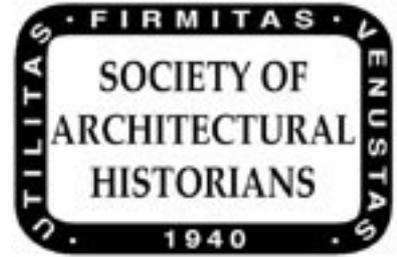




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# The Portuguese Precedent for Pierre Patte's Street Section

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The French architect and theorist Pierre Patte (1723–1814) is often credited with having been the first to illustrate a city street with its buildings and sewer system shown in section—a style of rendering that was to revolutionize the way succeeding generations of engineers and architects presented streets and their substructures (Figure 1).<sup>1</sup> While precedents for this method have been sought in the illustrations of contemporary French engineers, the unmistakable prototype is a drawing by the Portuguese military engineer Captain Eugénio dos Santos (1711–1760) for the reconstruction of Lisbon after the great earthquake of 1755 (Figure 2).<sup>2</sup> Comparison of these two drawings will make apparent a previously unnoted connection between French and Portuguese urban planning in the eighteenth century.<sup>3</sup>

On the morning of All Saints Day, 1755, two tremors and accompanying tsunami leveled about a third of the city of Lisbon.<sup>4</sup> Fires broke out and raged for days. King João V, overwhelmed by the crisis, empowered Sebastião José de Carvalho e Mello (1699–1782), known best by his later title, the Marquês de Pombal, to take command. Pombal sprang into action: he removed the dead, regulated the price of bread, and generally imposed order.<sup>5</sup> He then turned to the reconstruction, delegating the task of articulating a strategy to his nearly eighty-year-old chief engineer, General Manuel da Maia (1677–1768), who submitted his thoughts in three short manuscripts.<sup>6</sup> Pombal also commissioned the renowned physician António Nunes Ribeiro Sanches

(1699–1783) to write a tract on public health that would serve as a guide for da Maia and others charged with the reconstruction.<sup>7</sup>

Da Maia's first manuscript, dated 4 December 1755, rehearses the various possibilities for reconstruction: repair of existing buildings; comprehensive razing and rebuilding; or abandonment of the city for a new location. In the second manuscript, dated 16 February 1756, da Maia indicated that his first manuscript had met with approval and advocated the second option: complete reconstruction, beginning with the *baixa* (the lower city), in which every detail of the new grid plan and building elevations would be carefully regulated. Da Maia moved forward by asking six teams of engineers to propose plans for reconstruction, which are described in the third manuscript, completed 31 March 1756. Da Maia discussed each one, but made it clear that the team of Eugénio dos Santos and his colleague Colonel Carlos Mardel (1695–1763) was best qualified to carry out the reconstruction.<sup>8</sup> On 19 April 1756, the third manuscript was submitted to Pombal for approval, accompanied by five drawings by dos Santos, including a section of a street with sewer.

There is a variance between this section—which da Maia specifically mentioned in the manuscript<sup>9</sup>—and one that was likely among the drawings submitted to Pombal for final approval on 12 June 1758 (see Figure 2)—a discrepancy that may be accounted for by an advance in technology. Although da Maia insisted that buildings be kept to two stories above the ground floor to increase stability

in the event of an earthquake and to reduce the amount of falling debris to which a larger building would subject passersby, the later section shows *three* stories above the ground floor.<sup>10</sup> Dos Santos apparently felt secure enough to make this economically desirable addition because of a new antiseismic technique developed sometime in the two years following his initial design—the *gaiola*, a wooden “cage” built into the walls designed to absorb vibration.<sup>11</sup> The later date of Figure 2 is confirmed by its caption, which states that the “insertion of wood in the houses” is depicted—an unmistakable reference to the *gaiola*.<sup>12</sup>

Little more than a decade later, Patte produced a street section (see Figure 1) for his 1769 work *Mémoires sur les objets les plus importants de l'architecture*, a collection of essays hailed by the *Mercur de France* as “one of the most useful and interesting books ever produced on architecture.”<sup>13</sup> Patte recognized a need for specific information about building technology. Far too many volumes, he argued, dealt only with the question of proportions. “The most useful, the most essential part of architecture—in a word, construction—has barely been addressed. There is no in-depth work on the subject which attempts to transmit successive discoveries, where it is explained how we have come to solve problems and make important economies. We are obliged to make guesses because of our state of perpetual ignorance of previous experience.”<sup>14</sup> One of the novel subjects treated by Patte is the construction of sewer systems, presented in the context of a utopian urban reform in which problems of health and sanitation were rectified at the street level.<sup>15</sup> As a pioneer in the field, Patte was obliged to collect information—on building materials, foundations, the construction of quays and bridge piles, iron reinforcement for flat arches—wherever he could. To judge from the striking similarities between *Mémoires* and the manuscripts of da Maia, Patte appears to have adopted not only dos Santos’s section, but the information that it had been designed to present.

Da Maia’s main streets, which according to him were modeled after the tripartite system used in England, were to be 60 palms (40 French feet) wide, with 10 palms (7 French feet) reserved on each side for pedestrians, who would be protected from passing carts by regularly spaced bollards (see Figure 2).<sup>16</sup> Patte’s street was similarly divided into a road of 42 feet, with 9 feet on each side for sidewalks (see Figure 1).<sup>17</sup> Da Maia rejected the use of arcades, which had been built in Lisbon in the sixteenth and seventeenth centuries, because they were dangerous—troublemakers could easily hide in their shadows.<sup>18</sup> Patte concurred, sheltering pedestrians instead by means of an awning (see Figure 1, no. 4), to be unrolled in the event of inclement weather and

connected to wooden poles (see Figure 1, no. 3), which were then inserted into rings attached to the bollards (see Figure 1, nos. 1, 2).<sup>19</sup>

It was essential for da Maia that future construction in Lisbon be able to resist the two forces that destroyed the old city—tremor and fire. As we have seen, da Maia recommended that buildings be limited to two stories above the ground floor. Patte’s building reflects this proscription, but for a different reason: he did not wish to block sunlight from the street.<sup>20</sup> Da Maia recognized that the fires that consumed Lisbon moved easily from building to building. For this reason, he insisted on roof-level firebreaks (visible in Figure 2).<sup>21</sup> Patte, who believed that the Lisbon fires caused far more damage than the earthquake itself, had a more radical solution: structural wood was to be replaced entirely by lightweight and fireproof brick.<sup>22</sup> Ceramic tiles were preferred to wooden floors, and even doors might be made of iron.<sup>23</sup> In describing the fire-susceptible buildings of Lisbon, Patte revealed his awareness of the *gaiola*—technical information that seems to have come from another source familiar with the reconstruction effort, since it is neither mentioned by da Maia nor indicated explicitly enough in the caption of dos Santos’s section to have provided Patte with sufficient detail.<sup>24</sup>

Da Maia addressed sanitation in the third manuscript. He proposed three solutions for dealing with domestic waste, the best of which involved constructing a sewer system beneath each main street, with waste conduits connecting to adjacent houses (see Figure 2).<sup>25</sup> Rainwater from the roofs washed both liquid and solid wastes, jettisoned by residents, into the collecting sewer at the base of the alley between buildings. This was connected to a larger sewer beneath the street by means of a sloping conduit. Patte adopted the same system, with improvements. An indoor latrine (see Figure 1, R) was flushed using both rainwater accumulated in a tank directly above (see Figure 1, Y) and with water from the courtyard, which ran into the main conduit (see Figure 1, X) across the base of the commode (see Figure 1, T).

Dos Santos’s sewer was accessed by means of a manhole in the center of the street. Patte’s was as well (see Figure 1, E)—and he had the foresight to provide it with a locking cover, to prevent *malfaiteurs* from spending the night below.<sup>26</sup> Dos Santos’s sewer was flat-bottomed and vaulted in carefully cut ashlar, two facts criticized by Jacques Ratton (1736–1820), a French trader with close ties to the Pombal administration.<sup>27</sup> According to Ratton, the reason most of the streets designated by Pombal for sewers did not receive them was the costliness of ashlar.<sup>28</sup> Also, a flat-bottomed sewer allowed waste to accumulate, both because flow was reduced and objects were easily caught in the cor-

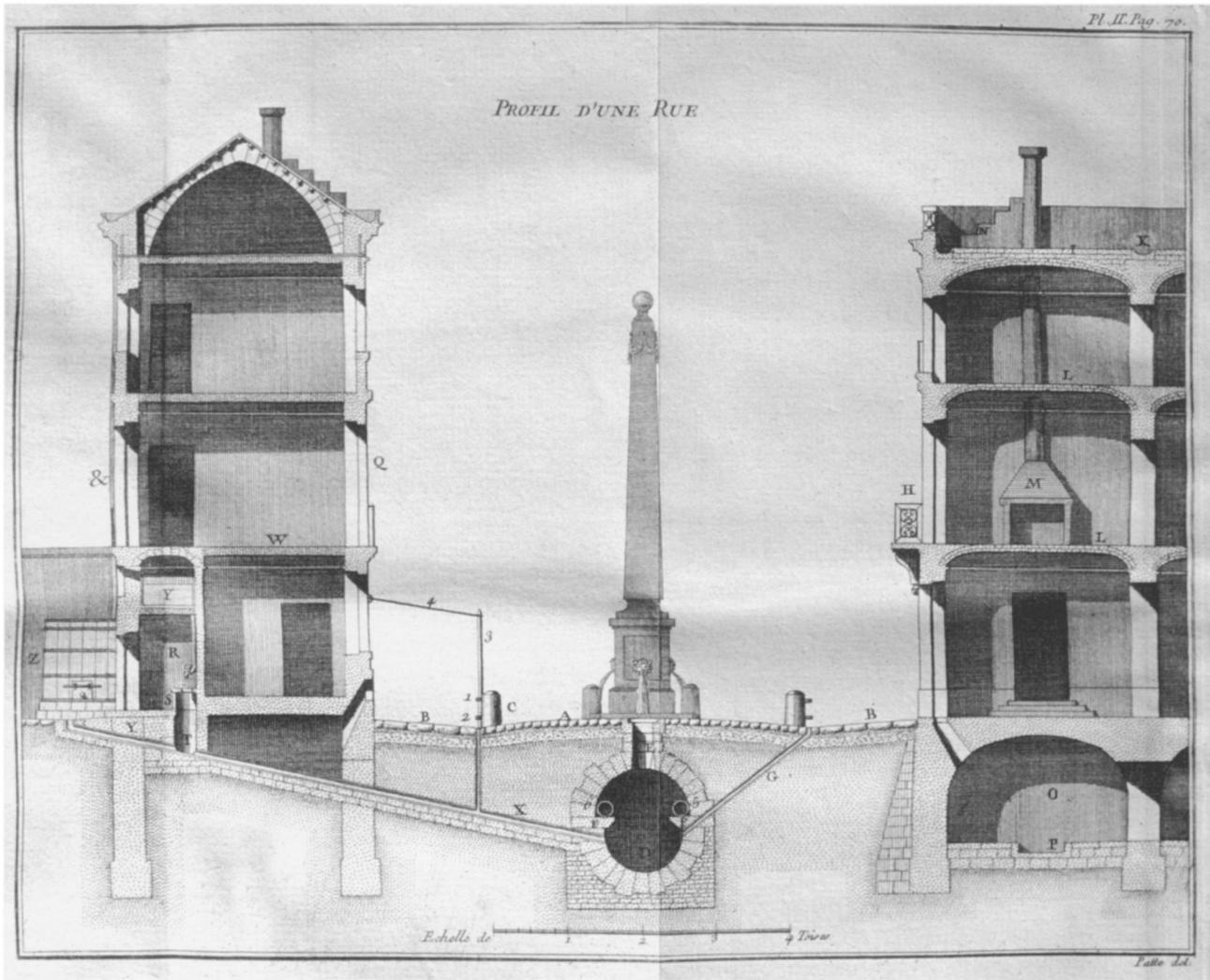


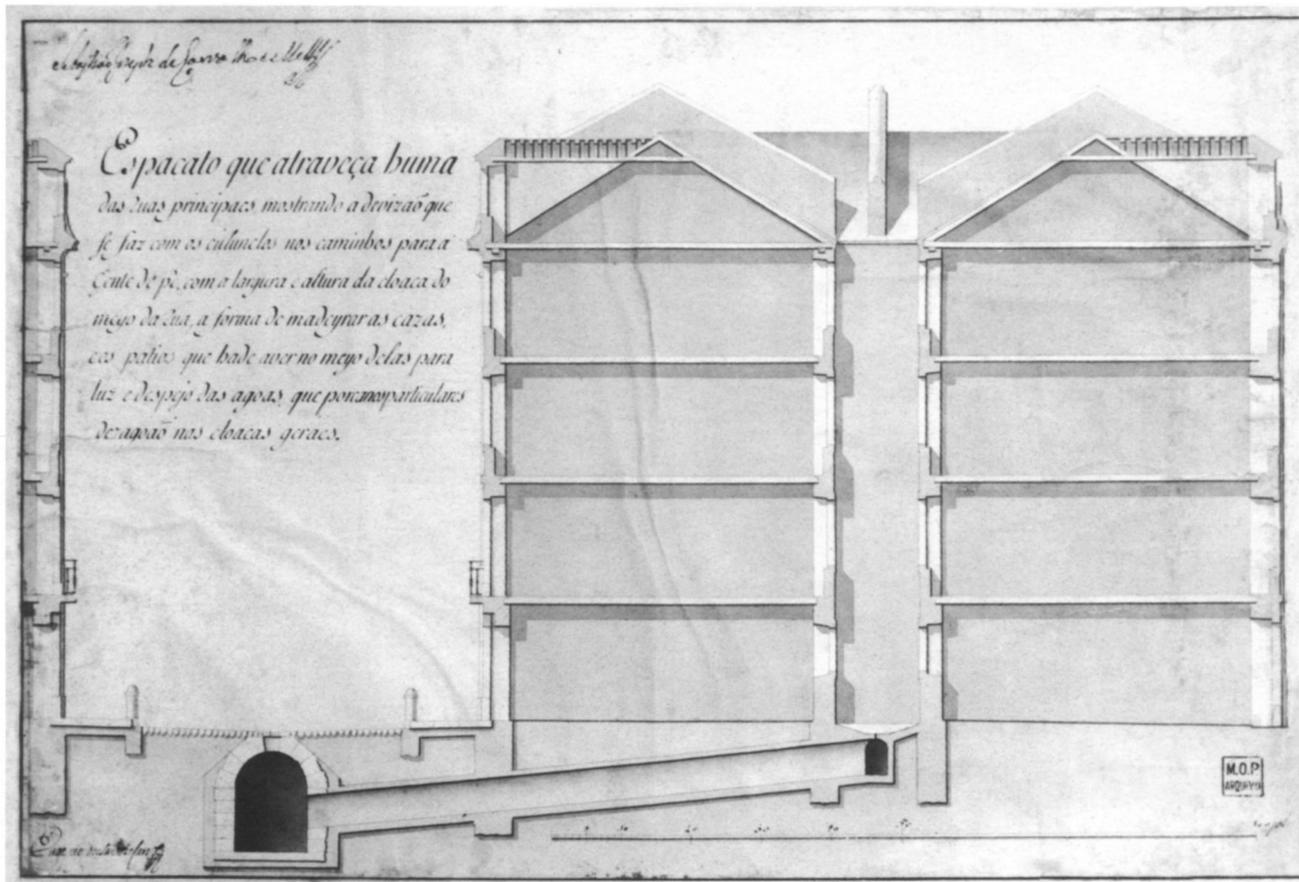
Figure 1 "Profil d'une rue": Pierre Patte's street section

ners. Patte gave his sewer bottom a semicircular profile to improve flow (Figure 1, D),<sup>29</sup> and enhanced da Maia's simple prescription that the sewers be washed with water "from the hills" by proposing to systematically flush all sewers with water collected in reservoirs supplied by aqueducts and wells.<sup>30</sup>

Da Maia was also interested in the question of public water supply. The city was fed by a large aqueduct on which he, Mardel, and dos Santos had worked, and which had survived the earthquake. Water had been routed to a number of public fountains, which da Maia wished to multiply in the reconstruction. He even dreamed of supplying each neighborhood with its own water conduit.<sup>31</sup> Patte, once again, took up the theme. He featured a public fountain, in the form of an obelisk, in his street section (see Figure 1),

and placed water conduits (see Figure 1, nos. 5, 6) *within* the sewer; supported by brackets which ran along its walls (see Figure 1, F), the conduits were thus protected and easily repaired.<sup>32</sup>

Specific precedents for da Maia's advanced urban reforms, articulated in dos Santos's and Mardel's designs, have been sought in the planning experiments of Amsterdam, Bordeaux, London, St. Petersburg, Turin, and Vienna. Yet da Maia suggested that he had little access to these examples: "The two most famous plans for restoration among the European courts have been those of London and Turin. Although I very much wished to learn how they proceeded in each of these cases, I had neither a book nor a public library of which I could avail myself."<sup>33</sup> Da Maia's ideas seem to have been largely his own, probably nourished



**Figure 2** Eugénio dos Santos, street section with sewer. The caption reads: "Section through one of the main streets showing the division of the road into sidewalks using bollards; the width and height of the sewer in the middle of the street; and the insertion of wood in the houses. The section also shows the courtyards one could have between houses for the purpose of light and for the disposal of [waste] water, which is then carried to the main sewer system via individual channels." Note dos Santos's signature in the lower left-hand corner; Sebastião José de Carvalho e Mello (Pombal) signed in the upper left.

by French works on military engineering, two of which he had himself translated and published.<sup>34</sup>

Da Maia's sources for sewer construction information were closer at hand: the system of main sewer with connecting channels to adjacent buildings had already been implemented in parts of Lisbon.<sup>35</sup> Mardel, who had lived in England and France before emigrating to Portugal in 1733, may have brought specific information about London's sewer system and tripartite streets.<sup>36</sup> A precedent for dos Santos's section drawing is more difficult to establish. As in the case of the urban reform scheme in general, there does not seem to have been a direct model.<sup>37</sup> Perhaps dos Santos had seen the sections of bridges showing foundations and riverbed drawn by engineers at the *École des Ponts et Chaussées* in Paris, for example, or the hydro-

graphic sections through Paris drawn in 1742 by geographer Philippe Buache for the Académie des Sciences.<sup>38</sup> Such drawings and the treatises that da Maia consulted may have made their way to Portugal from France via the same channel that seems to have supplied Patte with the texts of da Maia, the section of dos Santos, and information about the *gaiola*: Doctor António Nunes Ribeiro Sanches.

Portuguese by birth, Ribeiro Sanches left his native country in 1726, spending the next few years in England, France, and Italy before moving to Leyden in 1730 to study with Dutch scientist Herman Boerhaave. From 1731 to 1747, Ribeiro Sanches served as physician to the Russian court, ministering notably to the empress Elizabeth and to Catherine the Great. He also served as personal physician to Pombal, who was then Portuguese ambassador to the

Austrian court in Vienna.<sup>39</sup> In 1747, Ribeiro Sanches moved to Paris, where he lived and practiced until his death in 1783. During these years, he devoted the greater part of his energy to the maintenance and expansion of what has been called by Georges Dulac his *réseau*—an extensive network of scientists, politicians, diplomats, doctors, and philosophers including Jean d’Alembert, Jean-Baptiste d’Anville, Georges Buffon, Joseph Delisle, Denis Diderot, Antoine Jussieu, Abbé Jean Nollet, and René Réaumur, with whom he had significant intellectual interchange.<sup>40</sup> He served, for example, as liaison between the French and Russian academies of science until 1749, and then again beginning in 1763. He seems to have been the unofficial Parisian contact for visiting Portuguese scientists, doctors, and diplomats. And he was closely associated with the reforms taking place in his native country. His *Tratado de conservação de saude dos povos*, written at the request of Pombal at the time of the Lisbon disaster, addresses issues of light, clean air and water, and the proper handling of sewage—issues central to da Maia’s reconstruction.<sup>41</sup>

Particularly interesting is Ribeiro Sanches’s contact with the *Encyclopédie*. Diderot asked him to contribute an article on venereal disease, which appears in volume seventeen.<sup>42</sup> Patte also worked for Diderot: he was engaged in 1757 to direct the preparation of the plate volumes.<sup>43</sup> Though it ended badly—Patte publicly accused Diderot of plagiarism—there is a real possibility that the worlds of Patte and Ribeiro Sanches intersected here. Information shared by Pombal with Ribeiro Sanches, probably including specific technical information on the reconstruction—the manuscripts of da Maia, the section of dos Santos, or perhaps even a complete dossier of the approved project drawings—might well have been passed along to Patte, who would have welcomed it as essential information for his book in preparation.<sup>44</sup>

According to José-Augusto França, the great historian of Pombaline urban planning, “there had never been any reason for the West to focus on the architecture (let alone the art) of Portugal. . . . Lisbon was not studied; she created no doctrinaires; the urban planning ideas born there were not translated in treatises. . . . Nor did any album of plates reveal the creations of the architects of Lisbon to the world.” In the end, “no trace of Pombal’s urban planning can be found outside of Portugal.”<sup>45</sup>

Yet there was a trace—in Patte’s *Mémoires*. The section drawing became the standard means of presenting information on housing and street substructures, though its provenance in Patte—more so dos Santos—would be quickly forgotten, to be rediscovered only in the twentieth

century by historians of urban planning.<sup>46</sup> Patte’s brilliant sewer design itself, though sporadically emulated by theorists in the few decades before the Revolution, was forgotten as well.<sup>47</sup> The designs of the urban sanitation reformers of the nineteenth century—Eugène Belgrand, for example—were heralded as great innovations, though they had been prefigured by Patte by nearly a hundred years.<sup>48</sup>

Patte’s reputation as a theorist is based less on the section than on what he used it to illustrate: a utopian vision of a “street machine,” a full-service tender to the needs of the buildings above.<sup>49</sup> That Patte benefited from the experience of the Portuguese engineers is less a testament to a “shameless” appropriation (in any case a common practice at the time) than to the presence of a real international network of savants interested in solving the problems of the urban street together.

## Notes

I am grateful to Robin Middleton for his encouragement as I wrote this text, and to Kenneth Maxwell, Tomás Amorim, and Georges Dulac for their advice. Unless otherwise noted, all translations are mine.

1. Jean-Louis Cohen, “La Mise en coupe de Paris,” in Bertrand Lemoine and Marc Mimram, eds., *Paris d’ingénieurs* (Paris, 1995), 107, for example, situates Patte at the very beginning of a new conception of the “city below the city.”

2. On French precedents for Patte’s drawing see, for example, Antoine Picon, *Architectes et ingénieurs au siècle des lumières* (Marseille, 1988), 182.

3. Robin Middleton kindly drew my attention to dos Santos’s section.

4. Miguel Tibério Pedegache Brandão Ivo, the Lisbon correspondent for the *Journal Étranger*; and later colonel in the Portuguese army, was responsible for one of the first detailed reports of the disaster to be published in France. In his opinion, Lisbon was unsalvageable. *Journal Étranger* (Dec. 1755), 235–39. Pedegache Brandão Ivo also collaborated on a series of illustrations of the disaster: *Recueil des plus belles ruines de Lisbonne causées par le tremblement et par le feu du premier novembre 1755. Dessiné sur les lieux par M. M. Paris et Pedegache et gravé à Paris par Jacques Le Bas, premier graveur du cabinet du Roy en 1757* (Paris, 1757).

5. See Kenneth Maxwell, “Lisbon: The Earthquake of 1755 and Urban Recovery under the Marquês de Pombal,” in Joan Ockman, ed., *Out of Ground Zero: Case Studies in Urban Reinvention* (Munich, 2002), 21–45; Kenneth Maxwell, *Pombal, Paradox of the Enlightenment* (Cambridge, England, 1995), ch. 1; Thomas D. Kendrick, *The Lisbon Earthquake of 1755* (London, 1956), 24–42; and Francisco Luís Pereira de Sousa, *O terramoto do 1º de novembro de 1755 em Portugal*, vol. 3 (Lisbon, 1928).

6. A transcription based on the two known copies of the manuscripts (folios 666–83, codex 112/2-9, Biblioteca Pública de Evora, and sheaf 270, remittance dated 26 Dec. 1891, collection of the Ministério da Guerra, Instituto dos Arquivos Nacionais, Lisbon) was published by Cristóvão Ayres in *Manuel da Maia e os engenheiros militares portugueses no terramoto de 1755* (Lisbon, 1910) and is reprinted in José-Augusto França, *Lisboa pombalina e o iluminismo*, 2nd ed. (Lisbon, 1977), 291–308. I am grateful to Hérica Valadares for her translation of this text.

7. António Nunes Ribeiro Sanches, *Tratado da conservação da saúde dos povos. Obra útil, e igualmente necessaria aos magistrados, capitães generaes, capitães de mar, e guerra, prelados, abbadessas, medicos e pays de familias. Com hum appendix: Considerações sobre os terremotos, com a noticia dos mais consideraveis, de que faz menção a historia, e deste ultimo, que se sentio na Europa no 1 de novembro de 1755* (Paris, 1756), 2nd ed. (Lisbon, 1757). I am grateful to Richard Ramer for making the second edition available to me.

8. Manuel da Maia, ms. III §11 in França, *Lisboa pombalina*, 302.

9. Da Maia, ms. III §15, in França, *Lisboa pombalina*, 307. Da Maia also referred here to a plan showing a tripartite street with bollards. Such a plan, drawn by dos Santos, exists at the Museu da Cidade in Lisbon. To my knowledge, it has not been firmly dated and thus cannot be connected to the comments in the manuscript. Note that Patte also accompanied his section with a plan.

10. Da Maia, mss. I §17, II §5, and III §16, in França, *Lisboa pombalina*, 295, 298, 307.

11. According to both Pereira de Sousa and França, no contemporary document has yet been found explaining the invention of the *gaiola*. We know of it only because it still exists in buildings constructed by Pombal's engineers, and because it is referred to in the caption in dos Santos's section (see Figure 2). Though the invention of the system is traditionally attributed to Carlos Mardel, França suspects that it was a solution arrived at in common, subject to considerable experimentation. See Pereira de Sousa, *O terremoto*, 3: 782–83; and França, *Une Ville des lumières. La Lisbonne de Pombal* (Paris, 1965), 89, 128–31. Da Maia, ms. I §9, in França, *Lisboa pombalina*, 293, remarked that his height recommendations were not likely to be respected for long because people, in their pursuit of profitability, would soon forget the danger inherent in tall buildings.

12. The section in any case cannot be later in date than June 1759, when Pombal was given the new title Count of Oeiras. Pombal's previous title, Sebastião José de Carvalho e Mello, can be seen in the upper left-hand corner of the drawing. França, *Une Ville des lumières*, 89. I have not yet been able to ascertain whether the section drawing referred to by da Maia still exists.

13. *Mercur de France* (Oct. 1771), cited by Mae Mathieu, *Pierre Patte. Sa Vie et son oeuvre* (Paris, 1940), 130.

14. Pierre Patte, *Mémoires sur les objets les plus importants de l'architecture* (Paris, 1769), i–ii.

15. Patte, “De la distribution vicieuse des villes, et sur les moyens de rectifier les inconviens auxquels elles sont sujettes,” *Mémoires*, 1–70.

16. Da Maia, mss. III §14 and 15, in França, *Lisboa pombalina*, 306–7. Curiously, in paragraph 14, da Maia found the English street excessively wide and thus unsuitable for use in Lisbon. Yet in the following paragraph he described, without disapproval, a plan of an even wider tripartite street, which he included among the recommended drawings. Using the conversion of 1 Portuguese palm = 0.22 meters (0.67 old French feet, for comparison with Patte's figures), da Maia's initial plan was 13.2 meters wide (40 French feet, 2 inches), with divisions of 2.2 meters (6 French feet, 8 inches) and 8.8 meters (26 French feet, 10 inches).

17. Patte, *Mémoires*, 20–21.

18. Da Maia, ms. I §16, in França, *Lisboa pombalina*, 294.

19. Patte, *Mémoires*, 19. See Robin Middleton, “Diversity, but Hygienic Please: Pierre Patte's Arcade Verdict,” *Daidalos* 24 (June 1987), 72–79.

20. Patte, *Mémoires*, 11.

21. Da Maia, ms. II §5, in França, *Lisboa pombalina*, 298.

22. Patte, *Mémoires*, 52.

23. *Ibid.*, 51–55.

24. See n. 11. Patte stated that “there are regions in which it is necessary

to construct buildings entirely of wood, as much due to the difficulty of procuring stone as to the superior resistance of wood to the tremors caused by earthquakes.” Patte then seems to have addressed his fellow architect dos Santos directly: “By using wood rather than stone or brick to resist tremors, one avoids one trap while falling into another: for house fires, once they begin to move through the rooms, consume that which the earthquake has spared.” Patte, *Mémoires*, 52. Patte promised a full discussion of anti-seismic building techniques (“I will also examine the extent to which stone houses can be made resistant to earthquakes: since the importance of these matters requires an extended discussion, I thought it necessary to treat them separately in another part of these *Mémoires*”), but the discussion never materializes. Patte, *Mémoires*, 7.

25. Da Maia, ms. III §5, in França, *Lisboa pombalina*, 302–3. The other options involved the regular collection of only solid waste. This was less desirable because liquid waste, if left to seep into the ground, could cause problems. In the first manuscript (§7 in França, *Lisboa pombalina*, 292), da Maia wondered if Lisbon should be completely relocated to the nearby, more solid area of Belem; he suggested that the center city had fared badly in part because domestic waste water had weakened the ground and made it more susceptible to the effects of the earthquake. Patte, in a similar vein, noted that tremors were more frequent in areas in which the ground was regularly soaked with water. For this reason, when choosing the site for a city, it must be assured “through the examination of the ground and the surrounding area if the site might be susceptible to earthquakes. The terrible ravages caused and the number of cities destroyed by such calamities are well known.” Patte, *Mémoires*, 4.

26. *Ibid.*, 37.

27. Jacques Ratton, in J. M. Teixeira de Carvalho, ed., *Recordações de Jacome Ratton. Sobre ocorrências do seu tempo em Portugal de maio de 1747 a setembro de 1810* (London, 1813), 2nd ed. (Coimbra, 1920), cited by França, *Une Ville des lumières*, 40, 132.

28. Da Maia, ms. III §7, in França, *Lisboa pombalina*, 303, recognized that cost might eventually be a factor in the construction of sewers.

29. This form “is far better able to facilitate the flow of waste by keeping it from catching to the left and right near the edges.” Pierre Patte, “De la construction d'un cloaque ou puisard,” in J. F. Blondel, *Cours d'architecture, ou traité de la décoration, distribution et construction des bâtiments*, vol. 5 (Paris, 1777), 373. Ratton may have seen this work, or perhaps the Chevalier de Jaucourt's criticism of the “flat” and thus dysfunctional sewer built in Paris in 1737 in “Égout,” in Jean Alembert and Denis Diderot, eds., *Encyclopédie, ou Dictionnaire raisonné des sciences, des arts et des métiers, par une société de gens de lettres*, 17 vols. (Paris, 1751–72), vol. 5 (1755), 431.

31. Da Maia, mss. III §9 and 10, in França, *Lisboa pombalina*, 304.

32. Patte notes that water had been customarily transferred from reservoirs situated throughout Paris by means of a series of lead pipes buried some three to four feet below the pavement of the street. Lying so close to the surface, however, the pipes were subject to the unevenly distributed compressive forces of the carts moving above, and broke easily. Making a repair involved digging up the street, causing an unacceptable disruption of traffic. Iron pipes were even more susceptible to breakage. Patte noted that a project was proposed “about fifteen years ago” to place clay pipes even deeper below the level of the street to prevent their breakage, and to then have smaller lead pipes leading to individual houses. The pipes were to be set in a stone channel and covered with concrete. According to Patte, this was not a bad arrangement, except that a repair would still require that the street—and the concrete—be torn up. Patte, *Mémoires*, 31–33. It is possible that this project, which is not identified by Patte, was inspired by the discovery in 1756 of a portion of what was thought to be the Roman water

supply system of Paris by the Comte de Caylus, who found a series of clay pipes set in concrete during the excavations for Ange-Jacques Gabriel's Place Louis XV. Anne Claude Philippe Comte de Caylus, *Recueil d'antiquités égyptiennes, étrusques, grecques et romaines*, vol. 2 (Paris, 1756), 375–76, pl. 112. Though it is possible that Patte was inspired by Vitruvius's suggestion that underground water pipes be placed in vaulted chambers (bk. 8, ch. 6), his more immediate source is probably Bernard Forest de Bélidor's treatise *Architecture hydraulique, ou l'art de conduire, d'élever, et de ménager les eaux pour les différens besoins de la vie*, 2 pts., 4 vols. (Paris, 1737–53), pt. 1, vol. 2, 353–54. Bélidor also discussed the proper use of iron pipes as water conduits (pt. 1, vol. 2, 350–52). Patte had begun to formulate these ideas four years earlier in *Monumens érigés en France à la gloire de Louis XV*, where he wrote that “walkways should be constructed along the parapets of the quays. A gallery, with water conduits to distribute water to houses and fountains, could then be constructed below.” Patte, *Monumens érigés en France à la gloire de Louis XV* (Paris, 1765), 228 n. A.

33. Da Maia, ms. III §14, in França, *Lisboa pombalina*, 306. França concludes that “Pombal's Lisbon owes nothing to these distant urban projects.” França, *Une Ville des lumières*, 124.

34. Johann Freidrich Pfeffinger, *Fortification nouvelle* (Amsterdam, 1698), trans. as *Fortificação moderna* (Lisbon, 1713); and Antoine de Ville, *De la charge des gouverneurs des places* (Amsterdam, 1674), trans. as *O governador de praças* (Lisbon, 1708), cited in França, *Une Ville des lumières*, 123. See Philippe Prost, “De l'architecture des villes de guerre aux XVIIe et XVIIIe siècles en France,” in Xavier Malverci and Pierre Pinon, eds., *La Ville régulière. Modèles et tracés* (Paris, 1997), for examples of similar treatises, such as Bernard Forest de Bélidor's *La Science des ingénieurs dans la conduite des travaux de fortification et d'architecture civile* (Paris, 1729), esp. bk. 4, ch. 8, “De la distribution des rues dans les villes de guerre.” Of the resemblance between these great European urban experiments and that produced by da Maia and his engineers in Lisbon, França states that “if there is some similarity to prior projects, the reasons must be sought rather in a widespread idea that had been reinforced during the seventeenth century in France and whose origins were in the Italian Renaissance.” França, *Une Ville des lumières*, 121.

35. Da Maia, ms. III §5, in França, *Lisboa pombalina*, 302–3. It is also possible that da Maia and his engineers saw remains of the sewer system of Roman Lisbon (Olisipo). Both a Roman theater and cryptoporticus were revealed by the earthquake in 1755; preserved in the remains of the cryptoporticus was a small barrel-vaulted, flat-bottomed sewer. See Jorge de Alarcão, *Roman Portugal* (Warminster, England, 1988), vol. 2, 125–26.

36. See França, *Une Ville des lumières*, 154–55.

37. Fascinating—if unlikely—prototypes for dos Santos's section are drawings by Leonardo da Vinci contained in folios 36 R and 37 R, Paris Manuscript B (ca. 1487–90), Bibliothèque de l'Institut de France, Paris. A great plague had struck Milan in 1485; Leonardo responded by reworking the city in a utopian scheme of flowing water, open space, and flushing sewers. His sections, rendered in perspective, show the street, divided in three by bollards, with buildings above and drainage canal below. See Luigi Firpo, *Leonardo da Vinci: Engineer and Architect* (Montreal, 1987), 287–302.

38. On the section renderings of the École des Ponts et Chaussées, see Picon, *Architectes et ingénieurs*, 182 (see n. 2); on the hydrographic sections, see Jean Boutier, *Les Plans de Paris. Des origines (1493) à la fin du XVIIIe siècle* (Paris, 2002), 261–62.

39. Maxwell, “Lisbon,” 33 (see n. 5).

40. Georges Dulac, “Science et politique. Les Réseaux du Dr António Ribeiro Sanches (1699–1763),” *Cahiers du Monde Russe* 43, no. 2–3 (2002), 251–73.

41. Da Maia, ms. II §11, in França, *Lisboa pombalina*, 301, for example, noted that “the polluted waters that have collected on the street of the smiths and in the Rocio, where there is no means of properly disposing of them, threaten to contaminate the air.” It was for such reasons, he stated, that reconstruction would be a great benefit to the public health and good.

42. António Nunes Ribeiro Sanches, “Vérole,” in d'Alembert and Diderot, *Encyclopédie*, vol. 17 (1766), 83. There is also a note in Ribeiro Sanches's archives entitled “Melancholia. Pour écrire l'article dans l'Encyclopédie”—but the published article has a different author. Dulac, “Science et politique,” 269 n. 62.

43. Patte resigned on 9 June 1759 to work on a rival project begun earlier by Réaumur in association with the Académie des Sciences. See Mathieu, *Pierre Patte*, 23–40 (see n. 13).

44. The bearer of these items may have been one of the Portuguese diplomats who frequented Paris, such as José Joaquim Soares de Barros. Georges Dulac, personal correspondence, 5 June 2003. Patte, to my knowledge, never traveled to Portugal; see Mathieu, *Pierre Patte*, 4.

45. França, *Une Ville des lumières*, 119–20, 121.

46. A. Tournon, in *Moyens de rendre parfaitement propres les rues de Paris* (Paris, 1789), was perhaps the first to imitate Patte's sectional rendering. See Sophie Descat, “Pierre Patte, théoricien de l'urbanisme,” in Michel Le Moël, ed., *L'Urbanisme parisien au siècle des lumières* (Paris, 1997), 61–62; and Richard Etlin, “L'Air dans l'urbanisme des lumières,” *Dix-Huitième Siècle* 9 (1977), 127. Subsequent examples are reproduced in Michel Vernes, “Une Métropole crue moderne,” in Lemoine and Mimram, *Paris d'Ingénieurs*, 45–57 (see n. 1); Cohen, “La Mise en coupe de Paris,” 106–14 (see n. 1); and Christine Blancot and Bernard Landau, “La Direction des travaux de Paris au XIXe siècle,” 155–74, and Philippe Cébron de Lisle, “Belgrand et ses successeurs, les eaux et les égouts de Paris,” 175–84, both in Bruno Belhoste, Francine Masson, and Antoine Picon, eds., *Le Paris des polytechniciens. Des ingénieurs dans la ville 1794–1994* (Paris, 1994), 155–74; 175–84.

47. The Abbé de Lubersac, for example, emulated Patte's ideas on sewers in “projects for the cleanliness of the air of the capitol and the cleanliness of the air and water,” in *Discours sur les monumens publics de tous les ages et de tous les peuples connus, suivi d'une description du monument projeté à la gloire de Louis XVI et de la France, terminé par quelques observations sur les principaux monuments modernes de la ville de Paris, et plusieurs projets de décorations et d'utilité publique pour cette capitale* (Paris, 1775), lxxv–lxxvi.

48. According to Emile Gérards, the integration of water supply with sewage removal was invented around 1840. Emile Gérards, *Paris souterrain* (Paris, 1908), 486. This innovation is placed even later by Patrick Saletta, *À la découverte des souterrains de Paris* (Antony, 1990), 282, who states that Baron Georges Haussmann and Belgrand “decided, with the goal of maximum efficiency, to combine the network of waste water evacuation with that of fresh water supply.”

49. On what Paris and other important French cities were *actually* doing about their sanitation problems, see Pierre-Denis Boudriot, “Essai sur l'ordure en milieu urbain à l'époque pré-industrielle. Boues, immondices et gadoue à Paris au XVIIIe siècle,” *Histoire, Économie et Société*, no. 4 (1986), 515–30; Pierre-Thomas-Nicolas Hurtaut, “Égout,” *Dictionnaire historique de la ville de Paris et de ses environs*, vol. 2 (Paris, 1779), 725–31; Pierre Saddy,

“Le Cycle des immondices,” *Dix-Huitième Siècle* 9 (1977), 203–14; and Jean-Louis Harouel, *L’Embellissement des villes. L’Urbanisme français au XVIIIe siècle* (Paris, 1993). “The achievements, stated Harouel, “remain well below the level of ambitions” (10). The complete absence of Patte’s visionary ideas on *canalisation* from his chapter on sewers in Blondel’s *Cours d’architecture* (Paris, 1777) suggests that Patte was aware of their impracticality. “Useful things,” said Patte, “escape our grasp nearly every time, or

rather it is that they cannot be put into practice without a complication of means that render them unworkable.” Patte, *Mémoires*, 7 (see n. 14).

### Illustration Credits

Figure 1. Patte, *Mémoires*, pl. 2

Figure 2. Biblioteca e Arquivo Histórico do Ministério das Obras Públicas, Lisbon. Photograph courtesy Kenneth Maxwell