Techniques and Innovations

Prussian Blue

> It was the desire of the Royal Academy that the green colour which I observed during my experiments on arsenic might be made more generally known, together with the mode of preparation. . . . I have found the colour useful both in oil and water painting and . . . it has not undergone the slightest alteration in the course of three years.
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> Carl Wilhelm Scheele, "Method of Preparing a New Green Colour. 1778" in *The Chemical Essays of Charles-William Scheele* (1786; reprint, London, 1966), 253.

How does the search for a new color begin? It might begin with recognition of the need for improvement in a color source, material or technique, and the offer of a prize for that improvement. Or, an inventor might credit a less clearly-directed investigation as the source of inspiration, in which the new color was a by-product of the search for something else. Such narratives highlight the discoverer's recognition of society's needs and understanding of production techniques. Claims of accidental discoveries turned to advantage were a particularly common narrative in the invention of new colors during the eighteenth century. The Swedish chemist Carl Wilhelm Scheele explained development of the color called Scheele's green in this way. When announcing the invention, he stated that he came across the substance by accident while studying arsenic compounds. Scheele recognized the potential of this coloring material and refined the production process for several years before publishing a recipe and chemical description.[1] Serendipity may have been a starting point, but the application of scientific principles was important to its further development.

One of the best examples of serendipity turned to advantage is the history of the coloring material Prussian blue.[2] Accounts of its invention and subsequent development were familiar to readers of all interests, discussed along with descriptions of the process. Prussian blue—including its history—was both an intellectual and a practical model for several colormaking practices at the time. The story proved the close relationship between sciences and practices, and highlighted the opportunities each could provide the other.

As the chemist Georg Stahl told it, Prussian blue was the laboratory invention, initially accidental, of a Berlin-based colormaker and an alchemist.[3] Retracing their steps when a process expected to yield Florentine lake, a red color, produced blue, they immediately recognized a value for their "mistake." Further experiment led them to offer the discovery as a pigment that was less expensive than ultramarine , more stable than copper-based blues, and more versatile than indigo. Prussian blue was an immediate success among painters and its composition was subject to considerable speculation. The recipe remained a secret until 1724, when it was published in the *Philosophical Transactions*.[4] Once

available, instructions to make Prussian blue quickly spread throughout Europe and beyond.[5] Prussian blue was described in public lectures on chemistry and the arts and was included in journals, compilations of practical instructions, dictionaries, and encyclopedias both specialized and general.[6] Furnishing the pigment to colormen became a subspecialty of the color trades.

> Le *rouge de Prusse* est une substance donnant un rouge imitant le vermillon, qui sert communément aux Peintres d'impression, à mettre les carreaux en rouge, & aux Peintres à talens, pour leurs tableaux. Il est plus beau, plus vif que le brun-rouge d'Angleterre: Selon les uns, c'est une terre calcinée; selon d'autres, dont je crois l'opinion fondée, c'est le *colcothar* ou *caput mortuum* des eaux fortes qu'on réduit en poudre fine, après avoir bien lavées.
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> Jean-Félix Watin, *L'Art du peintre, doreur, vernisseur* 4th ed. (Paris, 1787), 22–23.

Eighteenth-century descriptions and discussions give the impression of considerable interest in the chemical foundations of Prussian blue—how it was created and how to use that information to make the color less expensive, more predictable, less likely to turn green with time, easier to work. Other investigators explored its possibilities as a key to chemical combination for other painters' pigments. In the 1790s, Thomas Henry read a letter to the Manchester Literary and Philosophical Society, announcing the discovery of some colors similar to Prussian blue. Henry's chemical analysis of those new colors employed contemporary chemical language and techniques, but his description of the processes of discovery more closely resembles the story recounted by Stahl sixty years earlier.[7] Other “Prussian" colors appeared, some involving production processes similar to that of Prussian blue, others merely relying on this designation to suggest a connection to this familiar and successful scientific novelty.[8]

Interest in Prussian blue extended beyond its possibilities as a painters' pigment. In 1749, Pierre-Joseph Macquer deposited at the Paris Academy of Sciences a sealed envelope: This *pli cachéte* was opened not long after and its contents, a mémoire by on the use of Prussian Blue as a dyestuff, was read to and subsequently published by the Academy. This episode suggests Macquer's concern that he be recognized as the inventor of this new dyestuff; there were other scientist with an interest in crossing the boundaries of techniques with this coloring material.[9]

The use of Prussian blue for textile painting and printing and for such related tasks wallpaper-making was also a preoccupation of mid-century experimenters.[10] Prussian blue was often the blue coloring material of eighteenth-century *indiennes*, as indigo was difficult to manipulate in these techniques.[11] Few written documents exist to prove the extent of early use of Prussian blue on textiles, but evidence from objects suggests that it was neither rare nor the standard for silk, and that it was used somewhat less for wool cotton and linen. Later publication of prizewinning essays on Prussian blue as a dyestuff

furthered its use in this way and added to general understanding of textile coloration.[12] When blockades limited supplies of indigo, the French government sponsored a reward for new or revived manufacturing methods to extract blue colors from native woad and to locate improved processes to use Prussian blue for textiles.[13] Following the established pattern, the coloring processes for the prizewinning samples were printed and distributed to appropriate manufacturers.

Prussian blue is an excellent example of a successful manufactured color and of the successful adaptation of a coloring material to different uses.[14] For consumers of ideas and objects in the eighteenth century, its history confirmed that the application of chemistry could improve practice. But the nature of Prussian blue led to some commercial problems. As a manufactured color, Prussian blue, like Naples yellow, Turner's yellow, and Scheele's green, involved materials and production methods that crossed the traditional boundaries of several groups: colormakers, apothecaries, drysalters, and manufacturing chemists. Production rights were frequently in dispute.[15] In France, sale of painters' materials was a responsibility of the painters' guild (the Académie de St-Luc). Manufactured colors, when they did not use traditional coloring materials or did not use them in traditional ways, threatened this closely guarded right. In 1764, masters from the Académie de St-Luc seized the Prussian-blue factory of sieurs Gly and d'Heure.[16] The owners turned to the Paris Academy of Sciences, asking for a determination of the nature of Prussian blue. Gly and d'Heure argued that theirs was a chemical factory with no connection to the art of painting, even though painters used their product. Jean Hellot examined the problem on behalf of the Academy, and agreed with the manufacturers. Prussian blue is a product of chemistry and should not be controlled by the painters' guild. The factory in the faubourg Saint-Marcel was allowed to reopen and continued to make Prussian blue through the next four decades; theirs was often considered the best that was made in Paris.[17]

In less than fifty years, the potential of an accident had been recognized, extended, and recombined. As a well-known series of events, this accident offered an endorsement of participation in scientific-based investigations into color, investigations that highlighted serendipity directed toward specific goals of improvement, broadly disseminated.

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.

Note 2: L. J. M. Coleby, "A History of Prussian Blue," *Annals of Science* 42 (1939): 206–11. See also Christoph Schümann, *Der Anteil deutscher Apotheker an der*

Entwicklung der technischen Chemie zwischen 1750 und 1850 (Frankfurt am Main, 1997), 230–37; Stefan Jacob, *Chemische Vor-und Frühindustrie in Franken die vorindustrielle Produktion wichtiger chemikalien und die Anfänge der chemischen Industrie in fränkischen territorien des 17., 18. und frühen 19. Jahrhunderts* (Düsseldorf, 1968), 189–90.

Note 3: Georg Stahl, *Experimenta, Observationes, Animadversiones, CCC Numero Chymicae et Physicae* (Berlin, 1731), 281.

Note 4: John Woodward, "Praeparatio Caerulei Prussiaci Ex Germania Missa," *Philosophical Transactions* 33 (1724–25):15–7; John Brown, "Observations and Experiments upon the Foregoing Preparation," *Philosophical Transactions* 33 (1724–25): 17–24.

Note 5: See, e.g., [Étienne-François] Geoffroy, "Observations sur la Preparation de Bleu de Prusse ou Bleu de Berlin," in *Mémoires de l'Académie royale des Sciences année 1725* (1727), 153–72. Peter Shaw's *Chemical Lectures . . .* (1734), Dossie's *Handmaid to the Arts* (1758; 2d ed., 1764), and *Dictionnaire portatif des arts et métiers* of Philippe Macquer (1766) are three other sources.

Note 6: Cadet [Louis-Claude Cadet de Gassicourt], "Eau Minérale Nouvellement Decouverte à Passy . . . Procédé Abrégé pour . . . le Bleu de Prusse, Avec des Réflexions sur l'Utilité de ce Bleu," *Journal œconomique* (November 1755): 92–99; "Procédé Abrégé pour Retire le Bleu de Prusse des Eaux Minerales de M. de Calsabigi, Avec des Réflections sur l'Utilite de Ce Bleu, par le Sieur Cadet, Apothicaire Major de l'Hotel Royal Des Invalides," *Mercure de France*, no. 1098 (December 1755): 193–201; Johann Georg Krünitz, ed., *Ökonomisch-Technologische Encyklopädie, oder Allgemeines System der Staats- Stadt- Haus und Land-Wirthschaft, und der Kunstgeschichte in Alphabetischer Ordnung*, ed. (Berlin: Pauli, 1784), s.v. "Blau (Berliner, Berlinisch oder Preußisch)," 5:593–97; "Outremer Factice, Présenté par M. Desmarests (4 November 1786)," in *Procès-verbaux de l'Académie royale de peinture et de sculpture 1648–1793* (Paris, 1875–92), 3:299; "MM. Roslin et Robert, Examinateurs de l'Outremere Factice du Sieur Desmarests (2 December 1786)," in *Procès-verbaux de l'Académie royale de peinture et de sculpture 1648–1793* (Paris, 1875–92), 9:300; "Rapport des Commissaires Nommés pour l'Examen de l'Outremer Factice du Sr. Dumarests (24 February 1787)," in *Procès-verbaux de l'Académie royale de peinture et de sculpture 1648–1793* (Paris, 1875–92), 9:336.

Note 7: Thomas Willis, "An Account of, and Observations on, Different Blue Colours, Produced from the Mother Water of Soda Phosphorata . . . ," *Memoirs of the Literary and Philosophical Society of Manchester* 4 (1793): 87–91.

Note 8: "Nicholas Croiset entrepreneur d'un Manufacture de rouge appelée rouge de Prusse, en Pourain, petitioné pour un privilege exclusif de six ans. . ." (five documents), May–December 1777, AN F/12/1506 #4.

Note 9: Meeting Minutes for 23 April 1749, *Procès Verbaux de l'Académie royale des Sciences* 68 (1749); Pierre-Joseph Macquer, "Teinture en bleu qui n'utilise ni pastel ni indigo," AdS *pli cacheté*,no. 23; Certification de la procès de teinture en bleu, 26 March 1749, AdS *pochette*. See also Pierre-Joseph Macquer "Éxamen Chymique de Bleu de Prusse," *Mémoires de l'Académie royale des Sciences année 1752 . . .* (Paris, 1756): 60–77; abbé Ménon, "Mémoire sur le Bleu de Prusse par M. l'Abbé Ménon Correspondant de l'Académie," *Mémoires de mathématique et de physique, présentés à l'Académie royale des Sciences, par divers sçavans, et lûs dans ses assemblées* [*Savants étrangers*], 1 (1750): 563–72; and "Second mémoire sur le bleu de Prusse," *Savants étrangers*, 1 (1750): 573–92.

Note 10: "An Entire New Method of Manufacturing Paper for Hanging and Ornamenting of Rooms, and Other Purposes, and That the Same Will Be of Greate Use and Benefit to the Publick," English Patent No. 685 issued to Edward Deighton (2 September 1753); "Composition Called "British Smalts, or Powder Blue," English Patent no. 1562 issued to Thomas Simpson (10 October 1786).

Note 11: James Martin, "Unraveling the Material History of Painted Silk Textiles through Microanalysis," in *The Conservation of Eighteenth-Century Painted Silk Dress*, eds. Chris Paulocik and Sean Flaherty (New York, 1995): 46–50.

Note 12: Documents concerning nineteenth-century efforts in France to improve Prussian blue for textiles can be found in AN F/12/2252.

Note 13: *Description du procédé de M. Raymond, . . . pour teindre la soie avec le bleu de Prusse . . .,* 1811, AN F/12/2252.

Note 14: Franco Brunello, *The Art of Dyeing in the History of Mankind*, trans. Bernard Hickey (Cleveland, 1973), 231; Coleby, "A History of Prussian Blue,"; R. D. Harley, *Artists' Pigments c. 1600–1835: A Study in Documentary Sources*, 2d ed. (London, 1982), 7–4; Helmut Schweppe, *Practical Information for the Identification of Early Synthetic Dyes, and Practical Hints on Dyeing with Early Synthetic Dyes* (Washington, D.C., 1987).

Note 15: *Requête des directeurs de l'Académie de St-Luc à Paris concernant un arrêt du Parlement du 26 fevrier 1760, à la bienfait de la commaunité des épiciers . . .*, 14 April 1760, AN F/12/103 #129.

Note 16: Mémoire lu par Hellot écrit par sieurs Gly et d'Heure concernant son bleu de Prusse, 6 and 9 February 1765, AdS *pochette*.

Note 17: Alfred Franklin, *Dictionnaire historique des arts, métiers et professions exercés dans Paris depuis le treizième siècle* . . . (Paris, 1905–6), s.v. "Bleu de Prusse, dit aussi bleu de Berlin (Fabricants de)." See also the *Encyclopédie méthodique: Arts et métiers méchaniques*, 8 vols. (Paris, 1782–91), 1:220

