meetings to present information, published prize essays, and offered money or medals for accomplishments that would lead to progress and improvement, encourage the arts and trades, or enhance and promote fine arts and literature. Their scientific pursuits—reading, performing experiments, presenting theories—were key aspects of the acquisition of "politeness."[13] For the academies or provincial societies, corresponding members might contribute foreign news: Their participation supplemented dissemination as it fed curiosity. Access to the new materials found in foreign lands and the examination of traditional practices offered opportunities to apply rationalized behavior to the known and the unknown.[14] The choice of honorary members could also confer prestige on a society; Benjamin Franklin is said to have accepted membership in more than two-dozen associations, including ones in Russia, Italy, and the Netherlands.[15] That number reflects public enthusiasm for participation in a culture of knowledge at least as much as it demonstrates Franklin's enthusiasm for public life.

Communal activities enhanced personal as well as civic prestige, and gave active members an opportunity to explore and gain a reputation for subjects beyond their regular occupations. Louis-Auguste Dambourney, a textile manufacturer in Rouen, published and oversaw publications relating to that subject for the local academy of sciences, belles-lettres and arts, and also served until his death as perpetual secretary for the agricultural society in that city. Thomas Henry, apothecary and chemist in Manchester, published articles about the advantages of literature, philosophy, and textile dyeing[16] Just as the existence of a lecture hall, a lending library, or an academy of the arts could mark a town as part of a world beyond its own physical borders, attendance at those institutions and related

individual pursuits marked certain people as participants in the polite culture of the European world.

Interpreting Authorities

> I do not, however, mean to say, that we ought to look upon the writings of these authors as invariable rules, or that we should have such respect for their systems as never to speak against them; but, … whilst we reject their opinions, let us leave them this glorious title; and let their names, transmitted to posterity, with all the veneration which they deserved, be for ever the basis of those columns, which all liberal artists will chearfully (sic) adorn with their trophies.
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> George Palmer, *Theory of Colours and Vision* (London, 1777), 46.

Eighteenth-century sciences present what seems to us a startling variety of theories and philosophies.[17] To modern readers, this may seem to contradict the idea of a search for a unified system of knowledge. Individualized interpretations and outright contradictions were not limited to natural or experimental philosophy but appear in other eighteenth-century debates, including interpretations of the past.[18] Propositions were refined and revised by many people, no matter how prominent the original author. In describing a world that is certain about the value of science, but where scientific or natural philosophical knowledge can literally mean so many things, we can point to an example of the more or less amiable coexistence of older mechanistic interpretations of matter with newer definitions and alternatives. Acceptance of a tenet of one scientific, economic, aesthetic, political, or other kind of theory did not imply equal or unchanged acceptance of all its parts. Authors might refer without irony or much analysis to philosophers with vastly different approaches or opposing conclusions. Even Newton, the acknowledged genius of his age, was not exempt from adaptation: his significance and his fame may have made his interests, including work in optics and color, even more susceptible to evaluation. Yet both Newtonian and anti-Newtonian attitudes, often encapsulated now as Newton's mathematical logic pitted against Goethe's sensory comprehension, could play out differently, without our common assumption that to support one is to disbelieve the other.[19] There was a greater subtlety to the meanings of Newtonianism in the eighteenth century, and so to the non-Newtonian and anti-Newtonian theories offered then.[20]

Just as we no longer condemn eighteenth-century chemists for belief in doctrines based on phlogiston, we cannot expect our definition of consistency to be demonstrated in every eighteenth-century philosopher. Louis-Bertrand Castel, for example, is counted among the French anti-Newtonians, but he had at times praised much of Newton's work and adopted or adapted it into his own. Consensus about a standard, in our recognized sense, had not been reached. The history of alternatives, in chemistry especially, and the development of new combinations of ideas suggests many different paths for eighteenth-century sciences. Some were similar to that of Christophe Opoix's work—limited institutional acceptance, but publication and diffusion through other respectable

sources. Other ideas, like those of Louis-Guillaume de la Follie, were studied with greater interest by specialized groups. It is also possible that, like the theories of those two men, other theories with a workshop provenience emerged from daily operations but never moved to a position of broader recognition.

If ideas arrived from many different sources, and if personal observation, experiment, and assessment are the hallmarks of eighteenth-century engagement, it is not surprising that variant interpretations existed among scientific theorists and philosophers as well as amateur investigators, or that connections were sometimes stretched as thin as a soap bubble.[21] This matches a vision of scientific activity that takes place within the world and that is mediated by many external, social events.

The broad themes of enlightenment, commerce, technology, and science were worked on—and worked out—in correspondingly varied places, by different individuals and groups. The interplay was affected by other regularly occurring motifs, not always so broad or so pervasive, but still widespread. These included the public expressions of concerns located within the newer forms of communal activity that supplemented and encouraged individual endeavors, about consumption and consumerism, and within the changing systems of support for the novelties and inventions that resulted from the interest in progress and improvement. Exploration of the sciences was not confined to men (or women) of science, nevertheless a recognizable hierarchy of ability existed for those who professed interest. To join the exploration of these themes was to join that hierarchy as well.

Consumption and Consumerism

Issues of consumerism—use, in its broadest sense, rather than usefulness—and corresponding questions of taste in all sectors of society are other forces in our image of European culture and its changes during the eighteenth century. Assessments of these concerns and their outcomes often connect the increasingly sophisticated eighteenth-century taste for novel tangible goods to presentations about such goods, and to more-abstract rationales for economic improvement.[22] Patterns of consumption and ideas about materialism—especially with respect to the triad of design, fashion, and trade—are well-studied portions of the economics of material culture.[23] We understand their underlying connections as a barter system: Wealth confers honor, and individuals receive esteem according to the wealth they possess.[24] Modifications to this system remind us that ownership of highly desirable objects can substitute for or symbolize that wealth. Objects that are marked by a potentially fleeting popularity or some degree of scarcity, objects in demand by an elite, exert a special hold over much larger groups of consumers individually and collectively. The use of sciences and the creation of technologies were a part of this too, whether consumable or tangible, or both, or neither. That

Y owns it and Z desires it sparks a commercial exchange that supports the quest for novelty as a way to achieve or maintain status. I would add to that equation the ideas that W makes it and X sells it.[25] When we speak of a Wedgwood vase or Watin's japanned boxes, or when we compare a copy of a painting to the original, we recognize the extra power that specific objects, even a redecorated room or a copy of the Journal de physique, exerted on eighteenth-century consumption patterns.[26] If Y and Z fuel inspiration and demand, W and X acknowledge that desirable things do not appear by magic, fully formed, on every merchant's shelf. Together, the four ciphers stand for a host of hopes and actions that relate back, in an elemental form, to the general hopes and aims of the Enlightenment as a public and a personal culture.

Historical writing about eighteenth-century consumer attitudes often calls on a social declension of the market, tacit or explicit recognition that goods are produced for specific groups, perhaps luxury, elite, middling, foreign. Studies of objects as decorative arts or material culture may also claim as strong a connection to economic history as to traditional art history, especially in the adoption of approaches that involve the production of objects as a component of their study.[27] These paths join when visual impact supplements economic value, a classic explanation for the study of material culture. We can trace, through petitions, contracts, and laws—which might first prohibit and later control imports, encourage local developments, insure objects through transshipment—a large portion of the history of these goods in the West and their transfer among regions of Europe. This tells us about the economic aspects of consumption, but it adds little about the social, aesthetic, scientific or technological concerns underlying trade, purchase, use and those aspects of the equation of consumption. In discussions that treat decorative arts within an art-historical framework, methodologies emphasize visual characteristics, locating significance in the outcome of one or a series of aesthetic reactions—in connoisseurship, issues of taste, status, and novelty of form. Where, in an approach based on the economics of trade, examination of an icon such as the Frog Service might rest on its significance as the second commission to the Wedgwood factory from Catherine of Russia, a more art-historical focus might concentrate on the relationships among the shapes of the pieces, or on the engravings of architecture and landscapes used in the decoration.[28] Yet in neither presentation are the substantive issues of production regularly acknowledged. Despite documents that indicate Wedgwood's interest in the sciences and technology and in their application to his manufacture, those aspects of this monumental undertaking remain separate, almost vestigial knowledge. In both instances, eighteenth-century culture is defined on the basis of consumer expectations and an aspect of an established intellectual hegemony.

Production processes played an active role in eighteenth-century patterns of

consumption, as they were tied to markets and to mutations of consumer tastes based in part on demands for novelty.[29] Rumor and hearsay, example and instruction, could spark new methods and new objects. These connections, absorbed into the everyday rhetoric of trade, need to be better integrated into our studies of the culture of eighteenth-century European technology. Practices themselves are idealized but not closely examined, and it is possible to misrepresent both their effect on the structure of innovation and their place as nodes within communications networks and as things in and of themselves. In the study of an age that is known for its intense interest in objects, the result is often a material culture without material.

> It is, now, near twenty years since I discovered that the Ingredients, used by the Chinese in the composition of their Porcelain, were to be got, in immense quantities in the County of Cornwall. And, as I have since that time, by abundance of experiments, clearly proved this to the entire satisfaction of many ingenious men, I was willing this discovery might be preserved to posterity, if I should not live to call it into a Manufacture . . . .
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> William Cookworthy, *Notes on the Cornish Materials for Making Porcelain* (n.d., n.p.), cited in Hugh Owen, *Two Centuries of Ceramic Art in Bristol*. (Gloucester, 1873), xv.

The ceramics industry provides an example of the advantages of an expanded description of influences. Pottery was available throughout Europe long before the Common Era. Familiarity with its sources, materials, and techniques and with its general properties and uses—factors that can slow or otherwise mediate acceptance of a novelty—were not issues in either innovation or consumption. Still, demand for porcelain, a fine and translucent variety of pottery brought west by missionaries and traders, inspired searches throughout Europe for the means of its creation.[30] A number of earlier successes, notably the Medici porcelain of the sixteenth century and a soft paste variation developed in France, preceded the closer imitation of Chinese-style porcelain at Meissen in the early eighteenth century. Once the goal of replication was more or less achieved, the important issue in the history of the ceramics industry shifts to become the diffusion of porcelain objects throughout Europe.

At least, this is the history we are often told. Recently, historians of technology have raised questions about consumer perceptions of European porcelain.[31] Were they objects made in Europe believed to be the same as the Asian goods or were they unique items as good as those objects they imitated? This and similar questions can be answered only with a better integration of understanding about production techniques and about their role in consumption. Efforts to solve the problem of porcelain production in the West reinforced interest and demand for materials and for technical understanding, and it supported collecting as well as manufacturing rivalries. It may be that discriminating tastes for porcelain in the eighteenth century extended deeper than surface characteristics and created meanings for the acquisition of different ceramic wares that we have not recognized. The taste for "true" European porcelain and for alternatives—faience,

bone china, stoneware and earthenware—was built on discoveries made from replication experiments as much as on markets that developed as a result of these new products. Local imitation of Chinese wares and, later, imitations of those imitations depended on the discovery of native deposits of kaolin or of similar nonfusible earth.[32] Projects to invent, or reinvent a product as good as porcelain included geological ventures and mineralogical comparisons as well as chemical tests of porcelain bodies and coloring experiments.[33]

Eighteenth-century innovations in the textile industry suggest that closer integration of production techniques into the issues of consumption would answer questions that parallel those arising in the development of eighteenth century pottery and porcelain manufacture. One aspect of special relevance concerns the introduction and use of cotton in Britain and throughout Europe. Initially, like porcelain, cotton goods were items of luxury and foreign imports that became increasingly more common and more local. The lively interest in its production during the eighteenth century has long been a topic in the study of textiles as designed objects and as commodities.[34] The availability of Asian goods inspired investigations and experiments to create products in Europe that were similar to yet different from the source of inspiration. The desire to imitate the Asian fabrics with painted or printed designs that were prohibited, closely controlled, or simply expensive in most of western Europe was a significant force behind changes in the consumption of all textiles. The British manufacturers who wished to improve the printed cotton industry had to overcome both the mechanical complexities of the printing processes and the social complexities of introducing new production systems based on new machinery. Their textiles became a model for quality and style, to a degree that the French felt a need to import British textile expertise, especially cotton workers, to compete.[35]

Pigment-making practices were affected by the same confluence of changing tastes and changes to production processes for the objects of which they were a part. Again, the East offered models that were useful, desirable, and visually interesting. Rumors of their better sources, materials, and techniques abounded. Efforts to imitate lacquered goods especially generated writing that included fanciful conjectures, analytical research reports, and experiments.[36] One practical outcome was the invention of vernis-Martin, a type of colored varnish and also a style in which that varnish was used. Like Manchester cottons and Meissen porcelain, vernis-Martin was not in composition or style identical to true Asian lacquerware. European artisans developed other techniques in imitation both of the Asian works and its French variation, many becoming desirable in their own right.[37]

Changing Systems of Patronage and Support

Support for the development and exploitation of innovations (novelties) took on

changed forms and new meanings in the eighteenth century; this, too, affected the pursuit of public, social, and cultural goals. Older-style patronage systems began to give way to invention-, and object- or idea-based favors. Petitions to the crown or royal agencies from polymaths like Arnaud Vincent de Montpetit or Antoine Loriot can be understood as attempts to create a career that imitated the court-bound style through a piecemeal collection of inventions, inventions that seem to be connected almost exclusively by the enthusiasms of their creator. Grants to exploit a novel change or invention, to support production rather than an individual or family, became more common and more typical for objects created in multiple—i.e., in the large production units that are a feature of industrialization.

> Les porcelaines étrangeres font sortir l'argent de l'Etat, ce feroit un très-grand avantage que la France pût se fournir cette marchandise à elle même & à nos voisins. L'attention qu'ont les entrepreneurs de ne se servir que des meilleurs dessinateurs, & des peintres les plus agréables, nous le fait espérer.
>
> "La Manufacture de Porcelaine de Vincennes, Transportée à Seve" *Le nouvelliste œconomique et litteraire,* 17 (March/April 1757): 86.

Within the context of participation in the progress and improvement of public and personal worlds, premium or patent systems affirmed a degree of individual and institutional involvement while preserving opportunities to gain from a discovery. An inherent paradox of any patent system, as others have noted, is that they stimulate invention while inhibiting diffusion.[38] In the French and German systems, which functioned alongside guilds or corporate communities of variable power and many regulations, improvements could be rewarded even as the processes of their discovery was officially discouraged and sale was limited or prohibited. Nor did patents prevent others from attempting to recreate desirable and successful objects, as Josiah Wedgwood, James Turner, and others found to their dismay.[39] The issue of disclosure versus dissemination was often a significant one for artisans hoping to earn a livelihood from their accomplishments. Clearly most objects gave up their secrets when examined by a skilled artisan. Perhaps as a result the differences between the promise of exclusive production given in a patent and the financial reward and public acclaim from a premium society was a less precise one than we may have imagined. In such situations, other benefits may take on greater significance.

> 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 and 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 ceding of control by the inventor that was a part of many reward systems appears to have been a recurring consideration within eighteenth-century artisan communities as well as outside them. A recent study has suggested that, for

nineteenth-century inventors, the choice to take a patent was connected to the level of skill required to exploit the invention. The difficulties of reverse engineering and the level of secrecy under which an industry normally operated figured in an inventor's decision for or against the time and effort of filing a petition and maintaining a patent.[40] The rationales behind this choice to file or forgo a patent in the nineteenth century are similar to those suggested but not yet proved for the eighteenth century. Access to basic information encouraged imitation in both eras, but sciences and industrial technology in the nineteenth century closed themselves to outsiders in ways they did not in the eighteenth.[41]

Premium Societies

A feature of eighteenth century social life was the founding of improvement or premium societies to encourage discoveries and their diffusion. The Society of Arts, the Dublin Society, and similar groups throughout Europe established competitions for products and production techniques. The rewards offered, which ranged from proclamations and medals useful for commercial promotion to significant financial support, were given in exchange for making critical information available to all. The idealism of these programs encouraged presentations couched in the same rhetoric of enlightenment found elsewhere, but the altruism of turning an invention to the public was not exempt from exploitation. In 1771, Edward Bancroft approached the Society of Arts about a premium for some textile coloring materials, including a red dyestuff used in Guyana and a dye assistant that would improve black and brown colors.[42]

The substances were tested and approved, but Bancroft withdrew his application in order to accept a patent. It is not clearly established, but still quite unlikely that Bancroft believed he could receive both an award from the Society of Arts and a patent from the Crown. His submission to the Society of Arts may have been part of a strategy to establish claims of quality for a new substance in a new market. Bancroft's persuasive abilities were considerable: His 1775 patent for the sale of quercitron in Britain was renewed when he argued that war hindered his ability to exploit its rights.[43] Once the patent was extended, Bancroft turned to the Council of Commerce in Paris for a similar privilege in France; he controlled access to this improved coloring material and its coloring technique in both countries until his death.

Bancroft may have been an unusually canny entrepreneur, but public recognition of the type he sought and then rejected offered inventors substantial opportunities for indirect support of their work. Jean-Jacques and Theodore de Beaune may have hoped for such an opportunity when they sent a prospectus for their dyehouse to the Society of Arts.[44] In their letter to the Chemistry Committee, they described delays to essential approvals that slowed their establishment in England. Acknowledgement by the Society might have

legitimized the brothers' search for alternate financing, creating for the project a notoriety that would extend its reach as an investment—and the reach of its products once was the manufacture was established.

Eighteenth-century investigators who nourished and were nourished by hope for an award—whatever its form—were not only recognized specialists within small communities of adepts who shared knowledge of weaving, medicine, politics, aesthetics, or something else.[45] Almost anyone could act in an enlightened manner, suggesting progress by locating improvement in the surrounding world. The existence of outlets such as premium societies to promote concerns for trade, the arts, and practical endeavors through information exchange, and rewards supported individual contributions to public life.

New Forms of Dissemination, Changing Forms of Participation

We know that many strategies for disseminating information typical in the eighteenth century are different from ours today. Just as the role of institutions was different then from what it is now, other approaches incorporate qualities and assumptions alien to us. Some, such as topical verses set to well-known tunes, no longer exist as a force of communication. Broadsheets and pamphlets—mainstays of communication in the eighteenth century—remain useful only within closely defined contexts in the twenty-first. Where did one find information in the eighteenth century, especially information about technological subjects? What might that information offer its collector? Within a culture predisposed to consider itself enlightened, inclined to recognize and solve problems, what communicated ideas, and how?

> Our present business is to discover the Means of producing, varying, changing, and destroying the Colours of Bodies; with a view to improve those several Arts that depend upon the use of Colours, Dyes, and Stains.
>
> Peter Shaw, "Lecture XIV. . . [On] Dyes and Stains" *Chemical Lectures* (London, [1734]), 165.

As I have suggested, the exchange of information was an essential component of the multiple worlds of the eighteenth century, and it circulated in a variety of ways. The transfer could be purely verbal or it could use combinations of verbal and visual strategies. It could be based in observation, or in reading. To a knowledgeable observer, objects offered plentiful information about production, in the same way that to a knowing consumer they offered information about fashion or taste. Fluency with certain skills—reading, measuring, throwing a pot, knowing the quantity of medium to combine with a pigment—offered other, more tacit, forms of information exchange.

In the effort to employ knowledge as a route to progress and improvement, information sources were used in multiple ways. An object might inspire examination and reading. Access to production descriptions or recipes might lead

to tests and discussion. Rumor of practices in other regions could suggest experimental techniques. Our recognition of these different uses for information highlights the need for a more integrated assessment of the ways all information was disseminated. We may assume, for example, that certain eighteenth-century publications were especially significant, because they were often cited by other eighteenth-century authors. Relying on such references alone to establish significance, however, has several drawbacks: Rhetorical statements aside, these citations may suggest the value of easy availability rather than that of useful content. The integration of objects with other records may answer some questions about use. The incorporation of unpublished, archival sources can provide some clues to verbal exchanges. Together, their description of the forms of exchange and its content create a more comprehensive whole.

Conclusions

> LXXVIII. Arts and manufactures were, for the most part, in their origin the work of chance; and since then receiving improvement by continual and successive trials, have been brought to the degree of perfection at which we see them now; commonly, without being obliged to science for their advancement. But this is no proof, that the success of them is founded on certain chemical truths or axioms, on certain general facts, which it comes under the province of chemistry to teach and to explain, and on account of which, it cannot but receive considerable light from chemistry : some of it has received already and doubtless it would have received much more, had it not been for that veil of mystery, with which private interest naturally sees to cover those lucrative employments.
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> Torbern Bergman, "Technical Chemistry," in *An Essay on the Usefulness of Chemistry* (London, 1783), 39–40.

What did the eighteenth-century cultures of technology and sciences offer the nonspecialist observer, reader, or listener? The questions posed by the natural and by the manufactured worlds were well known and open to study by anyone with the diligence to prove their truth. If access connoted permission, information derived from that access, which could perhaps answer those questions, might inspire simply because it was available. Any individual might participate in the Enlightenment by acting in an enlightened manner; beliefs about what this meant were clear. One learned and one worked to acknowledge the cultural goals of enlightenment and their accompanying social programs. The problems of the world, explained to so many, might be solved by anyone. This double belief was a critical aspect of the culture of science and technology in eighteenth-century Europe and of its integration into the lives of many.

Enlightened Participation

Eighteenth-century ideas of culture, technology, and the sciences incorporate concepts of enlightenment, progress, community, participation. Improvement was a focal point for all those interests. Nevertheless, to frame the eighteenth century as a constant and acknowledged group effort to solve the problems of the immediate and larger worlds would be an overstatement. It is unlikely that many eighteenth-century Europeans who used pottery or tableware, wore clothes, and

lived in houses with painted walls viewed their possessions as a group of technical fiascos in desperate need of repair. Even among those who thought about their possessions, the moral and ethical dilemmas of ownership often carried more weight than did the inability of objects to behave according to an ideal.[46] Still, it is clear that improvement of manufacturing and trade and the goal, whether articulated or implied, of increased consumption was a common eighteenth-century rationale for undertaking experiments that might lead to innovation. The idea that tangible objects could be improved does imply recognition of faults or defects that could be and deserved to be overcome. Rhetoric concerning the ideals of an enlightened society encouraged these efforts toward improvement and a more pragmatic awareness of novelty as a strategy to enhance trade. These concerns and contemporary manifestations of their relationships are not yet well explained, and we have much to learn about the connections between consumption, production, and philosophical or practical studies as issues in the culture of the eighteenth century.

> Le véritable moyen d'éclairer les arts, consiste bien moins à en décrire les procédés avec exactitude, qu'à en ramener toutes les opérations à des principes généraux; la description d'un art, quelqu'exacte qu'on la suppose, n'est jamais que l'histoire de ce qui se pratique.
>
> Jean-Antoine Chaptal, *Chimie appliquée aux arts* (Paris, 1807), 1:ix-x.

One of my objectives for this work is to explore the interactions between practical pursuits and theoretical or philosophical ideas in a way that expands what is considered as well as how it is considered. If the sciences were idealized concepts within eighteenth-century European understanding, they were still approachable, not removed to the academic laboratory or the university classroom and not made recherché in the lecture hall. However one defined it—topically (as mechanics, mathematics, natural philosophy, electricity) or as an attitude (of rationalization, simplicity, order)—science could be studied, learned, and applied to a variety of situations.

In part, this condition was owing to information about scientific ideas and to different sets of information about technological (including artisan) subjects available to expanding numbers of people. Information was not limited to elites—not to the elites among practitioners, such as painters or apothecaries, or to elites who were academicians, or to virtuous aristocrats, or to persons of leisure—but extended to manufacturers and their assistants, ladies' maids, impoverished radicals, government officials, university lecturers, retired soldiers, the merely curious. Concepts of a public life in science, and of science in public life, reinforced critical tenets to social and intellectual goals. In addition, technologies—practices—offered value to science by creating direct connections to cultural and material improvement. Paired, these concepts encouraged explorations with practical outcomes.[47] Throughout the eighteenth century the rhetoric accompanying the presentation of new ideas and new techniques,

however changed, does not deviate from the alliance with experimental practice, philosophical thought, old or new traditions, alone or in combination. All rhetoric aside, the result was a constant engagement.

Color as Subject and Model

Of the COLOUR-MAN

[The Colour-Man is] the apothecary to the Painter; as he buys the simple Colours and compounds some of them: He grinds those as require grinding, and adds that Expence to the prime Cost. He ought to be a thorough Judge of Colors, to know all their Properties, and common Tricks that are used in sophisticating Dyes of all sorts, not with an Intention of cheating his Customers, but to guard against the Imposition of those who would impose upon him in the Sale of Goods. The common Colour-Man generally sells Oils, Pickles and several Things that are sold in what are properly call'd Oil-Shops: but the Colour-Man properly confines himself to Painting.

R. Campbell, *The London Tradesman* (London, 1757), 105.

The investigation of color fits into this view of the eighteenth-century world at several junctures. Color was a topic with clear connections to the sciences. It suggested visible and tangible opportunities to join theories and practice, providing a unitary focus for systematic conjecture and experiment. Color had a universally established public role, as a way to differentiate between similar items. Connoisseurship relied on color to separate Genoese from Parisian black silks, tea services by Wedgwood or Meissen from those made at Sèvres, or a painting by Canaletto from one by Chardin. Even in more-humble settings however, color was familiar. It was not a distant planet, an unusual invertebrate, or an equation of motion. It existed within everyday experience, everywhere.

The availability of information about color, as a subject both of arts and of sciences, was a powerful impetus to exploration. Colormaking information might be gleaned from practitioners, from transcribed information, and through other activities. It studied as a model for regularizing, regulating, and ultimately improving other industries. Experiment with coloring methods and the discovery of techniques to enhance the goodness of colors was an opportunity to affirm individual beliefs about the place of the sciences in the improvement of society and manufactures. Examples of pigments, glazes, and dyestuffs made compelling scientific demonstrations and explanations. Any individual could use scientific ideas to find new colors or search for new methods to make "old" ones better. The geographical and disciplinary reach of any result combined with the attraction of personal experience to make color an especially appealing subject for study. This perception was further enhanced by the conundrums of color: The multiple definitions, and coexistent forms suggested parallels ripe for a combination that had eluded so many others.

Eighteenth-century literature about color and color production demonstrates the existence of strong links between practices and theories supplemented by

acknowledgment of prevailing cultural or social goals. Work with chemical theories would highlight the principles that expose innovations in the arts and trades. Efforts to understand practical operations would support or prove chemical understanding. While this was not the path of innovation chosen by artisans of the past, it was one that fit contemporary notions of contribution and commerce. A former military captain might take to experiment with white lead, minium cinnabar, verdigris, and, especially, oil of vitriol, leading him to petition the French Council of Commerce about his discoveries.[48] A ladies' maid might offer the Society of Arts a "trifling Coller"—a cosmetic rouge she believed could work as a textile dye.[49] An individual could claim a place in polite society by studying and improving this very obvious and basic component of material objects. Such attempts were consistent with philosophical ideas about the natural world and its relationship to the man-made one.

Two well-known examples demonstrate the use of eighteenth-century color-production techniques across disciplines. One was the conscious adaptation of enamel, glass, and ceramic techniques to other forms of painting, as a strategy to improve permanence. The extension of enamel painting materials—used in a technique developed for small-sized decorative items—to the creation of physically large pictures was intuitive in concept but not in execution. Expanding this art of painting on ceramic, solving its problems, would improve practices, commerce, and aesthetics at the same time. We know of the technical difficulties of this adaptation, through studies of Josiah Wedgwood's collaboration with the painter George Stubbs, in 1780.[50] Almost twenty years earlier, the Committee on Polite Arts of the Society of Arts had established a premium for landscape and sea painting using these materials: They offered 25–50 guineas for an enamel painting at least 3 by 2.5 inches.[51] The creation of enamel paintings that were paintings first and ceramic objects second was undertaken in Germany at the Königliche Porzellan-Manufaktur, in France by Alexandre Brongniart at Sèvres, by Dihl and Guérhard at their Paris manufacture, and elsewhere, with varying declarations of success.[52] The successful development of the technique required the correction of some problems that were less troublesome in smaller-scale works such as ceramic tiles: Substrates warped, coloring materials were difficult to apply evenly over larger surface areas, color keys varied in ways that palettes full of more traditional painters' pigments never did. Critical to success were the development of better techniques for choosing and preparing the materials and the transfer of knowledge about oil- or water-painting to vitreous color techniques.

Another familiar connection exists in the production and operational relationships between textile and wallpaper printing and in their mutual connection to engraving and other forms of picture printing. Similar tools were used to create these products, and information exchanges about coloring materials, especially

exchanges that addressed problems of adhesion and permanence, were profitable to both. Eighteenth-century textile printers might use the same plates for wallpaper, advancing a fashion for rooms decorated in a single pattern for walls and furnishings alike. Jacques-Fabien Gautier d'Agoty's experiences with the cotton-printing industry in Marseilles may not have been the sole inspiration for his color-printed pictures, but the connections were so obvious that his detractors never challenged that claim.

Color was a necessity for virtually all manufacturing enterprises, a fact that was consistently remarked upon in the eighteenth century (as it is now).[53] Color, when well produced and attractive, adds value. Consumer demands for novelty meant a persistent search for new colors and for improved methods to produce known ones. Throughout the century, as new materials were introduced or old materials were abandoned, and as tastes changed, the need to create colors for objects and colors on objects continued to be addressed in the workshop, as they were in public venues. Ideas about color, examples and descriptions of its production and improvement, were available to a broad range of people through an equally broad range of sources. Curiosity about color was piqued and supported by easy access to published information, to discussions and demonstrations, and to colored objects—both good and bad examples. In books and lectures directed to popular audiences, color was used to illustrate connections between methods and theories, as the familiarity and practicality of colormaking was emphasized alongside the scientific significance of color.

The study of color—experimentation with its physics and its chemistry, learning its techniques and attempting to improve them—joined scientific ideas to a practical purpose for a recognizable public goal. This integration was fostered by public acknowledgment of the problems that might be solved through the application of scientific understanding and the progress and improvement that would result. The lack of cohesion between the two kinds of color—Newton's colors and artists' colors—was not a deterrent to explorations.[54] Frequently noted, it seemed to suggest that any individual could use scientific ideas to find new colors or search for new methods to make "old" ones better. An additional implication, within a culture that encouraged such endeavors, was that the investigation could establish one's position within intellectual, technological, or social groups.

As subject and as a model, color extended the domain of knowledge outward, increasing it as it crossed boundaries, returning more abundant, more fruitful, better. Color was simple to research. Informative descriptions were easy to find. Materials were readily available, and practical examples, sources of inspiration, were everywhere. Colored objects could originate in one place, travel to others, and be changed there. They might seem to be lost and then reemerge, changed slightly but still recognizable. The intricacies of color production offered many

opportunities to improve or simplify the use of existing materials and methods. Color filled multiple roles in different domains even as its often transitory nature made it difficult to pin down. During the eighteenth century, investigations of color were about many things at once. They addressed the values of enlightenment on personal, local, and national levels. Investigation—of color, color production, and color theories—was about knowledge and instruction, the improvement of trade, and improved understanding of goods consumed. The boundaries of this information were not held close by time or geography; information came from everywhere and traveled everywhere. Color was philosophical but not exclusively; it was technical but not merely. It had theories; it was traded. And still it was something more. One might believe that colormaking would become clear if one engaged in practice. On the other hand, perhaps only a rudimentary knowledge of artisan techniques is required and deeper chemical understanding would be more useful. Creation of color in an object was never as simple as directing a prism toward a beam of light, and its intricacies offered many opportunities to improve or simplify the use of existing materials and methods. The multidirectional, multipurpose exchanges found in the range of color studies epitomize the cultures of technology and the cultures of sciences, as they also epitomize a larger Enlightenment project.

Notes:

Note 1: Carl Wilhelm Scheele, "Method of Preparing a New Green Colour. 1778," in *The Chemical Essays of Charles-William Scheele: Translated from the Transactions of the Academy of Sciences at Stockholm with Additions* (1786; reprint, London, 1966), 176–77; "A Method of Producing a Yellow Colour for Painting in Oyl or Water, Making White Lead and of Separating the Mineral Alkali from Common Salt, All to be Performed in One Single Process Which Would be of Great Publick Utility," English Patent no. 1281 issued to James Turner (26 February 1781). On the latter see also Ernst Homburg and Johan H. De Vlieger, "A Victory of Practice over Science: The Unsuccessful Modernisation of the Dutch White Lead Industry 1780–1865," *History and Technology* 13 (1996): 33–52.

Note 2: Johann Carl Barth, "Unterricht von dem nützen und Gebrauche eines ganz neu erfunden extrafeinen Lactmusses" in *Acta die von Joh. Carl Barthen zu Gr.Hayn erfundene blaue Farbe . .*(1780–82), Sächsisches Hauptstaatsarchiv Dresden Ms. 1200/11/115/XIX/1067.

Note 3: Danielle Rice, *The Fire of the Ancients: The Encaustic Painting Revival, 1755–1812* (Ph.D. diss., Yale Unversity, 1979); Ian Jenkins and Kim Sloan, *Vases and Volcanoes: Sir William Hamilton and His Collection*(London, 1996).

Note 4: T. S. Ashton, *The Industrial Revolution* (1947; reprint, London, 1971); Charles Singer, ed., *A History of Technology*, 8 vols. (Oxford, 1958); A. Wolf, *A History of Science, Technology, and Philosophy in the Eighteenth Century*(London, 1952).

Note 5: Margaret C. Jacob, "The Cultural Foundations of Early Industrialization: A Project," in *Technological Revolutions in Europe: Historical Perspectives,* ed. Maxine Berg and Kristine Bruland (Cheltenham, U.K, 1998), 67–85.

Note 6: Jan Golinski, *Science as Public Culture: Chemistry and the Enlightenment in Britain 1760–1820* (Cambridge, 1992); Larry Stewart, *The Rise of Public Science* (Cambridge, 1993).

Note 7: See, for example, Roy Porter, *English Society in the Eighteenth Century* (London, 1990); Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803* (Berkeley, Calif., 1971), esp. 66–69; and Roger Hahn, "Scientific Careers in Eighteenth-Century France," in *The Emergence of Science in Western Europe*, ed. Maurice P. Crosland (New York, 1976): 127–38.

Note 8: Golinski, *Science as Public Culture*; Stewart, *The Rise of Public Science;*Geoffrey V. Sutton, *Science for a Polite Society: Gender, Culture, and the Demonstration of Enlightenment* (Boulder, Colo., 1995).

Note 9: John Perkins, "Creating Chemistry in Provincial France Before the Revolution: The Examples of Nancy and Metz: Part 1," *Ambix*50 (2003): 145–81; Anne Puetz, "Design Instruction for Artisans in Eighteenth Century Britain," *Journal of Design History* 12, no. 3(1999): 217–39.

Note 10: Gwen Averley, "The 'Social Chemists': English Chemical Societies in the Eighteenth and Early Nineteenth Centuries," *Ambix* 33 (1986): 99–128.

Note 11: Trevor Levere and Gerard L'E. Turner, eds. *Discussing Chemistry and Steam: The Minutes of a Coffee House Philosophical Society* (Oxford, 2002).

Note 12: P. Fontes da Costa, "The Culture of Curiosity at the Royal Society in the First Half of the Eighteenth Century," *Notes and Records of the Royal Society of London*56, no. 2 (2002): 147–66.

Note 13: Golinski, *Science as Public Culture*; Stewart, *The Rise of Public Science*; Sutton, *Science for a Polite Society*; Alice N. Walters, "Conversation Pieces: Science and Politeness in Eighteenth-Century England," *History of Science* 35 (1997): 121–54.

Note 14: James E. McClellen III, *Science Reorganized: Scientific Societies in the Eighteenth Century* (New York, 1985).

Note 15: Eufrosina Dovichenko-Markoff, "Benjamin Franklin and the Russian Academy of Science," *Proceedings* (American Philosophical Society) 91, no. 3 (1947): 250–57; Raymond Phineas Stearns, "Colonial Fellows of the Royal Society of London, 1661–1788" *William and Mary Quarterly*, 3d ser., 3 (1946): 208–68; 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 16: "Notice de un pension de 600 livres donnée à Osmont maitre toilier à Darnetal," 13 May 1783, AN F/12/994; Dossier de *rose de Smyrne* de Osmont, 1783, AN F/12/1334B; Pierre-Joseph Macquer, "Rapport de roses solides sur le coton par le sieur Renauld de Rouen," 30 October 1782, AN F/12/994; "Pension de 1500 livres accordi, au S'r. Dambourney, secretaire perpetuel de l'Académie de Rouen—des decouverts en teinturier," 1783–35, AN F/12/1334; Dambourney to Peter Templeman, 18 May 1765, [R]SA PR.GE/110/19/3; [R]SA Committee Minutes for the Chemistry Committee, 18 Feb 1773, [R]SA Minutes of Various Premium Committees, 1772–73 [R]SA PR.GE/112/12/14.

Note 17: Peter Hanns Reill, "Between Mechanism and Hermeticism: Nature and Science in the Late Enlightenment," in *Frühe Neuzeit Frühe Moderne? Forschungen zur Vielschichtigkeit von Übergangsprozessen* ed. Rudolph Vierhaus (Göttingen, 1992), 393–421.

Note 18: See, for example, the fanciful interpretation of the origin and significance of Greek vases by d'Hancarville [Pierre François Hugues] in *Collection of Etruscan, Greek, and Roman Antiquities, from the Cabinet of the Hon. W. Hamilton, Etc. (Antiquités étrusques, Grecques, et Romaines, Tirées du Cabinet de M. Hamilton, Etc.)* (Naples, 1766–77). On the related subject of architecture and antiquarian culture more generally see F. H.Schmidt, "Expose Ignorance and Revive the Bon Gout—Foreign Architects at Jacques-François Blondel's Ecole des Arts," *Journal of the Society of Architectural Historians*61 (2002): 4–29; and Martin Myrone and Lucy Peltz, eds., *Producing the Past: Aspects of Antiquarian Culture and Practice 1700–1850* (Aldershot, Hants., England, 1999).

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