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*The French Connection: Indian Cottons, Their Early Modern Technology and diffusion**

Asia's production of cotton and silk textiles, porcelain and the refining of base metals, zinc in particular, in the early modern period were more advanced than the rest of the world. Fundamental to Asia's success and superiority in textile production was the technology employed by artisans in the selection of raw materials and the techniques used in their application and presentation. Before Europe could diverge technically from other parts of the globe, European textile manufacture had to converge through the acquisition and incorporation of new materials and technical knowledge from other parts of the globe, especially from India and China[1] or, alternatively, through new or incremental advances in technical knowledge, production processes, machines, and apparatus.

Cotton a vegetable fiber was "one of the most difficult fibers to dye," "unlike animal fibers such as silk and wool, which can accept most natural dyes with 'comparative' ease, inherent properties of the cotton fiber reject a permanent bonding."[2] Mordant and dyes were the basic proto-industrial raw materials used in textile manufacture. Mordant, particularly, alum was used to fix the coloring matter to form an insoluble colored compound.[3] Color was provided by dyes[4] derived from natural organic materials – insects, roots, leaves, bark, trees, earth and

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[1] For a preliminary discussion of convergence, which is not viewed as being exclusively determined by prices, see: George Bryan Souza, "Convergence before Divergence: Global Maritime Economic History and Material Culture," *The International Journal of Maritime History*, 17:1 (2005): 17-27. For Europe's divergence in the early nineteenth century from China and other areas of the world, see: Kenneth Pomeranz, *The Great Divergence: China, Europe and the Making of the Modern World Economy*, Princeton and Oxford: Princeton University Press, 2000.

[2] See: Mattiebelle Gittinger, *Master Dyers to the World: Technique and Trade in Early Indian Dyed Cotton Textiles*, Washington, D.C.: The Textile Museum, 1982, p. 19.

[3] For an overview of alum, see: C. Singer, *The Earliest Chemical Industry*, (London, 1948).

[4] For dyeing and dyed textiles: see: F. Brunello, *The Art of Dyeing in the History of Mankind* (Vicenza, 1973); and S. Robinson, *A History of Dyed Textiles* (Cambridge, 1969).

minerals – and applied to fabric by different printing, painting[5] or dyeing techniques.[6] Dyers, globally, were secretive about their recipes and processes.[7]

This paper examines the comparative superiority of Indian cotton technology. It isolates one example of Indian cotton textile production and compares it with an equivalent cotton textile produced contemporaneously in France. It determines how, for what reasons and which aspects of Indian cotton textile production technology were investigated by the French. And, whether and by what means, the knowledge that the French acquired was diffused[8] and incorporated into their production methods.

The initial examination focuses on the French experience in the last quarter of the seventeenth century and into the first half of the eighteenth century. It identifies that the general generic term "Indian textiles"[9] and even "Indian cotton textiles" has to be disaggregated and placed geographically, technically, and commercially in perspective. At this time, the French wrote three long and highly detailed first-hand reports about Indian cotton textile production in general and its technology, especially the methods of printing, painting, and dyeing in particular. They dealt geographically with two of the three centers of Indian textile production – the port city-hinterland[10] complexes of western India (Surat— Amedabad

[5] For printing, and painting techniques, see: S. Robinson, *A History of Printed Textiles* (Cambridge, 1969); G.P. Baker, *Calico Painting and Printing in the East Indies in the 17th and 18th Centuries*, 2 vols, (London, 1921); and Serge Chassagne, "Calico Printing in Europe before 1780," *The Cambridge History of Western Textiles*, David Jenkins, ed., 2 vols., Cambridge: Cambridge University Press, 2003, I, pp. 513-527.

[6] See: Gittinger, *Master Dyers*, 1982; and B.C. Mohanty, et. al., *Natural Dyeing Processes of India*, (Ahmedabad, 1987).

[7] See: P.O. Long, *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance* (Baltimore, 2001). For the first printed European treatise on dyeing technology, see: G. Rossetti, *The Plictho*, S.M. Edelstein and H.C. Gorghettey, trans., (Cambridge, Mass. and London, 1969).

[8] See: David J. Jeremy, *Transatlantic Industrial Revolution: the Diffusion of Textile Technologies between Britain and America, 1790-1830s*, Cambridge, Massachusetts: MIT Press, 1981; D.C. Coleman, "An Innovation and Its Diffusion: The 'New Draperies,'" in: *The Textile Industries*, vol. 8, in: *The Industrial Revolutions*, D.T. Jenkins, ed., Oxford and Cambridge: Blackwell, 1994; and J.R. Harris, *Industrial espionage and technology transfer: Britain and France in the eighteenth century*, Scholar Press, 1998.

[9] See: John Guy, *Woven Cargoes: Indian Textiles in the East*, London: Thames and Hudson, 1998; and Ruth Barnes, Steven Cohen, and Rosemary Crill, *Trade, Temple and Court: Indian Textiles from the Tapi Collection*, Mumbai, India: India Book House Pvt. Ltd., 2002.

[10] See: R. Murphey, "Traditionalism and Colonialism: Changing Urban Roles in Asia," *Journal of Asian Studies*, 29 (1969), 67-84; D.K. Basu, ed., *The Rise and Growth of the Colonial Port Cities in Asia*, (Berkeley: Lanham, University Press of America, 1985); F. Broeze, ed., *Brides of the Sea: Port Cities of Asia from the Sixteenth to the Twentieth Centuries*, (Honolulu: University of Hawaii Press, 1989); J. Kathirithamby-Wells and J. Villiers, eds., *Southeast Asian Port and Policy: Rise and Demise*, (Singapore: Singapore University Press, National University of Singapore, 1990); I. Banga, *Ports and their Hinterlands in India, 1700-1970*, (New Delhi: Manohar, 1992); S. Arasaratnam and A. Ray, *Masulipatnam and Cambay: A History of Two Port-Towns, 1500-1800*, (New Delhi, 1994); F. Broeze, ed., *Gateways of Asia: Port Cities of Asia in the 13th-20th Centuries*, (London, New York: Kegan Paul International, 1996); B. Stein and S. Subrahmanyam, eds., *Institutions and Economic Change in South*

in Gujerat, including Sironji in Rajputana and Burhanpur in Khandesh), and southern India on the Coromandel Coast (including, for example, Masuilipatam, Pulicat, Tegenapatam, Tranquebar, and Negapatnam). They did not deal with the third, north-east India or Bengal, including Orissa, and the Ganges valley (Hugli —Kasimbazar).[11] The first two authors (Roques and Beaulieux) were representatives of the French East India Company[12] (one a commercial and the other a naval officer) and the third (Coeurdoux) was a French missionary. At Amedabad in western India from 1678 to 1680, Roques wrote a report entitled, *La manière de nègocier dans les Indes Orientales* (The method of trading in the East Indies). It included details on the wood-block printing of chintz.[13] At Pondicherry, on the Coromandel Coast,

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Asia, (Delhi, New York: Oxford University Press, 1996); M. N. Pearson, *Port Cities and Intruders: The Swahili Coast, India, and Portugal in the Early Modern Era*, (Baltimore and London, 1998);R. Mukheyee and L. Subramanian, eds., *Politics and Trade in the Indian Ocean World*, (New Delhi, Oxford University Press, 1998); and S. Chaudhury and M. Morineau, eds., *Merchants, Companies and Trade*, (London, New York: Cambridge University Press, 1999).

[11] See: J. Irwin, "Indian textile trade in the seventeenth century: (1) Western India, (2) Coromandel Coast, (3) Bengal, (4) Foreign Influences" *Journal of Indian textile history*, I (1955), pp.15-44; II (1956), pp. 24-42; III (1957), pp. 19-70; IV (1959), pp. 57-64; and H.K. Naqvi, "Dyeing of Cotton Goods in the Mughal Hindustan (1556-1803)," *Journal of Indian textile history*, VII (1967), pp.45-56. For more general discussions of textile production to those regional economic and trade developments, see: K. Glamann, *Dutch Asiatic Trade, 1620-1740*, (Copenhagen and The Hague: Danish Science Press, 1958); Om Prakash, *The Dutch East India Company and the Economy of Bengal, 1630-1720*, (Princeton, 1985); Sanjay Subrahmanyam, *The Political Economy of Commerce: Southern India 1500-1650*, (Cambridge, 1990); Alexander I. Tchitcherov, *India: Changing Economic Structure in the Sixteenth-Eighteenth Centuries, Outline History of Crafts and Trade*, New Delhi: Manohar, 1998; Prasannan Parthasarathi, *The Transition to a Colonial Economy: Weavers and Kings in South India, 1720-1800*, (Cambridge, 2001); Shantha Hariharan, *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases and Prices in Gujarat, 1600-1800*, Delhi: Manak, 2002; and C.M. Sinopoli, *The Political Economy of Craft Production: Crafting Empire in South India, c. 1350-1650* (Cambridge, 2003), especially 171-190.

[12] For the French East India Company and its trade in Asia and with Europe, see: Paul Kaeppelin, *La Compagnie des Indes Orientales et François Martin*, Paris, 1908; Philippe Haudrere, *La Compagnie Française des Indes au XVIII^{e} Siecle (1719-1795)*, 4 vols, Paris: Librairie de l'Inde Editeur, 1989; Glenn J. Ames, *Colbert, Mercantilism, and the French Quest for Asian Trade*, DeKalb, Illinois: Northern Illinois University Press, 1996; Catherine Manning, *Fortunes à faire: The French in Asian Trade, 1719-48*, Aldershot, Hampshire, U.K.: Variorum/Ashgate Publishing Ltd., 1996; and Glenn J. Ames and Ronald S. Love, ed., *Distant Lands and Diverse Cultures: the French Experience in Asia, 1600-1700*, Praeger, 2003.

[13] The original or copy of the Roques report is located at the Bibliotheque Nacional, Paris, *Fonds Français* 14614. Although the entire 341 page manuscript has not been translated but, the significant and the crucial segments have been, which permit the appraisal found in this paper, see: P.R. Schwartz, *Printing on Cotton at Ahmedabad, India in 1678*, (Amemdabad, 2nd ed., Calico Museum of Textiles, 1996); Indrani Ray, "Of Trade and Traders in the Seventeenth-century India: An Unpublished French Memoir by Georges Roques" and "The Trade and Traders in Ahmedabad in Late Seventeenth Century: Extracts from Georges Roques' MSS," in: *The French East India Company and the Trade of the Indian Ocean: A Collection of Essays by Indrani Ray*, Lakshmi Subramanian, ed., New Delhi: Munchiram Manoharlal Publishers, 1999, pp. 1-62; and 63-76. For the trials and tribulations in Roques career in India, from his arrival for his second tour of service until his death from illness, see: Lotika Varadarajan, ed. and tr., *India in the 17th Century (Social, Economic and Political) Memoirs of François Martin (1670-1694)*, 4 vols, New Delhi: Munchiram Manoharlal Publishers, 1981-5, I pt.2, pp. 558, 642, 730, and 782; II pt.1, pp. 820, 824, 841, 844, 859, 861, 862, 866, 869, 873n, 875, 898, 906, 922, 939, 948, 956, 963, 972, 989, 999, and 1157; and II, pt.2, p. 1504.

Beaulieux in 1737, and Coeurdoux in 1742 and 1747 wrote authoritative letters and reports on the fabrication of painted cottons in southern India.[14]

Since the latter two reports deal with cotton textile production and techniques distinct geographically and technically from the first, this version of this paper concentrates on the Roques report and western Indian cotton textile production and techniques for wood-block printed chintz.[15] Salient aspects of the Indian producers' side of the story are identified and interwoven with comparable experience by French producers.[16] Afterwards, it will be determined whether any of the technological knowledge that was identified was diffused in France. And, if it was not, an explanation will be advanced.

Roques' documented that India was an early and a highly proficient proponent of printing "with thickened mordants with the aid of wood blocks."[17] The principal cotton textile described by Roques was the less expensive wooden-block printed chintz[18] as opposed to the more expensive painted chintz from this same region and elsewhere in India. It was produced at Sironji in Rajputana and Burhanpur in Khandesh, and Amedabad in Gujerat. Amedabad was one of, if not, the lowest cost production center for this textile in western, if not all of, India. The use of one or more carved wood blocks was actually "the predominant means of patterning cloth in the west of India," which had spread to the east of India. They "were used to apply the mordant to the prepared cloth." It was a "more mechanical but less time-consuming technique

[14] See: Paul R. Schwartz, "French documents on Indian cotton painting. (1) the Beaulieu mss; (2) New light on old material," and "The Roxburgh Account of Indian Cotton Painting: 1795," in: *Journal of Indian textile history*, II (1956), pp. 5-23; III (1957), pp.15-44; IV (1959), pp.47-56.

[15] A printed or spotted cotton cloth, see: Henry Yule and A.C. Burnell, *Hobson-Jobson: A glossary of Angol-Indian colloquial words and phrases*, first published 1886, new edition (William Crooke, 1903), reissued: London: Routledge & Kegan Paul, 1968, p.201 and: John Irwin, "The Etymology of Chintz and Pintado," *Journal of Indian textile history*, IV (1959), p. 77.

[16] For an overview of French printing and dyeing techniques, see: A. Juvet-Michel, "The Controversy over Indian Prints;" "The Great Textile Printing Factories in France;" "The Technique of French Textile Printing;" and "The Patterns of the 'Toiles de Jouy," in: *Ciba Review*, 31 [*Textile Printing in 18th Century France*], (March, 1940), pp. 1090-1097; 1098-1106; 1109-1116; and 1117-1122; and H. Wescher, "Dyeing in France before Colbert;" "Great Masters of Dyeing in 18th Century France;" and "The French Dyeing Industry and its Reorganization by Colbert;" in: *Ciba Review*, 18 [*Great Masters of Dyeing in 18th Century France*], (February, 1939), pp. 618-625; 626-641; and 643-646. For contemporaneous Dutch textile and cotton techniques, trade, and fashion, see: J.H. Hofenk de Graaff, "De techniek van sits en katoendruk," and E. Hartkamp-Jonxis, "Sits en katoendruk, handle en fabricage in Nederland," *SITS: Oost-West Relaties in Textiel*, E. Hartkamp-Jonxis, ed., (Zwolle, 1987), pp. 22-29 and 30-41; and J.H. Hofenk de Graaff, *Geschiedenis van de textieltechniek*, (Amsterdam, 1992).

[17] See: Schwartz, *Printing on Cotton at Ahmedabad*, p.1

[18] A printed or spotted cotton cloth, see: Henry Yule and A.C. Burnell, *Hobson-Jobson: A glossary of Anglo-Indian colloquial words and phrases*, first published 1886, new edition (William Crooke, 1903), reissued: London: Routledge & Kegan Paul, 1968, p.201 and: John Irwin, "The Etymology of Chintz and Pintado," *Journal of Indian textile history*, IV (1959), p. 77.

[that] ultimately robbed the medium of its vitality." In order for the mordant to adhere to the wood block, it had to be thickened with a resin or a similar substance; "this thickener acted as a contaminant to the mordant and had to be washed out of the cloth before immersion in the dye, or the color would lack brilliance."[19] Indian producers had confronted and surmounted the drawbacks or limitations in this process. In Europe, printing with wooden blocks was the primary method of cotton textile production. In contrast with their Indian counterparts, contemporary European producers, apparently, had not yet surmounted all the drawbacks or limitations inherent in this process.

Paul R. Schwartz prepared an enlightening detailed technical summary and evaluation of Roques description of wood-block printed chintz processes in western India. A shortened version is provided. It permits a discussion of some the technical issues. Amedabad producers used three types of blocks,

> one for the outlines of the designs; one for the ground; and a third type for the details, for which up to ten small blocks might be used….The worker prints first the outlines, then the ground, and then the details and the reserves of wax. Ahmedabad prints seem generally to have had coloured grounds, either red or violet….The method by which the colour was obtained is described in a rather confused fashion by Roques, who could not have understood it fully. Fortunately he lists the necessary ingredients: a root to produce the red;[20] alum; iron rust; myrobalan; gall-nuts; pomegranate rinds; terra merita (turmeric); verdigris; copperas; indigo; wheaten flour moistened and become sour; a gum extracted from a tree; wax; and ochre.
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> The use of iron rust and of alum provides us with evidence for the use of mordants, the gum forming the thickening. Alum (double salt of aluminium and potassium) in its natural form furnished a mordant for red, while the mordant for black was obtained by discharging an acid (flour soaked and become sour) on the iron. Myrobalan and gall-nuts are astringents containing tannin, which give a black with the iron, just as copperas (sulphate of iron) does with these plants. Turmeric, which is soluble in water, furnished a yellow suitable for surface application, and formed a green when superimposed on the blue of the indigo.[21]

[19] See: Gittinger, *Master Dyers*, p. 27.
[20] *Saranguy* or *al*, *Morinda citrifolia* or *Morinda tinctorium*.
[21] See: Schwartz, *Printing on Cotton at Ahmedabad*, p.11.

Three of Roques' observations concerning western Indian wood block printing of chintz production processes may be selected and compared with two contemporaneous French wood-block chintz printing production centers -- Marseilles[22] and Rouen.[23]

The first is the selection, preparation, and use of cotton fiber. In India, this chintz was woven from raw cotton that was available from local or internal regional Indian market supplies, Roques, in outlining the weavers' ability to technically manipulate warp and weft to his commercial advantage, raises two speculative and unanswered questions. The first, to what degree did raw cotton quality influence Indian and French producers? In the case of India, cultivation of a perennial (*Gossypium arboreum*) to an annual variety (*Gossypium herbaceum*) occurred around the thirteenth century C.E. and "India by this time clearly had mastered the difficulties of handling this plant fiber."[24] In the case of Marseilles raw cotton was supplied from the Levant and in the case of Rouen, it came, primarily, from the Caribbean. And, the second, had French producers reached the level of dexterity both technically and commercially that their Indian counterparts had in their handling and manipulating warp and weft?

The second comment on Roques' observations concerns mordant technology and the comparative status of this practice and process in Asia and Europe. Aluminous mordant dyeing is possible without alum through the use of materials of vegetable origin, bark and leaves, which possess the chemical properties to fast color to fabric.[25] However, alum, "a double sulfate of ammonium or a univalent metal (as sodium or potassium) and of a trivalent metal (as aluminum, iron or chromium)"[26] is of mineral origin. In addition to its use as mordant in textiles, alum is and was used as an astringent, as an emetic, and in the manufacture of baking powders, and paper. Alum of mineral origin was the principal source of mordant for Asian and European textile producers, until it was chemically manufactured in the late eighteenth century.

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[22] For Marseilles, see: Olivier Raveux, "Espaces et technologies dans la France méridionale d'ancien régime: l'example de l'indiennage marseillais (1648-1793)," *Annales du Midi*, CXVI – 246(2004): 155-170.
[23] For Rouen, see: H. Wescher, "Rouen and Its Port in Olden and Modern Times;" "The Medieval Cloth Trade;" "John Holker, a Promoter of the French Textile Industry;" "The 'Rouennerie' Trade and Its Entrepreneurs;" "Turkey Red Dyeing;" and "The Normandy Textile Printing Industry of the Eighteenth and Nineteenth Centuries," in: *Ciba Review*, 135 [*Rouen --- French Textile Centre*], (December, 1959), pp. 2-6; 7-9; 10-13; 14-20; 21-26; and 27-32.
[24] See: Gittinger, *Master Dyers*, p. 16.
[25] See: A. Bülher, "Dyeing among Primitive Peoples," *Ciba Review*, 68 [Dyeing among Primitive Peoples] (June, 1948), p. 2497-8.
[26] See: *Webster's New World Dictionary*, (New York, 1972), p.41.

After the mining and processing of this mineral became known and that knowledge was diffused, alum was relatively ubiquitous in China and India. The Chinese had developed a technique for making white alum by the sixth century C.E.[27] The use of alum in the fixation of color in textile dyeing processes in China, presumably, dates from this point onwards. In India, the use of alum (tūvārī) for the fixation of color in dyeing processes dates from the ninth century C.E. onwards.[28] In the early modern period, Chinese alum was involved as recent research has shown in inter-Asian maritime trade because it was commercially viable and useful technically as ballast for shipping purposes. Chinese alum found demand, commercial acceptance, and incorporation in Indian port cities and hinterland textile production centers.[29]

Other global textile production centers were neither ignorant nor was alum insignificant in their processes. Alum was known and used in antiquity[30] and the medieval period throughout Europe,[31] the Mediterranean[32] and Muslim worlds.[33] European textile producers were dependent upon supplies from distant locations. From the late Middle Ages onwards, European textile producers were using alum supplied from Tolfa near Rome, from Chios in the Mediterranean, and the Levant. England was an exception but this was a late phenomenon, since the English began mining and utilized rudimentary processing of deposits in Yorkshire only in 1608 onwards. It was not until late in the eighteenth century that the applied chemist,

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[27] See: Sung Ying-Hsing, *Chinese Technology in the Seventeenth Century: T'ien-Kung K'ai-Wu,* E-Tu Sen Sun and Shiou-Chuan Sun, trans., (Mineola, New York, 1966), p.206 and 213. For additional information on Chinese textile technology and alum, see: D. Kuhn, *Textile Technology: Spinning and Reeling*, Vol. V, Pt. 9, (Cambridge, 1986) and P.J. Golas, *Mining*, Vol. V, Pt. 13, (Cambridge, 1999), p.233 in: J. Needham, *Science and Civilization in China*, 7 vols. and 18 parts, (Cambridge, 1954- present).

[28] See: Mira Roy, "Dyes in Ancient and Medieval India," *Indian Journal of History of Sciences*, vol. 13, no.2, (1978), pp. 83-113, especially, pp. 84-85. Gittinger suggests that it was much earlier using evidence found at Mohenjo Daro, see: Gittinger, *Master Dyers*, p. 16.

[29] See: George Bryan Souza, "Ballast Goods: Chinese Maritime Trade in Zinc and Sugar in the Seventeenth and Eighteenth Centuries," in: R. Ptak and D. Rothermund, eds., *Emporia, Commodities and Entrepreneurs in Asian Maritime Trade, c.1400-1750*, (Stuttgart, 1990), pp. 291-315; and George Bryan Souza, "Country Trade and Chinese Alum: Raw Material Supply in Asia's Textile Production in the Seventeenth and Eighteenth Centuries," *Revista da Cultura*, 11 (2004), 136-153.

[30] See: Pliny, the Elder, *Natural History*, H. Rackham, trans., (Cambridge, 1962).

[31] For early descriptions of alum, its use in medieval Europe and trade, see: V. Biringuccio, *Pirotechnia*, trans., C.S.Smith and M.T. Gnudi, (Chicago, 1942; reprint: Cambridge, Mass., 1959), pp. 77-78 and 98-105; and G. Agricola, *De Re Metallica*, trans., H.C. Hoover and L.H. Hoover, (London, 1912; reprint: New York, 1950), pp. 564-570.

[32] See: Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II*, S. Reynolds, trans., (London, 1972); P. Horden and N. Purcell, *The Corrupting Sea: A Study of Mediterranean History*, (Oxford, 2000), pp.145, 346, 349, 354, 361, and 611.

[33] See: K. Fleet, *European and Islamic trade in the early Ottoman state: The merchants of Genoa and Turkey*, (Cambridge, 1999); S. Faroqhi, "Alum production and alum trade in the Ottoman empire (about 1560-1830)," *Wiener Zeitschrift für die Kunde des Morgenlandes*, 71 (1979), pp.153-175; and W. Heyd, *Histoire du Commerce du Levant au Moyen-Age*, 2 vols., (Amsterdam, 1962).

Jean Antoine Claude Chaptal, found a solution to this dependence upon foreign supplies of alum for French textile and cotton producers in his chemical factory at Montpellier; "he discovered the composition of alum, which he manufactured artificially. His factory was able to meet practically all the demands of the French dye-industry."[34]

Dependence upon foreign supplies of alum in France was not, however, the drawback or limitation that French producers had to confront and surmount in mordant dyeing technology as applied to wood-block printing of chintz. It was, as Roques observed, the thickening of the aluminous mordant with a resin or a similar substance in order for the mordant to adhere to the wood block and the action of this thickener as a contaminant, which required an additional washing process before immersion in the dye, or the color would lack brilliance. At present, it has not been determined whether French chintz producers using wood-block printing in general or at Marseilles or Rouen incorporated resins or similar substances to enhance their mordant dyeing technology or whether they incorporated the additional washing process. But, it appears that they, initially, did not obtain the same level of brilliance of color in their cottons in comparison with the western Indian chintz.

The third and final comment on Roques observations deals specifically with red dyes and red dyeing technology and the comparative status of their availability and utilization as well as the technical practice and process in Asia and Europe. Both, Asia and Europe in general and India and France in particular possessed internal supplies of natural organic materials that would produce red dyes and both were able to obtain additional external supplies to supplement and re-enforce specific deficiencies or specialized requirements. Within Asia and Europe, the external supplies of red dyes came overland and by sea. Roques, for example, mentions that sappanwood, a source of red dye, had been exported or re-exported from Surat to Le Havre in France, where it was tested by dyers and found technically and commercially successful for textile production.[35] Although he did not discuss the details, the sappanwood that was involved was either from Bima on Sumbawa in the Indonesian Archipelago or from southern Thailand (Siam) and became a commodity that was regularly exported to France by the French East India Company and acquired via intermediaries at Amsterdam by French

[34] See: H. Wescher, "Great Masters of Dyeing in 18th Century France," *Ciba Review*, 18 [*Great Masters of Dyeing in 18th Century France*], (February, 1939), p. 640.
[35] See: Schwartz, *Printing on Cotton at Ahmedabad*, p. 13.

textile producers from the Dutch East India Company.[36] While the availability of suitable sources for red dyes was not a major issue, there was a difference in this instance between Europe and Asia, French mercantilist doctrines generally favored cultivation, production, and utilization of internal sources of supply.[37]

Roques establishes that Indian producers were technically more advanced in employing red dyes, primarily, as the ground in the wood-block printing of chintz-- one of the lowest cost cotton textiles in production. Contemporaneous French producers at Marseilles and Rouen were either using the natural white of the cotton or employing black dyes as the ground. In Europe and France, red dyeing technology for cotton was considered the most difficult of an already difficult process. By the 1760s, European including French dyers had converged or resolved the pending technological issues for all animal and most vegetable fibers. This convergence had occurred through empirical practice and the transfer of knowledge, similar to what occurred in Asia, and the incorporation of scientific inquiry in the age of reason, which was dissimilar to the Asian experience.[38] European dyers were producing colors in those textiles that were equal to those produced in Asia, with the exception of red dyeing in cotton.[39]

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[36] See: George Bryan Souza, "Dyeing Red: S.E. Asian Sappanwood in the Seventeenth and Eighteenth Centuries;" *O Oriente*, 8 (2004), 40-58 and "Tingir de vermelho: o sapão da Ásia do Sueste nos séculos XVII e XVIII," in: Jorge M. dos Santos Alves, Claude Guillot, Roderich Ptak, eds., *Mirabilia Asiatica*, vol. 2, (Wiesbaden and Lisbon, 2005), 21-35; H.H. Zeijlstra, "Looi- en Verfstoffen," in: K.W. van Gorkom, *Oost-Indische Cultures*, 3 vols, (Amsterdam, De Bussy, 1913), III, 699-789; P. Boomgaard, "Forest management and exploitation in colonial Java, 1677-1897," in: H. Wheatley, ed., *Agriculture, resource exploitation, and environmental change*, (Aldershot, Hampshire, Great Britain; Brookfield, Vt.: Variorum, 1997); and, B. de Jong Boers, "Sustainability and time perspective in natural resource management: the exploitation of sappan trees in the forests of Sumbawa, Indonesia, 1500-1875," in: P. Boomgaard, et. al., *Paper landscapes: explorations in the environmental history of Indonesia*, (Leiden: KITLV Press, 1997), 261-280.

[37] My argument is not to be construed that French doctrines and practices were exceptional. Asian rulers did place similar practices in force in markets and on goods with similar impact, but not to the degree, length of time or with the long-term result that occurred in France. For French mercantilism, see: Charles Woolsey Cole, *French Mercantilist Doctrines before Colbert*, New York: Richard R. Smith, Inc., 1931; Charles Woolsey Cole, *Colbert and a Century of French Mercantilism*, 2 vols., New York: Colombia University Press, 1939; reprint: London: Frank Cass and Company, 1964; Charles Woolsey Cole, *French Mercantilism 1683-1700*, New York: Colombia University Press, 1943; reprint: New York: Octagon Books, 1971; and Thomas J. Schaeper, *The French Council of Commerce 1700-1715: A Study of Mercantilism after Colbert*, Columbus, Ohio: Ohio State University Press, 1983.

[38] See: Jean Hellot, *L'Art de la Teinture des Laines et des Etoffes de Laine, en grand et petit teint*, (Paris, 1750); A. Birembaut and G. Thuillier, "Une source inédite: Les cahiers du chimiste Jean Hellot," *Annales, economies, civilizations*, 21 (1966), pp. 357-64; Pierre Joseph Macquer, *L'Art du Teinturier en Soie*, (Paris, 1763); and H. Wescher, "Great Masters of Dyeing in 18th Century France," in: *Ciba Review*, 18 [*Great Masters of Dyeing in 18th Century France*], (February, 1939), pp. 626-641.

[39] For a general discussion of some red dyes, see: G. Sandberg, *The Red Dyes. Cochineal, Madder, and Murex Purple: A World Tour of Textile Techniques*, Ashville, N.C.: Sterling Publishing, 1997. For additional discussion about New World cochineal, see: R.J. Salvucci, *Textiles and Capitalism in Mexico: An Economic History of the "Obrajes," 1539-1840*, (Princeton, 1987). M.J. Sarabia Viejo, *La Grana y el Añil: Técnicas tintóreas en México y*

Lepileur d'Apligny attempted to address this issue in 1776, but it was not until the early nineteenth century that Chaptel resolved it with the publication of the *L'Art de la Teinture du Cotton en Rouge* and *Principe chimiques de l'art du teinturier degresseur*.[40]

Although in agreement with the evaluation that Roques report was "neither systematic nor always complete in technical details,"[41] Roques observations of the late seventeenth century did contain information that could have been of critical importance to French producers of printed chintz. At the present stage of this research, there is no evidence to suggest that this information was diffused. Writing under instructions to provide commercial information for the local and Paris based directors of the French East India Company, Roques' *La manière de nègocier dans les Indes Orientales* was read internally, discussed, and archived. In contrast, by being published, Coeurdoux's information on the fabrication of painted cottons in southern India were publicly scrutinized and disseminated.

Commercially, the low-cost wood-block printed chintz of western India was produced and sold primarily for export. It was purchased by indigenous and European merchants that incorporated it into their commercial strategies for inter-Asian maritime trade, which was primarily directed toward markets and consumption in the Indonesian Archipelago. Being a relatively small participant in this trade, the French East India Company directed their early purchases of these chintz for the French market. In general, the consumption of cotton textiles in Europe in the 1660s was shifting from household to personal use and was booming.[42] In France, the Company's exports of low cost western Indian wood-block printed chintz was oriented towards lower-middle class consumption, which competed with an inferior quality of "*indiennes*" or "*siamoises*" style chintz produced at Marseilles and Rouen. French mercantilist doctrines continued to be oriented towards the states' organization of space, resources, and fostering or protecting internal production of goods that would increase the wealth of the

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América Central, (Sevilla, 1994). J. Baskes, *Indians, Merchants, and Markets: A Reinterpretation of the "Repartimiento" and Spanish-Indian Economic Relations in Colonial Oaxaca, 1750-1821*, (Stanford, 2000). For a discussion of madder,See: G. Schaefer, "The Cultivation of Madder;" and "The History of Turkey Red Dyeing;" R. Haller, "The Chemistry and Technique of Turkey Red Dyeing; " and "Turkey Red Dyeing in South and South East Asia;" in: *Ciba Review*, 39 [*Madder and Turkey Red*] (May, 1941), pp. 1398-1406; 1407-1416; 1417-1421; and 1423-1426; and Robert Chenciner, *Madder Red: A History of Luxury and Trade,* Routledge/Curzon, 2000.

[40] See: H. Wescher, "Great Masters of Dyeing in 18th Century France," in: *Ciba Review*, 18 [*Great Masters of Dyeing in 18th Century France*], (February, 1939), pp. 636-637 and 640-641.

[41] Indrani Ray, "Of Trade and Traders, p. 1.

[42] See: Beverly Lemire, "Fashioning Cottons: Asian Trade, Domestic Industry and Consumer Demand, 1660-1780," *The Cambridge History of Western Textiles*, David Jenkins, ed., 2 vols., Cambridge: Cambridge University Press, 2003, I, pp. 493-512.

country via export. On October 26th 1686, the state intervened and decreed the prohibition of the importation of foreign printed cottons and the production of imitations in France. One explanation for this drastic and highly contested measure was that importation would increase the outflow of wealth and "An industry which produced inferior goods and worthless imitations that could not compete on foreign markets had no right to expect government support."[43]

Although a preliminary research in progress report, this paper may advance a number of tentative conclusions. By concentrating upon the richly detailed Roques report, isolating a

[43] For a discussion of the reasons for the prohibition of the importation of Indian printed cottons, including chintz, and their manufacture in France, which was vigorously evaded, see: A. Juvet-Michel, "The Controversy over Indian Prints," in: *Ciba Review*, 31 [*Textile Printing in 18th Century France*], (March, 1940), pp. 1090-1097, quote: p. 1093. For twelve key French regulations, Paris and provincial editions, pertaining to the production and commerce of cottons, both dyed and printed, and limitations applied to foreign cottons importation, see: *Arrest du conseil d'estat pour l'exécution de celuy de 27. Janvier dernier concernant les toiles de coton, tant peintes que blanches*, Paris: S. Mabre-Cramoisy, 1687; *Arrest du conseil d'estat du Roy, qui règle la quantité des étoffes de soye, d'or & d'argent, que la Compagnie des Indes Orientales peut faire venir des Indes, & vendre en France, après avoir esté marquées suivant l'Arrest du conseil du 14 aoust 1688. Et fait défenses à tous marchands, négocians & autres, d'acheter de ladite Compagnie, ni des marchands de Marseille, des toiles peintes, & écorces d'arbres, & d'en faire commerce; & à toutes personnes d'en porter, & d'en faire des vestemens & des meubles, dans tout le Royaume, à peine de confiscation, & de trois mille livres d'amende*, Bourdeaux: R. Brun, 1700; *Arrest du conseil d'estat du Roy, concernant les étoffes des Indes, de la Chine, & du Levant, toiles de coton peintes ou blanches, furies, mousselines & autres, avec injonction de faire marquer tous les meubles qui en sont composez, suivant les déclarations qui en ont été faites cy devant, à peine de trois mille livres d'amende contre ceux qui ne les ont pas déclarez*, Paris: J. de la Caille, 1716; *Lettres Patentes du Roi, concernant les toiles de coton blanches, & les toiles peintes, teintes & imprimées*. Lyon: Imprimerie P. Valefray, 1759; *Arret du conseil d'état du Roi, et lettres patentes sur icelui, registrées en Parlement. En interprétation de celui du 5 septembre 1759, concernant les toiles de coton blanches, & les toiles peintes ou imprimées*, Lyon: Imprimerie P. Valfray, 1760; *Arret du conseil d'état du roi, qui évalue les droits que les toiles peintes & mouchoirs de toiles de coton venant de l'étranger, payeront à l'entrée du Royaume*, Lyon: Imprimerie P. Valfray, 1760; *Declaration du Roi, portant règlement pour les plombs des toiles de coton, les toiles de lin, de chanvre & de coton peintes ou imprimées, venant de l'étranger*, Lyon: P. Valfray, 1764; *Arrest du conseil d'état du Roi, qui modère les droits d'entrées sur les toiles peintes ou imprimées venant de l'étranger; fait défenses d'en tenir magasin ou entrepôt dans les quatre lieus des frontières; & attribue au Sieur lieutenant-général de police à Paris, & aux Sieurs intendans des provinces, la connoissance de toutes les saisies desdites toiles*, Rennes: Imprimerie de la veuve François Vatar, 1772 and. Lyon: Imprimerie P. Valfray, 1772; *Lettres Patentes sur arrêt, en faveur des sieurs Oberkampf & Sarrasin de Maraise, entrepreneurs-propriétaires de la manufacture royale de toiles-peintes établie à Jouy, près Versailles, sur la rivière des Gobelins. Portant entr'autres prérogatives, que les toiles de ladite manufacture seront exemptes des visites, plombs & marques prescrites par les règlemens, & pourront, avec la seule empreinte de la manufacture imprimée sur chaque chef, circuler librement dans le Royaume, & être exportées à l' étranger*, Paris: P.G. Simon, & N.H. Nyon, 1784; *Arret du conseil d'état du Roi, qui en maintenant la prohibition des toiles peintes & imprimées étrangères, ordonne que celles peintes & imprimées dans les manufactures d'Alsace, pourront entrer dans l'intérieur du Royaume, & fixe les droits qu'elles acquitteront lors de leur introduction*, Paris: Imprimerie royale, 1789; *Arrest du conseil d'état du Roi, qui suspend l'exécution de celui du 16 Octobre 1788, concernant les mousselines & toiles de coton, ainsi que l'exécution de l'article V de l'arrêt du 10 Juillet 1785*, Paris: Imprimerie royale, 1789; *Arret du conseil d'état du Roi, qui prescrit de nouvelles formalités à remplir, pour constater que les mousselines, toiles de coton & toiles peintes & imprimées qui se fabriquent en Alsace, ont été réellement fabriquées dans cette province*, Paris: Imprimerie royale, 1789.

specific example of western Indian cotton textile production and techniques -- the wood-block printed chintz, and comparing it with contemporaneous and equivalent French production, discrete technical components that contributed to the comparative superiority of Indian cotton textile production in the late seventeenth and eighteenth centuries were identified and discussed. While the Roques report contained potentially useful information for French producers, the commercial rationale for the acquisition of this information, apparently, impeded the indirect or direct public diffusion of its findings. The sources of information that resolved pending technical issues for French cotton producers came more from the incorporation of scientific inquiry in the age of reason and less from empirical practice and the transfer of knowledge. The Asian experience was dissimilar, in part, possibly, because they were technically more advanced and did not face the necessity that Europe did to expand and develop new or incremental advances in technical knowledge, production processes, machines, and apparatus. And, although the state intervened in Asia and Europe, the degree, length of time, and the relatively steady purpose towards raw material availability and textile production was a comparatively more influential and significant contributory factor in French textile development in general and in cottons in particular than the state was in India.

Beyond the discrete example, the textual evidence, and argument provided about wood-block printed cottons, this paper raises a number of broader methodological and historiographical issues which have wider ramifications and implications. It explicitly and implicitly engaged the convergence/divergence debate, which incorporates and discusses the relationships of port-cities with their hinterlands, the role of overland and inter-Asian and global maritime trade in the supply and exchange of commodities, and the inter-connections of those commodities and activities with the histories of the political economies and societies that were involved, their impact on the environment and in comparison with the technology and science employed.

Before early modern Europe could diverge technically from other parts of the globe as this paper demonstrates European textile manufacture had to converge through the acquisition and incorporation of new materials and technical knowledge from other parts of the globe, especially from India and China or, alternatively, through new or incremental advances in technical knowledge, production processes, machines, and apparatus. In order to develop the convergence side of the debate, which is not exclusively about prices, this paper re-enforces

the argument that the local, regional, and global elements of the organization of space, resources—human, natural, technological, commerce, and production should be approached individually and holistically, via their inter-connections, and then compared with alternate experiences.