

Original citation:

Bycroft, Michael (2018) *Style and substance in rococo science*. *Journal of Interdisciplinary History*, 48 (3). pp. 359-384. doi:[10.1162/JINH_a_01162](https://doi.org/10.1162/JINH_a_01162)

Permanent WRAP URL:

<http://wrap.warwick.ac.uk/94208>

Copyright and reuse:

The Warwick Research Archive Portal (WRAP) makes this work by researchers of the University of Warwick available open access under the following conditions. Copyright © and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable the material made available in WRAP has been checked for eligibility before being made available.

Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge. Provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

Publisher's statement:

Bycroft, Michael (2018) *Style and substance in rococo science*. *Journal of Interdisciplinary History*, 48 (3). pp. 359-384. doi:[10.1162/JINH_a_01162](https://doi.org/10.1162/JINH_a_01162)

© 2018 The MIT Press

<https://www.mitpressjournals.org/loi/jinh>

A note on versions:

The version presented here may differ from the published version or, version of record, if you wish to cite this item you are advised to consult the publisher's version. Please see the 'permanent WRAP URL' above for details on accessing the published version and note that access may require a subscription.

For more information, please contact the WRAP Team at: wrap@warwick.ac.uk

Rococo science: Style and Substances at the Paris Academy of Science, c. 1710-1740

Accepted on 5 June, 2017, for publication in the *Journal of Interdisciplinary History*, under the title “Style and Substance in Rococo Science”

Author: Michael Bycroft

If ‘rococo science’ is a jarring phrase, this is not simply because we are accustomed to placing ‘art’ and ‘science’ in different mental categories. Consider the following statements, one about a set of ornamental engravings, the other about a theory of electricity. The first comes from the *Mercure de France*, the unofficial organ of the *style rocaille* in 1730s Paris; the second from the *Histoire et Mémoires* of the Royal Academy of Science, the official organ of French science in the same period.

There has appeared a suite of engravings in wide format that will pique the curiosity of the public and of curious people [*curieux*] of the best taste. These are fountains, waterfalls, ruins, rock-work, shells, and pieces of architecture that produce bizarre, singular and picturesque effects [*effets bizarres singuliers et pittoresques*] through their strange and enticing forms [*formes piquantes et extraordinaires*], of which no parts agree with the others.¹

¹ *Mercure de France*, March 1734, 558-9, quoted in Alastair Laing, ‘French Ornamental Engravings and the Diffusion of the Rococo,’ in *Le stampe e la difusione delle immagini e degli stili, Atti de XXIV Congresso Internazionale di Storia dell’Arte* (1979), 109–27, on 113-4. The subject of the review was *Livre d’ornements inventez et dessinez par J.O. Meissonnier* (Paris, 1734).

Such are the simple and primitive facts [*faits simples et primitifs*] to which all known experiments on electricity may be reduced; the number of such principles will diminish as we acquire a more exact knowledge of [electricity], which until now was known only by a few very complicated experiments [*expériences très-compliquées*] that depended on bizarre circumstances [*circonstances bizarres*]. Now, electricity is a general quality of matter that depends on invariable principles [*principes invariables*] and is subject to exact laws [*loix exactes*].²

Both these passages appeared in Paris in 1734, but their similarities end there. For the reviewer in the *Mercure de France*, ‘bizarre’ is a term of praise. For Charles Dufay, the author of the second passage, it is a term of abuse. For the reviewer, the value of the engravings under review, which were inspired by the works of the goldsmith Juste-Aurèle Meissonnier, lies in their irregularity, in the strangeness of their forms and the disagreement between their parts. For Dufay, the value of electricity lies in its regularity, in the generality of its phenomena and the exactness and invariability of its laws. The point of Dufay’s theory of electricity was to discover a small number of principles—the fewer the better—that frame all the known facts on electricity. By contrast, the point of the engravings was to question overwhelm the frame with a profusion of detail: consider the example in Figure 1 [see end of this document], where the curvaceous structure to the left of the engraving appears to frame the image, but where that structure is overrun by the fountain in the centre of the engraving and fades into the background on the right. Both the theory and the

²Charles Dufay, ‘Sixième mémoire sur l’électricité: Où on examine quel rapport il y a entre l’électricité et la faculté de rendre de la lumière, qui est commune à la plupart des corps électrique, et ce qu’on peut inférer de ce rapport,’ *Mémoires de l’Académie Royale des Sciences* (hereafter MAS) (1734): 503–26, on 525–6. This volume of the *Mémoires*, comprising papers read to the Academy in 1734, was published in 1736.

engraving were human creations intended to represent the natural world, but the theory was meant to represent nature as it was whereas the engraving was an artful imitation of nature, one that blended natural bodies (rocks, shells, waterfalls) and the fantasy of the artist.

These antitheses—regularity versus irregularity, structure versus the play of surfaces, nature—might be dismissed as curiosities if not for the fact that Dufay and Meissonnier were men of their time. For intellectual historians, Dufay exemplifies an epistemological and metaphysical shift that occurred in the natural sciences in the early decades of the eighteenth century. Seventeenth-century natural philosophers had revelled in strange and anomalous phenomena, in the irreducible complexity of nature, and in the playful interaction between natural bodies and human artefacts. Their eighteenth-century counterparts replaced anomalies with generalities, favoured simple rules over rich descriptions, and drew a sharp line between artefacts (the direct products of human action) and natural bodies (now understood as the products of laws decreed by a remote God). This new approach to nature emerged in the latter part of the seventeenth century and was firmly in place, at least at the Paris Academy of Sciences, in the second decade of the eighteenth.³

³An influential statement of this view is Lorraine Daston and Katharine Park, *Wonders and the Order of Nature, 1150-1750* (New York: Zone Books, 1998), chap. 5, esp. 352 (Dufay). Cf. Lorraine Daston, 'The Cold Light of Facts and the Facts of Cold Light: Luminescence and the Transformation of the Scientific Fact, 1600-1750,' *Early Modern France* 3 (1997): 1–27; idem, 'Nature by Design,' in *Picturing Science, Producing Art*, Cardine A. Jones and Peter Galison, eds. (Routledge, 1998), 233-53; idem, 'Preternatural Philosophy,' in *Biographies of Scientific Objects*, ed. Lorraine Daston (Chicago: University of Chicago Press, 2000), 15–41, esp. 40 (Dufay). See also Christian Licoppe, *La formation de la pratique scientifique: le discours de l'expérience en France et en Angleterre (1630-1820)* (Paris: La Découverte, 1996), 46, 98, 113-116, 118-119.

For historians of art, Meissonnier's sinuous candlesticks are typical of the French rococo, a stylistic movement with a similar timetable to that of early Enlightenment science. On most standard accounts, this movement had its origins among interior decorators working for Louis XIV in the latter part of his reign; it gained momentum during the Regency of Philippe II (1715-1723), in the redecoration of the Regent's Paris residence the Palais Royal, in Parisian interiors commissioned by wealthy financiers such as John Law and Pierre Crozat, and in the paintings of Jean Antoine Watteau and Jacques de la Joue; and it climaxed in the 1730s and 1740s, in interiors designed and executed by the sculptor Nicolas Pineau, in the paintings of François Boucher and Jean Baptiste Siméon Chardin, and in the gold- and silver-work of Meissonnier, the latter being 'the most extreme, characteristic, and novel expression' of the movement.⁴ Known at the time as 'le goût moderne,' 'le goût du siècle,' as the 'genre pittoresque,' or as the 'rocaille,' the movement has been referred to since the end of the eighteenth century as the 'rococo,' a term that began as a slur and has evolved into a neutral term for a distinctive phase in French painting and decoration.⁵

⁴Fiske Kimball, *The Creation of the Rococo Decorative Style* (New York: Dover, 1980), 161 ('most extreme'). This chronology is based on Hans Sedlmayr and Hermann Bauer, 'Rococo,' in *Encyclopedia of World Art* (New York: MacGraw Hill, 1966), vol. 12, 230-74, on 247-51. Sedlmayr and Bauer follow closely, though not exactly, the chronology developed in Kimball, *The Creation of the Rococo* and summarised in Kimball, 'The Creation of the Rococo,' *Journal of the Warburg and Courtauld Institutes* 4 (1941): 119-23. Other syntheses follow a similar chronology, eg. Eric Hubala, *Baroque and Rococo* (London: Herbert, 1989 [a translation of the first German edition of 1971]), 166; Germain Bazin, *Baroque and Rococo*, trans. Jonathan Griffin (London: Thames and Hudson, 1979 [based on first French edition of 1964], 194; John Whitehead, *The French Interior in the Eighteenth Century* (London: Laurence King, 2009 [1992]), 54-61.

⁵For an up-to-date summary of the history of these terms, see Colin B. Bailey, 'Was There Such

Definitions of rococo style vary, but irregularity, superficiality, and imitation are recurring themes. The first of these themes has been expressed in phrases such as ‘ornements irréguliers du meilleur goût français,’ ‘departure[s] from the normal and expected,’ ‘the irregular and the anomalous.’⁶ Irregularity was most obvious in the asymmetric designs of Meissonnier, but it was also present in the gravity-defying figures in Louis XIV arabesques, in the loose treatment of the ‘orders’ of classical architecture, in the fluid view of gender identity implied by Boucher’s paintings, and in the ambiguous social position of many of the practitioners and promoters of the movement, from the Dauphin circle in the later years of Louis XIV’s reign to the goldsmiths, porcelain-makers and other ‘decorative artists’ who crafted many characteristic works of the style.⁷ As for superficiality, an authority on the movement tells us that the conflation of depth and surface,

a Thing as Rococo Painting in Eighteenth-century France?’ in Melissa Lee Hyde and Katie Scott, eds. *Rococo Echo: Art, History and Historiography from Cochin to Coppola* (Oxford: Voltaire Foundation, 2014), 169-90, on 169-4. Cf. Kimball, *Creation of the Rococo*, 3-6.

⁶Gauvin Alexander Bailey, ‘Rococo and Spirituality from Paris to Rio de Janeiro,’ in Hyde and Scott, *Rococo Echo*, 233-253, on 243 (ornements irréguliers), citing a late eighteenth-century councillor in Brazil; Henry Fowler, *A Dictionary of Modern English Usage* (Oxford: Oxford University Press), 616, cited in Vernon Hyde Minor, *Baroque and Rococo: Art and Culture* (London: Laurence King, 1999), 14; Minor, *Baroque and Rococo*, 14 (irregular and anomalous).

⁷Kimball, *Creation of the Rococo*, 162 (asymmetry). Whitehead, *French Interiors*, 59 (asymmetry). Scott, *Rococo Interior*, 123-33 (arabesques). Sedlmayr and Bauer, ‘Rococo,’ 236-7 (classical orders). Melissa Lee Hyde, *Making up the Rococo: François Boucher and His Critics* (Los Angeles, CA: Getty Research Institute, 2006), chaps. 4 and 5 (gender identity). Scott, *Rococo Interior*, chap. 2 (decorative artists), chap. 6 (Dauphin’s circle), chap. 9 (financiers). Sedlmayr and Bauer, ‘Rococo,’ 231, 254 (decorative arts). Bazin, *Baroque and Rococo*, 206-10 (decorative arts).

was ‘the essential creative act in the genesis of the rococo.’ In the designs of walls and ceilings, pilasters gave way to slender fillets and horizontal borders to sinuous ones; in domestic furnishings, the play of surfaces was enhanced by strategically placed mirrors, windows, and light-fittings, and by the use of glossy materials (lacquer, porcelain, silk, gold leaf, polished wood) in clothing and furniture; in painting, solemn history paintings, gravid with theological and political symbolism, gave way to Watteau’s dreamlike pastoral paintings and Chardin’s charming scenes of bourgeois life.⁸ Ornament triumphed over architecture: ornament was the ‘primary sphere’ of the movement, the ornamental engraving was its ‘ideogram,’ and the excess of ornament was a favourite target of the movement’s critics, who decried ‘ornements surchargés,’ ‘les ornements de travers qui sont contre la régularité,’ ‘des ornemens bizarres & de travers,’ and ‘la profusion des ornements contournés.’⁹ Finally, imitations proliferated: glass beads that resembled natural pearls; French lacquer that aped the Japanese original; coloured papers that gave the appearance of cut velvet at a fraction of the price; miniature diamonds and mirrors that shone like their larger, aristocratic counterparts; and printed engravings, known as ‘*découpes*,’ that were designed to be cut out by their owners and stuck to furniture to imitate the designs of decorators such as Pineau and painters such as Jean-Antoine Watteau.¹⁰

⁸ Kimball, ‘The Creation of the Rococo,’ 121 (‘essential creative act’). Bazin, *Baroque and Rococo*, 177 (pilasters and horizontals). Sedlmayr and Bauer, ‘Rococo,’ 239 (furnishings).

⁹ Kimball, *Creation of the Rococo*, 3 (primary sphere). Hubala, *Baroque and Rococo*, 167 (ideogram). The quotes referring to ornament are due, respectively, to Voltaire (1733), Germain Boffrand (1742), Antoine-Joseph Dezallier d’Argenville (1787), and the Académie Française (1935); they are quoted in Scott, *Rococo Interior*, 253 and Kimball, *Creation of the Rococo*, 5, 180-1.

¹⁰ Pearls: below, section 3. Textiles and mirrors: Scott, *Rococo Interior*, 38-9, 31. Diamonds: Sedlmayr and Bauer, ‘Rococo,’ 239; Archives Nationales, T/1490/18, 853v. Cut-outs: Scott,

To sum up, it seems that artists embraced anomalies, surfaces and artful imitations in the same period that scientists shunned them. The co-existence of two apparently opposed cultural movements is a phenomenon that calls out for explanation. The burden of this paper is to show that the *stylistic* differences between academic science and rococo art can be dissolved if we pay attention to their common interest in making and manipulating *substances*. Section 2 shows that decorative substances—gold, gems, lacquer, porcelain, wrought iron, dyestuffs—were at the centre of the Academy’s programme of useful research between 1710 and 1740. I shall focus on two men who dominated the Academy’s experimental programme in this period, René Réaumur and Charles Dufay. These men were concerned as much with the beauty of their products as with the efficiency of the production process, and their notions of beauty resembled those of rococo artists. Réaumur and Dufay were also connected to the rococo movement through their patrons and collaborators. Section 3 shows that the study of rococo substances by these two men fed into fundamental research in what we would now call chemistry, physics and mineralogy. This research was sustained not just by the substances themselves but by the properties of those substances that made them rococo—their irregularity, their spectacular surfaces, and the fact that they were imitations. Section 1 sets the intellectual scene: it outlines the paper’s contribution to existing literature on science and art in the French rococo, on science and art more generally, and on the trajectory of the interdisciplinary field of the history of science.

Rococo Interior, 246-52; Alastair Laing, ‘Ornamental Engravings,’ esp. 115. Lacquer: Monika Kopplin, ‘Naissances des laques françaises dans le contexte européen du XVIIIe siècle,’ in *Les secrets de la laque française. Le vernis Martin*, ed. Anne Forray-Carlier and Monika Kopplin (Paris: Les Arts Décoratifs, 2014), 11–16, on 15–16. Forray-Carlier Anne, ‘Les débuts des Martin,’ in Forray-Carlier and Kopplin, *Vernis Martin*, 53–59, on 54, 55, 57. Cf. Sedlmayer and Baouer, ‘Rococo,’ 269, on the Rococo as ‘the illusionizing of art.’

1. Rococo science in perspective

This paper is not the first attempt to reconcile rococo art and academic science, but it is a new departure. Art historians have long associated the French rococo with nature and with the empirical study of nature. They have noted the presence of natural objects (shells, rocks, waterfalls, stalagmites, and so on) in ornamental engravings; they have found a strain of naturalism in the works of rococo painters ('all his endeavour was to follow nature,' one historian writes of Watteau); and they have drawn analogies between the sensual aesthetic of the Rococo and the sensationalist epistemology of philosophes such as Condillac.¹¹ Recently historians of art and science have made these connections more precise, mainly by focusing on the role of shells in painting and in natural history treatises. These historians have noted that shells were a common motif in rococo design, that the principles of variety and symmetry were common to the classification of shells and the decoration of dining rooms, and that the community of shell-collectors overlapped with the community of painters, art dealers, and art collectors. I extend these insights in three directions. I consider chemistry, mineralogy and experimental physics as well as natural history; I consider the decorative arts as well as painting and sculpture; and I consider

¹¹ Natural objects: Kimball, *Creation of the Rococo*, 153, 161; Whitehead, *French Interiors*, 56.

Painting: Michael Levey, *Painting and Sculpture in France, 1700-1789* (New Haven: Yale University Press, 1993), 29 ('all his endeavour'), cf. 1 (18th-century French painting), 43 (Watteau); Bazin, *Baroque and Rococo*, 203 (Chardin's 'naturalism'). Senses: Sedlmayr and Bauer, 'Rococo,' 238, cf. 241 (nature in the *Encyclopédie*); Jennifer Dawn Milam, *Fragonard's Playful Paintings: Visual Games in Rococo Art* (Manchester: Manchester University Press, 2006), chap. 2, 156-7 (Condillac). Gauvin A Bailey, *The Spiritual Rococo: Decor and Divinity from the Salons of Paris to the Missions of Patagonia* (Burlington: Ashgate, 2014), 4-5, usefully summarises recent work on Enlightenment themes in the rococo.

scientific activities that were central to the Academy's programme of experimental research, as opposed to the activities of non-academics (such as Antoine-Joseph Dezallier d'Argenville) or the activities of academics that have no immediate connection to the papers they presented to the Academy (such as buying shells at auctions). These are natural directions in which to travel for anyone concerned with the production of rococo substances and not just the substances themselves.¹²

The broader lesson of this paper is that there is much to gain from studying style and substance simultaneously. This hybrid approach is not as common as one might expect. Consider two recent (and very good) edited collections that are centrally concerned with connections between art and science in early modern Europe. *Science in the Age of Baroque* identifies three paradoxes that scientists shared with artists in the seventeenth century, the age of Newton and Boyle as well as Vermeer and Rubens. *Laboratories of Art* explores the connection between artisanal workshops and alchemical laboratories from the ancient world to the present day.¹³ The

¹² Alastair Laing, 'French Ornamental Engravings and the Diffusion of the Rococo,' in *Le stampe e la diffusione delle immagini e degli stili, Atti de XXIV Congresso Internazionale di Storia dell'Arte* (1979), 109–27, on 114-17. Katie Scott, *The Rococo Interior: Decoration and Social Spaces in Early Eighteenth-century Paris* (Yale University Press, 1995), 166-76. Emma Spary, 'Scientific Symmetries,' *History of Science* 42 (2004): 1–46. Idem, 'Rococo Readings of the Book of Nature,' in Marine Frasca-Spada and Nick Jardine, *Books and the Sciences in History* (Cambridge: Cambridge University Press, 2000), 255-75. Bettina Dietz, 'Mobile Objects: the Space of Shells in Eighteenth-Century France,' *BJHS* 39 (2006): 363-382. Daniela Bleichmar, 'Learning to Look: Visual Expertise across Art and Science in Eighteenth-Century France,' *Eighteenth-Century Studies* 46:1 (2012): 85-111.

¹³ Ofer Gal and Raz Chen-Morris, eds., *Science in the Age of Baroque* (Springer, 2012). Sven Dupré, ed., *Laboratories of Art: Alchemy and Art Technology from Antiquity to the 18th Century*

former volume is about stylistic affinities between scientists and artists; the latter volume is about the substances, and techniques for making those substance, that alchemists and artisans had in common. The words ‘porcelain,’ ‘glass’ anparamound ‘gold’ occur rarely in the former volume, and never to describe the production of those substances. Conversely, the words ‘baroque,’ ‘rococo’ and ‘mannerism’ do not occur in the latter volume. The former volume does cover the processes of art and science as well as the end results of those processes, but not the process of making substances. The latter does cover the products of art and science, but not their stylistic features. This disconnect does not diminish the merit of either volume—each has a well-defined aim that it achieves admirably. But it does suggest the need for more studies that merge style and substance.

The other methodological lesson of this paper is that the history of science and the history of art can succeed as history without losing sight of their subject matter, ie. art and science. To begin with the history of science, the overall trend in last half-century has been for historians of science to strengthen their ties with history and loosen those with science. This trend was well underway in 1981, when Arnold Thackray reported in this journal that ‘historians of science appreciate the intellectual challenge of science, but their methods, their questions, and their goals are those of historians.’ This trend has persisted in the twenty-first century, as shown by several reviews published in this journal and by recent reflections on the state of the field by two of its leading practitioners.¹⁴ This paper goes against the grain by showing the value of a continued

(Dordrecht: Springer, 2014).

¹⁴ Arnold Thackray, ‘Science, Technology, and Medicine,’ in *The Journal of Interdisciplinary History* 12:2 (1981): 299-314, on 314. Cf. Editors, ‘Interdisciplinary History,’ in *The Journal of Interdisciplinary History* 1:1 (1970): 3-5, on 3-4 (history of science ‘totally transformed in the last few decades’). Reviews at *Journal of Interdisciplinary History*, 31:1 (2000), 78; 36:1 (2005), 76; 38:1 (2007), 95; 41:1 (2010), 142. Recent reflections: Lorraine Daston, ‘Science Studies and

interaction between science and the history of science.¹⁵ The value of this interaction lies partly in the attention it draws to interdisciplinary phenomena *within* science: the richness of rococo science was due in large part to the strength of the connections between physics, chemistry and natural history in the Academy. A focus on science also makes room for what we may call, for want of a better word, mainstream science. Historians who have connected science to the rococo have focused on people and practices that an earlier generation of historians would have considered incidental to the main line of development in the sciences. There is much to be said for this enlarged view of eighteenth-century science, but our view of rococo science becomes even richer when we consider physics and chemistry alongside connoisseurship and shell-collecting. Finally, this paper owes much to histories of science written by modern scientists (especially Cyril Stanley Smith) and to those written about recent science (especially twentieth-century physics).¹⁶ These

the History of Science,' *Critical Inquiry* 35:4 (2009): 798-813, esp. 804-11; Nicholas Jardine, 'Chalk to Cheese,' *Times Literary Supplement*, December 16, 2011.

¹⁵ A few others have also gone against the grain, including several contributors to Kostas Gavroglu and Jurgen Renn, *Positioning the History of Science* (Springer: Boston, MA, 2007), and Hasok Chang, 'Putting Science Back into the History of Science,' BSHS Presidential Address, delivered at IHCSTM on Monday 22 July, 2013. In this journal, see a reviewer's praise for Martin Rudwick's knowledge of present-day paleontology, at *Journal of Interdisciplinary History* 40:4 (2010): 590.

¹⁶ Materials in physics: Joseph D. Martin, 'What's in a Name Change? Solid State Physics, Condensed Matter Physics, and Materials Science,' *Physics in Perspective* 17:1 (2014): 3-32; Joseph D. Martin and Michel Janssen, 'Beyond the Crystal Maze: Twentieth-Century Physics from the Vantage Point of Solid-State Physics,' *Historical Studies in the Natural Sciences* 45:5 (2015): 631-40. Cyril Stanley Smith, 'Porcelain and Plutonism,' in *Toward a History of Geology: Proceedings of the New Hampshire Conference on the History of Geology, 1967*, ed. Cecil J.

accounts are not part of the official historiography of eighteenth-century science, but they inform this paper by showing the importance of materials, as opposed to instruments, in experimental research.

An analogous point in art history is that style is still a useful category for placing works of art in their historical context. This, too, appears to go against the grain: in a recent collection of papers on the rococo we read that ‘Rococo is a bad word’ that we should not use and that, more generally, style is ‘so obsolete...as a critical concept that recent dictionaries of art historical terms have sometimes made a point by omitting it.’¹⁷ Now, it is true that the terms ‘rococo’ and ‘style’ do not now flow as easily from the pens of art historians as they did in 1943, when they appeared in the title and the opening pages of Kimball’s *The Creation of the Rococo Decorative Style*.¹⁸ But the demise of these terms should not be exaggerated: they are used freely and centrally in many recent scholarly works, from encyclopedias to surveys to monographs to book reviews to edited collections.¹⁹ Certainly they mean something different now than they did in 1943. But the tendency

Schneer, 317–38 (Cambridge, MA, 1969); idem, ‘Art, Technology, and Science: Notes on their Historical Interaction,’ *Technology and Culture* 11:4 (1970): 493-549.

¹⁷ Katie Scott, ‘Foreword,’ in Hyde and Scott, *Rococo Echo*, 1-30, on 2-3.

¹⁸ Kimball, *Creation of the Rococo*, ‘Introduction,’ 3-10.

¹⁹ Encyclopedias: Harold Osborne and Mark Jordan, ‘Rococo,’ in *The Oxford Companion to Western Art*, ed. Hugh Brigstocke, (Oxford University Press online, 2003); Mary Sheriff, ‘Rococo,’ in *Encyclopedia of the Enlightenment*, ed. Alan Charles Kors (Oxford University Press online, 2005). Surveys: Minor, *Baroque and Rococo*, 8, 15, 16-17; Gauvin A. Bailey, *Baroque and Rococo* (New York: Phaidon, 2012), 21; Whitehead, *French Interiors*, 54-61. Monographs: Thomas E. Crow, *Painters and Public Life in Eighteenth-Century Paris* (New Haven: Yale University Press, 1985), eg. 7, 11, 44, 65 (all refer to ‘Rococo style’); Hyde, Melissa Lee, *Making up the Rococo: François Boucher and His Critics* (Los Angeles, CA: Getty Research

has not been to radically revise the list of formal qualities that made up the rococo style, but to place those qualities in their social, political and economic context. Katie Scott's pioneering work on the rococo interior is one of several examples of this phenomenon. Scott agrees with Kimball that, for example, decorators under Louis XIV around 1700 tended to confound architecture with ornament; the difference is that Scott explains this tendency in terms of the court politics whereas Kimball invokes 'the mystery of personal artistic individuality.'²⁰

Institute, 2006), 9-12, esp. 11 ('rococo style of decoration and painting'); Bailey, *The Spiritual Rococo*, esp. 1-2. Reviews: Jeffrey Collins, 'Style and Society: Painting in Eighteenth-Century France,' *Eighteenth-Century Studies* 41, no. 4 (2008): 568-74, esp. 569 ('style'); Emma Barker, 'Rehabilitating the Rococo,' *Oxford Art Journal* 32, no. 2 (2009): 306-13, passim, esp. 306 ('style of painting'). Edited collection: Bailey, 'Rococo and Spirituality'; Bailey, 'Rococo Painting,' 169-190; Brigid von Preussen, "'A Wild Kind of Imagination": Eclecticism and Excess in the English Rococo Designs of Thomas Johnson,' in *Hyde and Scott, Rococo Echo*, 191-213.

²⁰Scott, *Rococo Interior*, ix (endorsement of Kimball's 'chronology and nomenclature'), chap. 6, esp. 125 (decoration under Louis XIV). Kimball, *Creation of the Rococo*, 6 ('artistic individuality'), 59-111 (decoration under Louis XIV). For other examples, compare the list of qualities at Hyde, *Making up the Rococo*, 11, with those at Sedlmayr and Bauer, 'Rococo,' 239 ('rocks, shells...tumbling motion...iridescence...light-hued tones'), 241 ('lighthearted play'), 251 ('warmer' colours, 'smooth...porcelainlike firmness'). Consider also the familiar stylistic traits mentioned at Bailey, 'Rococo and Spirituality,' 240 ('C-scrolls'), 241 ('celebrate nature and play'), 244 ('the sparkle of the gilding, the soft colours and the lightness of the décor'), 246 ('atmosphere of levity and brightness'), and at Preussen, 'English Rococo Designs,' 193 ('stylistic hybridity and asymmetry'), 211 ('eclecticism, excess and whimsy').

No doubt the phrase ‘rococo style’ can be construed in ways that are conceptually confused or historically inaccurate. The solution is not to avoid the phrase but to avoid such construals. To use the phrase is not to say that the rococo was the only style of painting or decoration that flourished in eighteenth-century Paris, nor that the term ‘rococo’ was used in this period to designate the style, nor that the style was invariable across time or across genres or even across the career of this or that artist, nor that this style was driven solely by the creative genius of artists acting apart from social and economic concerns, nor that there is any single cause that explains the pattern of formal qualities that make up the style. All we require, for the purposes of this paper at any rate, is that there was such a pattern in Paris in the period 1710 to 1740, and that the qualities that made up the pattern included irregularity, superficiality, and imitation, as defined and illustrated above.²¹ There is one last requirement. This paper is not just about the formal qualities that made up the rococo style, but also about the people who patronised the style, the materials that composed it, the publications in which it was promoted, and the places in Paris where it flourished. We need a phrase that refers to this whole complex. To this end, and with a nod to Kimball, I shall continue to refer to the rococo as a ‘movement.’²² Let us now consider the points of contact between this movement and academic science.

2. Scientists on substances

The institutional frame for much rococo science was the programme of useful research pursued by members of the Royal Academy of Science. Utility had been a major theme of the Academy since

²¹ This sentence and the last draw on the sensible discussions of ‘style’ and ‘rococo’ at Kimball, *Creation of the Rococo*, 3-10; Minor, *Baroque and Rococo*, 8, 15; Bailey, *Baroque and Rococo*, 21; and Collins, ‘Style and Society,’ 569, 574.

²² Kimball, *Creation of the Rococo*, 3 (‘general artistic movement’)

its founding 1666, but this theme became more formal, and more visible to the reading public, in the first few decades of the eighteenth century. Both shifts were reflected in the preface to the first volume of the Academy's *Mémoires*, published in 1701 and written by Bernard le Bovier de Fontenelle, the Academy's Permanent Secretary. Fontenelle wrote at length on the utility of the sciences, by which he meant the promotion of the scientific method, the dispelling of ignorance in society at large, and above all the improvement of navigation, cartography, human health and 'les Arts.' The latter category bundled together activities that we would now call 'industry' (mining, silk-weaving, ship-building...) with those we could now call 'decorative arts' (goldsmithing, gem-cutting, porcelain-making...).²³ The improvement of the arts went hand-in-hand with the integration of science and the state. Around 1700 the chemist Wilhelm Homberg convinced the Duke of Orléans, to whom he taught chemistry, that industry could not flourish without natural philosophy. In 1710 or 1711, a young and energetic naturalist, René Réaumur, was appointed to lead the Academy's project of describing arts and trades in France, and a decade later he published the first treatise on this project, a study of steel and iron. Between 1715 and 1718 he worked with the Duke of Orléans, now the Regent of France, to compile a survey of the mineral and vegetable resources of the kingdom. In 1731 one of Réaumur's protégés, Charles Dufay, became the first member of the Academy to be appointed to the Bureau du Commerce, an office set up in 1700 to regulate and stimulate the French economy. After Dufay's death in 1739, he was replaced at the Bureau by his friend and literary executor Jean Hellot. These developments reflect the conviction,

²³ Robin Briggs, 'The Académie Royale des Sciences and the Pursuit of Utility,' *Past and Present* 131 (1991): 38-88. Cf. Henry Guerlac, 'Some French Antecedents of the Chemical Revolution,' *Chymia* 5 (1959): 73-112; Alice Stroup, *A Company of Scientists: Botany, Patronage, and Community at the Seventeenth-Century Parisian Royal Academy of Sciences* (Berkeley: University of California Press, 1990). Bernard le Bovier de Fontenelle, 'Preface,' *Histoire et Mémoires de l'Académie Royale des Sciences*, 1699, i-xix, on iii-xi.

which derived ultimately from Francis Bacon, that natural philosophy and the arts worked best in concert. As Réaumur put it, ‘the useful, if looked at carefully, always contains something of theoretical interest, and it is rare if the theoretically interesting, when pursued, does not lead to the practically useful.’²⁴

The role of utility in the Academy’s researches has been studied in detail; the role of beauty much less so. Yet these two goals are hard to distinguish in the research of the four chemists just mentioned, and especially in that of Réaumur and Dufay. Let us begin with Réaumur’s treatise on steel and iron. The aim of the treatise was partly to propose cheaper, more reliable and more efficient way of converting steel into iron. But Réaumur also described a procedure for making wrought iron malleable, and here his aim was as much beauty as it was efficiency. This aim was quite general: ‘The production of more beautiful work, without sacrifice of quality and at lower cost, is the route to progress which we must endeavour to guide the arts.’ In his treatise Réaumur aimed not just to produce iron, but to produce a particular set of consumer goods that he discussed at length and that included a large number of decorative items such as locks, sword-hilts and coffee-pots. He developed the new technology with a particular set of aesthetic values in mind. His treatise included drawings of door-knockers whose lines would not be out of place in a book of ornamental prints by the interior decorator Nicolas Pineau. ‘*Ornement*’ was the key term in Réaumur’s aesthetic, as it was in the rococo movement as a whole (figure 2 [see end of this

²⁴David Sturdy and Christine Demeulenaere-Douyère, ‘Introduction,’ in *L’Enquête du régent, 1716-1718: sciences, techniques, et politique dans la France pré-industrielle* (Turhout: Brepols, 2008), 14 (Homberg), 16 (Réaumur). Guerlac, ‘French Antecedents,’ 78-80 (Hellot). René Réaumur, *L’Art de convertir le fer forgé en acier, et l’art d’adoucir le fer fondu* (Paris, 1722), 8. Quotes from Réaumur’s text are drawn from the English translation published as *Réaumur’s Memoires on Steel and Iron*, trans. Anneliese G. Sisco, ed. Cyril S. Smith (Chicago: University of Chicago Press, 1956). My page references are to the 1722 French edition.

document]). The *ornements* on balconies and banisters, Réaumur wrote, could now be done in iron rather than copper; iron chimney-pieces could now be made *orné* at a much lower price than before; cast-iron key-locks would be made even more *orné* than their wrought-iron predecessors; and in general there was much to be said ‘for making goods that are more desirable and more ornate.’²⁵

The ties between Réaumur’s work on steel and iron and the rococo movement thicken when we look beyond the treatise itself. The work was supported by the Regent, who arranged for samples of steel to be sent from as far away as Cairo to help Réaumur with his experiments, and who rewarded the scientist for his work with an outsized pension. In the same period the Regent was a major patron of rococo painters and decorators, spending a fortune redecorating the Palais Royal between 1715 and 1723. To put his ideas into practice, Réaumur set up a shop and foundry in a lavish apartment near the Palais Royal. The cast-iron objects that he sold there in the 1720s received a glowing review in the *Mercur de France*, where they took their place alongside reviews of the ornamental cut-outs that reached a peak of popularity in the same decade. The mode of production of those prints resembles that of Réaumur’s cast iron bannisters and belt-buckles. Despite their ornate appearance, both the cut-outs and the buckles were produced in large quantities by a mechanical process—the cut-outs with the printing press and the buckles with a

²⁵Réaumur, *Art de convertir*, 529 (‘beautiful work’); chap. 6, esp. 530 (balconies and balustrades), 532 (chimney-pieces), 534 (locks), 547 (in general). The decorative and aesthetic aims of Réaumur’s treatise are ignored in most existing studies of it, eg. Arthur Birembaut, ‘Réaumur et l’élaboration des produits ferreux,’ *Revue d’histoire des sciences et de leurs applications* 11:2 (1958): 138-166, esp. 151-5; Briggs, ‘Utility,’ 76-7; Guerlac, ‘French Antecedents,’ 89. The exception, as usual, is Cyril Stanley Smith, in his ‘Introduction’ to Réaumur, *Steel and Iron*.

mould. Neither the press nor the mould were new technologies, of course. The novelty was that they were now used to make large numbers of cheap copies of ornate, expensive luxury goods.²⁶

The production of beautiful imitations was also the aim of Réaumur's prolonged investigation into porcelain.²⁷ Réaumur set out to discover the secret of hard-paste porcelain at a time (the late 1710s) when the only porcelain produced in France was *pâte tendre*, a substance that was softer than Asian porcelain and less resistant to high temperatures. Réaumur laboured for many years to produce 'French porcelain that is as beautiful [belle] and as affordable [bon marché] as that from China.' The quality of his porcelain, its beauty, and its decorative possibilities, were a recurring concern in three papers that Réaumur read to the Academy in 1727, 1729 and 1739. He developed tests for measuring the quality of a porcelain based on its resistance to heat and the fineness of its grains. He implied that the beauty of porcelain was his main motivation for studying the material, and he worked hard to show that his own creations were comparable in beauty to the Chinese original, or at least that their beauty was out of proportion to their price. He commented on the process of painting and gilding porcelain, and recommended his porcelain made from glass bottles on the grounds that surface colours could be added easily as part of the heating process. As

²⁶ Regent's support: Réaumur, *Art de convertir*, 259 (Cairo), cf. 10, 11, 171. Regent's redecoration: Scott, *Rococo Interior*, 147-52, 185-6; Kimball, *Creation of Rococo*, 121-30. Réaumur's shop: Mary Terrall, *Catching Nature in the Act* (Chicago University Press, 2014), 45-7; Daniel Bontemps and Catherine Prade, 'Un magasin parisien d'ouvrages en fonte de fer ornée au XVIIIe siècle: une réussite méconnue de Réaumur,' *Bulletin de la Société de l'histoire de Paris et de l'Ile-de-France* 118 (1991): 215-61. *Mercure de France*: Laing, 'Ornamental Engravings,' 117.

²⁷ Standard accounts of this research are Guerlac, 'French Antecedents,' 84; Jean Torlais, *Un esprit encyclopédique en dehors de L'Encyclopédie: Réaumur, d'après des documents inédits* (Paris: Albert Blanchard, 1961), 93-105.

in his treatise on steel, Réaumur thanked the Regent for supplying raw materials for these experiments, and especially for the talcs and flints that served as domestic substitutes for the two main ingredients (*kaolin* and *petuntse*) in Chinese porcelain.²⁸ Réaumur displayed a similar combination of commercial, aesthetic and scientific intelligence in his studies of precious stones, fake pearls, silk garments, gold thread, and purple dyes.²⁹

Réaumur was soon joined in these studies by his Charles Dufay, a soldier and aristocrat who served the Academy with energy and distinction between his entry into the institution in 1723 and his death in 1739. To historians of chemistry and quality control, Dufay is known as the author of a new set of test procedures for distinguishing fast dyes from fugitive ones. To historians of textiles and global trade, Dufay was the author of an early and influential account of the procedure used by indigenous artisans in India to apply dyes to cotton fabrics. To biographers of Dufay, his involvement in textile dyes in the 1730s was a by-product of the experimental prowess he had displayed in the preceding decade in domains apparently unconnected to the decorative arts, such

²⁸ René Réaumur, ‘Idée générale des différentes manières de faire la porcelaine; & quelques sont les véritables matières de celle de la Chine,’ *MAS* (1727): 185-203, on 202 (‘French porcelain’), 187 (quality), 186 (beauty), 199 (Regent). Idem, ‘Second Mémoire sur la Porcelaine,’ *MAS* (1729): 325-46, on 328 and 339-40 (quality), 332 (beauty), 201 (painting and gilding), 329 (Regent). Idem, ‘Art de faire une nouvelle espece de Porcelaine,’ *MAS* (1739): 370-88, on 375-8 (quality and beauty), 379 (colours).

²⁹ Réaumur, ‘Découverte d’une nouvelle teinture de pourpre,’ *MAS* (1711): 166–96. Idem, ‘Mémoire sur la matiere qui colore les perles fausses,’ *MAS* (1716): 229–44. Idem, ‘Examen de la soye des araignées,’ *MAS* (1710): 386–408. Idem, ‘Expériences et reflexions sur la prodigieuse ductilité de diverses matières,’ *MAS* (1713): 199–220. On Réaumur and precious stones, see Michael Bycroft, *Gems and the New Science: Craft, Commerce and Classification in Early Modern Europe* (unpublished manuscript), chap. 4.

as electricity and luminescence. New research shows that Dufay had in fact been heavily engaged in the decorative arts even before he entered the Academy in 1723.³⁰

That was the year of the publication of *Traité des vernis*, a translation into French of a treatise on Asian varnish that had first appeared in Florence three years earlier. The Italian treatise, written by the naturalist Filippo Buonanni, was made up of recipes for imitating Asian lacquer with European ingredients. The translation has usually been attributed to the naturalist and lawyer Antoine-Joseph Dezallier d'Argenville. A comparison between the text of the treatise and Fontenelle's éloge, as well as the discovery of a draft of the treatise in Dufay's hand, show beyond doubt that the translator was Dufay rather than Argenville. A close study of the *Traité des vernis*, and especially of Dufay's 86 footnotes, shows that the Frenchman tested and augmented many of Buonanni's recipes, and that he read many of the treatises that Buonanni cited, including artists' manuals such as Abraham Bosse's 1645 etching manual, *Traité de manières de graver en taille-douce*. Dufay's footnotes show that he spoke to painters in Italy, from whom he derived practical

³⁰The standard accounts of Dufay's life and work are Brunet P., 'L'oeuvre scientifique de Charles François du Fay,' *Petrus Nonius* 3, 2 (1940) 77-95, and Heilbron J., 'Dufay, Charles-François de Cisternay,' in Gillispie C.C. (ed.), *Dictionary of Scientific Biography*, 17 vols. (New York: 1970-1980) vol. 4, 214-217. Cf. Michael Bycroft, 'Physics and Natural History in the Eighteenth Century: the Case of Charles Dufay' (unpublished PhD dissertation, University of Cambridge, 2013). Chemistry and quality control: Guerlac, 'French Antecedents,' 78-80; John J. Beer, 'Eighteenth-Century Theories on the Process of Dyeing,' *Isis* 51, no. 1 (1960): 21-30, on 23-25; Agusti Nieto-Galan, *Colouring Textiles: a History of Natural Dyestuffs in Industrial Europe* (London: Kluwer Academic, 2001), 94-95. Textiles and global trade: Felicia Gottmann, *Global Trade, Smuggling, and the Making of Economic Liberalism* (London: Palgrave MacMillan, 2016), 119-20, and references therein. Experimental prowess: Fontenelle, 'Eloge de Du Fay,' 76.

information such as the meaning of the term *acqua di rasa* and the best method for determining the heat of linseed oil used to make lacquer. Dufay's interest in varnish went well beyond the production of the raw material. One of his longest footnotes was a description of a method for applying gold leaf to a varnished surface, a procedure which gave the most impressive results (he said) when applied to red varnish. Other footnotes record particular examples of varnished objects that Dufay noticed in Rome, such as streetlamps and the locks of watch boxes. The analogies between Dufay's studies of Chinese varnish and Réaumur's contemporaneous study of Asian porcelain are impossible to miss. It is no surprise that Réaumur was the academician most closely involved in guiding Dufay into the Academy in 1723.³¹

After entering the Academy, Dufay continued to apply his talents as an experimenter to decorative materials. His most substantial project in this area, aside from his later work on textile dyes, was an attempt to introduce artificial colours into hard stones such as agate, marble and carnelian. His aim was not just to colour stones but to do so in a way that appealed to contemporary taste. He dyed agate with a view to imitating the figured stones that were 'entre les mains de toute le monde,' and that Argenville would illustrate soon afterwards in his best-selling works on the natural history of shells and stones. After explaining how to apply a white stain to carnelian, Dufay advised artists how to add shading to the stain and how to achieve fine lines suitable for making miniature portraits. When he dealt with marble, Dufay did not work with specimens of arbitrary sizes but with ones which could be used as table-tops, and at least one of his dyed tables found its way into the workshop of a Parisian marbler. He not only showed how to colour marble but also how to etch fine lines into its surface. Here he was responding to a new trend in interior decoration: 'for several years now we have seen tables and chimneys of white marble decorated with very

³¹ This paragraph is based on Michael Bycroft, 'What Difference Does a Translation Make? The *Traité des vernis* (1723) in the Career of Charles Dufay,' in Sietske Fransen and Niall Hodson, *Translating Early Modern Science* (Leiden: Brill, forthcoming in 2017).

delicate sculptures and that seem to be the result of great labour.’ There was indeed a transformation in the style of fire-places and chimney-pieces around 1700 (figure 3 [see end of this document]). They were a central feature of rooms in the period, a common subject of books of architectural engravings, and a harbinger of wider stylistic changes in interior decoration. In the latter decades of the seventeenth century, mantle-pieces tended to be large, high, rectangular, and sparsely decorated. In the early decades of the eighteenth century they became low, curvaceous, and ornate, and were usually made of marble. Dufay’s aim was to imitate the ‘delicate sculptures’ of these pieces without the ‘great labour’ that appeared to go into them. Dufay even gave a name to this typically Réaumurian procedure: ‘*prestige*,’ he wrote, was ‘the very easy execution of a work that seems at first sight to be of great difficulty and duration.’³²

Dufay’s involvement in the Parisian art world was concrete and personal. Fontenelle tells us that he valued decoration for its own sake: ‘il avait beaucoup de goût pour les choses de pur agrément.’ Fontenelle also says he developed a taste for antiquities during a 10-month stay in Rome in 1721-22, where he studied ‘the superb ruins of that capital of the world.’ Both of these interests are manifest in manuscript that historians have so far overlooked, a thirty-page manuscript

³²Charles François Dufay, ‘Mémoire sur la teinture et la dissolution de plusieurs especes de pierres,’ *Histoire de l’Académie Royale des Sciences*, 1728, 50–67, esp. 63 (tables and chimneys), 66 (‘entre les mains’). Idem, ‘Second mémoire sur la teinture des pierres,’

Mémoires de l’Académie Royale des Sciences, 1732, 169–81, esp. 175-9 (portraits).

Antoine-Joseph Dezallier d’Argenville, *Oryctologie* (Paris, 1755), 169–70, pl. 5, 238–39, pl.

10. Rococo fireplaces: Kimball, *Rococo Decorative Style*, esp. 65-9, 118. Dufay’s table: M.

le Comte Caylus, ‘Sur un moyen d’incorporer la couleur dans le marbre, et de fixer le trait,’

Histoire de l’Académie des Inscriptions et Belle-Lettre, 1758, 294–312, on 304. Dufay,

‘Second mémoire sur la teinture des pierres,’ *MAS* (1732): 169–81, on 180–81 (*prestige*).

For a similar view of artisans, see Réaumur, ‘Ductilité prodigieuse,’ 206.

entitled ‘Sur l’origine de la peinture’ that survives in the archives of the Paris Academy of Sciences. Here Dufay traced the history painting from ancient times to the present. He paid particular attention to practical techniques such as wax-painting, to periods when the general public acquired a taste (‘on a prit gout’) for the art form, and to the virtuosity of ‘connoisseurs,’ both ancient and modern, who could identify the author of a painting by sight alone (‘a la seule inspection’). Dufay praised the ‘great beauty’ of mosaics he had seen in Rome and noted that a recently excavated painting exhibited a ‘taste entirely similar to those that we know today.’ At the end of the manuscript he revealed that he had himself unearthed an ancient work of art while in Rome, a fresco that would be analysed soon afterwards in the pages of the *Académie Royale des Inscriptions et Belles-Lettres*.³³

The movements of this fresco exemplify Dufay’s connections to major art patrons of the day. The object was discovered by Dufay, transported to Paris by Armand Gaston de Rohan, and given by him to the Regent. We have already noted the Regent’s simultaneous patronage of Réaumur and rococo decorators. Rohan was a Cardinal (his main business in Rome was the election of a new Pope), priest to the royal household (he presided at the confirmation of Louis XV in 1722), a member of the tight circle of advisors around the Regent—and a boyhood friend of Dufay’s father. He was also an art-lover who used his time in Rome to secure an important set of paintings for the Regent and to enrich his own collection with portraits of French kings. He also worked on a larger scale, employing Louis XIV’s sculptors and architects to renovate his château in Saverne after it was damaged by fire in 1709; in the 1730s he undertook extensive work on the Palais Rohan in Strasbourg. Both these redecorations have been identified retrospectively as

³³ Fontenelle, ‘Eloge,’ 75 (ruins), 79 (gout). ‘Sur l’origine de la peinture,’ Archives de l’Académie Royale des Sciences, Dufay dossier, in folder entitled ‘Donner à l’abbé Nollet.’ Claude Gros de Boze, ‘Sur un morceau de peinture à fresque, apporté de Rome,’ *Histoire de l’Académie des Inscriptions et Belle-Lettre* 3 (1725-1718): 446–451.

exemplars of rococo style. We know that Dufay cared for his dying father at the Saverne residence in 1723, when the redecoration there was largely complete; perhaps he also visited the Palais Rohan during the 1730s.³⁴

Dufay was also involved with two other important figures who straddled the worlds of art and science in early eighteenth-century Paris. Louis-Henri, Duke of Bourbon was a grandson of Louis XIV, first minister of France between 1723 and 1726, and owner of a splendid chateau at Chantilly. Between 1718 and 1722 he redecorated the chateau in a flamboyant style that is now virtually synonymous with the rococo. In the same period, and into the 1730s, he developed a cabinet of natural history that Argenville considered one of Europe's finest. Dufay helped to fill this cabinet, as we learn from letters exchanged in the 1730s between Dufay and Sir Hans Sloane, the owner of a vast collection in London that would later form the core of the British Museum. Dufay had visited the collections of both men, and he advised each on which items would (and would not) be suitable to send to the other. He also used the Duke's gems in his experiments, and he supported the Duke's attempts to manufacture painted cotton (and probably also his attempts to make lacquer) at the workshops the Duke set up for the purpose at Chantilly. The second key figure was Edme-François Gersaint, an art dealer who sold rococo objects such as Watteau paintings and ornamental engravings at his boutique on the Pont Neuf. Dufay bought a set of shells at Gersaint's first public auction of natural curiosities, in 1736. Soon afterwards he wrote to Sloane to inform

³⁴Claude Muller, *Le siècle des Rohan: une dynastie de cardinaux en Alsace au XVIIIe siècle*

(Strasbourg: Nuée bleue, 2006), 59–62, 87–88. Dufay to Réaumur, 31 May 1723, 13 Jul 1723, in 'Lettres de Dufay à Réaumur,' in *Correspondance historique et archaelogique* 5 (1898): 306–9. Catherine Grodecki, 'La Résidence de Saverne sous les trois premiers cardinaux de Rohan,' in *Le Château de Saverne*, ed. Alphonse Wollbrett (Saverny, 1969), 39–53. Jean-Daniel Ludmann, *Le Palais Rohan de Strasbourg* (Strasbourg: Editions Istra, 1980). Cf. Hubula, *Baroque and Rococo*, 167.

him that Gersaint, ‘un fort honneste homme, tres connoisseur,’ was about to visit London to ‘établir des correspondences pour son commerce.’ Dufay greased the wheels of exchange—both material and social exchange—between dealers, collectors, artisans and entrepreneurs.³⁵

3. Substances in science

Showing that a scientist studied the decorative arts is one thing; showing that the arts shaped his science is quite another; and showing that the rococo elements of those arts shaped his science is another thing again. The case of the two electricities illustrates these distinctions. In a paper published in 1734, Dufay described a simple experiment involving a glass tube, a piece of gum copal, and a piece of gold leaf. Essentially, Dufay found that the tube (when electrified) and the copal (when electrified) had opposite effects on the same piece of gold leaf. He concluded that there were two species of electricity, species that would become known as ‘positive’ and ‘negative’

³⁵ Chantilly and rococo: Kimball, *Decorative Style*, 131. Duke’s cabinet: Dezallier, *Lithologie et conchyliologie*, 210–11, cf. Gersaint, *Catalogue raisonné*, 31. Pheasants, geese and rooster to Duke: Sloane to Dufay, HS Ms. 4068: 23 May 1737, f. 317; 13 Jun 1737, f. 326, cf. Dufay to Sloane: 13 Jun 1737, HS Ms. 4055, f. 119; 24 May 1737, HS Ms. 4058, f. 271. Portrait and medallion to Sloane: Sloane to Dufay, 25 July 1737, HS Ms. 4068, f. 329, cf. Grandjean de Fouchy, ‘Eloge de Sloane,’ 319. Exotic seeds intended for Duke: Dufay to Sloane, 18 Aug 1737, HS Ms. 4055, f. 166. P. R. Schwartz, ‘La Fabrique d’Indiennes du Duc de Bourbon (1692–1740) au Château de Chantilly,’ *Bulletin de la Société industrielle de Mulhouse* 722 (1966), 17–3. The Duke’s lacquer workshop (but not Dufay) are mentioned at Forray-Carlier and Kopplin, *Secrets de la laque française*, 28. Gersaint: Guillaume Glorieux, *A l’enseigne de Gersaint: Edme-François Gersaint, marchand d’art sur le Pont Notre-Dame, 1694–1750* (Seysse: Editions Champ Vallon, 2002), 562, cf. 470, 280–81; Dufay to Sloane, 15 Apr 1739, HS Ms. 4056, f. 76; cf. Geoffroy to Sloane, 18 Apr 1739, HS Ms. 4056, f. 79.

later in the century. Two of the materials in the experiment were throwbacks to Dufay's translation of the *Traité des vernis*. Gum copal was one of the ingredients in Buonanni's main recipe for European varnish, and gold leaf was the subject of one of Dufay's longest footnotes in the treatise. This is surely a case of a decorative art—and one strongly associated with the rococo—shaping a piece of fundamental physics. But it is not a complete case. Firstly, there is no evidence that the glass tube owed anything to Dufay's interest in the decorative arts. Secondly, there is something dissatisfying about the example of gold leaf and gum copal. Consider copal. This material may have derived from Dufay's study of lacquer, but the properties that made lacquer a rococo substance—its glossiness, its Oriental associations—were unrelated to the property—ease of electrification—that made copal an effective material in the experiment.

Réaumur's study of shells provides a more satisfying example. Shells appealed to collectors such as Argenville because of their 'bizarre' and 'extraordinary' forms. These were precisely the properties of shells that interested Réaumur when he set out to explain the mode of their formation. 'It seems that she [ie. Nature] has taken pleasure in varying their shapes, structures, and colours,' he wrote at the beginning of one of his earliest academic papers.³⁶ He was especially intrigued by the 'variété reguliere' garden snails. The background colour of their shells was variously white, lemon, yellow, or some intermediate hue; these colours were overlain with stripes that followed the spiral form of the shell and thickened as they neared the opening of the shell; the stripes were black on some shells, brown or red on others; some shells had five or six of these stripes, others only one; sometimes two stripes widened so much that they merged to form a single stripe. Réaumur did not dismiss these varieties as irrelevant or illusory. Instead he tried to explain them using his general theory of shell formation. According to this theory, animals construct their shells by secreting tiny particles of earth onto their bodies through pores in their sieve-like skin;

³⁶ René Réaumur, 'De la formation et de l'accroissement des coquilles des animaux tant terrestres qu'aquatiques, soit de mer soit de riviere,' *MAS* (1709): 364-400, on 365.

these particles accumulate over time to form the large, complex structures we call shells. Réaumur posited that differently shaped pores release differently shaped particles, which reflect differently coloured rays of light. The match between the colours on the skin of snails, and the colours on their shells, seemed to confirm this hypothesis. The ‘irregularités’ of shells were not only explicable but also a source of new evidence for the theory: the match between the shells and the skins was compelling because of, not despite of, the irregular colours of each.³⁷

This point generalises. Although regularity was the aim of the researches of Dufay and Réaumur, irregularity was one of their most important means to that end. Consider Dufay’s eight ground-breaking papers on electricity. The conclusions of these papers refer to ‘principes invariables’ and ‘loix exactes’ that were nothing less than the basic regularities of static electricity. But the body of each paper is filled with ‘circonstances singulières,’ ‘variétés,’ ‘bizarreries,’ ‘merveilles,’ and even ‘prodiges.’ In most cases, Dufay’s response to these phenomena was not to dismiss them but to use them to advance his investigation. He used the contrary behaviour of glass tubes and gum copal, a phenomenon that flew in the face of all past experience, to develop the principle that like electricities repel and unlike electricities attract. He used the ‘strange effects’ discovered by experimenters to strengthen his principles. He not only accepted these effects as real but also turned their strangeness to his advantage, recommending his theory of electricity for ‘the Number of obscure and puzzling Facts it clears up.’ Far from dismissing irregularities, Dufay used them to dismiss regularities. ‘One cannot report too scrupulously the singular happenings in these experiments,’ he wrote at the end of an especially exasperating series of experiments, ‘especially when they appear not to agree with the principles one is trying to establish.’ Similar statements can be found in Dufay’s papers on magnetism, fire-resistant salamanders, sensitive plants, figured

³⁷ Ibid., 379-82, 384-7.

stones, and mock suns, phenomena that were considered extraordinary at the time and that (with the exception of fire-resistant salamanders) Dufay accepted as real and studied with enthusiasm.³⁸

As for irregular phenomena, so for superficial ones. The colours of Réaumur's shells are notable not just for their bewildering variety but also for the spectacle they offered to the naked eye. Dufay and Réaumur studied the kind of surface effects that were all the rage in the rococo interior. The stand-out example is Réaumur's study of the manufacture of fake pearls. As he explained to the Academy in 1711, the art of making fake pearls was an ancient one that had recently been perfected by a pair of French artisans. The new imitations were so convincing (Réaumur tells us) that they confounded even jewellers. Their verisimilitude and popularity was recorded by the shopkeepers of Paris, who petitioned the king to ban the new substance in the hope of protecting the value of real pearls and preserving the distinction between women of low birth (who wore fake pearls) and women of quality (who wore real ones). The new pearls were triply superficial: they resembled real pearls but were not so; they were made of hollow glass spheres coated with a thin layer of liquid known as 'essence d'Orient'; and this liquid came not from the Orient but from the river Seine, where it dwelt in the scales of the bleak, a fish that was widespread in France and not the least bit exotic.³⁹ It was the milky shimmer of this liquid that engaged Réaumur when he read a second paper to the Academy in 1716. He concluded that the shimmer was due to tiny grains in the liquid. Each grain shone brilliantly under Réaumur's microscope; their individual sheen explained their collective shimmer. Réaumur then drew a remarkable series

³⁸ This paragraph is based on Michael Bycroft, 'Wonders in the Academy: the Value of Strange Facts in the Experimental Research of Charles Dufay,' *Historical Studies in the Natural Sciences* 43:3 (2013): 334-70, on 344-53.

³⁹ Réaumur, 'De l'art de faire des perles,' PV 23 May 1711, n.p. Shopkeepers: Archives Nationales, T/1490/18, p. 846r. Cf. *Mercure galant*, Aug 1686, pp. 233-35; Martin Lister, *A Journey to Paris in the Year 1698* (London, 1699), 142, 144.

of analogies between the shimmer of the liquid, the colourful iridescence of the bellies of live fish, the silvery sheen of insects' legs, and the brilliant powder that covered the wings of butterflies. All these phenomena, he argued, were the collective effect of thousands of tiny particles set against a background of solid colour. He backed up this explanation with analogies to artificial colours such as tapestries made of leather and red varnish, black enamels that become blue or white when ground, and diamonds that become transparent when ground.⁴⁰

The equivalent in Dufay's research was a series of papers on the luminescence of precious stones. These papers also show the importance of decorative materials in another form—one might say a deeper form—of superficiality in the sciences. Rather than seeking the first causes of things, as seventeenth-century natural philosophers had done, Réaumur and Dufay often had the more most goal of organising the known facts in a given domain of nature. To use distinctions made famous by Jean le Rond d'Alembert in the preliminary discourse of the *Encyclopédie*, they preferred 'principes' over 'causes' and the 'esprit systématique' over the 'esprit de système.'⁴¹ Dufay's papers on light and electricity are instructive because many of the 'principes' therein were grounded on Dufay's large collection of precious stones. Dufay showed (amongst other things) that a large number of gems glow in the dark after being roasted, rubbed, or subjected to the heat of the sun or a flame; that all gems attract light bodies after being rubbed then heated; and that gems can be divided into two classes according to the amount of rubbing and heating that is

⁴⁰Réné Réaumur, 'Mémoire sur la matiere qui colore les perles fausses,' *Mémoires de l'Académie Royale des Sciences*, 1716, 229–44, on 231–35, 240–43. Idem, 'Formation des coquilles des animaux tant terrestres qu'aquatiques, soit de mer soit de riviere,' 372–73. Idem, 'Description de l'Art de faire des Cuirs dorés,' *Histoire de l'Académie Royale des Sciences*, 1714, 106. Cf. René Réaumur, 'Expériences et reflexions sur la prodigieuse ductilité de diverses matières,' *MAS* (1713): 199–220

41.

required before attraction occurs. A close study of Dufay's papers shows that he experimented on 27 of the 37 species of precious and semi-precious stone recognised by contemporary mineralogists such as Argenville. Dufay owed these specimens to a wider culture of incorporating gems into natural history collections and personal jewellery. This is evident from a set of laboratory notes in which he jotted down the names of individuals who lent him precious stones (mainly diamonds) for his experiments on light and electricity. These names include not only the social elite (such as the Duke of Bourbon) but also people of more modest means, such as the chemist Claude-Joseph Geoffroy, who lent him a cross embedded with emeralds. It is surely no coincidence that Dufay gathered his collection at a time when precious stones—especially small, brilliant-cut diamonds—were a staple of interior decoration and a common accessory among legal professionals, merchants and even artisans. In Dufay's hands, brilliants became the stuff of the 'esprit systématique.'⁴²

Precious stones also crossed the divide between art and nature. They held clues to the nature of light and electricity, but they were also ripe for imitation. Dufay's papers show that the connections between art and nature remained rich even at time when natural philosophers no longer ascribed imagination to nature. For Dufay and for most of his learned contemporaries, the 'figures' on naturally occurring stones—figures resembling people, landscapes, or human artefacts—were the result of pure chance rather than the craftiness of nature. Yet Dufay insisted that scientists had much to learn from figures introduced into stones by human craftsmen: 'that which deceives one can enlighten others, and allow them to probe more deeply into the mysteries

⁴² 'Principes' over 'causes': Charles Dufay, 'Electricité et lumière,' on 523. Diamonds in wider culture: Hans Sedlmayr and Hermann Bauer, 'Rococo,' 239; Archives Nationales, T/1490/18, 853v. Dufay's gem collection and experiments thereupon: Bycroft, 'Physics and Natural History,' chap. 3.

of nature.⁴³ How so? Dufay's papers on decorative stones suggest several answers. Firstly, imitations were made by manipulating natural materials; consequently they could shed light on the behaviour of those materials. When Dufay treated agate with silver nitrate, he simultaneously coloured the agate and classified it as an acid-resistant mineral. Lest this example seem trivial, it is worth noting that Dufay's procedure for colouring stones (dissolving them in spirit of nitre) was nearly identical to the one he used to discover many new phosphors. Secondly, high-quality imitations were usually the outcome of a long process of trial-and-error in which the experimenter tested a large number of materials with little theory to guide his choice of materials and operations. This process often led to rules such as Dufay's finding that agates with natural veins are harder to dye than those without. These two activities—trial-and-error experimentation and the discovery of empirical rules—were just as effective in the search for the laws of light and electricity as they were in the manufacture of marble fireplaces. The final point is that the analogies between art and nature were sometimes indirect. The colours of fake marble did not tell Dufay much about the colours of real marble. But steel and porcelain told Réaumur an awful lot about the formation of minerals. Steel, he said, was the end result of the gradual process of impregnating iron with salts and sulphurs. Similarly, glass and porcelain were two stages in the process of impregnating pottery with 'vitrifying matter.' Likewise, crystal and flint were two stages in the process of impregnating common earth with a 'stony juice.' Réaumur made these analogies explicit. If pressed, he would probably deny that nature was an artisan in any literal sense—God had intentions and imagination, but Nature did not. But Réaumur drew analogies between nature and the laboratory *as if* he believed in nature-the-artisan.⁴⁴

⁴³ Dufay, 'Teinture et dissolution,' 50.

⁴⁴ Minerals compared to porcelain: Réaumur, 'Nature et formation,' 257-64. Minerals compared to iron: Réaumur, 'Nature et formation,' 249-51, 262, 268-71, cf. *idem*, *Art de convertir*, 338.

Porcelain compared to steel: *idem*, 'Nouvelle espece de porcelaine,' 379-83, cf. Smith,

We have done enough to give a quite specific characterisation of nature-the-artisan as seen through the eyes of Réaumur and Dufay. Nature's productions were irregular, dazzling, and imitative—as irregular as the colours of shells and the electricity of glass tubes, as dazzling as diamonds and the bellies of fish, as imitative as the colours of shells, insects, fish and butterflies. But these extraordinary effects were the outcome of simple processes, and one could discover the latter by studying the former—not by ignoring what was irregular, dazzling and imitative, but by paying close attention to it. Nature was the great prestidigitator, an endless source of *prestige*, of 'work that is of very easy execution but that seems at first sight to be of great difficulty and duration.' Nature was not just any artisan, but a rococo artisan.

'Porcelain to Plutonism,' 322-3. For a comparison between mineral- and enamel-formation, see René Réaumur, 'Description d'une mine de fer du pays de Foix; avec quelques reflexions sur la manière dont elle a été formée,' MAS (1718): 139-42, on 141-2.

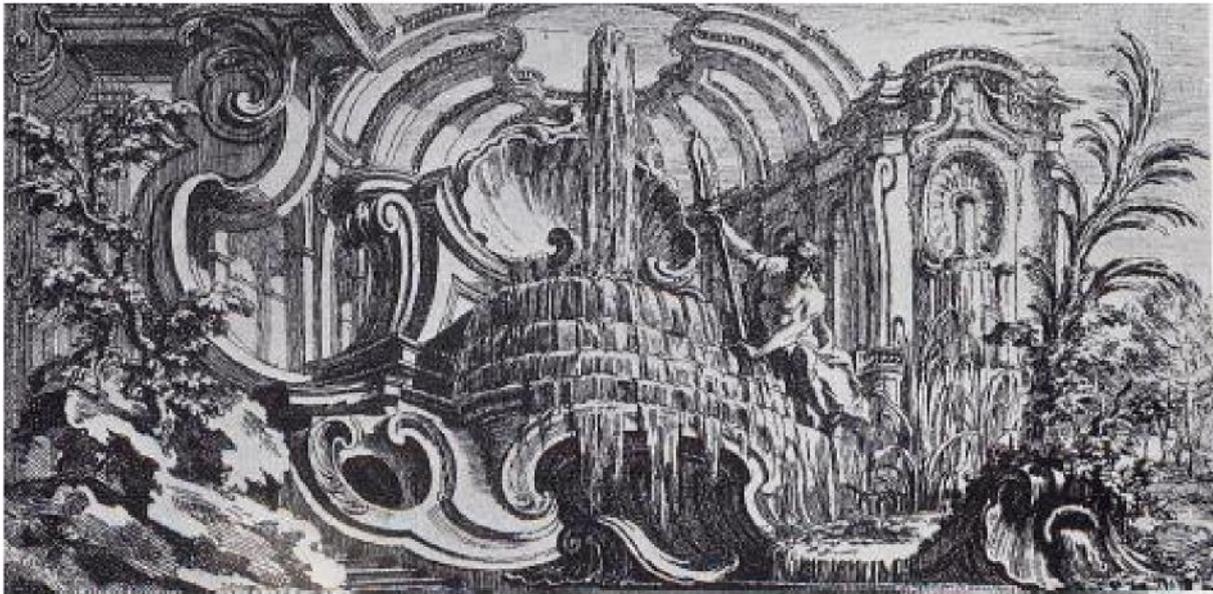


Figure 1. Engraving after Meissonnier, from *Livre d'ornements inventez et dessinez par J.O. Meissonnier* (Paris, 1734). Source: Kimball, *Rococo Decorative Style*.

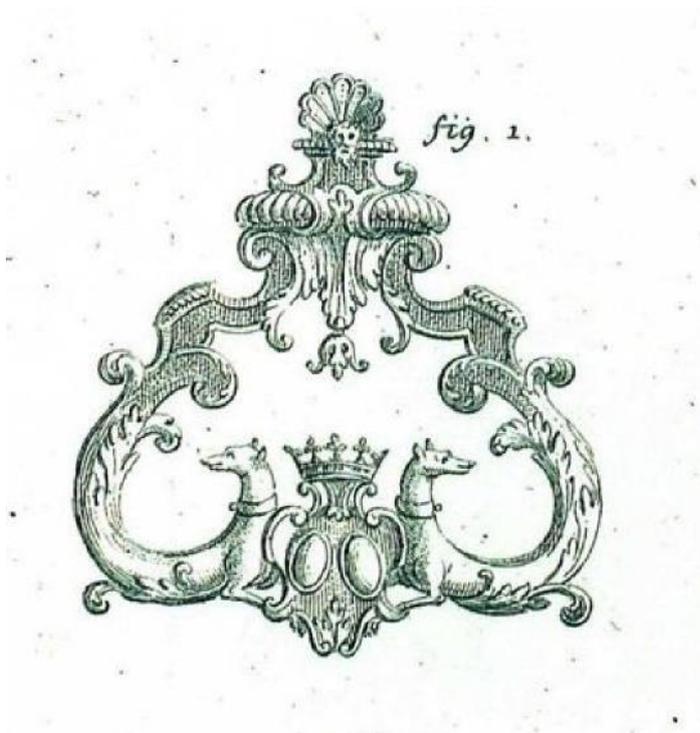


Figure 2. Design of a door-knocker in René Réaumur, *L'Art de convertir le fer forgé en acier, et l'art d'adoucir le fer fondu* (Paris, 1722).



Figure 3. Marble fire-place dating from c. 1730-40. Charles Dufay claimed to have a simple recipe for producing the ‘very delicate sculptures’ that he observed on tables and fire-places and that ‘seemed to be the result of great labour.’ Source: John Whitehead, *The French Interior in the Eighteenth Century* (Dutton Studio Books, 1993).