

# Guilds, Patents, and the Circulation of Technical Knowledge

Northern Italy during the Early Modern Age

**CARLO MARCO BELFANTI**

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In the history of technology the early modern period is often described as a kind of gray area wedged between the technical conquests of the Middle Ages and the “miracle” of the Industrial Revolution, a time during which, despite extraordinary scientific progress, there were no technological innovations comparable to those that went before or came after.<sup>1</sup> This picture distorts our understanding of an era marked by an important phenomenon in the history of technology: the spread of technical knowledge through the movement of people. Technical knowledge of the time was essentially practical—gained from direct personal experience, jealously guarded by the individual craftsman. Consequently, the diffusion of technical knowledge depended first and foremost on the migration of those in possession of it, rather than on the proliferation of technical treatises.<sup>2</sup>

The classic instance of the movement of large numbers of people in this period is the flood of refugees from religious persecution, fleeing from the Spanish Low Countries to Holland and England or from France to Germany and even further afield. Traditional scholarship tells us, for example, that it was Protestants from Flanders who brought to England the technical knowledge behind the wool manufacturing process known as the “new draperies.” The skill most widely disseminated by the migration of religious

Carlo Marco Belfanti is professor of economic history at the University of Brescia, Italy. He has done extensive work on guilds in early modern Italy, and this article presents a synopsis of the results of his research. He thanks the *Technology and Culture* referees and Pamela Long for their very useful comments.

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1. See Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (New York, 1990), 57–80.

2. Carlo M. Cipolla, “The Diffusion of Innovations in Early Modern Europe,” *Comparative Studies in Society and History* 14 (1972): 46–52; David Landes, *The Wealth and Poverty of Nations* (London, 1998), 278.

refugees was that of making silk.<sup>3</sup> The knowledge involved in working silk spread to Switzerland, Germany, and England with successive waves of French Huguenots during the seventeenth century, especially after the suppression of religious freedom in France in 1685.<sup>4</sup> Journeymen from central Europe, who from the fourteenth century on were obliged to spend a period of time working in a city other than their own before becoming masters of their trade, were another source of technical expertise.<sup>5</sup> By the eighteenth century in France these itinerant journeymen, organized into clandestine associations or guilds (*compagnonnages*), represented a significant part of the skilled workforce.<sup>6</sup>

These examples encompass the best-known aspects of the question, but they do not exhaust it. The early modern era saw the introduction of a fundamental institutional innovation that proved to be a powerful stimulus to the mobility of the specialized work force: the creation by almost all the European states of laws and regulations intended to reward and safeguard invention. Awareness of the importance of technical creativity to economic growth led states to implement policies aimed at attracting the craftsmen who were sources of innovative manufacturing activity. The fundamental tool of this policy was the granting of patents.<sup>7</sup> Thus, not only cities but also

3. Cipolla, 46–52; Domenico Sella, “European Industries 1500–1700,” in *The Fontana Economic History of Europe*, vol. 2, ed. Carlo M. Cipolla (London, 1976), 402–3; Joan Thirsk, *Economic Policy and Projects: The Development of a Consumer Society in Early Modern England* (Oxford, 1978), 43–44.

4. William Cunningham, *Alien Immigrants to England* (London, 1897); Warren C. Scoville, “The Huguenots and the Diffusion of Technology,” *Journal of Political Economy* 60 (1952): 294–310; Liliane Mottu-Weber, “Production et innovation en Suisse et dans les États allemands (XV<sup>ème</sup>–XVIII<sup>ème</sup> siècles),” in *La seta in Europa secc. XIII–XX*, ed. Simonetta Cavaciocchi (Florence, 1993), 141–64.

5. See Catharina Lis and Hugo Soly, “An Irresistible Phalanx: Journeymen Associations in Western Europe, 1300–1800,” *International Review of Social History* 39, no. 2, suppl. (1994): 11–52; Reinhold Reith, “Arbeitsmigration und Gruppenkultur deutscher Handwerksgelesen vom 18. bis ins frühe 19. Jahrhundert,” *Scripta Mercaturae: Zeitschrift für Wirtschafts- und Sozialgeschichte* 23 (1989): 1–35, and “Labor Migration and the Diffusion of Technical Knowledge: The Example of the Habsburg Monarchy in the 18th Century” (paper presented at the Seventeenth International Economic History Congress, Madrid, 24–28 August 1998); Josef Ehmer, “Worlds of Mobility: Migration Patterns of Viennese Artisans in the 18th Century,” in *The Artisan and the European Town, 1500–1900*, ed. Geoffrey Crossick (Aldershot, 1997), 172–99; Marino Berengo, *L'Europa delle città: Il volto della società urbana europea tra Medioevo ed Età Moderna* (Turin, 1999), 448–51.

6. In addition to Lis and Soly, see, for example, Michael Sonenscher, *Work and Wages: Natural Law, Politics and the Eighteenth-Century French Trades* (Cambridge, 1989), 295–327; Cynthia M. Truant, *The Rites of Labor: Brotherhoods of Compagnonnage in Old and New Regime France* (Ithaca, N.Y., 1994).

7. Karel Davids, “Shifts of Technological Leadership in Early Modern Europe,” in *A Miracle Mirrored: The Dutch Republic in European Perspective*, ed. Karel Davids and Jan Lucassen (Cambridge, 1995), 345–46.

a large number of manufacturing towns became strategic crossroads for the transmission of technical know-how during the early modern period. Frequently, in fact, those who could not obtain adequate recognition of their skills in one urban center sought a warmer welcome in another. Adding this element to an existing picture based principally on the epic events of the age (such as the creation of religious refugees) or on the migrations of journeymen renders it a more complex and fluid image of the dynamic circulation of technical know-how. In fact, if we change focus from a panoramic view of Europe to look more closely at the various national realities, it immediately becomes clear that the diffusion of technical knowledge via the movement of peoples took many different shapes, varying with period and place.

This article is concerned with northern Italy between the sixteenth and the eighteenth centuries. That region saw neither relevant in-migrations of craftsmen fleeing religious persecution nor institutionalized forms of tramping for journeymen. Instead, the mobility of the skilled workforce was regulated by the actions of two institutions dedicated to opposing objectives (or at least appearing to be so): the urban craft guilds and the patent laws. On the one hand, the states of northern Italy were among the first to encourage the spread of technical knowledge by conceding privileges and monopolies to those who introduced new processes and products.<sup>8</sup> On the other, they were also home to strong, deep-rooted guild organizations, which traditional scholarship has characterized as rigidly conservative obstacles to technological progress in the Italian economy during this period.<sup>9</sup>

There is a literature on the patent system and an even richer one on the guilds, but with regard to the question of the diffusion of know-how each has often ignored the other.<sup>10</sup> This article draws on both to demonstrate

8. Pamela O. Long, *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance* (Baltimore, 2001), 88–101.

9. See, among others, Carlo M. Cipolla, "The Economic Decline of Italy," in *Crisis and Change in the Venetian Economy in the Sixteenth and Seventeenth Centuries*, ed. Brian Pullan (London, 1968), 135–39.

10. On Italian patent systems, see, among others, Giulio Mandich, "Le privative industriali veneziane (1450–1550)," *Rivista del diritto commerciale e del diritto generale delle obbligazioni* 24 (1936): 511–47, and "Primi riconoscimenti veneziani di un diritto di privativa agli inventori," *Rivista di diritto industriale* 7 (1958): 101–55. For more recent studies, see Manlio Calegari, *La Società patria delle arti e manifatture: Iniziativa imprenditoriale rinnovamento tecnologico nel riformismo genovese del settecento* (Florence, 1969); Roberto Berveglieri, *Inventori stranieri a Venezia (1474–1788): Importazione di tecnologia e circolazione di tecnici, artigiani, inventori* (Venice, 1995); Renzo Sabbatini, *L'innovazione prudente* (Florence, 1996). Scholarship on the Italian guilds is copious. The most recent works are Simona Cerutti, *Mestieri e privilegi: Nascita delle corporazioni a Torino* (Turin, 1992); Elisabetta Merlo, *Le corporazioni, conflitti e soppressioni: Milano tra Sei e Settecento* (Milan, 1996); Alberto Guenzi, Paola Massa, and E. Piola Caselli, eds., *Guilds, Markets and Work Regulations in Italy, 16th–19th Centuries* (Aldershot, 1998); Luca Molà, *The Silk*

that patents and guilds were not always in conflict but rather were two aspects of the same institutional setup, whose objective was to attract craftsmen who knew technical "secrets." It is impossible to fully comprehend the dissemination of technical knowledge without considering the combined action of the two. Their interaction demonstrates that the existence of such an institutional context was a necessary condition, although not always sufficient in itself to ensure that the transfer of technical knowledge would occur. The creation of networks, at times semiclandestine, through which craftsmen could renew their supplies of raw materials, semi-finished goods, and equipment, was also a determining factor in the consolidation of manufacture based on imported technique.

The final part of this article shows how this system, based on a particular institutional context and a well-oiled commercial network, experienced a crisis in the eighteenth century, when the objective of the competition between manufacturing centers changed from acquiring secrets related to the production process to adopting product innovations in response to market demand. Consumers' choices were increasingly conditioned by the caprices of fashion, which had become the arbiter of good taste in many sectors, from cloth to clothing, from household objects to ornamental articles. Competition came to be based on design, on creativity, and on novelty. That was a battle that could not be won with the old strategy of attracting craftsmen by granting them privileges and then mastering their secrets.

This article is based on both secondary sources and primary research, some of which has been published elsewhere piecemeal. It offers a global interpretation of the mechanisms that determined the circulation of the skilled workforce. Northern Italy was made up of a few states and many cities; the evidence gathered here, while it does not cover the whole of this complex reality, does illustrate a series of case studies that, given their importance and representativeness, allows us to form a reliable interpretation of the facts.

### Guilds and Secrets

For a long time, technical knowledge in the preindustrial economy was essentially, though of course not exclusively, based on the accumulation and filtering down of craft experience. It was a process of relatively slow growth through incremental technical change.<sup>11</sup> The guilds played a decisive role in accumulating, preserving, and transmitting technical know-how in many European urban centers, above all in Italy, by codifying

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*Industry of Renaissance Venice* (Baltimore, 2000); Francesca Trivellato, *Fondamenta dei Vetrai: Lavoro, tecnologia e mercato a Venezia tra Sei e Settecento* (Rome, 2000).

11. Karl G. Persson, *Pre-Industrial Economic Growth: Social Organization and Technological Progress in Europe* (Oxford, 1988), 9–10.

knowledge related to various production processes and ensuring that this heritage was preserved and handed down from generation to generation through severe and rigidly organized apprentice systems.<sup>12</sup> The technical supremacy achieved by many manufacturing centers in northern Italy between the Middle Ages and the early modern period is explained by guild practice as well as by the acquisition of a strategic position in international trade.<sup>13</sup>

It was often in such a context—thanks to easy access to raw materials, or consistent demand, or favorable environmental conditions—that the specialties that distinguished European manufacturing centers from one another emerged or became established. As Carlo Poni reminds us, the Bolognese silk merchants thought that the value of the veils produced in Bologna derived from “the unrepeatable quality of the local silk as well as [from] the waters of the Savena canal where they were washed.”<sup>14</sup> The majority of the most important manufacturing cities in preindustrial Europe were known on the international market for one (and sometimes more than one) particular item of trade. Giovanni Botero, in a treatise on the “causes of the greatness of the cities” written at the end of the sixteenth century, observed that such specialization was in effect a fundamental attribute of urban rank:

It will be of great advantage, in attracting people to our city, that she should have some important trade in her hands: this may be either wholly, or in part, due to her rich earth from which all things come; or due to the capability of her inhabitants. . . . There is also an excellence in skill, which either for the quality of the water, or for the subtlety of the inhabitants or for the hidden knowledge of the same, or for other similar reason succeeds better in one place than another, as with weapons in Damascus and in Schiraz [Persia], as with tapestries in Arras [France], woollen cloth in Florence, velvet in Genoa, brocade in Milan and scarlet cloth in Venice.<sup>15</sup>

Similar views were expressed a couple of centuries later by Marsilio Landriani, who, while traveling across Europe to visit the most important centers, had used the opportunity to understand how manufacturing had changed over time.<sup>16</sup> He recalled the lost supremacy of Italian silk manu-

12. Persson, 9–10; Stephan R. Epstein, “Craft Guilds, Apprenticeship, and Technological Change in Preindustrial Europe,” *Journal of Economic History* 58 (1998): 688–93; Berengo (n. 5 above), 437–46.

13. Davids (n. 7 above), 343–45.

14. Carlo Poni, “Per una storia del distretto industriale serico di Bologna (secoli XVI–XIX),” *Quaderni Storici* 25 (1990): 131.

15. Giovanni Botero, *Della ragion di stato . . . con tre libri delle cause della grandezza delle città*, ed. L. Firpo (Turin, 1948), 377–78.

16. On Landriani, see Sergio Escobar, “I viaggi di informazione di Marsilio Lan-

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facture thus: "There is no one who is unaware that Venice taught all of Europe the art of making brocade, that we owe to Genoa the making of the best velvet and the perfected art of dyeing, that Florence and Tuscany supplied the best *moelle* . . . and lustre cloth, Bologna the veil, and that Milan, as well as having many silk manufactures . . . was one of the cities in which manufacture with gold and silver most prospered."<sup>17</sup>

These production specialties, alongside others, arose from the creation of a grid of competence and complementary techniques.<sup>18</sup> In the silk sector, for example, this grid comprised spinners, weavers, and dyers, as well as the joiners who built and repaired the silk-throwing mills and looms, the workers who made the combs used in the weaving process, and those who created the motifs reproduced in the cloth.<sup>19</sup> The supremacy acquired in a particular production sector was jealously defended through careful protection of the knowledge of the techniques employed, with every member of the corporation bound to secrecy.<sup>20</sup> The intent was to block the spread of technical knowledge and so forestall competition. Guarding the knowledge that underpinned manufacturing supremacy became a priority for the guilds and for the state, particularly in strategic production sectors—those that represented the core manufacturing business of a city or town. Other, less relevant, products were not honored with similar attention.<sup>21</sup>

Skilled craftsmen carefully kept their trade secrets even where a formal guild structure did not exist, as in the case of traveling artisans in the building sector—plasterers from Como or stonecutters and stonemasons from Tuscany or Brescia, who went wherever church or palace building sites opened up.<sup>22</sup> Similar patterns are found among the *pratici lombardi* (Lom-

driani: Un caso di spionaggio industriale," in *Economia, istituzioni, cultura in Lombardia nell'età di Maria Teresa*, ed. Aldo De Maddalena, Ettore Rotelli, and Giorgio Barbarisi (Bologna, 1982), 2:533–42.

17. Mario Pessina, ed., *Relazioni di Marsilio Landriani sui progressi delle manifatture in Europa alla fine del Settecento* (Milan, 1981), 11. See also Sabbatini (n. 10 above), 72–74.

18. On this point, see Nathan Rosenberg, "Factors Affecting the Diffusion of Technology," *Explorations in Economic History* 10 (1972–73): 3–33, and "Technological Interdependence in the American Economy," *Technology and Culture* 20 (1979): 25–50. See also Persson (n. 11 above), 24–31.

19. The importance of the combs is analyzed and underlined by Marsilio Landriani in his report on the making of silk in Lyons, in which he judges them to be "one of the principle articles in the making of silk"; Pessina, *Relazioni di Marsilio Landriani*, 28. See also Poni, 119, 138–39. A thorough analysis of the production process for silk cloth at Lyons is provided in *Relazioni di Marsilio Landriani*, 12–33.

20. Karel Davids, "Openness or Secrecy? Industrial Espionage in the Dutch Republic," *Journal of European Economic History* 24 (1995): 333–49; Epstein (n. 12 above), 703–4; Pamela O. Long, "Invention, Secrecy, Theft: Meaning and Context in Late Medieval Technical Transmission," *History and Technology* 16 (2000): 223–41; Sabbatini, 58–60.

21. On this point, see Paolo Preto, *I servizi segreti di Venezia* (Milan, 1995), 381–421.

22. Carlo M. Belfanti, "L'economia della pietra," in *Il marmo bresciano: Territorio,*

bard handymen) employed by the various Italian states to build and work blast furnaces, who managed to safeguard their technical patrimony and dominate the trade until the beginning of the eighteenth century.<sup>23</sup> Much less well known but equally interesting is the case of the glassmakers of Altare, a village in the Ligurian hinterland. The statutes of their guild permitted them to move elsewhere for work on condition that they paid a tax to the local administration, did not produce certain types of glass, limited their absence to a maximum of three months, and, of course, kept the secrets of the craft.<sup>24</sup>

In addition to guarding their craft secrets, artisans needed to faithfully adhere to practices that yielded work of the standard that had made a product successful in the first place. During the early modern period the guilds often ended up creating an institutional context generally inhospitable to radical innovation—a situation, as Patrice Flichy has put it, characterized by “ordinary technical activity with incremental innovation.”<sup>25</sup> This both limited the diffusion of techniques and erected a barrier against the introduction of new processes and products.<sup>26</sup> The guilds’ hostile attitude toward radical innovation is most perceptible in the seventeenth and eighteenth centuries.

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*vicende, economia*, ed. Antonio Porteri and Carlo Simoni (Brescia, 1997), 45–56. In these trades there was little distinction between craftsman and artist; see Peter Burke, “L’artista: Momenti e problemi,” in *Storia dell’arte italiana*, vol. 2 (Turin, 1979), 87–113.

23. Manlio Calegari, “Forni ‘alla bresciana’ nell’Italia del XVI secolo,” *Quaderni storici* 24 (1989): 95–96.

24. In the course of the eighteenth century the Altare glassmakers spread out all through Europe. See René Leboutte, “Le secret gyrovagique: Migrations de verriers dans les Pays Bas aux 16e–18e siècles” (paper presented at the Twelfth International Economic History Congress, Madrid, 24–28 August, 1998), and Corinne Maitte, “Mobilités, migrations des spécialistes et communauté villageoise: Les verriers d’Altare (XVIe–XVIIIe siècles)” (paper presented at the international conference “Mobilité du capital humain et industrialisation régionale en Europe: Entrepreneurs, techniciens et main d’oeuvre spécialisée (XVIe–XXe siècles),” Paris, 27–28 November 1998). See also Corinne Maitte, “Corporation et politique au village: Altare entre migrations et différenciations sociales,” *Revue Historique* 303 (2001): 47–78.

25. Michael T. Hannan and John Freeman, “Structural Inertia and Organizational Change,” *American Sociological Review* 49 (1984): 149. Patrice Flichy, *L’innovazione tecnologica* (Milan, 1996), 173. On the distinction between “strategic innovations” and “small improvements,” see Abbott Payson Usher, *A History of Mechanical Inventions* (Oxford, 1966), and Mokyr (n. 1 above).

26. See, for example, Ettore Verga, “Le corporazioni delle industrie tessili in Milano: Loro rapporti e conflitti nei secoli XVI e XVII,” *Archivio Storico Lombardo* 30 (1903): 101–5; Paolo Malanima, *La decadenza di un’economia cittadina: L’industria di Firenze nei secoli XVI–XVIII* (Bologna, 1982), 237–51; Roberto Berveglieri, “Cosmo Scatini e il nero di Venezia,” *Quaderni Storici* 18 (1983): 168; Molà (n. 10 above), 199–201. On the question of resistance to the introduction of new techniques, see Joel Mokyr, “The Political Economy of Technological Change: Resistance and Innovation in Economic History,” in *Technological Revolutions in Europe*, ed. Maxine Berg and Kristine Bruland (Cheltenham, 1998), 39–64.

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teenth centuries—that is, in the period during which urban manufactures in northern Italy began to lose ground to international competitors invading the market with low-quality, low-cost goods.<sup>27</sup> In many cases the decision to raise barriers in defense of the high-quality, traditional processes and products that had made the fortunes of the Italian cities up to the sixteenth century was neither short sighted nor foolish. The guild system was an organized system of production whose constituent elements—long apprenticeship, marked specialization, limited membership—had been “planned” to produce a limited amount of high-quality goods. In the majority of cases the guilds answered the challenge to that system using the weapons they had available, insisting on the traditional techniques and products—the mix that had been a winner for centuries.

But the guilds did not represent an obstacle to the introduction of new techniques everywhere or at all times; the situation could vary from city to city and also from sector to sector. In Venice, for example, the guilds responded to the introduction of new techniques in silk weaving and glass-making, both vital sectors of the economy, by keeping tradition and innovation in tension, allowing one or the other to prevail according to what circumstances required.<sup>28</sup> Moreover, innovations in the silk sector went through a bureaucratic evaluation procedure that involved organs of the state, guilds, and individual operators in complex negotiations whose outcome was often uncertain.<sup>29</sup> The world of the guilds was a composite one, made up of merchant and craft components, each in their turn organized according to the hierarchies of the trade, each able to obstruct or support innovation according to the advantage or the economic damage it seemed to promise. The attitude of the guilds toward technical innovation had many facets, all of which need to be taken into account in order to avoid Manichean judgments. The guilds were certainly not those bastions of blinkered conservatism that traditional scholarship has depicted, but neither were they institutions dedicated to the promotion and diffusion of innovation.

### Guilds and Patents

The rulers of cities with strong guilds nevertheless remained in the international market for technical know-how. Venice was among the most enterprising in this regard, and the leaders of the Venetian Republic were very active in their attempts to attract craftsmen skilled in various types of

27. Richard T. Rapp, “The Unmaking of the Mediterranean Trade Hegemony: International Trade Rivalry and the Commercial Revolution,” *Journal of Economic History* 25 (1975): 499–525.

28. Molà; Trivellato (n. 10 above).

29. Molà, 163–76.



manufacture, from metallurgy to arms making, earthenware to cloth. In 1668, for example, an attempt was made to recruit English specialists in certain textiles, while at the beginning of the eighteenth century emissaries of Venice traveled to Florence to recruit silk dyers—an effort that succeeded in luring Cosmo Scatini, a Florentine dyer who knew the secret of dyeing silk black. Between 1727 and 1732 the Venetians twice tried to bring experts in the making of silk veils from Bologna.<sup>30</sup>

If Venice was particularly keen on recruiting a specialized labor force to establish new manufactures, other cities also understood the strategic importance of such an effort. In 1662, for example, the city of Turin planned to strengthen the local manufacture of silk by acquiring the know-how to build a Bolognese-style hydraulic silk mill. The official charged with the operation was to recruit experts in the construction and maintenance of the mill from outside the city. The implementation of the plan encountered some difficulties, but in the end it succeeded and the new mill went into operation in 1665.<sup>31</sup> In 1554 the Republic of Lucca established a special office, the *Offizio sopra le Nuove Arti*, to undertake the task of “examining the ways of introducing new ‘arts’ to the city, by searching for and finding men who were able and expert in these.”<sup>32</sup>

In effect, the range in specialization that characterized the important manufacturing cities also primed a competitive mechanism that pushed city governments into using every sort of stratagem to purloin manufacturing expertise from their rivals. Giovanni Botero emphasized the importance of such a political strategy: “The prince who wishes to render his city populous should therefore introduce every sort of industry and artifice, which will bring master craftsmen from other places. [He should] give them housing and comfort and take great ingenuity into account and esteem invention and those works which savor of the singular or the rare, rewarding perfection and excellence.”<sup>33</sup>

How did manufacturing centers manage to reconcile the guilds’ determination to protect their secrets with the need to acquire new skills and techniques? The answer to this question lies in an institutional setup able both to govern the slow, predictable metabolism of the guild system and to react to the swift rhythms of the marketplace. The guilds’ tendency to slow progress down was balanced by the ability of city councils and princes to grant patents intended to stimulate innovation and, above all, to attract craftsmen who would bring with them new manufactures.<sup>34</sup> In Venice, the

30. Preto (n. 21 above), 382–86.

31. Giuseppe Chicco, *La seta in Piemonte, 1650–1800* (Milan, 1995), 26–38.

32. Sabbatini (n. 10 above), 21.

33. Botero (n. 15 above), 249.

34. On the origins of the patent system, see Christine MacLeod, *Inventing the Industrial Revolution: The English Patent System, 1660–1800* (Cambridge, 1988), and “The Paradoxes of Patenting: Invention and Its Diffusion in 18th- and 19th-Century Britain,

best-known example, patents were mainly used to reward craftsmen who introduced processes or products unknown in the local context and who, for precisely that reason, rarely entered into conflict with the city craft guilds.<sup>35</sup> Patent holders were required to render the patented procedure viable within a year. The monopoly conferred by patent rights ran for some number of years, at the end of which period the new manufacture, if successful, could be assimilated by the guild system.<sup>36</sup> Innovations were thus incorporated into the organizational structure intended to consolidate and preserve them. So, for example, the Florentine Cosmo Scatini, who obtained a patent for silk dyeing, applied to be enrolled in the dyers' guild once his privilege ran out, promising to teach the Venetian craftsmen the process. And the craftsman who introduced the weaving of silk stockings on a frame was rewarded with a ten-year monopoly; it was renewed once, and since there was no guild of framework knitters for him to join when it finally ran out, one was created.<sup>37</sup>

The guilds and the patent system, then, fulfilled different functions within the same institutional context.<sup>38</sup> Conflicts could not always be

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France, and North America," *Technology and Culture* 32 (1991): 885–910; Pamela O. Long, "Invention, Authorship, 'Intellectual Property,' and the Origin of Patents: Notes toward a Conceptual History," *Technology and Culture* 32 (1991) 846–84; Liliane Hilaire-Pérez, "Invention and the State in 18th-Century France," *Technology and Culture* 32 (1991): 910–30, and "Technical Invention and Institutional Credit in France and Britain in the 18th Century," *History and Technology* 16 (2000): 285–306; Nicolás García Tapia, *Patentes de invención españolas en el Siglo de Oro* (Madrid, 1990); Marcus Popplow, "Erfindungsschutz und Maschinenbücher: Etappen der Institutionalisierung Technischen Wandels in der Frühen Neuzeit," *Technikgeschichte* 63 (1996): 21–46; Karel Davids, "Shifts of Technological Leadership" (n. 7 above), 345, and "Patents and Patentees in the Dutch Republic between c. 1580 and 1720," *History and Technology* 16 (2000): 263–83. For a comparative perspective now, see Liliane Hilaire-Pérez, *L'invention technique au siècle des Lumières* (Paris, 2000). As regards the Italian situation, see Mandich; Calegari, *La Società patria delle arti e manifatture*; Berveglieri, *Inventori stranieri a Venezia*; and Sabbatini (all n. 10 above).

35. Berveglieri, *Inventori stranieri a Venezia*, 23–24. The craftsmen from Lucca who moved to Venice in the late Middle Ages were also absorbed into the city guilds: Luca Molà, "L'industria della seta a Lucca nel tardo Medioevo: Emigrazione della manodopera e creazione di una rete produttiva a Bologna e Venezia," in Cavaciocchi (n. 4 above), 435–44. See also Giacomina Caligaris, "Trade Guilds, Manufacturing and Economic Privilege in the Kingdom of Sardinia during the Eighteenth Century," in Guenzi, Massa, and Piola Caselli (n. 10 above), 69.

36. Berveglieri, *Inventori stranieri a Venezia*, 27–29. For analogies with the Dutch system, see Davids, "Openness or Secrecy?" (n. 20 above). Similar procedures were adopted in Lucca; Sabbatini, 27–28.

37. Berveglieri, "Cosmo Scatini" (n. 26 above), 170. In Lucca, too, those who obtained the privilege were expected to teach the new technique to the local workforce; Sabbatini, 59. Similar evolutions took place in Turin and in Genoa; see Carlo M. Belfanti, "Fashion and Innovation: The Origins of the Italian Hosiery Industry in the Sixteenth and Seventeenth Centuries," *Textile History* 27 (1996): 132–47.

38. Luigi Bulferetti and Claudio Costantini, *Industria e commercio in Liguria nell'età*

avoided; much depended on, among other things, relations between the guilds and the political authorities and the determination with which city governments strengthened the patent system. The available case studies lead us to conclude that the introduction of new processes or products tended to create conflict with the merchant guilds more frequently than with the craft guilds.<sup>39</sup>

A few examples will serve to illustrate the point. The adoption of the technique for dyeing silk patented by Scatini in Venice at the beginning of the eighteenth century led to the planning of a centralized dye works in which all the Venetian dyers could work using the new procedure and on which the state would have conferred a monopoly. The project was shipwrecked by the hostility of the silk merchants' guild, which feared that through it the craftsmen might gain strength vis-à-vis the merchant class.<sup>40</sup> Similar conflicts arose in Milan and Padua in the second half of the seventeenth century. These cities had well-established putting-out systems for knitting stockings (using needles), of silk and wool respectively. When foreign craftsmen sought to introduce knitting frames "in the English fashion" their proposals met with resistance from merchants, who understood that the new technique might give rise to a strong organization of skilled craftsmen who would be much more difficult to control than their present docile, mainly female, home-based workforce. Conjuring up the specter of thousands thrown out of work by mechanization, the merchants prevailed.<sup>41</sup> On another occasion in Milan, a mid-eighteenth-century innovation in the production of Indian cotton cloth, protected by patent, did not come into conflict with the craft guild at all but was strenuously opposed by the merchant haberdashers' guild.<sup>42</sup>

Craftsmen did oppose innovation in some cases, fearing its potential consequences. The resistance of Florentine spinners to the introduction of

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*del Risorgimento (1700–1861)* (Milan, 1966), 85; Berveglieri, *Inventori stranieri a Venezia* (n. 10 above); Sabbatini (n. 10 above); Caligaris; Belfanti, "Fashion and Innovation."

39. On the relations between craftsmen and merchants, see Giorgio Borelli, "A Reading of the Relationships between Cities, Manufacturing Crafts, and Guilds in Early Modern Italy," and Angelo Moioli, "The Changing Role of the Guilds in the Reorganization of the Milanese Economy throughout the Sixteenth and the Eighteenth Centuries," both in Guenzi, Massa, and Piola Caselli (n. 10 above), 19–31, 32–55. On conflicts between the workforce and the merchants in the silk sector, see Poni (n. 14 above), 135–36, and, more generally, Paola Massa, "Tipologia tecnica e organizzazione economica della manodopera serica in alcune esperienze italiane (secoli XIV–XVIII)," in Cavaciocchi (n. 4 above), 211–15.

40. The new technique and the monopoly would, in fact, have strengthened the craftsmen's position, giving them control over a delicate phase of the production process and excluding the merchants—who, instead, aimed at controlling the entire production cycle directly. Berveglieri, "Cosmo Scatini."

41. Belfanti, "Fashion and Innovation."

42. E. Merlo, "Corporazione e manifattura privilegiata a Milano (1755–1780)," *Studi storici* Luigi Simeoni 41 (1991): 221–32.

the Bolognese-style silk mill in the seventeenth and eighteenth centuries, for example, was motivated by fear that the new mills would put them out of work.<sup>43</sup> In sixteenth-century Venice, on at least two occasions and for presumably similar reasons, the guilds opposed patent innovations in silk making.<sup>44</sup>

Nonetheless, it is fair to assume that such an efficiently functioning, two-speed system was, along with ready access to raw materials and know-how, a decisive factor in a city's or region's technical supremacy.

### Traitors?

The expertise of the artisan was tacit knowledge, transmitted from master to apprentice in the daily routine of the workshop and inseparable from the artisan himself. Unlike codified knowledge, which could be conveyed in the form of a recipe or a manual, tacit knowledge could not be transferred from one place to another except by moving the craftsman as well.<sup>45</sup> Conflicts between merchant and craft components of the guild system could inspire craftsmen to move from one locale to another where their skills might obtain better economic and social recognition. Of course, other causes could arise as well, as when famine in Mantua drove many craftsmen from the city in 1590, or Brescian gunsmiths left in search of work because commissions from the state fell off.<sup>46</sup>

In situations such as these (and there are many other examples), craftsmen felt it legitimate to break the social contract of solidarity that was the basis of the guild structure; that is, they felt authorized to "betray" both their social group, from which they had learned their skills, and the state by transferring their knowledge elsewhere. Naturally, neither the guilds nor the state agreed, especially if a strategically important manufacture were involved, and those craftsmen who went abroad were considered traitors

43. Malanima (n. 26 above), 243–44.

44. Molà, *The Silk Industry* (n. 10 above), 199–201. For some Milanese examples, see Verga (n. 26 above), 102–4.

45. Long, "Invention, Secrecy, Theft" (n. 20 above). See also Frédérique Sachwald, "Cooperative Agreements and the Theory of the Firm: Focusing on Barriers to Change," *Journal of Economic Behavior and Organization* 35 (1998): 208–9. On tacit knowledge, see Michael Polanyi, *The Tacit Dimension* (Garden City, N.Y., 1966), and Paul A. David and Dominique Foray, "Economic Fundamentals of the Knowledge Society," Stanford Institute for Economic Policy Research Discussion Paper no. 01-14, February 2002.

46. Merchants in Mantua complained of the exodus of "many silk and wool craftsmen who go to other cities; because of the famine it is said." Carlo M. Belfanti, "Una città e la carestia: Mantova, 1590–1592," *Annali della Fondazione Luigi Einaudi* 16 (1982): 140. Carlo M. Belfanti, "A Chain of Skills: The Production Cycle of Firearms Manufacture in the Brescia Area from the Sixteenth to the Eighteenth Centuries," in Guenzi, Massa, and Piola Caselli (n. 10 above), 266–83.

and treated as such.<sup>47</sup> To cite one of many examples, Ugolino Menzani of Bologna was tried in absentia and condemned to death at the beginning of the seventeenth century for having exported equipment for throwing and twisting silk to Venice. A painting showing him hanged upside down remained on public display in Bologna for more than a century.<sup>48</sup>

One might expect that the transfer of knowledge originated in centers that had reached a high level of technical maturity in a particular production sector; indeed, if an industry had reached a point of diminishing returns, that could exacerbate conflict between merchants and crafts and direct the flow of knowledge toward less technologically advanced locales. However, case studies indicate that the movements of the workforce could also be determined by different factors. For example: the instigators of numerous attempts in the first half of the eighteenth century to export the techniques of silk throwing and twisting and of making silk veils from Bologna did not seek out cities where the silk industry was nonexistent or in its infancy; on the contrary, they preferred places that already had a solid silk-making tradition, such as Venice or Zurich.<sup>49</sup> Craftsmen who brought the secret of framework knitting with them from England offered their services to the governments of the most important Italian silk cities.<sup>50</sup> It is plausible to argue, then, that by preference the transfer of technical know-how took place between centers of comparable technological maturity.

A specialized manufacture or technique could be more easily transferred to places where similar manufacturing traditions already existed and which therefore had, in some degree, technical competence, access to raw materials, knowledge of the market, and a distribution system in place. In other words, the transfer of technical knowledge had more chance of success in a context offering the advantages of what Brian Arthur has called "increasing returns to adoption."<sup>51</sup> It was both more complex and more expensive, in terms of transaction costs, to transfer knowledge to virgin territory.<sup>52</sup>

47. Fabio Giusberti, *Impresa e avventura: L'industria del velo di seta a Bologna nel XVIII secolo* (Milan, 1989), 11–66. See also Preto (n. 21 above), 382–417.

48. Carlo Poni, "Archéologie de la fabrique: La diffusion des moulins à soie 'alla bolognese' dans les États Vénitiens du XVI au XVIII siècles," *Annales: Économies, Sociétés, Civilisations* 27 (1972): 1480; Giusberti, 19.

49. Giusberti, 11–66.

50. Belfanti, "Fashion and Innovation" (n. 37 above).

51. Brian Arthur, "Competing Technologies: An Overview," in *Technical Change and Economic Theory*, ed. Giovanni Dosi et al. (London and New York, 1988), 590–91. See also Dominique Foray, "Choix des techniques, rendements croissants et processus historique," in *La technoscience: Les fractures du discours*, ed. J. Prades (Paris, 1992), 66.

52. Gary S. Becker and K. M. Murphy, "The Division of Labor, Coordination Costs, and Knowledge," *Quarterly Journal of Economics* 107 (1992): 1137–60. Some cases of failure are documented in Salvatore Ciriaco, "La manodopera italiana e il mercato serico

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Naturally, this applies to sectors marked by an advanced level of technology, in which barriers to entry were higher. Thus, in order to export the technique of the Bolognese-style silk water mill it was not enough that an expert spinner should be willing to emigrate; it was also necessary to have, among other things, a joiner who could build and maintain the mill, a craftsman able to make the spools, and so on.<sup>53</sup> As David Jeremy wrote of technology transfer from England to the United States in the nineteenth century, "industrial espionage . . . is not a simple matter of sending a machine, a formula or even a skilled worker from country A to country B. Technology transfer, for that is what industrial espionage seeks to achieve, is a much larger and more complex process demanding a range of technical, economic and cultural preconditions in the recipient state as well as carriers appropriate to the technology concerned."<sup>54</sup>

One strategy for satisfying that demand was the practice, already common in the late Middle Ages, of merchants or city governments moving whole groups of skilled artisans.<sup>55</sup> Worker migrations, as individuals or in groups, were often based on information collected from merchants, other craftsmen, or other intermediaries. It is worth noting that such information had to be accurate with regard to packing and transportation of machinery, tools, and other equipment.<sup>56</sup>

Emigration of a skilled workforce might also be influenced by other conditions, such as the ability of workers to stay in touch with home in order to retain access to technical information and to markets. The political turbulence of the fourteenth century led many silk craftsmen to abandon Lucca for Bologna, Florence, and Venice, but once peace had been reestablished they renewed their links with their city of origin and created a production network that shared markets and know-how.<sup>57</sup> Most often, however, the migration of a skilled workforce severed its connections to home, and the success of such transplanted artisans depended in large

germanico (secoli XVI–XVIII)," in Cavaciocchi (n. 4 above), 375–86; Chicco (n. 31 above), 80–91, 287–88, 293–94; Sabbatini (n. 10 above), 51–54.

53. See Poni, "Per una storia" (n. 14 above), 138; Giusberti (n. 47 above), 16–20; Chicco, 26–38.

54. David Jeremy, "Transatlantic Industrial Espionage in the Early Nineteenth Century: Barriers and Penetrations," *Textile History* 26 (1995): 119.

55. Maureen Fennell Mazzaoui, "Artisan Migration and Technology in the Italian Textile Industry in the Late Middle Ages (1100–1500)," in *Strutture familiari, epidemie, migrazioni nell'Italia medievale*, ed. Rinaldo Comba, Gabriella Piccinni, and Giuliano Pinto (Naples, 1984), 522–25; Molà, *The Silk Industry* (n. 10 above), 37–42.

56. Mazzaoui, 523; David Jacoby, "The Migration of Merchants and Craftsmen: A Mediterranean Perspective (12th–15th Century)," in *Le migrazioni in Europa secc. XIII–XVIII*, ed. Simonetta Cavaciocchi (Florence, 1994), 553; Molà, *The Silk Industry*, 17–42; Giusberti, 25–27.

57. Molà, "L'industria della seta" (n. 35 above), 435–44.

measure on their ability to exploit complementary technical competences and gain access to raw and semifinished materials.<sup>58</sup>

The problem was perfectly clear to the artisans themselves, and in some cases they were able to find efficient solutions. Again, a couple of examples will illustrate. Venetian glassmakers skilled in the manufacture of beads left that city in great numbers during the eighteenth century, departing for many Italian and foreign regions. The Venetian authorities opposed this exodus, with mixed success.<sup>59</sup> In the course of numerous investigations they discovered the existence of a vast clandestine trade between Venice and the new manufacturing centers in the glass paste used to make beads.<sup>60</sup> A similar circumstance came to light during the trial in Bologna of a group of persons who had tried to export the technique for making silk veils. Testimony revealed that a merchant who had taken this trade secret to Florence some twenty years before had kept in touch with his home city in order to renew his supplies of raw materials.<sup>61</sup> The Bolognese veils were made of a very fine, light cloth, produced in both a smooth and a crêpe finish, and their quality depended to a large extent on the use of high-quality Bolognese silk and, above all, on the thread made in the silk mills of Bologna.<sup>62</sup>

The movement of skilled workers from one manufacturing center to another thus seems to have activated networks of communication through which information and goods flowed in a more-or-less legal manner, despite limitations and prohibitions. The existence or creation of such networks could play a determining role in the transfer of technical knowledge. We cannot exclude the possibility that places lacking any relevant production infrastructure might still benefit from gaining the technical know-how needed to establish a manufacture. Success depended on the ability of skilled artisans to find and exploit, even if only partially, conditions similar to those of the technical and economic environment from which they had come. It was precisely to this end that mercantile states, who brought in craftsmen from outside their own territory, also sought to facilitate the setting up of new industries through tax exemptions and other privileges that would in some way compensate, at least in part, for the gap between them and established competitors.

58. See, for instance, Jacoby, 554.

59. Preto (n. 21 above), 403–21.

60. Barbara Bettoni, “La manifattura veneziana delle perle di vetro nel XVIII secolo” (tesi di laurea, Università di Brescia, 1997–98), 176–81.

61. Giusberti (n. 47 above), 21–22.

62. Poni, “Per una storia” (n. 14 above), 94–100.

## A Changing World

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Between the sixteenth and the eighteenth centuries craftsmen from the various manufacturing centers scattered ever more widely across Europe.<sup>63</sup> Their dispersion was matched by the spread of technical know-how to such an extent that by the end of the eighteenth century, as Marsilio Landriani observed in the passage already quoted, the Italian cities had lost their ancient position as the leading producers of silk.<sup>64</sup> A self-styled Dutch merchant, author of a pamphlet produced in Bologna in 1771, declared that manufacture "is no longer an arcane secret in our days."<sup>65</sup> He was echoed in the same year by the anonymous author of a report on the silk industry, who observed that no manufacturing center had been able to remain the exclusive source of a particular specialty for more than one or two centuries before its secrets were purloined "either by the betrayal of its own people or by the industry of the outsiders," and who further argued that "the world now feeds, more than at any other time, on novelties and appearances."<sup>66</sup> It would seem that traditional manufacture no longer had many secrets to hide. To the mobility of artisans was added the publication of texts and *planches* from the *Encyclopédie*, which contributed to codifying, in some sense, that tacit knowledge that had for so long been the province of the workshops.<sup>67</sup>

Is the comment by the anonymous Bolognese about his contemporaries' passion for "novelty" and "appearance" perhaps to be interpreted as a sign of rising interest in product innovations? Recent studies have demonstrated that product innovation became increasingly important in the preindustrial economy, to both the marketing strategies of producers and the choices of consumers.<sup>68</sup> It might consist in the launch of an absolutely

63. Davids, "Shifts of Technological Leadership" (n. 7 above), 341.

64. Pessina, *Relazioni di Marsilio Landriani* (n. 17 above).

65. Poni, "Per una storia," 108.

66. *Ibid.*, 129.

67. Italy also saw the publication of important technical works in the second half of the eighteenth century. See, for example, Mario Infelise, *L'editoria veneziana nel '700* (Milan, 1999), and Daniele Baggiani, "Tecnologia e riforme nella Toscana di Pietro Leopoldo: La traduzione del 'The advancement of arts, manufactures and commerce' di William Bailey," *Rivista storica italiana* 105 (1993): 515–54. John Pannabecker calls attention to the shop-floor orientation of the illustrations in the *Encyclopédie*, which operate in unacknowledged tension with the elite orientation of the essays they illustrate; codification had its limits even in the *Encyclopédie*. See John R. Pannabecker, "Representing Mechanical Art in Diderot's *Encyclopédie*," *Technology and Culture* 39 (1998): 33–73.

68. Thirsk (n. 3 above); Neil McKendrick, John Brewer, and J. H. Plumb, *The Birth of a Consumer Society: The Commercialization of Eighteenth-Century England* (Bloomington, Ind., 1982); Lorna Weatherill, *Consumer Behaviour and Material Culture in Britain, 1660–1750* (London, 1988); Carole Shammas, *The Preindustrial Consumer in England and America* (Oxford, 1990); J. Brewer and R. Porter, eds., *Consumption and the World of Goods* (London, 1993); Anton J. Schuurman and L. S. Walsh, eds., *Material*



new product, or in the substitution of materials to render an old one less costly or better suited to the market, or in the invention of clothing fashion, or in the introduction of brands that conferred an identity on goods.<sup>69</sup>

The Italian manufacturing cities were alive to the possibilities of this particular aspect of innovation during the sixteenth century, as two examples from the textile sector will show. In the second half of the sixteenth century Italian silk manufacturing faced a significant change in demand marked by increasing orientation toward less expensive cloth. The most important production centers reacted by adapting their products.<sup>70</sup> Venetian silk makers introduced a new article, *brocatelle*, a mixed fabric made up of top-grade silk and lower-quality fibers such as flax, cotton, or second-grade silk, that gave Venice a commanding position in the trade in cheaper silk cloth.<sup>71</sup> But the most significant product innovation was without doubt knitted stockings, which in the second half of the century rapidly became a fashion item throughout Europe. More elastic and better-fitting than similar garments traditionally made in cloth, they are one of the earliest examples of ready-made clothing, which could be bought and worn without needing the work of a tailor. It is impossible to document how and where knitted stockings originated, but two northern Italian cities quickly came to dominate the trade, Mantua for woolen stockings and Milan for silk.<sup>72</sup>

In the sixteenth century the cities of northern Italy remained vigorous manufacturing centers, not lacking in ingenuity or creativity, and it would be possible to give more examples similar to these from that period. But between the seventeenth and eighteenth centuries Italian manufactures began to lose ground. Scholars have analyzed and debated the reasons for this decline.<sup>73</sup> While the question does not really lie within the scope of this article, I should like to underline that, among the various explanations proposed, the emergence of Paris and London as centers of product innovation must play a decisive role. The rise of Paris is connected with the royal court, which fed a lively and varied demand for luxury consumer goods, which were in turn copied by the aristocracy. Sustained demand among aristo-

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*Culture: Consumption, Life-Style, Standard of Living, 1500–1900* (Milan, 1994); John Styles, "Product Innovation in Early Modern London," *Past and Present* 168 (2000): 125–69.

69. Styles, 148.

70. Molà, *The Silk Industry* (n. 10 above), 177–85.

71. *Ibid.*, 170–71.

72. Belfanti, "Fashion and Innovation" (n. 37 above). According to a tradition handed down by Gravenor Henson, the first historian of the English knitting manufacture, stockings knitted on needles were introduced into Great Britain by a merchant from Mantua; Stanley D. Chapman, ed., *Henson's History of the Framework Knitters* (New York, 1970), 12.

73. See Cipolla, "The Economic Decline of Italy" (n. 9 above), 127–45, and, more recently, Paolo Malanima, *La fine del primato: Crisi e riconversione nell'Italia del Seicento* (Milan, 1998).

crats and courtiers stimulated the creativity of Parisian craftsmen, who had to accommodate the tastes of a capricious clientele.<sup>74</sup> Parisian leadership in design was not limited to goods destined for the elite. The luxury sector, in fact, represented a sort of laboratory for the development of items that might eventually be reproduced in more modest materials and made accessible to a wider consuming public—a pattern that still holds true today in one fashion or another. The “populuxe goods” discussed by Cissie Fairchild and the production of semiluxury commodities are examples of such forms of product innovation.<sup>75</sup> On the other hand, recent research suggests that French society was more consumption oriented than scholars had previously thought.<sup>76</sup>

London owed its rise as a center for design and innovation to its position as the most important commercial crossroads in the world, through which passed all manner of merchandise that influenced European taste in the period. English producers exploited their position and ably imitated these exotic products, sometimes using different materials, sometimes adapting them to European tastes.<sup>77</sup> These were the methods of product innovation that underpinned the success of semiluxury commodities like “decorative metal wares, ceramics and glass, light furnishings and clocks and watches.”<sup>78</sup>

The anonymous Bolognese author of the report on the silk industry quoted above would have us believe that Italian producers were in some measure aware of the increasingly important role of product innovation, but it was not exactly so. In the eighteenth century, few Italian manufactures held a commanding international position, and those that did tended to occupy market niches. The Venetian glass industry, once famous for its mirrors, was now essentially a supplier of beads to the colonial powers, whose merchants used them to barter with the indigenous populations of

74. Sonenscher (n. 6 above), 210–43.

75. Cissie Fairchild, “The Production and Marketing of Populuxe Goods in Eighteenth-Century Paris,” in Brewer and Porter (n. 68 above), 228–48. Patrick Verley, “Eessor et déclin des industries du luxe et du demi-luxe en France au XIXe siècle,” in *Le luxe en France du siècle des Lumières à nos jours*, ed. Jacques Marseille (Paris, 1999), 107–23.

76. Daniel Roche, *Histoire des choses banales: Naissance de la consommation dans les sociétés traditionnelles (XVIIe–XVIIIe siècles)* (Paris, 1997); Colin Jones and R. Spang, “Sans-Culottes, Sans Café, Sans Tabac: Shifting Realms of Necessity and Luxury in Eighteenth-Century France,” in *Consumers and Luxury: Consumer Culture in Europe, 1650–1850*, ed. Maxine Berg and Helen Clifford (Manchester, 1999), 37–62.

77. Styles (n. 68 above).

78. Maxine Berg, “Product Innovations in Core Consumer Industries in Eighteenth-Century Britain,” in Berg and Bruland (n. 26 above), 138–57; Helen Clifford, “Concepts of Invention, Identity, and Imitation in the London and Provincial Metal-Working Trades, 1750–1800,” *Journal of Design History* 12 (1999): 241–55; Styles; Maxine Berg, “New Commodities, Luxuries, and Their Consumers in Eighteenth-Century England,” in Berg and Clifford, 63–87, quote at 69.

Africa and North America.<sup>79</sup> Similarly, the Remondini publishing house of Bassano became famous throughout the continent for its prints; prevalently of a religious character, they were sold from Portugal to Russia, and even reached Latin America, all made possible by a network of correspondents and, above all, a veritable army of itinerant salesmen.<sup>80</sup>

Italian manufactures' loss of competitiveness in the eighteenth century was particularly serious in the silk sector. Lyons had become the undisputed center of silk manufacturing in Europe, thanks in part to the ingenious product innovation of changing the patterns of the *façonné* cloth annually.<sup>81</sup> Silk was too important to the economies of the northern Italian cities for them to accept without a struggle the secondary role to which they had been relegated. Their first line of attack was to imitate the features that made Lyons silk so attractive, but this strategy failed because of their lack of "designers capable of such inventions."<sup>82</sup> Some cities, including Milan and Turin, responded by recruiting designers from Lyons.<sup>83</sup> And some advocated a more complex but more farsighted response: training designers. Design schools were established in some of the principal silk-making centers. In Milan a "school for the designs of our manufacture" was set up in 1773 and entrusted to the direction of Benedetto Lamy of France.<sup>84</sup> The creation of the Academy for Design in Venice dates to 1763. Its students were expected to learn how to draw the motifs for *façonné* cloth on paper and then transfer the drawing to the loom.<sup>85</sup> The director of the academy was Pietro D'Avanzo, author of a treatise that may have been used as a handbook by the students.<sup>86</sup>

The dearth of surviving documentary evidence makes it difficult to evaluate the role played by the design schools, but the irreversible decline in Italian silk manufacture would seem to indicate that not even the

79. Trivellato (n. 10 above), 239–45.

80. Infelise (n. 67 above), 228–29, 260–61, 270–71.

81. Carlo Poni, "Fashion as Flexible Production: The Strategies of the Lyon Silk Merchants in the Eighteenth Century," in *World of Possibilities*, ed. Charles F. Sabel and Jonathan Zeitlin (Cambridge, 1997), 37–74; Lesley Ellis Miller, "Innovation and Industrial Espionage in Eighteenth-Century France: An Investigation of the Selling of Silks through Samples," *Journal of Design History* 12 (1999): 271–90.

82. Carlo Poni, "Moda e innovazione: Le strategie dei mercanti di seta di Lione nel secolo XVIII," in Cavaciocchi, *La seta in Europa* (n. 4 above), 24–25.

83. Bruno Caizzi, *Industria, commercio e Banca in Lombardia nel XVIII secolo* (Milan, 1968), 114; Felice A. Duboin, *Raccolta per ordine di materie delle leggi cioè editti, patenti, manifesti, ecc. emanate negli stati di terraferma sino all'8 dicembre 1798 dai sovrani della real casa di Savoia*, bk. 16, vol. 18 (Turin, 1849), 297, 346.

84. Archivio di Stato di Milano, Commercio, P.A., b. 231, 30 marzo 1773.

85. Archivio di Stato di Venezia, V Savi, Diversorum, b. 370, n. 60, 3 December 1763 more veneto.

86. Pietro D'avanzo, *Regole per la meccanica del telaio da seta 1753*, ed. Ileana Chiappini di Sorio (Venice, 1981).

attempt to train designers met with success. The inefficiency of the Venetian academy is attested to by the fact that when D'Avanzo died in 1777 the Venetian ambassador to France was charged with engaging a designer there who could teach the secret of the superior design motifs of Lyonnais silk. In his reply the ambassador clearly illustrated the reasons for which the initiative was bound to fail—and which were, in the end, the reasons for the failure of the design schools: “The mere fact of being in Lyon itself, with the intense competition between workshops, the constant practice refining their skills, the observation of the work of others and the necessity of inventing new designs lest goods be left in the warehouses: all these factors in one place concur to stimulate and spur on their powers of invention and their will in such a particular, even unique, way that the same designer will not have equal success, transport him where you will, even to Paris.”<sup>87</sup>

### The Circulation of Knowledge

From the sixteenth to the eighteenth centuries the cities of northern Italy acted as poles for the movement of skilled artisans, a powerful impulse toward the propagation of technical knowledge. The mobility of a skilled workforce was not caused in this case, in contrast to others, by religious persecution or institutionalized forms of itinerant work, but by competition between city economies, on the one hand, and the institutions that regulated urban manufacture, on the other.

The guilds had elaborated, consolidated, and transmitted the stores of knowledge that had allowed many cities and towns to become specialized manufacturing centers. Together with marked political fragmentation, the variety of specialties that distinguished cities from one another contributed to a competition for the trade secrets that underpinned economic success. Patent laws introduced by many states beginning in the fifteenth century offered advantages to those who had the skills to set up new manufactures.<sup>88</sup>

87. Archivio di Stato di Venezia, V Savi, Diversorum, b. 388, n. 45, 28 April 1777 more veneto. Marsilio Landriani drew the same conclusion: “The trade in cloth from Lyon is not only sustained by their excellent market, by the perfection of the execution of the work, by the prestige of their fashion, but also through the elegance and the vivacity of the designs and by the embroidery for which the cloth acquires a considerable value, above all others in Europe. In this sense there is no other nation or city, which can compete with or be equal to Lyon. The great numbers of designers that are found there, and who, as a measure of their superiority, by talent acquire greater fortune, excite an emulation and a competition which promotes the art of design and an astounding perfection. Each year the valid designer makes a journey to Paris to study, in the infinite variety of the fashion and the caprice of the elegant Parisiens, the color, the decoration, the bizarre touch or imagination that could give originality and brio to his designs.” Pessina, *Relazioni di Marsilio Landriani* (n. 17 above), 30–31.

88. Long hits the mark when she writes: “The role of the patent in the process of the

A key to acquiring the secret of a production process lay in the movement of artisans who could apply and transmit tacit technical knowledge—a kind of black box of the preindustrial economy. The migration of skilled workers often created synergetic effects, activating flows of goods and technical equipment between the place of origin and the new settlement. In the majority of cases, activation of these networks, which were vital to the success of the transfer of technical knowledge, took place in a wholly or partially clandestine fashion, which was nonetheless very effective. Guilds and patents formed an institutional pairing, aimed at managing and transmitting new production techniques while minimizing conflict.

During the eighteenth century the spread of codified knowledge and the diffusion of technical know-how made possible by the efficient functioning of the guild/patent system seemed to have revealed every secret of traditional manufacture. Competition came to center on the product itself, with creativity and design the fundamental ingredients for success. Marsilio Landriani, comparing the important manufactures of the continent with the Italian situation, understood that product innovation had become strategic in a society where good taste was dictated by continually changing fashion: “The fashion does not demand a correction of the design but rather an infinite and capricious variety, a happy invention, similar to the chance and the circumstances of the moment; it even demands an apparent solidity. For, in fact, what would be the use of real solidity if the instability of fashion condemns as absurd today, that which it hailed as excellent yesterday?”<sup>89</sup>

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transmission of craft knowledge, I would argue, is at least as important as its role in encouraging innovation and invention.” “Invention, Secrecy, Theft” (n. 20 above), 231.

89. Pessina, *Relazioni di Marsilio Landriani*, 15.