Enlightened Secrets: Silk, Intelligent Travel, and Industrial Espionage in Eighteenth-Century France

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A great variety of travelers moved through Europe in the eighteenth century. While grand tourists headed south to experience Mediterranean climate and admire Renaissance masterpieces, savants from Mediterranean countries set out on northern tours through England, France, and the Netherlands; philosophers such as Voltaire and Pierre-Louis Moreau de Maupertuis traveled back and forth between Paris and Berlin, while itinerant demonstrators followed more erratic trajectories within and across national borders. Travel was quintessential to the culture of Enlightenment: it was part of the educational trajectory of men and often women of letters, and it was a topic of conversation, a literary genre, and an element of social mobility.[1] It was also crucial to the enlightened economy.[2] At a time

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1. Daniel Roche, ed., *Les Circulations dans l'Europe moderne*; Roche, *Humeurs vagabondes*. On travel and scientific culture, see Mary Terrall, *The Man Who Flattened the Earth*; and Marie-Noëlle Bourguet, Christian Licoppe, and Heinz Otto Sibum, eds., *Instruments, Travel and Science*. On travel and social mobility in the eighteenth century, see the articles by Vincent Denis, 359–77, and Stéphane Van Damme, 379–406, in Carla Hesse and Peter Sahlins, eds., *French Historical Studies* 29, no. 3 (2006), a special issue dedicated to "Mobility in French History."

2. Peter Jones, *Industrial Enlightenment*; Pierre-Yves Beaurepaire and Pierrick Pour-

of great industrial innovations, travels aimed at gathering intelligence on technical matters unfolded along the same routes followed by grand tourists and learned savants. The material presented in John Harris's study of industrial espionage and technology transfer provides compelling evidence that trade and technological developments were driving factors for eighteenth-century travel just as much as cultural exchange and individual refinement.[3]

Harris focused exclusively on French attempts to import British technology, yet the geography of industrial travel was far from unidirectional.[4] This article examines the role of travel in the attempts of the French state to launch the national production of high-quality silk threads and to reduce the large volume of imports from the neighboring kingdom of Piedmont-Sardinia. I analyze in particular the secret journey of Jean-Antoine Nollet (1700–1770), an acclaimed celebrity in the world of experimental science, who in 1749 was charged by the French Bureau of Commerce with the task of gathering technical intelligence on the manufacture of silk in Piedmont. Nollet traveled to Italy under the cover of a "philosophical duel" with a number of Italian savants—his involvement with silk never became public.[5] By discussing the strategies that Nollet employed to carry out his mission, and by framing his activities within the changing political economy of the bureau, this article offers a critical examination of the relationship between the openness of academic knowledge and the secrecy of state affairs in the age of Enlightenment.[6]

The public culture of science has long been the main lens through which we understand the enlightened engagement with natural philosophy and, more recently, the early processes of industrialization and the enlightened economy.[7] Such emphasis on the public, however, has obscured the role that secrecy continued to play in the eighteenth century.[8] Here, I focus

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chasse, eds., *Les Circulations internationales en Europe*. For a global perspective, see Simon Schaffer, Lissa Roberts, Kapil Raj, and James Delbourgo, eds., *The Brokered World*.

3. John Harris, *Industrial Espionage and Technology Transfer*.

4. For criticism of Harris's approach in the context of industrial development, see Patrice Bret, Irina Gouzévitch, and Liliane Hilaire-Pérez, eds., "Les techniques et la technologie entre la France et l'Angleterre"; Hilaire-Pérez, "Les échanges techniques"; and Hilaire-Pérez and Catherine Verna, "Dissemination of Technical Knowledge."

5. The controversy is discussed in Paola Bertucci, "Sparking Controversy" and *Viaggio nel paese delle meraviglie*.

6. On the problematic distinction between openness and secrecy up to the sixteenth century, see Pamela Long, *Openness, Secrecy, Authorship*. In *The Information Master*, Jacob Soll has urged historians to pay more attention to the relationship between the public sphere and state secrecy.

7. On the public culture of science, the fundamental works are Larry Stewart, *The Rise of Public Science*; and Jan Golinski, *Science as Public Culture*. Historians such as Margaret Jacob, Larry Stewart, and Joel Mokyr have linked the openness of scientific knowledge to the British Industrial Revolution. See Jacob and Stewart, *Practical Matter*; and Mokyr, *The Enlightened Economy*.

8. Jürgen Habermas's notion of the public sphere has elicited a flurry of historio-

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on the French state's interest in silk manufacture and on Nollet's secret journey with the aim of entering this unexplored territory. In contrast with Harris's unproblematic use of the category of *industrial espionage*, I argue for the necessity of historicizing terms such as *secrets* and *espionage* and propose the notion of *intelligent travel* to discuss journeys aimed at gathering technical information. Unlike industrial espionage, the category of intelligent travel does not take secrecy for granted. Intelligent travels were carried out openly by inspectors of manufactures or ambassadors as part of their job descriptions, as well as by merchants, artisans, or savants who resorted to some form of secrecy to ensure the success of their mission. Intelligent travels were characterized by varying degrees of secrecy that are to be understood in relation to the sociability of scientific and technical exchanges, and to the increasing interest of the French state in technological matters. By separating secrecy from the practice of technical intelligence-gathering through travel, I show that the openness of academic culture was one of the resources that intelligent travelers mobilized to serve the state in secret.

Industrial Espionage and Intelligent Travel

In the age of Enlightenment, the association of secrecy with the absolutist state created by Louis XIV in concert with Colbert elicited critical responses, yet opinions on the legitimacy of spying were far from unanimous.[9] In his *Esprit des lois*, baron de Montesquieu advised good monarchs not to employ spies, famously declaring that "espionage might perhaps be tolerable if it could be exercised by honest people": for him spies were abject men, whose ignominy would reflect on the reputation of the king himself.[10] However, the entry on "spy" in the *Encyclopédie* (the manifesto of the French Enlightenment) explained that "good spies" were essential to the military art and that the state should spare no cost for maintaining them; spies were particularly devoted state servants, who risked their lives for the crown.[11] Similarly, the *Treatise on Embassy and Ambassadors* highlighted

graphical discussions among scholars of the eighteenth century, who have repeatedly emphasized the public dimension of Enlightenment political and cultural debates. As Thomas Broman pointed out in "The Habermasian Public Sphere," however, the emphasis on the public in the history of science was not directly informed by the notion of the public sphere, but rather by the sociology of scientific knowledge. See Habermas, *The Structural Transformation of the Public Sphere*. It is impossible to list here all the works that have been inspired by Habermas's public sphere, but see at least Craig Calhoun, ed., *Habermas and the Public Sphere*; the articles in "Forum: The Public Sphere in the Eighteenth Century"; and James Melton, *The Rise of the Public*.

9. On the state of secrecy created by Colbert, see Soll, *The Information Master*.

10. Baron de Montesquieu, *Oeuvres de Montesquieu*, 173. Unless otherwise indicated, all translations in this article are mine.

11. *Encyclopédie*, vol. 5, 971.

the value of secrecy, remarking that "a man who speaks all he thinks, and who has not aged in the habit of never revealing his secrets, is unable to manage state affairs."[12]

Intellectuals such as Diderot and Voltaire publicly stigmatized secrecy, even though the latter engaged in diplomatic espionage while in Prussia.[13] Ange Goudar, an outspoken critic of the French political system, made the increased amount of secret activities the target of his satire. In *The French Spy in London*, he feigned criticism of Montesquieu's negative assessment of the spies' morality, explaining that a multitude of "honest people" had engaged in espionage, with remarkable social returns: "The prince's friend and the spy have become very consequential men: the former makes the pleasures of the Court, the latter those of the City."[14] In Goudar's work, every traveler who reported information from one country to another was a spy of some sort; spies were everywhere, and their ever-increasing number led to specialization. Paraphrasing Lawrence Sterne's *Sentimental Journey*, Goudar offered a taxonomy of the various spies traveling across the globe: there was "the spy of the court, the spy of the city, the spy of the palace, the spy of the table, the spy of the bed, the spy of the street, the spy of the game, the spy of men, the spy of women, the spy of spectacles, etc."[15] No industrial spy was mentioned by Goudar. This absence is even more significant when we consider that Goudar himself gathered technical intelligence for the French state in his youth.[16]

Whether with admiration or contempt, eighteenth-century readers were accustomed to the idea that travelers could be spies. Yet they were unfamiliar with the idea of the industrial spy. The word *espionnage* made its entry in the *Dictionary of the French Academy* only at the turn of the nineteenth century.[17] But it had been a recurring neologism in French popular novels, such as Jean-Paul Marana's *The Turkish Spy*, Mathieu-François Pidansat de Mairobert's *The English Spy*, Goudar's *The Chinese Spy*, and the above-mentioned *The French Spy in London*—texts that catered to the reader's fascination with travel literature, satire, and secrecy.[18] These works

12. *Traité des ambassades*, 156–57.

13. Hilaire-Pérez, "Diderot's Views on Artists' and Inventors' Rights."

14. Ange Goudar, *L'Espion François à Londres*, 1:1.

15. Ibid., 1–8; on Goudar, see Jean-Claude Hauc, *Ange Goudar*.

16. Goudar provided information to the French ambassador at Constantinople about the manufacture of *londrins* (woolen clothes made in the Levant that imitated those made in London). He was the son of Simon Goudar, general inspector of manufactures in Languedoc, and the brother of François, a textile manufacture owner who in the early 1740s traveled to Turkey to "find the secret of dyeing cotton in red, in the style of Adrianople" (qtd. in Hauc, *Ange Goudar*, 25).

17. *Espionnage* was then defined as "the action of spying, the craft of the spy": see *Dictionnaire de l'Académie Françoise*, 1:524.

18. Jean-Paul Marana, *L'Espion turc*; Mathieu-François Pidansat de Mairobert, *L'Espion anglais*; Ange Goudar, *L'Espion chinois* and *L'Espion François à Londres*. *Espi-*

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were fictional, often satirical, accounts of individual travelers reporting diplomatic news or courtly gossip from a foreign country. They associated the action of spying with those of traveling and observing—actions that were also tied together in the etymological root of the verb "to spy," from the Latin for "to observe."[19]

These fictional observers did not focus on natural or technical knowledge. Eighteenth-century spies were involved in strategic domains commonly controlled by the state, such as diplomacy, military art, the police, and in the case of Catholic countries, the Inquisition. As is well-known, however, the attempt to steal secrets of the arts motivated several travelers in the early modern period.[20] The fact that they were not perceived as spies points to the absence of a clearly formulated connection between espionage and technical knowledge until at least the eighteenth century. I suggest that such connection was created in the course of the century as a consequence of the state's growing involvement in technical matters.[21]

The category of industrial espionage takes this very same connection for granted. It unproblematically associates practices of secrecy that characterized diplomatic or other forms of espionage with industrial travels, assuming also that travelers engaged in hiding the real purpose of their journey. In fact, when dealing with the actual trajectories of his "industrial spies," Harris himself had to acknowledge that there were "varying degrees of espionage in different tours devoted to intelligence-gathering," ranging from "a tour apparently merely seeking education and enlightenment," which he branded "innocent espionage," to "an expedition of straightforward spying."[22] As Montesquieu and other authors pointed out, however, those who spied were never "innocent": for good or ill, they were well aware of what they were doing and for whom, and of the risks they were taking. I suggest that we substitute the word *secrecy* for *espionage* in Harris's sentence: there were indeed varying degrees of secrecy in the intelligent travels that the French state sponsored throughout the century. Intelligent travels were journeys aimed at gathering technical intelligence.

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on turc and *Espion chinois* were translated into English as *Letters Writ by a Turkish Spy* (1687) and *The Chinese Spy, or Emissary from the Court of Pekin* (1765).

19. Etymological dictionaries published in the late eighteenth or early nineteenth centuries traced the origin of the verb *to spy* to the German *spähen* or to the Latin *aspicere*, both meaning "to observe." See M. Ménage, *Dictionnaire étymologique*, 1:541; and B. de Roquefort, *Dictionnaire étymologique*, 1:278.

20. On the exploration of the secrets of nature in the early modern period, the classic study is William Eamon, *Science and the Secrets of Nature*; see also Elaine Leong and Alisha Rankin, eds., *Secrets and Knowledge*. See also the special issue "Openness and Secrecy in Early Modern Science," edited by Karel Davids, in *Early Science and Medicine* 10 (2005).

21. On the increasing politicization of technical innovations in eighteenth-century France, see Hilaire-Pérez, *L'invention technique*.

22. Harris, *Industrial Espionage*, 527.

They were not necessarily secret, but they could be. Intelligent travel differs from industrial espionage in that it makes the connection between secrecy, technology, and travel an object of historical analysis. It is an analytical category that invites reflections on the strategies that travelers adopted in order to fulfill their task.

As one of these strategies, secrecy in particular should not be taken as a monolithic term whose meaning remained unchanged through time. Recent scholarship has demonstrated how fruitful it can be to address the various meanings of secrecy in history.[23] The pioneering work of Pamela Long on the mechanical arts from antiquity to the sixteenth century has brought to light a wealth of sources that indicate that the historical relationship between openness and secrecy was much more complex than a polarized opposition. She demonstrates in particular that artisans could simultaneously advocate openness and protect secrecy.[24] Similarly, I will illuminate the multifaceted culture of secrecy in which intelligent travels unfolded, offering new insights on the relationship among secrets, secrecy, and technology transfer.

Silk, Secrets, and the State

Silk was a sensitive topic for the eighteenth-century French state. It was a commodity in high demand, employed to make curtains and wallpapers, to upholster chairs and sofas, and to weave sheets, cloths, socks, and veils. It was a luxury good that required several stages of production and mobilized various kinds of markets. From silkworms to aristocratic palaces, the path of the silk thread was a long one: it involved skilled workers, sophisticated technical apparatus, inflexible regulations, and various kinds of merchants and designers. The French city of Lyon was Europe's silk capital: thanks to the introduction of annual fashions, its fabrics were much in demand and circulated widely.[25] Exports of silk fabrics made in Lyon constituted a flourishing business for the French economy, yet there were aspects of the silk trade that troubled the Bureau of Commerce. The Lyon merchants did not rely upon locally produced silk threads for producing their precious fabrics, but purchased *organzine* from Piedmont. Organzine was the thread used as the warp in the process of weaving silk. Each thread of organzine was produced from two threads of raw silk that were first twisted on themselves and then twisted around each other. This double-

23. See Dániel Margócsy and Koen Vermeir, eds., special issue of *British Journal for the History of Scienc*e on "States of Secrecy," vol. 45 (2012). However, the volume bypasses the age of Enlightenment.

24. Long, *Openness, Secrecy, Authorship*.

25. On silk in Lyon, see André Doyon and Lucien Liaigre, *Jacques Vaucanson*; Charles Ballot, *L'introduction du machinisme*; Carlo Poni, "Fashion as Flexible Production"; and Hilaire-Pérez, "Cultures techniques et pratiques de l'échange."

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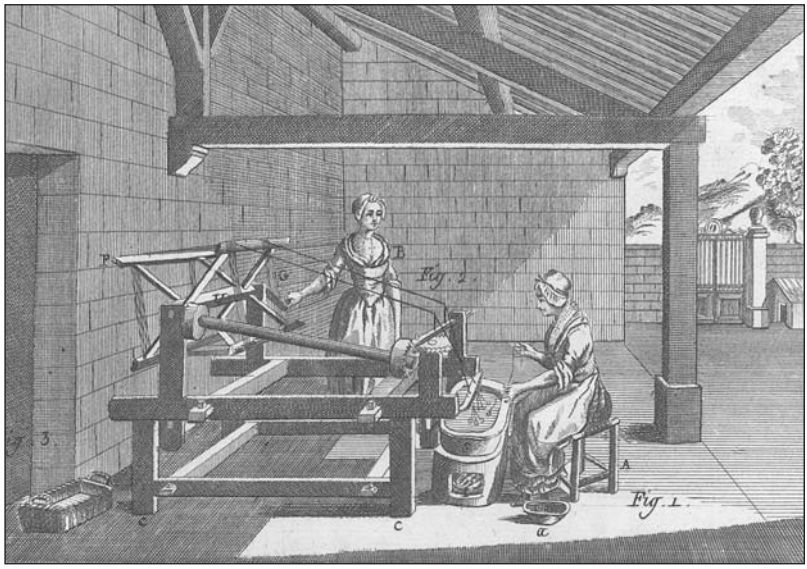

FIG. 1 Plate from the *Encyclopédie* that illustrates the making (*tirage*, or spinning) of raw silk in Piedmont. The cocoons were immersed in the basin of hot water shown on the right to kill the worm and partially dissolve the gum holding the cocoon together. The spinner would then bring into contact a number of sticky filaments (two to twenty-five, according to the desired thickness of the thread) to form a rudimentary thread; she would then twist two threads round each other before winding them individually on the manually operated reel. This process of twisting, called *croisade*, strengthened the thread and made its section round. Since the individual filaments are almost invisible, the *croisade* was a very delicate process that took several years of apprenticeship to be mastered. A to-and-fro device operated by gears ensured that the thread overlapped on the reel only after 875 turns. This prevented the threads from sticking to each other, a fault that the French called *vitrage*. The combination of basin and reel was called *tour à filer*, or spinning machine. The to-and-fro device was not present in traditional French spinning machines. In order to transform raw silk into *organzine*, the thread underwent two more twisting processes: first on itself, then round another twisted thread. These processes were performed by water-operated silk mills. (Source: Courtesy of Museo Galileo—Institute and Museum of the History of Science, Florence. Used with permission.)

twisting process was operated by sophisticated water mills (figs. 1–2). The reason why Lyon merchants preferred the foreign product had to do not only with the scarcity of French silk threads, but above all with the perceived superior quality of Piedmont-made organzine: the thread was uniform and resistant, and when woven, produced better fabrics.[26]

26. On silk manufacture in Piedmont, see Giuseppe Chicco, *La seta in Piemonte*. On

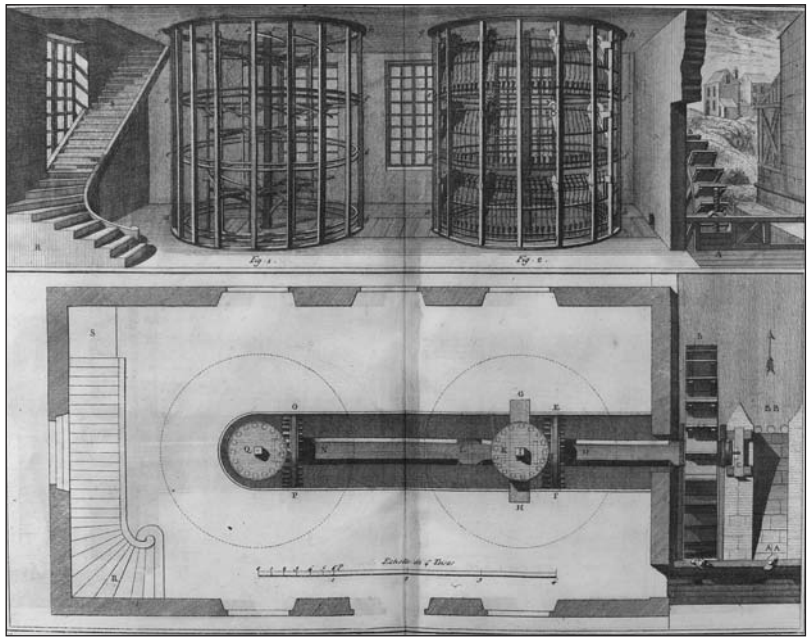

FIG. 2 Plate from the *Encyclopédie* that illustrates the water-operated silk mill that transformed raw silk into organzine. (Source: Courtesy of Museo Galileo—Institute and Museum of the History of Science, Florence. Used with permission.)

The mercantilist political economy of the French state demanded a dramatic decrease in imports of organzine. In the early 1740s, the General Controller of Finances, Philibert Orry, launched a program for promoting the manufacture of silk threads in France. He encouraged the cultivation of mulberry trees in the southern provinces, with a short-term plan of stimulating the trade of cocoons and the manufacture of raw silk (*tirage*, or spinning), and a longer-term vision of finally producing French organzine. Orry's short-term policy proved successful, with several small spinning manufactures (*petits tirages*) opening in the southern provinces, but the quality of the French products continued to disappoint the Lyon merchants who kept importing large quantities of organzine from Piedmont.[27]

Since the times of Colbert, the French state had considered manufactures and the arts as strategic domains to be kept under the control of the central administration. As Philippe Minard has shown, the Bureau of Commerce supervised manufactures in the provinces through numerous

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the "quality" of Piedmont's *organzine*, see Poni, "Standards, Trust and Civil Discourse." On the long-term history of silk manufacture in Italy, see Luca Molà, *The Silk Industry*; and Molà, Reinhold Mueller, and Claudio Zanier, eds., *La seta in Italia*.

27. *Encyclopédie*, s.v. "Murier," 10:870.

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inspectors and *intendants* who controlled the fabricants' compliance with regulations aimed at ensuring the products' quality.[28] In the course of the eighteenth century, the gathering of information through travel became a common means of rationalizing the exploitation of resources, with intelligent travelers becoming increasingly crucial for the political economy of the state.[29] They provided information on the technical aspects of manufactures as well as on the organization of labor, but above all their reports allowed administrators to compare the various policies that foreign states implemented to encourage innovation.

In line with this approach, Piedmont became the destination of several intelligent travels whose aim was to "steal the secret" of Piedmont's workshops. As Long and others have shown, this phrase (often employed by travelers as well as administrators) should not be taken at face value.[30] What did eighteenth-century travelers mean when they prepared themselves to "steal a secret"? What kind of information did administrators expect? And, more importantly, was the stolen secret the final solution to the problem of importing technology from a foreign country? The idea of a secret or a set of secrets to be stolen was crucial to the notion of industrial espionage as formulated by Harris, who wished to emphasize the role of individuals (his "industrial spies") in the process of technology transfer. However, when we historicize the notion of "secret," the resulting picture is less clear-cut. Not only do we find secrets that are not secret, we are also confronted with a variety of interpretations of what constituted the "secret."

The ambiguity of secrets is embedded in the semantics of the word. The *Dictionary of the French Academy* indicated that, when used as an adjective, the meaning of secret—hidden or concealed—differed from the meaning of the term used as a noun. Hence, secrets were not necessarily secret. In the specific context of the arts and sciences, for example, a secret was "a method known by a few people to make something, to produce some effects." Such were the secrets of the chemists, of the physicians, and of the locksmiths: these secrets could be wonderful, rare, ingenious, or useful; they could be donated, communicated, bought, or sold. In a number of mechanical arts, the dictionary continued, secrets were "some specific resources that can be put to various uses."[31] Hence, mechanical secrets and secrets of the arts were processes, inventions, or methods that were not necessarily secret: not only could they be shared within artisanal communities, they could even become open knowledge and still be called secrets. This was the case, for example, of the many books of secrets that had been

28. Philippe Minard, *La Fortune du colbertisme*. On French eighteenth-century political economy, see Simone Meyssonnier, *La Balance et l'horloge*.

29. Christine Lebeau, "Circulations internationales"; Chandra Mukerji, *Impossible Engineering*.

30. Long, *Openness, Secrecy, Authorship*; Pamela Smith, "What Is a Secret?"

31. *Dictionnaire de l'Académie Françoise*, vol. 2.

published since the sixteenth century. They contained descriptions of alchemical recipes, medical remedies, and artisanal procedures that, being published, could not be properly regarded as secret secrets.[32]

The technical processes through which the Piedmontese made organzine were largely open secrets in France. The regulations issued by the king in 1724 established exactly how organzine was to be produced. They determined by law each phase of silk manufacture, including technical details (such as the dimension of the individual components of silk mills and spinning apparatus, and how they were to be built), as well as legal ones (such as how workers were to be apprenticed and paid). Piedmont's system of production was heavily regulated, and it worked through surveillance, discipline, and punishment: the regulations were enforced through a vast apparatus of inspectors, and transgressors could be heavily fined, imprisoned, or banned from making silk.[33] De facto, the regulations divulged the secrets of Piedmont's organzine and by the late 1740s, copies both in the original Italian and in translation were circulating in France.[34]

In addition to the regulations, intelligent travelers brought back to France models of Piedmont's mills and spinning machines, as well as skilled workers, enticed in spite of the severe laws that the king of Pied-mont-Sardinia had issued to prevent spinners from leaving the kingdom.[35] François Jubié, the first in a dynasty of successful silk manufacturers in southern France, had traveled to Piedmont at the beginning of the century "to study the different preparations of silk and to steal from Italy the secrets of its workshops." He persuaded spinners, imported machinery, and established a manufacture of organzine that satisfied Lyon merchants.[36] In the 1740s, when the bureau's intention to encourage the local manufacture of organzine became known to manufacturers in the provinces, the frères Jubié, François's children, tried to persuade the bureau that they held the secret of Piedmont's success, and they wanted state aid to expand their activities to other provinces in a regime of semi-monopoly.[37] Before grant-

32. See Eamon, *Science and the Secrets of Nature*; and Leong and Rankin, eds., *Secrets and Knowledge*.

33. See Chicco, *La seta in Piemonte*.

34. Archives Nationales, Paris (hereafter AN), F12/1432A.

35. An anonymous letter to the bureau dated 1747 mentions a model of Piedmont's spinning machine in the orangerie of Jean Le Nain, *intendant* of Languedoc: AN, F12/1453A; on the enticement of skilled workers from Piedmont, see AN, F12/1432A.

36. AN, F12/1434 and F12/1435.

37. In the Archives Nationales in Paris there is plenty of material on the Jubiés. In 1745, they obtained an eight-year privilege by royal council decree (*arrêt*) for setting up a manufacture of organzine at Montauban. The Bureau of Commerce was aware of their role in the manufacture of high-quality organzine in France and supported their activities, eventually granting them the state aids they requested. One of the Jubiés became inspector of manufactures. See AN, F12/1435 and F12/1436; their overall plan is discussed in AN, F12/1432A: "Memoire sur le bon tirage de soie." See also Ballot, *L'Introduction du machinisme*.

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ing this to the Jubiés, however, the bureau decided to send other intelligent travelers to Piedmont.

The reasons for the bureau demanding more information from Piedmont highlight the shortcomings of the notion of industrial espionage in accounting for the processes of technology transfer. Studies in the social history of technology have questioned determinist notions of technical success, emphasizing in contrast the local and contingent nature of early processes of mechanization. Although machines and skilled workers did migrate between different geographical and administrative contexts, what constituted technical success—or what it meant that a machine "worked"—was the result of new negotiations occurring at the local level.[38] This perspective challenges the idea, implicit in the notion of industrial espionage, that once the "secret" is identified and stolen it can be successfully transferred to another context. The problem of setting up silk manufactures in France that would produce organzine of the same quality as that of Piedmont was not just a matter of "stealing the secret" of Piedmont's workshops. The local fabric of the French state presented the bureau with problems not present in Piedmont; the tension between the local intendants' support for the *petits tirages* and its own preference for the top-down imposition of regulations was the most pressing one.[39] Although individual travelers believed they brought back to France the secret of Piedmont's success, the state faced the problem of devising strategies for enforcing a working system of production on its territory. As Chandra Mukerji has shown in the case of the building of the Canal du Midi, this process entailed complex negotiations at the local level, and it could even undermine the structure of power of the central state.[40]

If the quality of French-made silk threads was a pressing problem for the bureau, it was not perceived the same way by the *petits tirages* in the provinces. These family-scale businesses that operated only during the silk season (roughly fifty days per year) did not have any incentive to focus on producing better-quality silk threads. As scholars have shown, the production of high-quality threads was hard on spinners; in Piedmont, it was enforced by a rigid system of surveillance, as well as by a reformed salary system.[41] This explains why the machines and the spinners that Jubié imported from Piedmont did not solve the problem of establishing high-quality, French-made organzine. Although the Jubiés' manufactures were successful at a relatively small scale, their requests to the bureau had greater polit-

38. Donald MacKenzie, "How Do We Know the Properties of Artefacts"; in the case of the eighteenth-century manufacture of olive oil, see Massimo Mazzotti, "Enlightened Mills."

39. Ballot, *L'Introduction du machinisme*.

40. Mukerji, *Impossible Engineering*.

41. Chicco, *La seta in Piemonte*; Poni, "Standards, Trust and Civil Discourse." Piedmont's spinners received a fixed daily salary, unlike French spinners, whose pay depended on the amount of raw silk they produced.

ical implications that touched on the delicate issue of the relationship between the central state and its provinces.

As Liliane Hilaire-Pérez has argued, in eighteenth-century France, technological innovations and their applications to manufactures were political matters.[42] The problem of achieving and maintaining high-quality organzine was as related to the understanding of the reasons behind Piedmont's success as it was to the role that the French state should play in the organization of manufactures. The fact that technological innovations had political implications was very clear to Jacques Vaucanson, the newly appointed inspector of silk manufactures. His intelligent travel to Piedmont in 1742 convinced him that the strict enforcement of regulations was the secret of Piedmont's success.[43] However, Vaucanson did not advocate the imposition of the very same regulations in France: he proposed that the state should supervise the creation of five great Royal Manufactures, funded by a large company made of the wealthiest Lyon merchants, who had an interest in locally produced, less expensive organzine.[44] The Royal Manufactures would employ silk mills and spinning machines invented by Vaucanson himself, and would operate according to regulations that he prepared. Although the bureau compensated Vaucanson's inventions generously, in 1744, as is well-known, this top-down "great design" fared poorly because of the violent riots organized by Lyon master-workers, who feared that the new regulations would deprive them of all the privileges they had secured several years earlier.[45]

Vaucanson's proposals, like those of the Jubiés, aimed at establishing large manufactures of raw silk at the expense of the *petits tirages*.[46] Local intendants, however, were aware that these manufactures provided employment to many local residents and responded to the bureau's request to improve the quality of French silk by encouraging inventions aimed at correcting the faults of the silk produced in *petits tirages*. For example, the intendant of Languedoc, Jean Le Nain, resolved to entrust to a local resident, who had a "talent for mechanics," the task of improving the quality

42. Hilaire-Pérez, *L'invention technique*. On the politicization of technology in eighteenth-century France, see also Steven Kaplan, *Les ventres de Paris*.

43. Doyon and Liaigre, *Jacques Vaucanson*.

44. Archive Départementale de l'Hérault, C 2272, dossier 30. "Des observations que le sieur Vaucanson a faites dans sa tournée de la précédente année 1742 des soies de France et de celles du Piémont et de la différence de leur fabrication," published in Doyon and Liaigre, *Jacques Vaucanson*, 456. Vaucanson traveled with Lyon entrepreneur Claude Montessuy, who left a report of their tour: AN, F12/1447.

45. Vaucanson's compensation for his spinning machine is listed in AN, F12/823. The material in AN, F12/821 lists several other generous compensations Vaucanson received from the bureau. On the failure of his "great design," see Doyon and Liaigre, *Jacques Vaucanson*.

46. The Jubiés believed that the bureau should abolish the *petits tirages*; see "Memoir sur le bon tirage de la soie," AN, F12/1432A.

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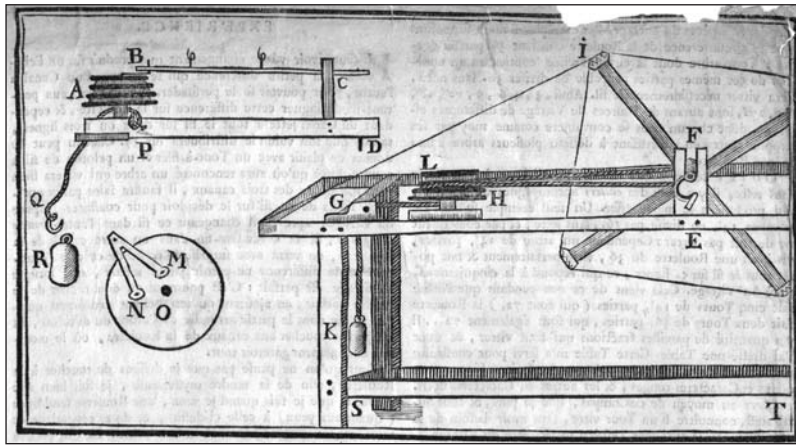

FIG. 3 Soumille's roulette (on the left) applied to traditional French spinning machines (right). According to Soumille, traditional French spinning machines worked like those of Piedmont when corrected with his roulette: the thread would not overlap on the reel until perfectly dry, thus avoiding the vitrage. (Source: Detail from "Moyen infaillible d'éviter le vitrage," Archives Nationales de France, Paris. Used with permission.)

of locally produced raw silk.[47] The abbé Soumille devoted several years to the study of silk manufacture, focusing on the faults that derived from the use of traditional French spinning machines (*tour à tirer la soie*) employed in the *petits tirages*. He conceived of a simple device—a roulette—that could be applied to the machines to correct such faults (fig. 3). Unlike Vaucanson's machine or those employed in Piedmont, Soumille's roulette did not require complex changes in the organization of labor: spinners could continue to work as they used to, without having to learn new techniques. According to Soumille, the *petits tirages*, just as larger manufactures, would be able to produce faultless raw silk without purchasing ex-pensive machinery. Costing only 54 *sous*, the roulette was an inexpensive device that presented itself as a convenient alternative to Vaucanson's machines, and several manufactures began to employ it in Languedoc. Local intendant Le Nain urged the bureau to issue an ordinance that would impose it on all manufactures in his jurisdiction.[48]

Making decisions about which strategy to adopt proved difficult for the members of the Bureau of Commerce. To complicate things further, several reports that circulated at the bureau suggested that not everything about Piedmont's workshops was known in France, and that the available information was inaccurate. Crucial technical details, such as the exact number of teeth on the gears of Piedmont's spinning machines, were in-

47. Materials about the "affair Soumille" are in AN, F12/2201.
48. AN, F12/2201. See also Hilaire-Pérez, *L'invention technique*.

consistent in various reports from Italy.[49] It was in this climate of uncertainty that the bureau decided to recruit a new kind of consultant. Accustomed to being offered expert advice by affiliates of the Royal Academy of Sciences, bureau members recruited the abbé Jean-Antoine Nollet, a learned savant with a background in the mechanical arts and an associate in the class of mechanics at the academy.[50] Unlike Vaucanson, the Jubiés, or other intelligent travelers, Nollet did not have any vested interest in the manufacture of silk. The bureau believed that his report would differ from those already available, as it would offer neutral expert advice based on theoretical, as well as practical knowledge. Nollet would provide the "necessary instructions to verify the information that we already have, or that we think we have" on the manufacture of organzine, "following the rules of the most certain physics." Such advice, the bureau members believed, would put an end to any uncertainty about the secret of Piedmont's success: "the things that are already known in France, and that he will confirm, will be regarded as undeniable . . . those that will appear imprecise, or unknown, he will reestablish or will make known by means of principles, which has not been done so far."[51]

Secrecy, Dissimulation, and Public Science

When he traveled to Piedmont in 1749, Nollet was at the apex of his career. He had been a member of the Paris Academy of Sciences since 1739, promoted to associate in 1742. He owed his celebrity to the courses of experimental physics that he offered in his house in Paris that, since 1734, had attracted wide audiences, including aristocratic ladies and local and foreign savants. Nollet was also an instrument-maker (he furnished Voltaire's expensive physics cabinet) and an acclaimed author of popular books that were translated into various languages. He was not new to Piedmont. It was there that he held his first court position: in 1738, he was summoned by the king of Piedmont-Sardinia to work for six months as the physics tutor to the crown prince. This royal assignment was only the first

49. AN, F12/1453: "De la méthode dont le piemontois se servent pour tirer le soie qu'il cueillent" (1747). It is impossible to survey here all the material contained in the F12 file at the Archives Nationales in Paris on the attempts to improve the quality of French-made silk threads. There is no study on the manufacture of silk threads in France, except references in Doyon and Liaigre, *Jacques Vaucanson*, and in Ballot, *L'Introduction du machinisme*.

50. Nollet was commonly referred to as "abbé Nollet," yet he was only a theology graduate, not an abbot. In the eighteenth century, the term *abbé* could indicate a layman who wore the ecclesiastical robe. This was also the case with the "abbé" Soumille. On the relationships between the academy and the bureau, see Roger Hahn, *The Anatomy of a Scientific Institution*, and Charles C. Gillispie, *Science and Polity in France*.

51. AN, F12/1453: "Observations sur le filage des soies" (Gaudin to Trudaine, Jouy, 30 June 1749).

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in the abbé's career. Six years later, he was invited to teach physics to the French dauphin at Versailles, a position frequently renewed and extended so that the entire royal family could enjoy his spectacular physics lectures. In the 1740s, he specialized in electricity, a branch of experimental philosophy that boomed in European courts and palaces thanks to demonstrations based on sparks and shocks. It was electricity that gave him a good cover for his travel south of the Alps. In 1747, a number of Italian savants claimed that they could use electricity to cure instantaneously all kinds of diseases, but their experiments did not seem to meet with success in other countries. Skeptical about these seemingly miraculous treatments, Nollet staged a philosophical duel with his Italian counterparts. So officially, he toured Italy in order to meet with his adversaries, whom he challenged to perform the electrical cures in his presence.[52]

Nollet was not new to the Bureau of Commerce. The general controller of finances Jean-Baptiste Machault and his intendant Daniel-Charles Trudaine were both honorary members of the Royal Academy of Sciences, an institution strictly tied with the worlds of technology and commerce.[53] Nollet's mentors at the academy, René Réaumur and Charles de Chisternay Dufay, both served the Bureau of Commerce. The former was an expert on the mining industry and championed the idea that members of the academy should serve as state administrators.[54] Dufay, who had initiated Nollet in the knowledge of electricity and traveled with him to England and the Netherlands, worked for the bureau as an expert on textile dyes. Through his relationship with Réaumur and Dufay, Nollet's reputation grew not only in the world of the academy, but also in state administration. Positions as experts for the Bureau of Commerce were often awarded on the basis of personal connections, so on Dufay's death in 1740, Nollet was surprised to learn that his colleague Jean Hellot was chosen as his mentor's successor: "This position was promised to me . . . and I was flattered with this expectation even more positively not more than three weeks ago . . . I am not saddened and I will not become, because of this, more active in running from waiting room to waiting room in order to seize fortune."[55] Although he commented that waiting rooms were not his place, in the course of the ten years between his first and his second travel to Piedmont, Nollet had learned to live the life of the courtier. The king invited him repeatedly at Versailles where, in addition to his lectures for the royal family, he staged

52. On Nollet, see Jean Torlais, *L'abbé Nollet*; Geoffrey Sutton, *Science for a Polite Society*; and Lewis Pyenson and Jean François Gauvin, *The Art of Teaching Physics*.

53. Hahn, *Anatomy of a Scientific Institution*; Gillispie, *Science and Polity in France*; Hilaire-Pérez, *L'invention technique*.

54. Archives de l'Académie des Sciences, Paris (hereafter AASP): Dossier Réaumur, *Réflexion sur l'utilité dont l'Académie des Sciences pourrait être au Royaume, si le Royaume lui donnait les secours dont elle a besoin* (n.d.).

55. Bibliothèque Publique Universitaire, Geneva: Nollet to Jallabert (20 January 1740), published in Isaac Benguigui, *Théories électriques*.

well-attended spectacular demonstrations. The Bureau of Commerce members resided at Versailles and it is likely there that Nollet resumed his interactions with Antoine-Louis Rouillé, comte de Jouy, the bureau director.[56]

Unlike Vaucanson, who traveled to Piedmont in his official role as France's inspector of silk manufactures, Nollet went under cover. Only a small, restricted number of people were informed of the real reasons for his journey. Everyone else believed that he was traveling through Italy as a member of the Paris Academy of Sciences, interested in putting an end to an international debate on controversial electrical therapies. The bureau planned his departure so he could be in Piedmont during the silk season and forwarded to him a number of memoirs that explained the processes of the manufacture of silk. Nollet was instructed to send his letters to an intermediary at Jouy, near Versailles, who would forward them to the bureau.[57]

The secrecy surrounding this operation was similar to the strategies employed in diplomatic espionage, yet Nollet should not be regarded as a "straightforward spy," in Harris's vocabulary. He did not need to cipher messages, as Voltaire did from Prussia in his letter to the minister of Foreign Affairs, nor did he find himself in the uncomfortable position of having to lie to the king of Piedmont, who warmly welcomed him back after ten years. His correspondence with Trudaine at the Bureau of Commerce points to a more sophisticated engagement with the culture of dissimulation and secrecy. Nollet explained: "I have done nothing in Piedmont that might expose me to reproaches from the King, who honors me with his kindness. I haven't concealed any of my researches or initiatives from H. M., he knows everything from myself, and he has approved everything."[58]

This apparently paradoxical declaration points to the intriguing ways in which the values of openness that sustained academic reputations could be put at the service of secret affairs. Nollet's journey unfolded along gentlemanly codes of behavior that complied with the ideal formula Francis Bacon enunciated in his *On Simulation and Dissimulation*: "openness in fame and opinion, secrecy in habit, dissimulation in seasonable use, and a power to feign, if there be no remedy."[59] Although it was increasingly under scrutiny in the eighteenth century, dissimulation was still widely practiced at Versailles. Works such as *The honest man, or The art of pleasing the court* and *Treatise on the court* explained that dissimulation—the ability to disguise one's intention and to withhold information without lying—was essential in the life of the courtier.[60] If lies were utterly incom-

56. On science at court, see Mario Biagioli, *Galileo, Courtier*.

57. AN, F12/1453.

58. Nollet to Trudaine, Venice, 31 July 1749, "Observations sur le filage des soies," in AN, F12/1453.

59. Bacon's standing on dissimulation and secrecy is discussed in Jon Snyder, *Dissimulation and the Culture of Secrecy*; and Steven Shapin, *A Social History of Truth*.

60. Nicolas Faret, *L'honneste-homme*; Eustache de Refuge, *Traité de la Cour*.

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patible with gentlemanly status, dissimulation, on the contrary, was an art that required self-control and presence of mind, virtues that a natural philosopher like Nollet had long mastered.[61]

Whereas the normative treatises on dissimulation published in the seventeenth century fail to offer any insight on the actual *practices* of dissimulators, Nollet's letters to the bureau provide firsthand accounts of the different registers he employed while dissimulating, and of the ways in which he hoped to capitalize on his ability as a dissimulator. They point in particular to the function that his public reputation played in covering the secret reasons behind his interest in silk. Nollet's status at the court of Turin (the capital of the Kingdom of Piedmont-Sardinia), as well as his fame as a popular demonstrator and honored academician, allowed him to disguise his visits to silk mills as a tribute he paid to his hosts' technical and economic success. As a respected savant, he could easily dissimulate the nature of his interest in silk manufacture as learned curiosity:

> I don't know what the people who had the complaisance to take me around will have thought of me: I saw them hundreds of times laughing up their sleeve at the eagerness with which I walked into the workshops [*cassines*] to see in all stages those little creatures that work for men's luxury; these gentlemen will have undoubtedly thought that, by looking so many times at the same thing, I was curious to the point of childishness, and I think that they will have believed me strongly deprived of memory, since they saw me doing and repeating the same thing twenty times in different places.[62]

Nollet's reputation and his international notoriety were crucial elements to the success of his mission. When he arrived in Turin, he was warmly welcomed by the king, who still remembered with pleasure the lectures and entertaining demonstrations the abbé had given to the royal family a decade earlier. Charles Emmanuel III offered Nollet an apartment at court, another in the city, and a servant. He also invited him to once again stage scientific spectacles for the royal family and to join them in official ceremonies. The king was so enthusiastic over his guest as to grant him a knightly decoration that had never before been bestowed on a Frenchman.[63] Meanwhile, in the course of two months, Nollet visited silk manu-

61. On early modern discussions on dissimulation and secrecy, see Snyder, *Dissimulation and the Culture of Secrecy*.

62. Nollet to Gaudin, Turin, 21 June 1749, "Observations sur le filage des soies" in AN, F12/1453.

63. During his journey through Italy, Nollet completed a diary in which he annotated his activities daily. The manuscript diary is kept in the Bibliothèque Municipale de Soisson, MS 150, "Journal du voyage de Piémont et d'Italie en 1749" (hereafter "Journal"). Nollet was initially inclined to refuse this decoration, the Cross of St. Maurice; it took several years to obtain permission from the French king to accept it: AN, O1/402, f. 664v–665 (29 December 1760).

factures and compiled detailed memoirs with drawings of reels and gears, measurements of components, analyses of the cocoon and mulberry-tree-leaves trade, examples of common frauds, and descriptions of silkworms' maladies. No one at court questioned the nature of his curiosity. On the contrary, the royal family was so pleased with their guest's interest in silk manufacture that the crown prince made a point of taking Nollet personally to a silk manufacture not far from the royal palace at Venaria.[64]

Intelligent Networks and the Moral Economy of Secrecy

Historians of science and technology have variously adopted and reinterpreted E. P. Thompson's influential notion of a *moral economy* to discuss the systems of values that characterize scientific and technical exchanges.[65] Similarly, I will employ this concept not so much to test the validity of Thompson's analysis, but rather to discuss the implicit moral values that regulated the exchange of information during intelligent travels. While Harris employed the concept of industrial espionage to call attention to the individuals who contributed to the processes of technology transfer, the notion of intelligent travel highlights the local relationships that each traveler established in order for his or her mission to succeed—which I will call "intelligent networks." In order to obtain useful information, travelers who reached foreign countries had to rely upon translators, interpreters, intermediaries, and other go-betweens who provided access and information.[66] It was only through their intercession that knowledge could be obtained, as Mukerji has vividly shown in the case of the Canal du Midi.[67] These intelligent networks mediated the kind of knowledge that travelers received and were therefore crucial to any understanding of the secret. Mediators could misrepresent essential data, or keep silence on crucial pieces of information—as several intelligent travelers realized. Hence,

64. Nollet, "Journal." The memoirs Nollet sent to the bureau during his travels through Italy do not survive, yet his journal records the details he obtained on the manufacture of silk.

65. E. P. Thompson introduced the term *moral economy* to provide an explanation of crowd action in eighteenth-century England that distanced itself both from the psychology of the mob and from exclusively economic motivations. Thompson pointed to a system of moral values that tacitly regulated the exchanges between producers and consumers; the riots resulted from a widespread sense of social injustice resulting from the violation of such tacit values. See Thompson, "The Moral Economy." Historians of science and technology have variously appropriated and reinterpreted Thompson's idea; see, for example, Robert Kohler, *Lords of the Fly*; Strasser, "The Experimenter's Museum"; Lorraine Daston, "The Moral Economy of Science"; and W. Patrick McCray, "Large Telescopes."

66. On the role of intermediaries and go-betweens, see Schaffer et al., eds., *The Brokered World*.

67. Mukerji, *Impossible Engineering*.

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the ability to organize a reliable network of informants was a distinctive skill of a capable intelligent traveler. The constitution of such networks rested on an economy of exchange that was tacitly regulated by shared moral rules: a moral economy of secrecy.

We can see these dynamics at work by analyzing how Nollet constituted his intelligent network in Piedmont. His status as a savant, as well as his background as an artisan, made it possible for him to rely on a heterogeneous group of informants, comprising academicians, merchants, owners of manufactures, and workers. The moral economy of secrecy required a diversified repertoire of rewards—what Nollet called "*petites gallanteries*"—to be offered in exchange for information.[68] If bribing was effective with the poorest workers, monetary compensation would have been insulting to other sources who inhabited the same academic world as Nollet. Self-identified citizens of the Republic of Letters shared tacit rules of free exchange and open circulation that set them morally apart from the world of trade where information was sold and bought. Disinterestedness and trust were primary values in the learned communities in which Nollet operated; avoiding pecuniary motives among peers was essential to characterize their transactions as cultural exchanges.[69] The abbé's main contact, for example, the recently retired physics professor at the University of Turin, Francesco Garro, joined Nollet's network in exchange for a position as a foreign correspondent for the Paris Academy of Science. Nollet, who had met Garro ten years earlier during his first visit to Turin, knew that "in order to become a foreign correspondent for the Academy, which I have promised to him, he will do, and will do well, all I ask of him."[70]

Garro accompanied Nollet in his tour of the Italian peninsula, acting as his interpreter, and was instrumental in recruiting Piedmont's royal mechanician, Isaac François Matthey, to Nollet's network. Matthey had obtained his position as a result of various strategic inventions in the military domain that were kept as "state secrets." Prior to his appointment, he had distinguished himself through a number of inventions addressed to silk manufacturers and merchants.[71] Although he held a royal appointment, Matthey's

68. Nollet to the Bureau, Turin, 21 June 1749, in AN, F12/1453.

69. On the gentlemanly codes of early modern experimental philosophy, see Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump*.

70. Nollet to Trudaine, Venice, 31 July 1749, in AN, F12/1453.

71. In 1747, Matthey obtained a royal privilege for a furnace that allowed owners of silk manufactures to save on wood. He also designed a hygrometer that enabled merchants to measure how much humidity had been absorbed by silk bundles, and, most important, a machine, later called a "serimeter," that allowed them to select the most suitable bundles. The serimenter was commissioned by a Genevan banker and caused "a lot of distress and jealousy to the merchants who did not own it" (Nollet, "Journal," f. 49v). On the privilege that Matthey obtained and his various inventions for silk manufacturers and merchants, see Biblioteca Reale, Torino: Storia Patria 1096 (Ghiliossi di Lemie, *Arti e Manifatture*), f. 111. Matthey's inventions are referred to as "state secrets" by Edward Gibbon in his *Viaggio in Italia*, 61–62.

pension from the king was modest, and at the time of Nollet's visit, he was preparing a formal complaint in which he demanded more substantial rewards for his contributions to the state's prosperity.[72] Rewards for inventions were regulated by patron–client relationships and were heavily dependent on the king's will and whims. Academic credentials could bolster inventors' reputations and enhance their chances of gaining the king's favor. Hence, with his offer to present Matthey's newly invented hygrometer at the Academy of Sciences in Paris, Nollet easily obtained the inventor's collaboration. Nollet received from Matthey drawings of silk mills and measurements of each element, as well as details about the commerce of silk.[73] Matthey also provided an address in Geneva for Nollet to safely exchange letters with the bureau.[74]

The moral economy that regulated the exchanges among Nollet, Garro, and Matthey highlights the role that the public culture of science played in blurring the border between secrecy and openness. Both Garro and Matthey were public figures in Piedmont's cultural life. They contributed to the creation of an educational and research center based at the arsenal in Turin, which focused on the useful applications of experimental philosophy.[75] In their interactions with Nollet, both Garro and Matthey treaded a fine line between secrecy and openness: they offered Nollet access to the manufactures as a peer, a learned savant with a strong interest in the practical applications of experimental knowledge, without asking too many questions as to the destination of the information he was gathering. It is unlikely that they did not realize what they were contributing to, but it was in the interest of preserving their own reputations to dissimulate in their turn according to Nollet's wishes. Visits to the arsenal or to silk manufactures were not unusual requests on the part of learned foreigners; it was one of the royal mechanician's duties to provide access to such places. In 1764, Edward Gibbon enjoyed Matthey's guided tours and was impressed by his inventive ingenuity.[76]

Thanks to his background as an instrument-maker, Nollet could also barter invention for information. He explained to his correspondents in Paris that he had repaid an "honest man" of "the innumerable curious things he had the compliance of sharing with me" by designing for him a more efficient furnace. The man owned a silk manufacture and introduced Nollet to all the processes leading to the production of organzine, with a

72. Archivio di Stato, Torino: Reg. 22, ff. 91v–92v.

73. Nollet, "Journal." Nollet did present Matthey's invention to the academy; see AASP, *Procès Verbaux*, tome 71 (1752), f. 389.

74. Matthey belonged to a Protestant minority with strong ties to the Haldimans, a Geneva family of bankers who exported Piedmont's organzine. This is recorded in the De Luc papers held in the Bibliothèque Publique Universitaire, Geneva: Haldiman to De Luc, Turin, 6 September 1771.

75. Vincenzo Ferrone, *La nuova Atlantide e i lumi*.

76. Gibbon, *Viaggio in Italia*, 59.

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view toward obtaining from Nollet an improved furnace that would cut the expense of wood.[77]

The mobilization of learned curiosity to dissimulate the interests behind intelligent travel, however, did not work in the world of trade and commerce, whose inhabitants did not share the same tacit values of the academic world. Accustomed to guarding themselves against frauds and cheating, Piedmont's merchants became suspicious of Nollet's insistent curiosity. After two months of visiting manufactures, Nollet reported to the bureau that it had become "prudent to hide myself from the sight of the merchants in Turin, who began to gossip loudly about my researches." He needed to return to the philosophical duel that secured his disinterestedness and so distance himself, at least for some time, from the world of trade where his intentions were now being questioned. In justifying his determination to avoid further communication with the bureau, he underscored the difference between his open practice and the malicious intentions that the merchants were projecting on it: "a lot of people have gossiped and if I had engaged in correspondence with statesmen in France, they would not have failed to put my intentions in a bad light, thus making a crime of what I could do innocently."[78]

Nollet's insistence on the "innocence" of his travel may remind us of Harris's label of "innocent espionage." However, as we have seen, Nollet traveled under cover, bribed informants, and sent his letters to the bureau via mediators. But the notion of straightforward spy, as discussed above, is equally difficult to apply. This impasse is due to the inability of the category of espionage to take into account the varying degrees of secrecy that travelers mobilized. If we think instead in terms of intelligent travel, we can discuss the multifaceted cultures of secrecy, dissimulation, and openness that were available to our historical actors. The case of Nollet's journey undoubtedly indicates that the French state began to apply methods typically employed in diplomatic espionage to the domain of technology. It also shows that the connection between technical knowledge and state-directed espionage, which was still invisible in dictionaries and texts of the eighteenth century, was emerging at that time.

The Circulation of Secret Knowledge

Intelligent travels such as Nollet's could be handsomely rewarded: several inspectors of manufactures and expert consultants for the Bureau of

77. Nollet to Trudaine, 21 June 1749, in AN, F12/1453. Most likely, this man was one of the Gioanettis, a family of magistrates and owners of silk manufactures in Turin, who gave Nollet access to their silk manufactures. In 1746, the Gioanettis signed a petition to the king to obtain more favorable regulations for entrepreneurs. See Simona Cerutti, *Giustizia sommaria*.

78. Nollet to Trudaine, 21 June 1749, in AN, F12/1453B.

Commerce received their appointments after presenting the results of their journeys.[79] By insisting on the difference between his innocent curiosity and the suspicious world of trade, between the gossiping merchants and the welcoming gentlemen who openly showed him the processes of silk manufacture, Nollet placed himself in the latter context. He wanted his superiors at the Bureau of Commerce to understand his report as the work of a savant, profoundly different from any other report they might have received. In offering to complete his mission by visiting silk manufactures in the French provinces, Nollet was clearly inviting his superiors at the bureau to reward him with a position in state administration.[80] The bureau, however, had different plans for how to use the information Nollet provided, as well as for the expertise on silk manufacture that he had obtained during his intelligent travel.

While Nollet was in Italy, a reorganization at the top of the bureau gave new directions to the policies to encourage French manufactures. The arrival of Trudaine as the bureau's director in 1749, followed by the appointment of Vincent de Gournay as intendant of finances, resulted in a distinctively more liberal approach to political economy.[81] The new bureau rejected the emphasis on regulations that characterized Orry and Rouillé's leadership, in favor of an enlightened political economy of improvement, aimed at educating manufacturers and merchants in the provinces.[82] This, in turn, resulted in a more cautious consideration of Piedmont's heavily regulated system of production, which was no longer regarded as the model to be imitated in France.

The new bureau's emphasis on improvement, education, and emulation privileged Vaucanson's inventions, which were gaining a lot of attention in the public domain. In 1745, the *Mercure de France* published an enthusiastic article about Vaucanson's spinning machine, which prompted the minister of the Marine, the count of Maurepas, to propose his election to the Academy of Sciences.[83] In line with a new public interest in technological achievements, the Academy of Sciences entrusted Vaucanson with the presentation of his new inventions for increasing the production of French organzine at a public meeting.[84] The academy's public meetings were attended by a variety of people not normally allowed in the institution, and

79. Minard, *La Fortune du colbertisme*, 214–15.

80. AN, F12/1453B.

81. On the eighteenth-century French political economy, see Meyssonnier, *La Balance et l'horloge*.

82. Montessuy elaborated a project for a spinning academy around 1750. Maîtregarde of the Lyon merchants, he accompanied Vaucanson in Piedmont in 1741 and contributed to his plan. See Doyon and Liagre, *Jacques Vaucanson*.

83. Gillispie, *Science and Polity*; *Mercure de France*, November 1745, 116–20.

84. Jacques Vaucanson, "Construction d'un nouveau tour," 142–54. On the public interest in technological innovations, see Stewart, "A Meaning for Machines"; and Hilaire-Pérez, "Technology, Curiosity, and Utility."

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the topic of silk manufacture matched contemporary public interest. Making silk had become a fashionable domestic amusement for those who wished to savor countryside practices in urban context: among the many goods that could be purchased in the high-end rue Saint-Honoré were prepackaged boxes containing silkworm grains, mulberry tree leaves, and instructions on how to breed silkworms and spin silk from cocoons at home.[85]

Complying with the emphasis on education and improvement established by Trudaine and Gournay at the bureau, the memoir that Vaucanson read at the academy's public meeting launched a campaign against the ignorance that pervaded the manufacture of raw silk in the southern provinces and solicited the intervention of the central government to eradicate what he saw as the faulty procedures of ignorant artisans-turned-entrepreneurs. In line with the more liberal orientations of the new bureau, Vaucanson's new plan did not invoke regulations. He explained that the superiority of Piedmont's organzine was to be looked for in the very first stage of the manufacture of silk: the making of raw silk (*tirage*). Contrary to what happened in France, in Piedmont, it was carried out with minimal waste and with no faults. The preparation of organzine itself was no secret: it was because the Piedmontese produced better raw silk that they could prepare organzine of superior quality and sell it at a higher price. The techniques for making organzine were well-known in France, but because of the poor quality of local raw silk, all the subsequent preparations were doomed to be of similar poor quality. Vaucanson pointed to widespread ignorance as the cause of French backwardness: "perhaps we will be surprised that such an industrious and active nation as ours remained in [a state of] ignorance in this subject for so long." He blamed the poor quality of French raw silk on the *petits tirages*, who maximized profit at the expense of quality. The manufacture of raw silk, Vaucanson declared, was in the hands of "people from the countryside, unable to correct themselves, and normally little inclined to allow others to instruct them."[86] He explained that in Piedmont, the making of raw silk relied upon a delicate process, the *croisade*, which depended entirely on the spinners' embodied skills. This tacit knowledge embodied in the hands of Piedmont's spinners was acquired in the course of a long apprenticeship and was virtually absent in France. Vaucanson's new spinning machine (*tour à la double croisade*) automated the *croisade*, making the spinners' expertise superfluous (fig. 4). Vaucanson presented his technological innovations within a political project that accorded with the new bureau's visions. The bureau rewarded him with the extraordinary amount of 10,000 *livres*.[87]

85. *Affiches de Paris*, 21 April 1749.

86. Vaucanson, "Construction d'un nouveau tour," 145.

87. AN, F12/821. Vaucanson received an annual salary of 12,000 *livres*. The Jubiés strongly opposed Vaucanson's spinning machine; see AN, F12/1432A: "Observation sur le tour a filer la soie de Vocanson" (this memoir contains a draft of regulations that the Jubiés sent to Trudaine in 1751).

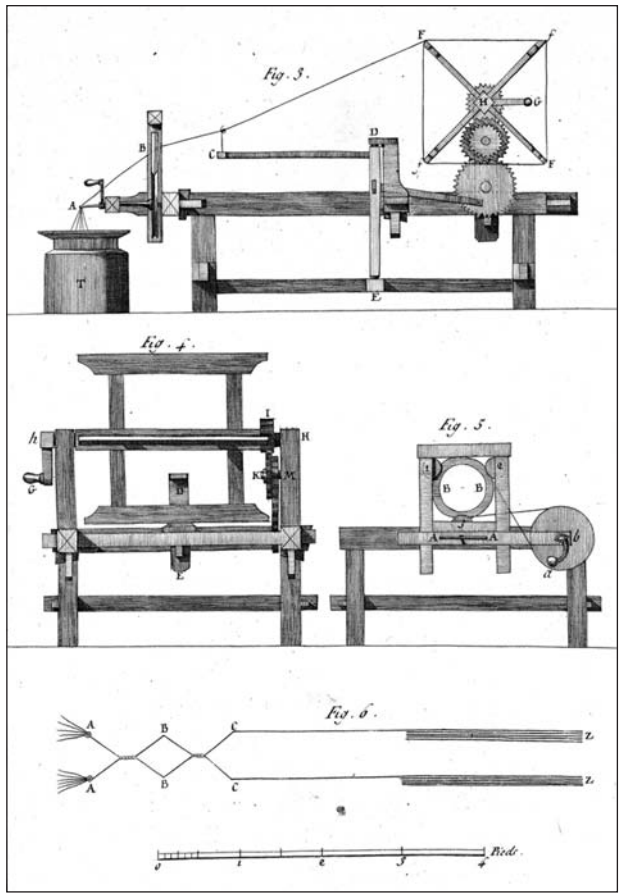

FIG. 4 Vaucanson's spinning machine (*tour à la double croisade*) as represented in the *Encyclopédie*. According to Vaucanson, this spinning machine replaced the skills embodied in the spinners' hands by a system of gears that automated the *croisade*. (Source: Courtesy of Museo Galileo—Institute and Museum of the History of Science, Florence. Used with permission.)

Vaucanson's memoir was a revised version of the one he had prepared on his return from Piedmont in 1743, and it was presented just a few days before Nollet's return from Piedmont. Although there is no documentary evidence that Vaucanson used Nollet's memoirs to prepare his own, it is quite implausible that the bureau would not have handed the new data from Piedmont to the inspector of silk manufactures to double-check information and to help him elaborate a new plan for the improvement of French-made organzine. Even the timing of Vaucanson's lecture at the academy's public meeting, just a few days before Nollet's return, seems to indicate that the bureau wanted to prevent the public from making any connection between Nollet and Vaucanson's inventions.

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Archival evidence indicates also that Nollet realized how the memoirs he sent from Piedmont were used, and that he resented the bureau's handling of his secret service. In presenting to Trudaine a detailed list of the "expensive steps I have been obliged to take in Piedmont and in Italy with respect to the researches that Mr. General Controller and Mister Roullié entrusted me with," he underscored: "[I]f I have been charged with researching and collecting data that you already had, of which I had not been informed, I dare to say that I have as much merit as if I had discovered everything anew."[88] While in his letters from Italy he had emphasized the "new pleasures" that serving the state gave him, describing himself as the "happiest of physicists," confronted with the bureau's delay in rewarding him for his secret service, Nollet emphasized instead his compliance with the bureau's orders and the discomforts he had suffered while pursuing them.[89] He calculated that the bureau should pay him about 4,500 livres, an amount that corresponded to a per diem of one gold *louis* and that included expenses for transportation, lodgings, food, servants, and bribing informants within the silk workshops.[90] Compared with the ordinary per diem of 6 or 7 livres that inspectors received from the bureau for their tours, the remarkably higher amount that Nollet requested indicates how special he believed his journey to be.[91] Machault's decision to round down Nollet's compensation to 4,000 livres, less than the amount that Vaucanson had received in 1742 for a shorter journey, confirms that for the new bureau, Nollet's memoirs were not particularly crucial.[92] The bureau had decided to invest in Vaucanson's inventions, which promised to produce high-quality organzine with French technology.[93] Nollet's memoirs had been requested by a different bureau, which believed in imposing regulations (hence in imitating Piedmont's system of production) more than in encouraging innovation and promoting emulation and improvement.

In spite of its new directions in political economy, the bureau did not intend to waste the secret expertise the abbé had gained while in Italy. In order to make good use of it, however, it was essential that his intelligent travel should remain secret. Thus, in 1753, the king rewarded Nollet with a new chair of experimental physics at the Collège de Navarre, a position that enhanced the abbé's reputation in the public arena while maintaining secrecy about the actual reason for his travel to Piedmont. The reason for this secrecy was twofold. Nollet had traveled to Italy as a member of the Academy of Sciences interested in closing a controversy over the healing

88. AN, F12/810.

89. AN, F12/1453B.

90. AN, F12/810. Nollet paid 50 livres "dans les cassins et ateliers" in Piedmont, but no money is mentioned to obtain the memoirs and drawings from his informants in Turin.

91. On the intendants' per diem, see Minard, *La Fortune du colbertisme*.

92. AN, F12/821 (on Vaucanson's expenses), F12/810 (on Nollet's reimbursement).

93. Doyon and Liaigre, *Jacques Vaucanson*.

virtues of electricity. His reputation was strictly linked to that of the institution. The academy itself would have incurred international blame had the secret reason behind his journey become public. Perhaps more importantly, the bureau intended to allocate Nollet's expertise to the domain of state secrecy: his knowledge of the manufacture of silk could turn useful again if nobody knew about it. Although Nollet expected public recognition for his services in the form of a position in the administration, the bureau in-stead planned for the abbé an activity as a secret consultant.

Academic Openness and State Secrecy

The archival records demonstrate that Nollet understood the value of working in secret for the state as his public reputation escalated. His expertise on the manufacture of silk turned useful to the bureau in the early 1750s, in the context of the abbé Soumille's pressing requests. Like Garro, Matthey, and Nollet himself, Soumille saw inventions as a means to obtaining public recognition and academic status. In 1737, he had been elected a corresponding member of the Paris Academy of Sciences as a result of the several devices he had sent to the institution for approval. Academicians like Duhamel de Monceau and Jean Hellot were familiar with his work and ready to write letters of recommendation for him. In his quest for recognition, Soumille complied with the protocols of academic openness: none of his inventions was kept secret. On the contrary, in collaboration with the local intendant, Soumille organized public trials aimed at comparing his roulette with Piedmont's spinning machine; they were styled on the theatrical experiments that sanctioned Nollet's ascent in the learned world. The demonstrations took place at Le Nain's orangerie and confirmed that the two models worked equally well. As a result, Le Nain urged Trudaine to issue an ordinance that would impose Soumille's roulette on all manufactures in Languedoc.[94]

Soumille was eager to be perceived as an expert who understood both the practice and the theory of the manufacture of silk. As with the artisans described by Long, he hoped that by publishing the theory underpinning his invention, he would obtain credit and reputation in the academic world. He produced a book-length manuscript that offered a geometrical explanation of the various kinds of faults (*vitrage*) that resulted from traditional spinning machines. The book described the roulette as a rational solution to the practical problem of *vitrage*, understood in geometrical terms.[95] In asking the bureau to consider his manuscript for publication, Soumille employed codes of communication and exchange typical of the academic world. He suggested that his roulette could be put to the test against both

94. AN, F12/2201.
95. AN, F12/642 and F12/2201.

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Vaucanson's and the traditional French spinning machines in the presence of a large audience at the Beaucaire fair, one of the best-attended in France. He presented himself as disinterested and invoked no secrecy. He also indicated that he had obtained information about Piedmont's machines through Jean Jallabert, professor of experimental physics in Geneva.[96]

Academic protocols of neutral arbitration guided Trudaine's decision-making process. He asked academicians like Hellot and Duhamel to provide written evaluations of Soumille's previous inventions, and entrusted Nollet with the evaluation of Soumille's theory of spinning faults. Trudaine's request for expert opinion did not differ from the work that Nollet carried out for the Academy of Sciences, where he, as well as other members, routinely evaluated inventions. However, while academic reports could become public, the evaluation that Trudaine demanded was to remain secret. In spite of Soumille's compliance with the rhetoric of academic openness, concerns of a different nature informed Nollet's recommendations not to publish his memoir. Nollet explained to Trudaine that Soumille's detailed descriptions of the faults that were so common in French manufactures constituted an open admission of France's inferiority to Piedmont and, as such, should not become public. He also suggested that the bureau should not miss the opportunity to benefit from Soumille's expertise. Nollet recommended that Soumille, just like Nollet himself, should "work in silence" for the state.[97]

Trudaine issued the ordinance, but Soumille's manuscript was never published. Hoping to gain public reputation and academic recognition, Soumille had complied with the rhetoric of openness that scientific academies throughout Europe had elaborated. Yet, the very same academicians who contributed to the creation of that rhetoric knew from firsthand experience when to demand secrecy.

Conclusion

By presenting Nollet's intelligent travel to Piedmont and the secret circulation of the intelligence he gathered, this article has shown that full-fledged citizens of the enlightened Republic of Letters, who shared the rhetoric of academic openness, also mastered the arts of secrecy and dissimulation typical of early modern courts. The public sphere and state secrecy have been presented as distinct, often contrasting, arenas of knowledge production, yet the trajectories of people like the abbé Nollet, the abbé Soumille, Isaac Matthey, and Francesco Garro testify to more complex interactions between the public culture of useful knowledge and the secrecy of state affairs. The history of the French attempts to import Italian technology for the manufacture of silk threads indicates that in order to

96. AN, F12/2201.
97. AN, F12/2201.

understand the eighteenth-century relationship between useful knowledge and the French state, we need to move beyond the notion of the public sphere and take into account the persistence of practices of secrecy that characterized earlier periods. The concept of the public sphere as formulated by Jürgen Habermas—a bourgeois realm of open communication and ex-change that set itself in contrast to the state—is at odds with the complex trajectories analyzed here, where the court and the state were as crucial to the making of public reputations as the academy and the virtual Republic of Letters. Public authority and expertise were built on less public, or indeed secret, forms of exchange and circulation.

I have also argued that the connection between espionage and technical knowledge emerged at the end of the eighteenth century as a result of the increasing involvement of the French state in technological innovations and their applications to manufactures—the politicization of technology that Hilaire-Pérez and Steven Kaplan have effectively analyzed.[98] Yet, we can appreciate the making of this connection only if we step away from the category of industrial espionage. The alternative notion of intelligent travel that I have proposed shows that secrecy and openness should not necessarily be seen as opposed practices in the processes of technology transfer. I have analyzed the multifaceted cultures of secrecy that were employed by intelligent travelers in search of the secret of Piedmont's success, as well as the highly mediated nature of such secrets. The notion of intelligent travel calls attention to the local dynamics that made the gathering of technical information possible; it shifts the focus from the individual spy as a cunning thief of technology to the locally situated, collective intelligence that underpinned technology transfer.

The links between academic openness and state secrecy highlighted here tightened in the course of the eighteenth century. French administrators, who were often also members of the Paris Academy of Sciences, became increasingly aware that academic status could conveniently lend an aura of gentlemanly disinterestedness to intelligent travel. In the early 1760s, when Gabriel Jars prepared his journey to gather practical intelligence on the English mining industry, Trudaine made sure he obtained the official title of correspondent of the Academy of Sciences before setting out on his tour. Jars regarded the position as "the most advantageous I could have when in a foreign country, they would suspect less an inquisitive member of an Academy than a man of the art."[99] Similarly, in the 1750s, the abbé Pierre-Augustin Boissier de Sauvages, a member of several academies and an author on the natural history of silkworms, proposed himself to the bureau for a tour aimed at gathering practical intelligence on silk manufacture under the guise of a "curious person."[100] By the end of the

98. Hilaire-Pérez, *L'invention technique*; Kaplan, *Les ventres de Paris*.

99. AN, F12/1311 (Jars to Trudaine, May 1764), quoted in Harris, *Industrial Espionage*, 591n12.

100. AN, F12/1453B.

century, however, learned entrepreneurs in Birmingham, such as James Watt and Josiah Wedgwood, had come to be wary of the "clever [French] scientific people" who wanted to visit their manufactures.[101] Their reluctance to open their workshops to the "curious" French indicates that even our historical actors did not regard academic openness and state secrecy as worlds apart.

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