Heating Methods and Their Impact on Soane's Work: Lincoln's Inn Fields and Dulwich Picture Gallery

TODD WILLMERT Minneapolis, Minnesota

During the years of Sir John Soane's practice, there were tremendous advancements in central heating methods. Stoves and fireplaces were no longer the primary means of heating spaces as hot air, steam, and hot water systems were introduced and gained currency. Soane designed expressive stoves, and fireplaces remained especially important to him because of their cultural associations, but he also readily recognized the possibilities of central systems and utilized them as they became available. The result is a compelling dialogue between his architecture and the diversity of available heating strategies. To understand fully Soane's manipulation of space or design intent in such major works as Lincoln's Inn Fields and Dulwich Picture Gallery, it is critical to understand his awareness of heating methods and his expertise in addressing the architectural opportunities they offered.

SIR JOHN SOANE is justly renowned for his skilled use of natural light in such works as 12–14 Lincoln's Inn Fields and Dulwich Picture Gallery, but his other environmental considerations in these buildings have not been recognized. Of particular interest is his use of both traditional and modern heating methods. Fireplaces were an important element of his architecture because of their psychological connotations. Their domestic and cultural overtones could not be ignored. Soane's stove designs illustrate a wide range of expression. While Soane embraced traditional heating methods, he also took advantage of the central heating systems emerging during his career. Steam, hot water, and hot air systems—heating innovations developed in Great Britain during the industrial revolution—provided new means of controlling the thermal environment, and Soane recognized and exploited them for the comfort they afforded building occupants as well as for the design opportunities they presented.

Research for this study was made possible by a grant from the Reynolds Scholarship Program at Dartmouth College. The Samuel H. Kress Foundation provided funding for the study's images. At Sir John Soane's Museum, Margaret Richardson, Helen Dorey, Susan Palmer, and Christina Scull aided in the search for relevant documentary material. At Dulwich Picture Gallery, Giles Waterfield allowed me to examine records in his possession. Aside from their help in assembling documents, their insight into Soane's architecture contributed to this research. An earlier draft of this study was completed under the guidance of Dean Hawkes and Nick Baker. On this version, Kathleen James, Leon Satkowski, and Susan Ubbelohde offered substantiative criticism.

Heating methods informed Soane's architecture profoundly in his residence at Lincoln's Inn Fields. Within a span of forty-five years, Soane employed fireplaces and stoves as well as three different types of central systems. Because of their domestic associations, fireplaces heated the residential rooms in the front of the house. Although mirrors and decorative planes in these rooms make them spatially complex through illusion, they are actually simple, contained chambers easily heated by fireplace. In contrast, the rich, layered spaces in the rear, the "rooms" of Soane's professional life, were heated centrally. Initially, these interlocking spaces were discrete rooms, some of which were heated by stoves or fireplaces, but they evolved to explore explicitly what is illusionary in the residential rooms. The professional spaces, because of their spatial complexity, were practicable only in light of modern heating technologies.

At Dulwich Picture Gallery, Soane investigated thermal control in a physical, sensory manner. He juxtaposed an unheated mausoleum, almshouses heated by fireplaces, and a centrally heated gallery to reinforce the building's programmatic elements. The unheated mausoleum was in direct contrast to the centrally heated galleries, creating a critical tension. The development of different thermal realms, a concept Soane reinforced through lighting and materials, was crucial to his intentions.

Before turning to a detailed analysis of Lincoln's Inn Fields or Dulwich Picture Gallery, however, it is necessary to outline innovations in heating in the late eighteenth and early nineteenth centuries and Soane's commentary on them. Soane's pioneering use of the heating technologies is more obvious when seen against this background. An examination of the Bank of England Stock Office, an early major project, will succinctly summarize Soane's interest in different heating methods and his command of both traditional and modern heating.

Soane's commentary on heating technologies and the historical context

Soane's career, spanning from 1768 to 1835,[1] was a period of unparalleled innovation in central heating technologies. Two

1. Soane was born in 1753 and died in 1837. The title of Soane's *Memoirs* implies that his career was framed by the years 1768 and 1835.

major families of heating systems—water systems dependent on pipes to distribute steam or hot water, and hot air systems employing ducts to deliver warmed air—gained currency in a relatively short time frame during the years of his practice. The sustained development of both steam and hot air heating started in the 1790s, and the major advancements were in place by the 1830s. Real innovations in hot water heating began in the 1810s and stretched through the 1830s. With a career concurrent with these heating developments, Soane was well positioned to use and comment on the emerging technologies.

Aside from the evidence found in bills, letters, and journal entries illustrating his use of the modern heating systems, Soane's knowledge and interest in the innovations is documented in two ways: his library collection and, most important, his lectures delivered as Professor of Architecture at the Royal Academy. Soane's library contains many of the seminal texts written in his era concerning heating systems.[2] He did not usually annotate his books, however, so it is impossible to tell if he read them or how he referred to them.[3] A clearer manifestation of Soane's awareness of heating systems and their development is his series of lectures. After his appointment as Professor in 1806, Soane wrote six lectures between 1806 and 1809 and started to deliver them in 1809. He started to deliver a second set of six in 1815.[4]

In the second set—specifically, in Lecture 8—Soane touched on the means of controlling a building's thermal environment.[5]

Soane began his discussion of heating methods with a brief historical survey. He noted that such authors as Vitruvius, Pliny, and Seneca described how their culture effectively considered orientation to utilize solar gain. Evidence from Soane's own Italian archaeological explorations supplemented literary sources in his discussion of their chimneys and fire usage. Fires were "occasionally used in the living rooms of the ancients," but, in contrast to "the present custom," Soane thought they built fireplaces and chimneys in the middle of rooms.[6] He found no evidence that chimneys were built in "the thickness of the walls." There is, however, the "frequent recurrence of flues to convey heat from the hypocaustum into the habitable rooms of the ancients." Flues were built in a room's walls and/or under its floor. The fire's combustion products traveled in the flues, warming the room surfaces, which in turn heated the room proper by radiation. In hypocaust systems, a heating method used most notably in Roman baths, these elongated chimneys gave the "comfort of warmth" without the "appearance of fire."

Since classical architecture was a key source of inspiration for Soane, it is not surprising that he looked to the classical world's heating strategies. He regretted, however, that "perhaps in no part of our art is there so little to be learnt from [the ancients] as in respect of the due warming . . . of rooms." Heating was not a major concern in the Mediterranean world; the climate "rendered fires less necessary than" in the British Isles. As Soane could learn little from classical precedents, he welcomed the modern developments in heating technology: "So necessary is warmth to existence that we cannot be surprised at the various inventions that have been produced for the better and more economical warming of our houses." Soane commented on the important innovations of Benjamin Franklin, whose closed stove burned more efficiently than previous stoves, but he concentrated on the central steam and hot water systems for good reason. The new central systems were a breakthrough. They heated more evenly and efficiently than stoves and fireplaces, and they were easier to manage than stoves or fireplaces distributed throughout a building.

Steam systems, first proposed in the mid-eighteenth century, were developed only in the last decades of the century, simultaneous with the establishment of Soane's independent practice in 1781. Soane specifically mentions the "labours and talents" of Matthew Boulton and James Watt, who "usefully and successfully" applied steam to heat buildings. These innovators heated the Twist Mill in Salford with steam in 1799, but both

J. Soane, *Memoirs of the Professional Life of an Architect between the Years 1768 and 1835*, London, 1835.

2. As Soane wrote in Lecture 6, he "never lost any opportunity of collecting . . . every book and print that came within my reach on the subject of architecture." J. Soane, *Lectures on Architecture: Delivered to the Students of the Royal Academy from 1809 to 1836 in Two Courses of Six Lectures Each*, ed. A. Bolton, London, 1929, 106. Soane's library contained seventeen books and pamphlets relating to heating issues. Among the most important were works by the Marquis J. B. M. F. de Chabannes, *On Conducting Air by Forced Ventilation, and Regulating Temperature in Dwellings*, London, 1818; and R. Buchanan, *Practical and Descriptive Essays on the Economy of Fuel and the Management of Heat*, Glasgow, 1810.

3. There are no annotations in the most noteworthy heating books in Soane's library. According to Christina Scull, Librarian of Sir John Soane's Museum, and Margaret Richardson, Assistant Curator of Sir John Soane's Museum, Soane was not in the habit of annotating books. He did own eleven copies of Laugier's *An Essay on Architecture*, and some of those are annotated, however. Giles Waterfield, Director of Dulwich Picture Gallery, writes that a book of 1806 by George Tappen, *Professional Observations on the Architecture of the Principal Ancient and Modern Buildings in France and Italy*, which Tappen presented to Soane in 1807, is "heavily annotated." G. Waterfield, *Soane and After: The Architecture of Dulwich Picture Gallery*, London, 1987, 24.

4. Soane, *Lectures*, 5, 106, 107, 152; and A. Bolton, *The Works of John Soane*, London, 1924, appendix A. The frequency of the lectures and the dates of their delivery are not always known. Bolton comments that Lecture 1 was first given on 27 March 1809, Lecture 6 on 16 January 1812, Lecture 7 in 1815, and Lecture 10 on 9 March 1815. Soane likely wrote the second set of lectures in the first half of the 1810s. No lectures were delivered in 1813 or 1814. Millenson notes that Lecture 6 was written in 1809 and revised several times in 1811 before delivery in 1812. See S. F. Millenson, *Sir John Soane's Museum*, Ann Arbor, 1987, 44. The work is a revision of the author's Ph.D. dissertation, University of Michigan, 1979. Portions of the book's first two chapters appeared as "The Genesis of Sir John Soane's Museum Idea: 1801–1810," *JSAH*, XLIII, 1984, 225–237.

5. In Lecture 7, Soane discussed, among other things, the environmental effects of siting and orientation. There are several lecture drafts in the Soane Museum. Once the heating section was written, Soane did not make substantive textual changes.

6. Soane, *Lectures*, 124. All the subsequent Soane quotations in this section are drawn from Lecture 8, ibid., 123–125.

executed smaller projects in the 1780s.[7] While Boulton and Watt explored steam heating through a range of scale, most innovations occurred in large industrial buildings.[8] The development of steam heating in nonindustrial buildings was slower, but by 1824 steam heating had become so well established that Thomas Tredgold was able to advocate it for every imaginable building type.[9]

Soane wrote perceptively of the steam systems. "No mode yet discovered has been more safe, economical, or better adapted for the purpose" of heating, although "no method is more dangerous, expensive, or ineffectual, than steam, when improperly used by ignorant persons." Though steam heating proved efficient and could deliver heat far from a central boiler, its high temperatures and pressures were potentially quite problematic. "A much more simple and perhaps equally effectual mode of warming buildings . . . is that which has been introduced within these last few years, by means of heated water." Because they operated at lower temperatures and pressures, hot water systems were easier to work with than their steam counterparts. These advantages had drawbacks, however. Lower temperature and pressure translated into less heating capacity and diminished range from the furnace.

Hot water and steam systems were nearly identical in terms of hardware and mechanics. Both use a central furnace or boiler to heat water or make steam, which is then conveyed to rooms in three- to six-inch pipes.[10] The rooms are heated through radiation, as the pipes give off heat. The differences between these systems, aside from their attendant advantages and disadvantages, are important, however. Hot water systems are based on a circuit, with water flowing away from the furnace, out to the rooms, and back to the furnace again.[11] Steam systems pose some difficulty in returning water (the condensed steam) to the boiler. Because the steam gives off its heat through condensing, the system is not circulating. The water must drain back to the boiler, or the water of condensation must simply exit the system. A disadvantage to the latter alternative is that water must continually be added to the system to replace that lost.[12]

The drawbacks to steam provoked further developments in hot water systems. One particularly important innovation was pressurized hot water heating, patented in 1831 by Angier March Perkins.[13] The pipe network in a Perkins system is fitted with an expansion loop. When the water expands through heating, it fills the loop, enabling water to be heated beyond its boiling point.[14] Water reached temperatures of only 150 to 180 degrees Fahrenheit in ordinary hot water systems, while temperatures of 300 to 400 degrees were achieved in pressurized hot water systems.[15] The result was that one-inch pipes in pressurized systems could deliver the same heating capacity as the larger, more cumbersome pipes of earlier hot water systems. The problems attendant with steam systems, high temperatures and pressures, were present in the Perkins system,[16] but in other respects it was superior to steam and conventional hot water systems.

Soane's comment that hot water systems were only "introduced within these last few years" accords with the historical chronology. Although hot water heating predates steam heating and well-documented hot water systems were in operation in the 1700s,[17] the sustained development of hot water heating started only in the 1810s, contemporary with Soane's lectures, through the efforts of innovators like Chabannes.[18] Initial progress was slow, however. The testing ground was mainly in horticultural buildings, like greenhouses, and critical discussion in heating treatises was lacking.[19] The wider acceptance of hot

7. Watt is most renowned for his work on steam engines. He used steam to heat parts of his house in 1784 or 1785. Boulton heated his bath with steam in 1789. See Buchanan, *Practical and Descriptive Essays,* xii–xiii. On p. xi, Buchanan writes that steam heat was first proposed in 1745 by Colonel William Cook.

8. R. Bruegmann, "Central Heating and Forced Ventilation: Origins and Effects on Architectural Design," *JSAH,* XXXVII, 1978, 147. Much of the historical overview is drawn from this excellent study. Soane's comment that steam is used "not only in our manufactories, but likewise for the warming of apartments of different magnitudes" might suggest that while steam was used for a variety of applications, industrial ones were more common, as consistent with the historical chronology.

9. T. Tredgold, *Principles of Warming and Ventilating,* London, 1824. A second, improved edition was also published in 1824, and a third edition appeared in 1836. All subsequent references to this work are to the edition of 1836.

10. Tredgold, *Principles of Warming,* 139; and C. J. Richardson, *A Popular Treatise on the Warming and Ventilating of Buildings: Showing the Advantage of the Improved System of Hot Water Circulation,* 2d ed., London, 1839, 24. The first of three editions of Richardson's work was published in 1837. There are differences among the editions. All subsequent references are to the second edition.

11. Richardson, *Popular Treatise,* 21–22.

12. Tredgold, *Principles of Warming,* 149–153, 318–319.

13. The Perkins system is described in depth by Richardson, *Popular Treatise.* In the entry on A. M. Perkins in *Dictionary of National Biography,* 22 vols., Oxford, 1921–1922, XV, 889, it is stated that his father, Jacob Perkins, was also involved in the system's development. Subsequent patents, for modifications, were granted in 1839 and 1841.

14. Richardson, *Popular Treatise,* 24–29, 35. To heat the water, commonly one-sixth of the continuous pipe circuit was coiled and placed in the furnace. Richardson noted that coke or hard coal was the best fuel.

15. Ibid., 29, 87.

16. Bruegmann, "Central Heating," n. 19.

17. Sir Martin Tiewald built a scheme for warming a greenhouse by piped hot water in 1716. A more widely known application followed in 1777 when a Frenchman, Bonnemain, constructed a sophisticated system to heat his chicken incubator. Bonnemain was "in the habit of describing his apparatus to others" and "a good account of it, explained by figures, was given in a French publication." W. Bernan, *On the History and Art of Warming and Ventilating Rooms and Buildings,* London, 1845, 265.

18. Richardson, *Popular Treatise,* 22.

19. Bruegmann, "Central Heating," 148. Soane comments that hot water "may be so applied that the various rooms in public buildings and private dwellings, hot houses, green houses, and such like structures, may be heated so as to produce any general temperature that may be required." The stress here is on horticultural buildings, consistent with the most common application when the lecture was written.

water systems lagged until advances like pressurization were in place. In 1824, Tredgold wrote that hot water systems were impractical, but twelve years later he had "subsequently [become] a convert to its acknowledged practicability."[20] Charles Hood, by 1837, could describe hot water systems as commonplace.[21]

Hot air systems, another important heating innovation of Soane's time, were developed concurrently with the steam and hot water systems. The first central heating method, hypocaust heating, was used in the eighteenth and nineteenth centuries, mostly in horticultural buildings. The systems heated public buildings too at times, but the danger of fire limited their popularity.[22] When flues, a main component of hypocaust systems, were linked with a stove, however, the result was a more efficient system that also addressed safety problems. In hot air systems, air is drawn past a stove, warmed by it, and conveyed by flues to rooms, which are heated directly by convection. Thus, a common stove could be transformed into a central system when coupled with flues.[23]

While hot air systems were suggested as early as the seventeenth century, they were developed much later, in mills of the British Midlands.[24] William Strutt was particularly instrumental in the advancement of hot air heating. He heated a new Derby mill with a single hot air furnace in 1792–1793. Between 1806 and 1810, Strutt designed and constructed a well-documented system to heat the Derbyshire General Infirmary.[25] Chabannes's hot air installations, like that in the House of Commons, were also widely known through his treatise of 1818.[26] Though the technology was developed in mills and other large projects, by the late 1820s advances in furnace designs, ducts, and air movers enabled hot air heating to become the common means of heating smaller buildings for the rest of the nineteenth century.[27]

Within a short overview on heating techniques in Lecture 8, Soane illustrated an informed awareness of heating methods and developments.[28] The lecture delivery and the Dulwich Picture Gallery opening coincided: Soane's commentary on heating issues, the prime of his career, and the wider application of central heating systems were therefore contemporary.[29]

Bank of England Stock Office

Soane held a sustained interest in heating methods from the outset of his career, utilizing central heating innovations as the technologies were being developed. For example, he used steam heating at Tyringham, a building "completed and occupied in the year 1797," shortly after the initial experimentations in the heating method.[30] Soane wrote of the Tyringham system:

> The greater part of the mansion house and offices was most effectually warmed with steam; and so substantially and perfectly was the apparatus constructed that after having been in constant use for upwards of twenty years, the works were as perfect as on the day on which they were finished, although the original expense did not exceed two hundred pounds.[31]

The tone of Soane's comments clearly illustrates his pride, but given the chronology of steam heating development, it is difficult to find fault with this. His successful use of steam at such an early date was an achievement.

Other projects in the 1790s, the decade Tyringham was built, illustrate that Soane did not simply select the most novel heating system available. He was also comfortable working with technologies the Romans had developed. In the early years of his practice, he was commissioned to design horticultural outbuildings like greenhouses and forcing rooms.[32] These projects invariably used the open fires and chimneys associated with hy-

20. Tredgold, *Principles of Warming,* 315. Descriptions of hot water systems at the Windsor Palace Orangery and Westminster Hospital are included in this edition. See appendix, pls. 1, 2.

21. C. Hood, *A Practical Treatise on Warming Buildings,* London, 1837, 1.

22. Bruegmann, "Central Heating," 144. Bruegmann writes that "whether [the hypocaust system] survived from antiquity or was rediscovered [by eighteenth-century Europeans] is a tantalizing question." In n. 3 he adds: "The question of how much Renaissance and Baroque architects knew about Roman hypocausts requires more study."

23. Ibid., 144.

24. Ibid., 144.

25. C. Sylvester, *The Philosophy of Domestic Economy as Exemplified in the Mode of Warming, Ventilating, Drying and Cooking . . . Adopted in the Derbyshire General Infirmary,* Nottingham, 1819.

26. Chabannes, *On Conducting Air.* Chabannes was involved in all aspects of heating technology. In 1817, he heated a conservatory with hot water heating, a method that is promoted in this work as well.

27. Bruegmann, "Central Heating," 146. After an intense phase of development in the 1830s, steam systems replaced hot air as the preferred method of heating large buildings. Ibid., 147.

28. Because they were developed mainly in mills (a building type outside the realm of his practice), Soane probably had little contact with hot air systems until the 1820s, when he used them himself in residential projects. For this reason, it is not surprising that Soane did not address hot air technologies in his lecture. Soane was well aware of the underlying concepts and principles behind the systems, however. Aside from his own forays into hypocaust heating, he designed at least one heating system—in 1792 for the Bank of England Stock Office—that used hot air–hypocaust principles.

29. Except for the projected arcade on the east front and postponed completion of the almshouses, the Dulwich gallery was essentially completed by 1813. Picture installation, however, began in late 1814, and in 1815 facilities were made available to Royal Academy students and privileged visitors. The gallery was not open to the public until 1817. See Waterfield, *Soane and After,* 23–24.

30. Soane, *Memoirs,* 31. For a discussion of the building, see Bolton, *Works of Soane,* 12–23. Bolton, p. 12, incorrectly writes that the steam system was in "no doubt the Perkins' high pressure small pipe system." Perkins's system was not patented until 1831. To his credit, Bolton often notes heating methods in the structures he describes, but he is often in error.

31. Soane, *Memoirs,* 31.

32. Soane Museum (hereafter, SM), Drawer 8, Set 3 contains fifty drawings of thirty-eight projects for outbuildings. See K. Butti and J. Perlin, *A Golden Thread,* London, 1980, chap. 4, for a discussion of some types of this era's horticultural buildings. Roman heating methods are considered at length in chap. 2.

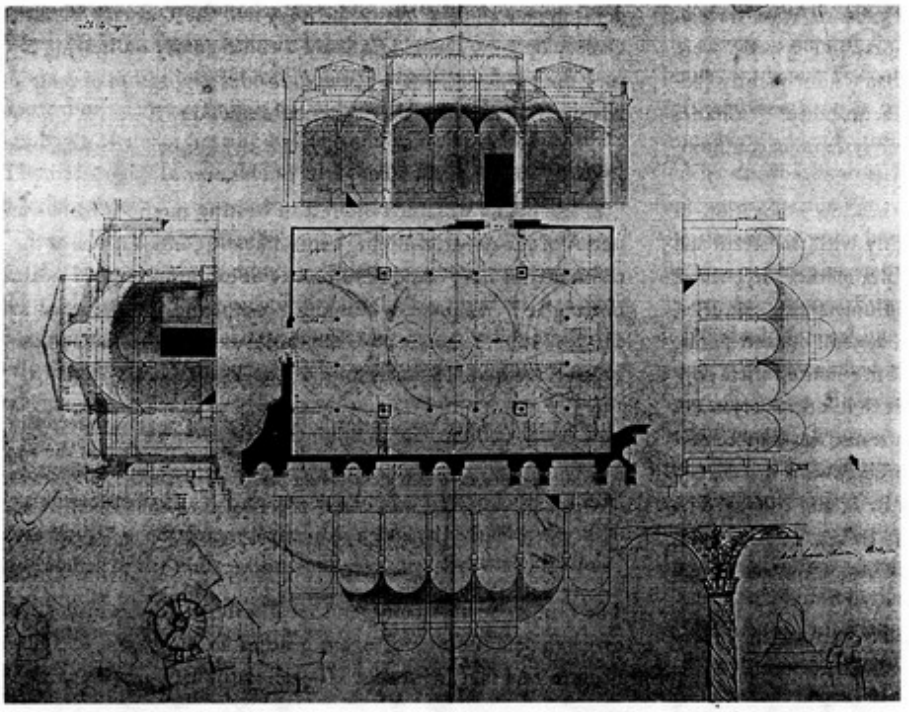

Fig. 1. Survey of Robert Taylor's Bank of England Stock Office, London. The sheet, executed by John Soane's staff, is dated 19 November 1791. Margin sketches in lower left and right illustrate a stove and central column (by courtesy of the Trustees of Sir John Soane's Museum).

pocaust heating. Long chimney flues, winding their way through masonry walls and/or floors, carried the fire's products of combustion. The smoke heated the chimney flue and its encasing surfaces, which in turn warmed the room by radiation. As the technology behind these schemes looked back to older precedents, Soane's knowledge of Roman hypocaust techniques found practical application in his work.

A remarkable series of studies for the redesign of the Bank of England Stock Office in 1792–1793, Soane's first major project as Bank architect, illustrates how he used his broad knowledge of heating systems.[33] Robert Taylor, Soane's predecessor at the Bank, heated with traditional methods.[34] Soane continued this practice during his own tenure, but he investigated more advanced central systems as well. It is doubtful that steam would have been readily available when he redesigned the Stock Office. Hot water systems were not developed until the 1810s. Though Soane had limited options, he did explore the alternatives that were at his disposal—stoves and hot air–hypocaust.

Soane's initial ideas concerning Stock Office heating are indicated in notes on a sheet of survey drawings (Fig. 1).[35] Margin sketches illustrate a stove and column, presumably destined for the center of the new Office, which were further developed in five variations on a column-flue scheme. In this series, a central stove is surmounted by a column-flue (Fig. 2). The column supports the vault while its hollowed interior, the flue, removes smoke. A flame replaces the column-flue in another stove design (Fig. 3). In keeping with the tenor of the five studies where the central stove is so prominent, Soane calls attention to the stove's fire with a symbolic flame. The stove is closed so as to burn efficiently, meaning that its fire would not be visible to room occupants. The symbolic flame is a visual counterpoint to the flame inside the stove. Only one of the stove studies is dated—a column-flue variation of 1 March 1792—so their order cannot

33. Soane was appointed Bank architect in 1788 and completed projects already in progress and smaller works before redesigning the Stock Office. E. Schumann-Bacia, *John Soane and the Bank of England,* New York, 1991, 48.

34. M. Binney, *Sir Robert Taylor: From Rococo to Neoclassicism,* London, 1984, 74. See pl. 9 for a Bank of England plan that shows fireplace locations. Apparently, some of the rooms were unheated: in pls. 10 and 11, room perspectives show no visible means of heating. Pl. 16 shows a perspective of the 1787 Reduced Annuity Office, Taylor's last Bank space. The central object in this room might be a stove.

35. Summerson attributes the margin sketches to George Dance. Soane frequently consulted Dance, the architect with whom he apprenticed, in the early years of his practice. J. Summerson, "The Evolution of Soane's Bank Stock Office at the Bank of England," *Architectural History,* XXVII, 1984, 136. The Stock Office is also discussed at length in Schumann-Bacia, *Soane and Bank,* 51–60.

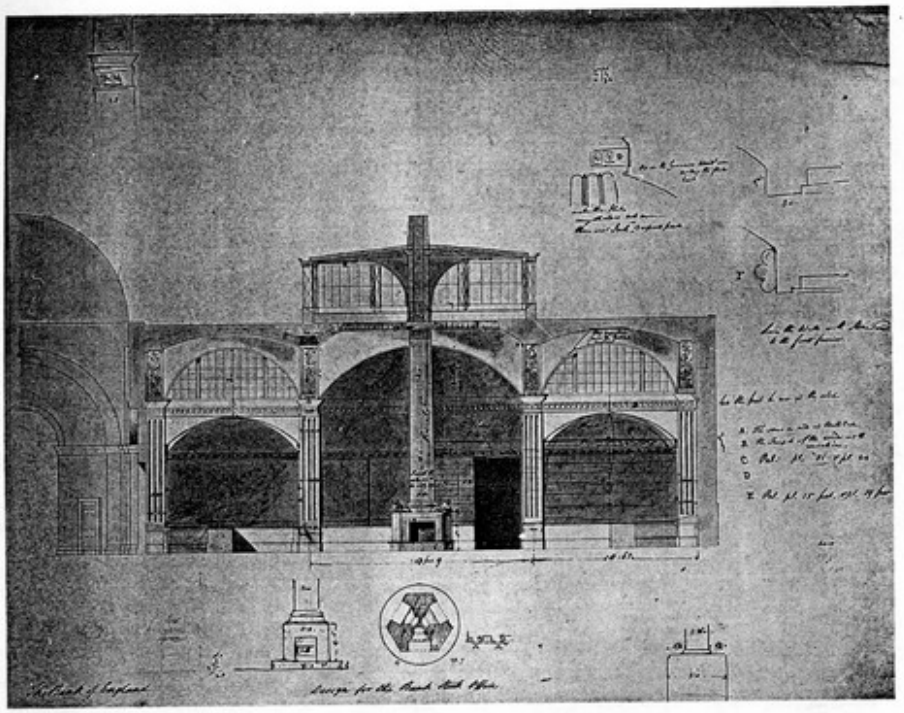

Fig. 2. Bank of England Stock Office. Soane study of central stove-column. Five variations of this scheme were drawn. One of the studies is dated 1 March 1792 (by courtesy of the Trustees of Sir John Soane's Museum).

be precisely determined, but an undated design for a system based on hot air–hypocaust principles was perhaps the next step in the design process (Fig. 4). In this scheme, the drawing notes "revolutions for warm air and smoke." Ducts beneath the floor evidently distributed air warmed by a central basement furnace. This was the hot air portion of the system. Soane also used the fire's combustion products to heat the room: the chimney too wound its way underneath the room's floor so the fire's smoke could give off heat. Hypocaust principles were applied to supplement the hot air system.

The hot air–hypocaust design was never executed, but (if this chronology is correct) it might have influenced the Stock Office heating strategy. Perhaps Soane found it difficult to call attention to prominent stoves if the possibility of central heating made their very existence questionable. Polished drawings of a more modest stove that forgoes the structural feats and symbolic overtones of the previous stove studies indicate a new direction to the design process (Fig. 5). As this sheet is dated 23 February 1793, nearly a year after one of the initial investigations, the exhaustive study of heating alternatives must have narrowed the choice to an understated stove. Soane finalized designs later: a sheet establishing stove elevations and internal workings followed the drawings of late February (Fig. 6).

Since the stove in these working drawings is similar to that found in perspectives of the space (Fig. 7), it must have been

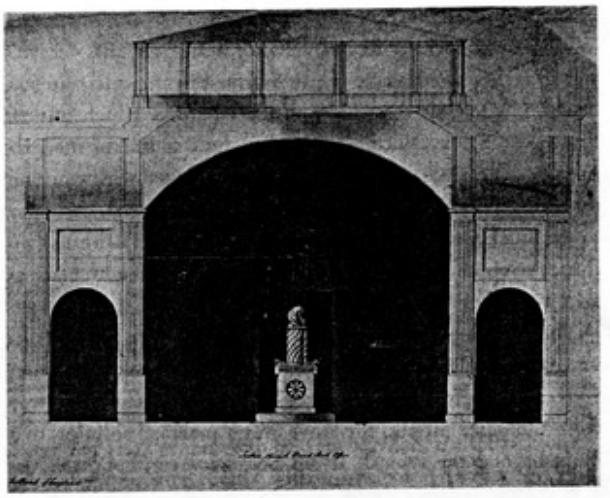

Fig. 3. Bank of England Stock Office. Study of central stove with symbolic flame (by courtesy of the Trustees of Sir John Soane's Museum).

the one that was eventually constructed by stove maker A. Ramellie in April 1793.[36] This heating strategy called for a massive

36. Ramellie's account for 13 April reads, "Erecting a heating stove to warm the Bank Stock Office placed in the cellar underneath according to the estimate £138:18:0." Bolton, *Works of Soane*, 64; and SM, Bank of England Accounts, vol. 2, 150.

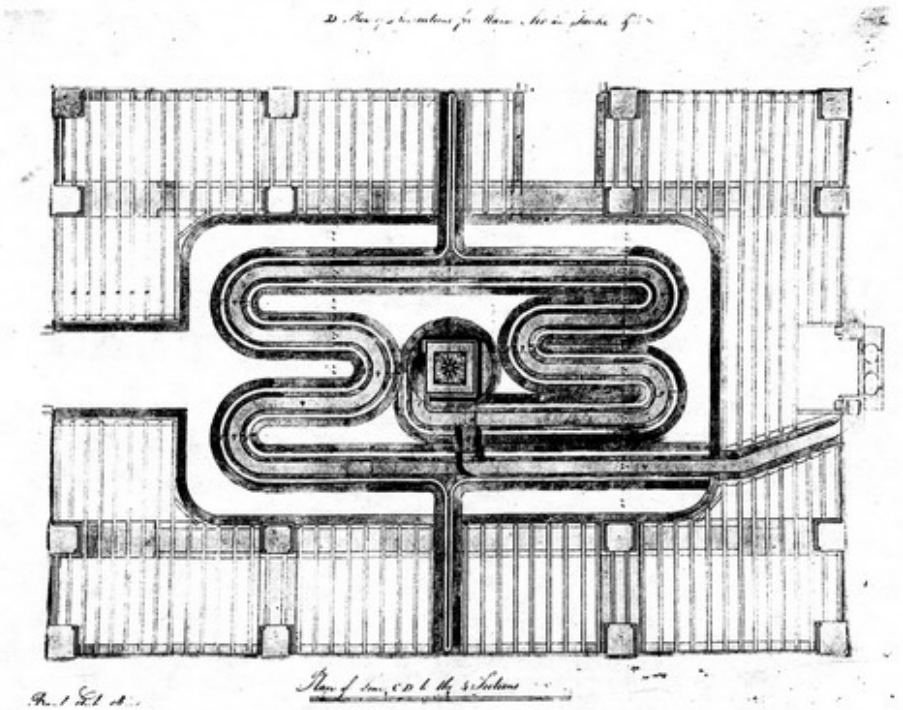

Fig. 4. Bank of England Stock Office. Study of hypocaust–hot air system. There are separate channels for smoke and hot air in this under-floor heating system (by courtesy of the Trustees of Sir John Soane's Museum).

brick firebox in the basement surmounted by a metal stove. With a maze of internal channels for warm air, this "stove" was in reality a receptacle for air warmed in the cellar firebox below.[37] Warm air rose to fill the metal stove, which in turn heated the Stock Office. A secondary heat source in the perspective, a fireplace, is similarly well documented with working drawings (Fig. 8). The fireplace is uniquely situated, the entry to the Stock Office cellar being directly below it. With its two flues, the chimney evidently contains a flue for the fireplace as well as one for the stove.

The process of designing the Bank Stock Office heating system was lengthy and thorough, but the end result was rather conventional. By keeping the fire, its fuel, and its servicing away from the office proper, the stove was a practical solution that went beyond the typical. It did not, however, approach the sophistication of Soane's earlier investigations, which contained creative ideas about heating with distinctive stoves and central systems. As there was no exploration of fireplaces in the design process, it was obviously a secondary heat source, probably there more for visual and psychological reasons. The gap between the innovative studies and the conservative result was extreme, perhaps signifying that the two layers of Bank organization to whom Soane was accountable, the Court of Directors and its Committee of Building, contributed to the directions he took.[38] Soane might have been to ready to incorporate expressive stoves or central heating in the Stock Office, but Bank directors were not.

In spite of Soane's interesting heating explorations in the Stock Office, the Bank's heating methods remained essentially conservative. Studies for heating in subsequent Bank rooms consisted of stove elevation sketches or presentation drawings,[39] and tradesmen's bills demonstrate Soane's association with five stove makers during his tenure as Bank architect.[40] It was not until

37. Bolton, *Works of Soane,* 64, calls them "serpent stoves," no doubt because of their internal maze.

38. Schumann-Bacia, *Soane and Bank,* 45, 48, writes that the Committee of Building established architectural programs. The Court of Directors reviewed and approved designs and directed the Committee, all of whom were directors, to oversee the work.

39. SM, Drawer 10, Set 8 contains these drawings. Items 8–18 illustrate stove designs dating from 1793 to 1811. In 1804, a heating supplier made drawings for a hot air system to heat the Accountants' Office. A basement furnace heated hot water; air was drawn past the hot water and ducted to the office. There is no documentation that suggests this system was constructed. See SM, Drawer 10, Set 8, Items 5, 6, 7, 5a, 7a. An accompanying letter dated 4 Dec. 1804 is from William Stark and Son.

40. Bolton, *Works of Soane,* 61. Bolton notes only "principal tradesmen," so there might have been more than five stove makers at the Bank. The Rotunda was heated by two stoves in 1795, and the 1799 Consuls Transfer Office by four stoves, each nestled against a pier. See ibid., 64, 42, 68. See Schumann-Bacia, *Soane and Bank,* 46, 55, 59, 71, for illustrations of stoves in Bank rooms.

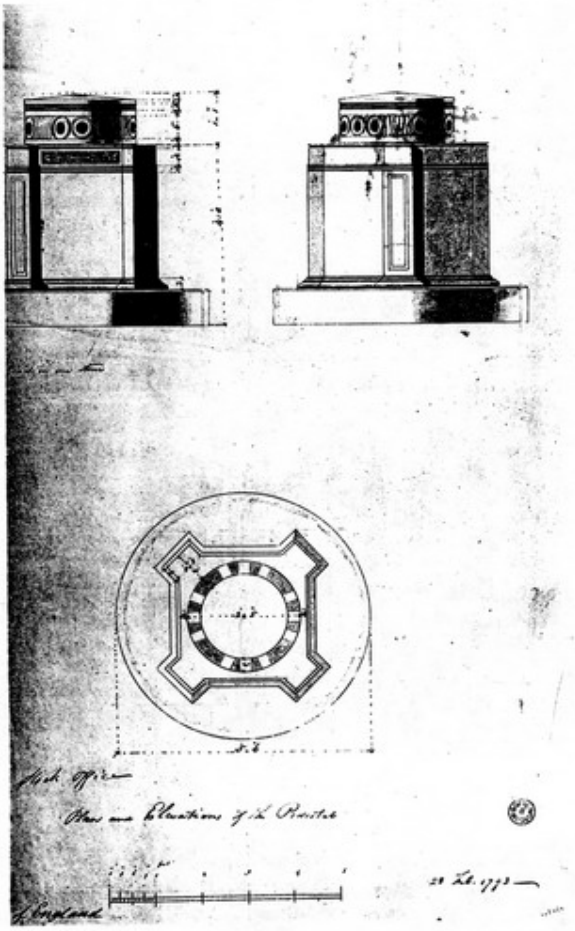

Fig. 5. Bank of England Stock Office. Study of stove, dated 23 February 1793 (by courtesy of the Trustees of Sir John Soane's Museum).

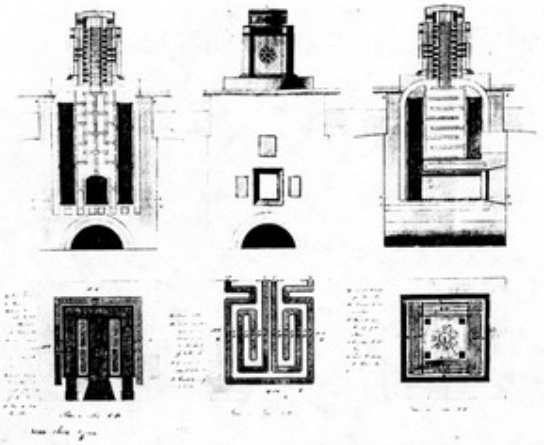

Fig. 6. Bank of England Stock Office. Study of stove (by courtesy of the Trustees of Sir John Soane's Museum).

Fig. 7. Bank of England Stock Office. Perspective and plan (by courtesy of the Trustees of Sir John Soane's Museum).

the 1830s, long after the central systems gained widespread acceptance, that one was installed in any part of the Bank. In 1831, letters from H. C. Price on 31 January and from Mr. Walker on 2 February address hot water heating in the Directors' Office and the Court Room, and Soane's journal entry for 2 March states that he was "attending at Bank with proposals for warming the Court Room." The schemes evidently did not fare well at the meeting, as a letter from A. M. Perkins dated September 1832 proposed to heat the Payhall, the Court Room, and various smaller rooms with a hot water system. Perkins argued that his apparatus would replace sixteen fireplaces and save on fuel expenses. A letter of 26 September 1832 to Soane from the Committee of Building confirms this system's commission and directs him to see that Perkins's plan is properly executed. By 1833, the same year Soane retired as Bank architect, a Perkins hot water system was installed in the Court Room.[41]

41. SM, Box 8, Bundle 34. Bolton, *Works of Soane*, 68, notes that this installation cost £100.

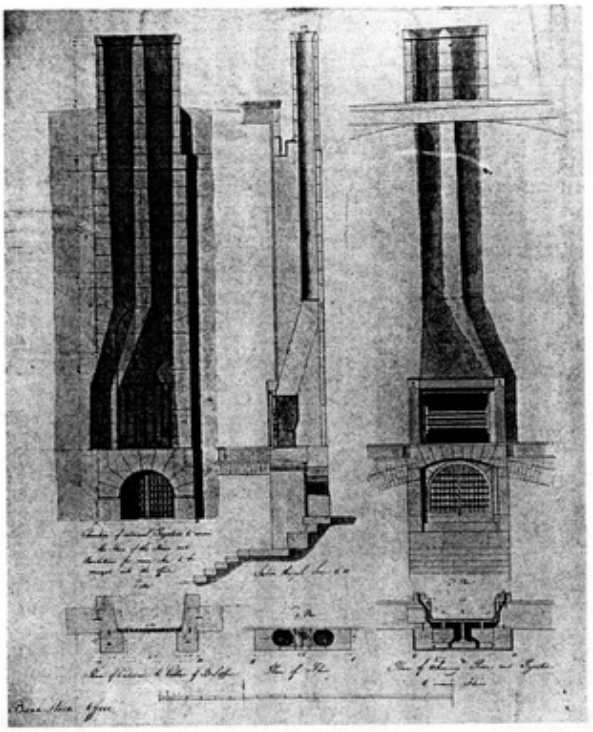

Fig. 8. Bank of England Stock Office. Fireplace. The lower left caption reads: "Elevation of external Projection to secure the Flues of the Stoves and Revolutions for warm Air to be conveyed into the office." Additionally, the images in the lower left and right might indicate some circulatory channels, possibly making this more than a simple fireplace (by courtesy of the Trustees of Sir John Soane's Museum).

The office-museum at Lincoln's Inn Fields

In Soane's era, heating a vast room like the Stock Office was a tremendous challenge that called for extensive thought and attention. His thoroughness cannot be attributed simply to the project's scale, however. Even though he was not called upon to investigate innovative heating methods in subsequent Bank additions, the habits Soane developed at the Stock Office are evident in other works. Nowhere is this better illustrated than in Soane's own house at Lincoln's Inn Fields. During the forty-five years he lived there, stoves, fireplaces, and three types of central heating—steam, hot air, and hot water—warmed the rear portion of the house, those spaces associated with his professional life.

Soane continually made alterations to his residence, particularly the professional spaces, during his forty-five years at Lincoln's Inn Fields. A few years are especially important, however. In 1792, Soane bought number 12 and proceeded to rebuild the structure as a residence with his professional office on the site of the former rear stables (Fig. 9).[42] An upper and a lower office

42. The office and museum go by various names. The upper office is currently called the students' room or upper drawing office. The lower office is now called the colonnade. The museum includes spaces such as the dome, catacombs, crypt, and sepulchral chamber. The term *professional spaces* suggests especially the office, museum, picture room, and study. The study, called the library in some drawings, existed only between approximately 1808 and 1812. The work of Helen Dorey, Curatorial Assistant, and Susan Palmer, Archivist, at Sir John Soane's Museum, was extremely critical to this section of the paper.

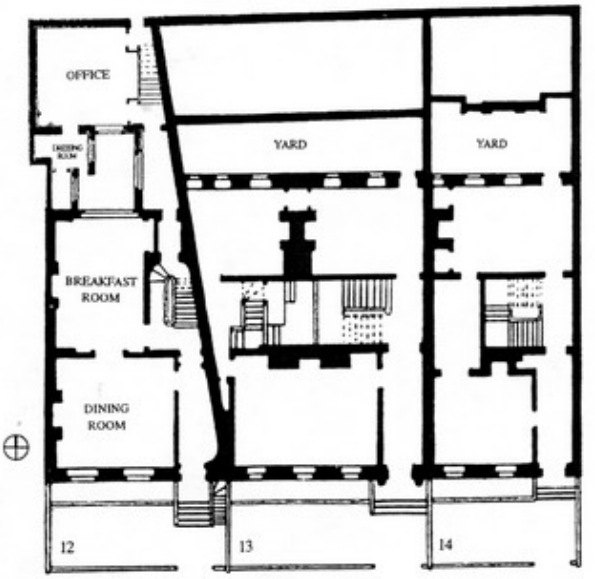

Fig. 9. 12–14 Lincoln's Inn Fields, London. Ground-floor plan as existing in 1794 after the completion of number 12 (author, based on Museum documents and guidebook plans).

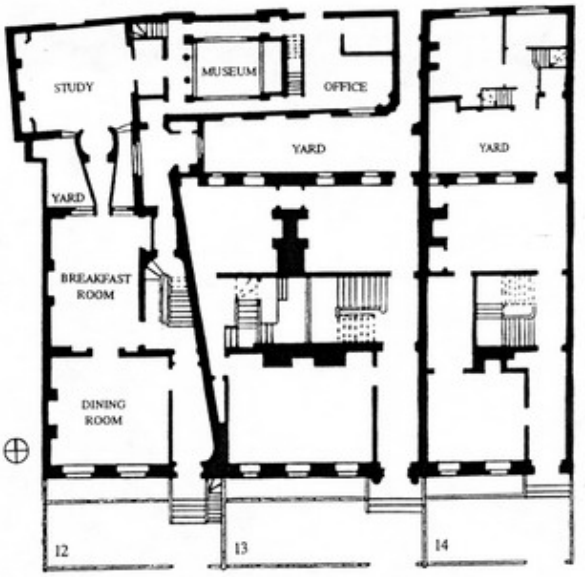

Fig. 10. 12–14 Lincoln's Inn Fields. Ground-floor plan as existing about 1809 (author, based on Museum documents and guidebook plans).

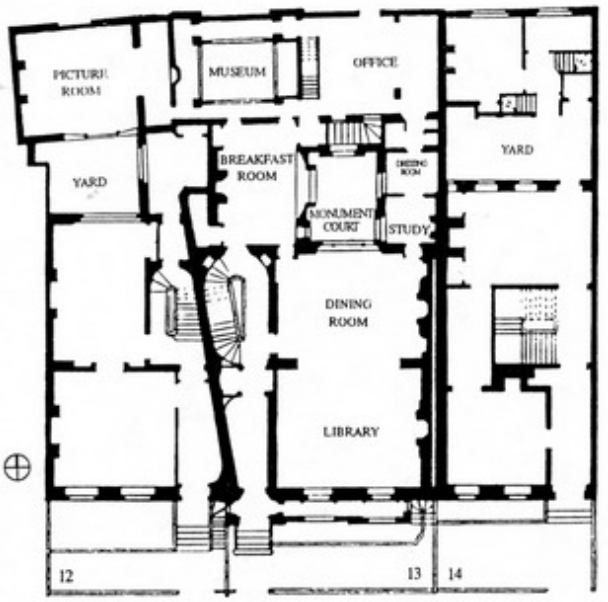

Fig. 11. 12–14 Lincoln's Inn Fields. Ground-floor plan as existing about 1819. Between 1813 and 1819 the picture room did not exist (author, based on Museum documents and guidebook plans).

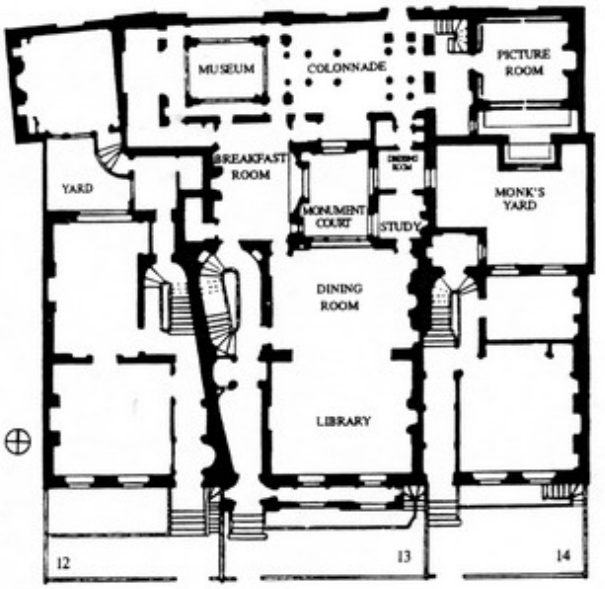

Fig. 12. 12–14 Lincoln's Inn Fields. Ground-floor plan as existing about 1825 (author, based on Museum documents and guidebook plans).

remained in the back of number 12 until 1809, when the museum and new upper and lower offices were constructed in back of 13 Lincoln's Inn Fields, the adjacent property, which Soane had purchased in 1808 (Fig. 10). The old office was converted to a study. In 1812, Soane started to rebuild number 13, and he moved into the residence in 1813 (Fig. 11). The office and museum remained in the same location, but now they were joined to number 13. In the first half of the 1820s, Soane completely changed the spatial character of the upper and lower offices and their relationship with the museum when he removed the separating wall, altering the whole composition so that the office and museum merged. In this time frame, Soane also purchased number 14 in 1823, using the rear portion of the property in 1824 to build a new picture room (a previous one having existed behind number 12 from 1819 to 1824) (Fig. 12).[43]

That Soane had an office and picture room connected with his residence needs no explanation. The museum is more unusual, as are its origins. When Soane purchased Pitzhanger Manor in 1800, he conceived of this country retreat as a place where he could educate his two sons into his profession, as well as showcase his own architectural talents. While Soane displayed casts in the passageway linking office and residence at number 12 before 1800, the space Soane first outfitted as a museum was at Pitzhanger. Here architectural models, fragments, and casts were exhibited to serve as a private classroom for his sons' artistic education. To Soane's disappointment, however, his sons showed no interest in the profession, and his hopes of starting an architectural dynasty were dashed. Pitzhanger was sold in 1810, as one of its primary purposes faded.[44]

Soane's aim of establishing "a race of artists"[45] points to his need for immortality. In the end, he used the museum at Lincoln's Inn Fields, and the house itself, to align himself with the classical tradition and perpetuate his own name. Additional factors behind the museum were Soane's professional needs and his desire to foster architectural education. Before the sale of Pitzhanger, Soane had built his first museum space behind number 13. For a practicing neoclassical architect like Soane, his casts and fragments housed there served as a three-dimensional archive.[46] His election as Professor of Architecture in 1806 also might have prompted him to expand the display area beyond

43. For chronology and general information about Sir John Soane's Museum, see J. Summerson, *A New Description of Sir John Soane's Museum,* London, 1988. This is a museum guidebook, published and revised over the years by the museum trustees. Appendix 1 gives a chronology of the museum. See also Millenson, *Soane's Museum,* chap. 2, for a discussion of the evolution of the office-museum. This work is the best study of the museum and its collection.

44. Millenson, *Soane's Museum,* chap. 1, considers Pitzhanger Manor in depth. Chaps. 1 and 2 also discuss Soane's motivation behind building the museums at Pitzhanger and Lincoln's Inn Fields. Soane's museum was born in a time of transition from an age of private collections to an age of public museums. Chap. 7 discusses this important era.

45. J. Soane, "Crude Hints towards a History of My House in L.I. Fields," 1812, manuscript, Sir John Soane's Museum, 59.

46. Millenson, *Soane's Museum,* 5. Many architects of Soane's era, such as Robert Adam, collected architectural specimens. Henry Holland, one of Soane's teachers, had an important collection that Soane knew. See also Summerson, *New Description,* appendix 1: Soane had purchased casts as early as 1792 and 1795.

the limited space in the office passageway. "On my appointment to the Professorship I began to arrange the books, casts and models, in order that the students might have the benefit of easy access to them."[47] Architecture students at the Royal Academy, where architecture was a stepsister to painting and sculpture, lacked educational materials. In an effort to elevate the study of architecture, Soane made his collections available.[48]

There was an abstract link between the museum, which held other architects' creations, and the office, where Soane created. Soane also made a literal link. When Soane wrote about his house in the 1830s, he called each space a room, but each "room" in the office-museum is a room in name only.[49] The office-museum interpenetrations in plan and section go beyond the self-contained space we usually associate with a room. For instance, the upper office is basically a platform held aloft by a forest of columns. It floats above ground level, held away from the walls, so that light can penetrate through to the basement. The upper office is separate from the rest of the space, but it lacks architectural elements like windows that commonly define a room. Instead of giving the office attributes of a contained space, Soane established its spatial continuity with the museum. In the office, one enjoys views beyond, to the museum and its collection. This is in keeping with its use. Soane's staff was largely composed of pupils studying the profession. It made sense to make visible the museum's architectural casts and fragments, actual models of details they might be drafting.

It was logical and advantageous that the office have views to the museum. On the other hand, the linkage created a number of thermal problems. Since Soane and his staff worked eleven or twelve hours a day, six days a week,[50] the office was the most heavily utilized room in the house. Yet it lacked four proper walls to contain the heat of radiant sources like stoves. The abundant skylights, which provide excellent top lighting for drafting and viewing objects, compounded the heating difficulties. Charles James Richardson, a member of Soane's architectural staff from 1824 until Soane's death in 1837, discussed the problems:

> The Soane Museum presents great difficulties to the procuring a circulation of warm air within it, as has been sufficiently proved by the repeated failures of the various systems which from time to time have been introduced there for that purpose, several of which are in my recollection. Among them was one of steam and one by the common method of heated water.[51]

While Richardson mentions the failure of the office-museum's early central systems, the space was conceived in terms of central heating. No other heating method would enable Soane to create such complex, layered spaces while simultaneously heating them adequately. The problem was waiting for the technological advancements to catch up with his spatial ideas.

A discussion of Soane's innovative central heating applications at Lincoln's Inn Fields centers on the evolution of the office-museum complex. Few records document heating in the residence proper, but there is a significant collection of bills, letters, and journal entries about heating the professional spaces. Of these rooms, it is not surprising that the office was mentioned most frequently. As heating was not so critical in the less occupied museum spaces, there is less documentation on heating there. When each of the professional rooms was isolated from one another by walls and doors, each room was heated by its own stove or fireplace. Recognizing the importance of ensuring his staff's thermal comfort, however, Soane gathered estimates and installed a central system as soon as the spatial complexity of the office-museum made it necessary to heat the entire space.

As the office was radically transformed from contained rooms to spaces embedded in the museum, the heating strategy evolved. Originally, the office was heated by stoves. It appears that the museum was initially unheated, but eventually stoves heated it as well. The major heating change occurred in the first half of the 1820s. In 1824, hot air heating, originally employed in 1821 to serve the office, was used to heat all the professional spaces when they were enlarged and evolved from discrete rooms into the series of spaces that now characterize the rear portion

47. Soane, *Lectures,* 106. In Lecture 6, the source of this quotation, Soane also notes the importance of casts in architectural education, especially for those "young architects" without the "advantage" of studying "original works on the spot." He has "often lamented" the paucity of resources for Royal Academy architecture students "to refer to" and has therefore "never lost any opportunity of collecting casts from the ruins of ancient structures, marble fragments, vases and cinerary urns, as well as every book and print that came within [his] reach on the subject of architecture, and the arts related thereto."

48. Millenson, *Soane's Museum,* 7, 44–45. In 1810, Soane prepared designs for a museum extension that would occupy number 13 and would further his goals of making his collection accessible to architecture students. In 1812, Soane instead proceeded to build number 13 into a residence, leaving the 1810 extension unbuilt. In Soane's era, the practice of architecture was evolving from a gentlemen's hobby to a true profession, making education critical. This period is considered by J. Wilton-Ely, "The Rise of the Professional Architect in England," in S. Kostof, ed., *The Architect,* Oxford, 1977, 180–208.

49. J. Soane, *Description of the House and Museum on the North Side of Lincoln's Inn Fields,* London, privately published in 1830, 1832, and 1835. Unless noted, all subsequent references are to the last edition.

50. Soane's office hours are discussed in A. Bolton, *Architectural Education a Century Ago,* London, n.d., 3. Bolton, *Works of Soane,* xxv, wrote that office hours were twelve hours a day, 7 to 7 in winter and 8 to 8 in summer. Appendix C in this work considers the nature of the staff, that is, the people who worked with Soane, their title, and years in office.

51. Richardson, *Popular Treatise,* 51–52. The "Soane Museum" in this passage is the museum, offices, and picture room. The only documentation of a steam system is one that heated the office for five months during the winter of 1820 and 1821. According to Bolton, *Works of Soane,* appendix C, Richardson started working for Soane only in 1824. Therefore it is confusing how he had a "recollection" of steam heating. Either the dates Bolton gives of Richardson's employment are not accurate, there was a steam system installed after 1824 that is not accounted for in Soane's records, or Richardson simply recalled that Soane had earlier used a steam system.

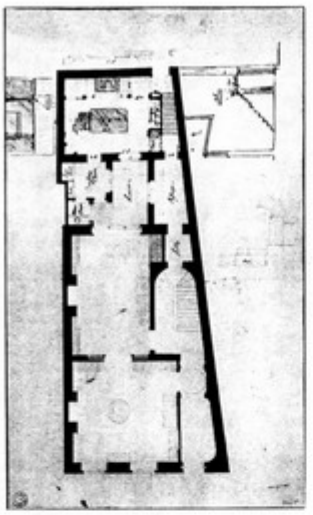

Fig. 13. 12 Lincoln's Inn Fields. 1792 (by courtesy of the Trustees of Sir John Soane's Museum).

Fig. 14. 12 Lincoln's Inn Fields. Perspective of lower office looking east, dated 20 July 1808 (by courtesy of the Trustees of Sir John Soane's Museum).

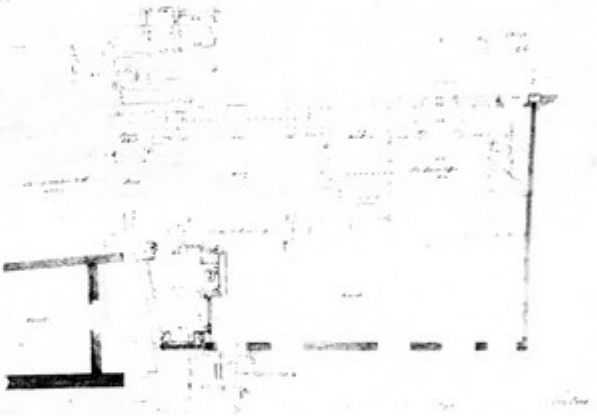

Fig. 15. 12–13 Lincoln's Inn Fields. Ground-floor plan of office and museum addition behind 13 Lincoln's Inn Fields, dated 4 July 1808. A bedroom and closet are indicated in the west half of the office (by courtesy of the Trustees of Sir John Soane's Museum).

of Lincoln's Inn Fields. This system, as well as others, proved inadequate. Soane installed other hot air systems and two types of hot water systems between 1825 and the early 1830s. Soane's struggle to heat the office-museum, as revealed through documents in Sir John Soane's Museum, attests to the accuracy of Richardson's comment that the space was difficult to heat.

The evolution of the office-museum illustrates that the spatial transformation was wedded with the heating strategy. In the earliest plan, of 1792, the lower office is a simple room with four masonry walls (Fig. 13). As the lower and upper offices were linked only by stairs, however, there was not the continuity between the two levels as found today. The rooms' character enabled traditional radiant heat sources to function effectively (Fig. 14). Payments confirm that stoves heated the office. Soane paid £–8.0 for "setting stove in office" on 15 January 1795, the first documentation of lower office heating. In 1803, he paid Cutler, Allan, and Macnaughton £2 for "a new stove for upper office," the first reference to the heating of the upper office. Many other stoves followed. Soane purchased another from Cutler's firm in 1804 for £4.1.0 and received £3.1.0 credit on the old one. In 1805, new stoves were installed: Cutler billed for "exchanging lower office stove, taking down old one, and fixing new one complete £1.1.0," and on 13 May Soane paid £4.7.6 for "the stove in the upper office."[52]

In 1808, Soane bought the freehold of number 13 and prepared designs for a new office and his first museum in an extension linked to number 12. The old offices were converted into a study. The earliest of three extant plans for this construction phase is dated 4 July 1808 (Fig. 15), and the last, 16 March 1809 (Fig. 16). Double-height windows probably provided some connection between office levels, but each level might have been heated by its own radiant source, as in the old offices (Figs. 17 and 18). To examine the three-dimensional aspects of the office, Soane used a rendered perspective. A drawing dated 13 July (Fig. 19), a view of the lower office from the alley entry looking inward to the courtyard, corresponds closely with the plan of 4 July. The study shows a corner stove or fireplace, traditional heating methods Soane used in the earlier office. Corner stove niches in the plans (Figs. 15 and 16), like those in the 1792 plan (Fig. 13), also indicate similar heating methods. In fact,

52. Other bills between 1803 and 1807 refer to altering stoves or fixing chimneys. In 1803, the office was remodeled. According to Helen Dorey, Fig. 14 documents the office before it was transformed to a study.

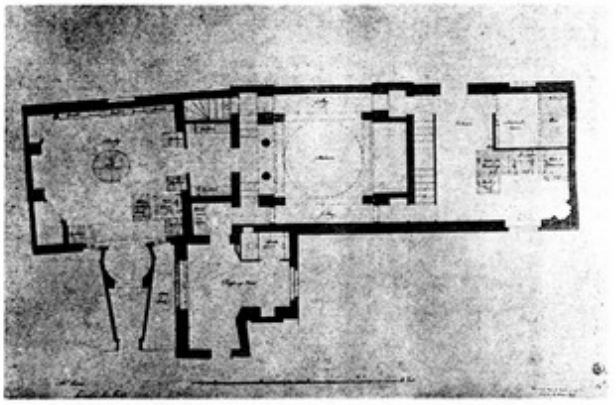

Fig. 16. 12–13 Lincoln's Inn Fields. Ground-floor plan of office and museum addition behind 13 Lincoln's Inn Fields, dated 16 March 1809. A servant's room and drawing cases are indicated in the east half of the office (by courtesy of the Trustees of Sir John Soane's Museum).

Cutler and Macnaughton billed on 20 June 1809 for "1 enclosed stove for the lower office, fixing do with bricks and mortar."[53]

At this initial stage of the office-museum evolution, the two-story office and museum were discrete rooms. The plans show a substantial wall between the spaces. The sections cut through the office and museum illustrate this same wall. The rendered perspectives treat the office and museum as rooms, not spaces that could be experienced simultaneously as can the office and museum today.[54] The office study does not indicate the con-

53. Cutler and Macnaughton bill on 15 Oct. 1808 "for the use of a heater stove and large cast stove, pipe etc. Mens time & fixing 10s." Macnaughton was paid £37.5.0 on 18 Oct. These might be temporary stoves during the construction period. For heating the study, plans indicate a fireplace, the corner niche being replaced by a fireplace centered on the room's west wall. The definition of *stove* needs consideration. *Oxford English Dictionary,* 2d ed., 20 vols., Oxford, 1989, XVI, 808, states that the word *stove* also is "applied to the metal structure of a more or less open fireplace, a 'grate'. This use, common in England, appears to be unknown in the U.S." The type of stove, something that fits in a fireplace, is different from the stove typically envisioned, a closed metal box like that shown in Fig. 14. The Jan. 1809 study stove is listed in Soane's journal as "Skidmore for study stove £15.9.0" and in the bill as "grate for study £15.9.0." On 13 Feb., the journal reads "Bailey for stove, study £8.15.0," but it is "grate for study" on check stubs. The bill describes it as "stove in lieu of what Skidmore made and took away . . . a neat cast iron register stove with double rarefying back and top and brass rosette ornaments £8.15.0." Evidently, a fireplace was created in the study, and register stoves were inserted. The grates in the library and dining room in number 13 are described in bills as "register stoves." Burton and Company were paid £111 in March 1814 for grates in these residential rooms. In *OED,* XIII, 503, *register* is defined as "a contrivance, usually consisting of a metal plate or plates by which an opening may be wholly or partially closed, used for regulating the passage of air, heat, or smoke. In ordinary use now chiefly applied to the adjustable plate which regulates the draught of a common fire-grate."

54. J. Summerson, "The Soane Museum 13 Lincoln's Inn Fields," in *John Soane* (Academy Editions), London, 1983, 24–39. See pp. 28–29 for six studies of the museum. See Millenson, *Soane's Museum,* chap. 2, for discussion of the office evolution.

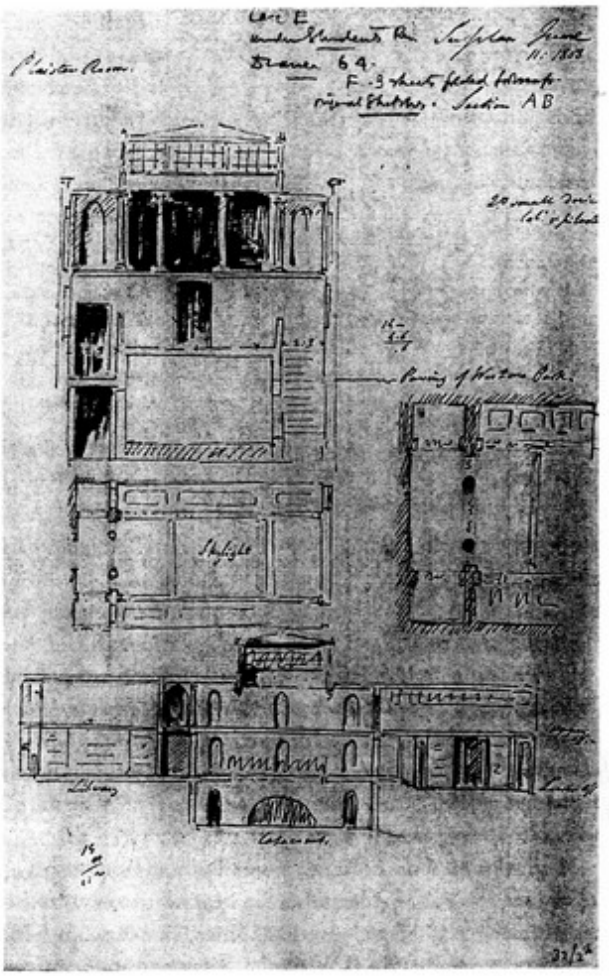

Fig. 17. 12–13 Lincoln's Inn Fields. Section studies of office and museum addition, dated 11 June 1808. The bottom section is cut through the study, museum, and upper and lower offices and looks north (by courtesy of the Trustees of Sir John Soane's Museum).

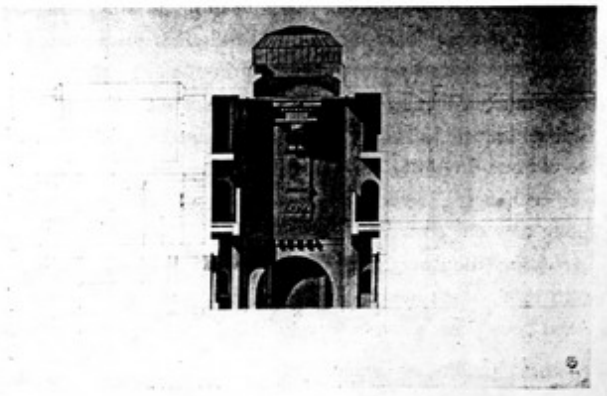

Fig. 18. 13 Lincoln's Inn Fields. Section through museum and upper and lower offices looking south, 1808 (by courtesy of the Trustees of Sir John Soane's Museum).