Useful Knowledge in the Indian Subcontinent

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The concept useful knowledge has been receiving growing attention from economic historians since the publication of Joel Mokyr's *Gifts of Athena*. Mokyr uses the term to refer to both the scientific and practical knowledge about the natural world that makes economic and technological progress possible. And for him, the emergence of institutions to both develop new forms of useful knowledge as well as to diffuse existing knowledge systems was crucial for the industrialization of Europe in the eighteenth century.

At the same time, however, Mokyr asserts, "Most techniques before 1800 emerged as a result of chance discoveries, trial and error, or good mechanical intuition and often worked quite well despite nobody's having much of a clue as to the principles at work."[1] He also says, "Most practical useful knowledge was unsystematic and informal, often un-codified and passed on vertically from master to apprentice or horizontally between agents." It would appear, then, that before the industrial age of the nineteenth century, the creation of useful knowledge was not systematized and did not possess systematic links to production processes. Furthermore, useful knowledge was transmitted largely through informal networks and face-to-face contact. The possessors and disseminators of useful knowledge were very much artisans and mechanics, not the engineer, expert or authority.

[1] Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton, 2002), p. 32.

With these claims, Mokyr is very much in a powerful stream of economic historical thinking on the relationship between knowledge and production before the nineteenth century. Mokyr continues in the tradition of Peter Mathias and others who have argued against a powerful link between developments in science and industrialization before the nineteenth century. At the same time, however, from the ranks of economic historians and historians of science, arguments have been put forward for the central role that scientific advances played in the development of new technologies and techniques of production. A. E. Musson and Eric Robinson, for example, have argued for a "fruitful" collaboration between science and technology during British industrialization.[2] This view has been endorsed by Margaret Jacob and others who have examined the problem from the perspective of the history of science.

The purpose of this paper is not to resolve these debates within early-modern European history. It raises them, however, to point to the fact that answers to the problem of divergence between Europe and Asia must take stances upon unsettled, and at times hardly examined, questions in the histories of both Europe and Asia.

Along those lines, this paper explores systems for useful knowledge that existed in seventeenth and eighteenth-century India, with some focus on southern India, especially the Tamil and Telugu speaking areas along the coast both to the north and to the south of the present-day city of Chennai and the area in the interior which formed in the eighteenth century the state of Mysore. The Indian subcontinent has not had its Joseph Needham. For this reason, the histories of science and technology in India have been barely excavated, and, as a consequence, the Indian experience has rarely

[2] A. E. Musson and Eric Robinson, *Science and Technology in the Industrial Revolution* (Toronto, 1969), p. 7.

figured in comparative accounts of technology and knowledge. Joel Mokyr's *Lever of Riches,* for instance, includes long discussions on China, but very little material on India.

Before getting to useful knowledge, however, let me examine more broadly some of the knowledge collection and dissemination systems that existed in eighteenth-century South India. Some of this information may be obtained from an unusual eighteenth-century source that survives from this area, a diary maintained by the merchant, Ananda Ranga Pillai, from 1736 to 1761. In these years, Ananda Ranga Pillai resided in the city of Pondicherry, which was the trading post for the French East India Company, and he was employed as a company merchant, that is supplying the French with textiles and other products as well as helping them negotiate the political and commercial world of south India. His diary was kept in Tamil and the English translation runs to twelve volumes, nearly five thousand pages.

The diary gives us valuable insights into the kinds of knowledge that an Indian merchant found useful and worthy of careful attention. This knowledge falls roughly into two categories: commercial and political.

Ananda Ranga Pillai was a fount of information on the political events of the day. Among them were informed discussions of the Maratha incursions into the Tamil country and the outcomes of sieges in South India. There was also a long and detailed summary the Afghan Nadir Shah's sacking of Delhi. Ananda Ranga Pillai's diary also contains long disquisitions on European events, on relations between France and Britain, the state of politics in central Europe, including succession disputes.

The second form of knowledge found in the diary deals with commercial matters. In this category we must include such things as the timing of the arrival of European ships, which was keenly watched as these events could have repercussions for the prices of many goods. Ananda

Ranga Pillai was also kept informed on the state of markets in places like Mocha and Manila, where he sent goods for sale under his own account. Prices in South Indian markets were also closely monitored by this merchant.

All of this information was assembled by Ananda Ranga Pillai on the basis of a system of agents with whom he corresponded regularly. Therefore, a system of postal communication was clearly in place in early eighteenth-century South India. Some of these points on commercial intelligence have also been made by Christopher Bayly in his *Empire and Information*. The key point that emerges, however, is that eighteenth-century south India certainly possessed a well working network for the diffusion of knowledge and information.

What is missing in Ananda Ranga Pillai's papers is discussion of production, whether agricultural or manufacturing. This is despite the fact that he had interests in both areas. He possessed family land in a village near Pondicherry, which he visited on occasion. And he also was very much involved in the trade of manufactured goods, especially cotton cloth. These he obtained through the time-honored system in the Indian subcontinent of making advances of cash to the weavers, who then purchased yarn, wove the cloth for delivery by a specified date. Again, Ananda Ranga Pillai employed agents who undertook these tasks, acting as his intermediaries with the producers themselves. The absence in these diaries of useful knowledge as it pertained to the manufacturing of goods, however, should not be taken as a sign of its absence in the Indian subcontinent altogether. Rather, we must conclude that merchant-princes like Ananda Ranga Pillai, whether they were in India, China, Russia or western Europe, may not have been the bearers of this information.

At the same time, we should not conclude that all persons of high social status in India at the time were uninterested in technical knowledge. A north Indian manual, entitled “Book of Regulations,” and written around 1700, provides a compendium of useful knowledge for the rich and it includes information on iron and gold working, engraving, alchemy, weaving, sewing, carding, dyeing, pottery making and cooking. More than a hundred years earlier, the Mughal emperor Akbar was praised by chroniclers for his interest in crafts and technology. And in the eighteenth century, the prince Qaim Khan Bangash was known for his avid interest in cannon casting and designed footwear. Bangash’s designs are still found in the north Indian heartland today.[3]

Nevertheless, when we get closer to weavers and other producers, we find far more material on technology of production. Such a procedure is complicated in the Indian historical case due to the lack of sources and the fact that in south India producers possessed the political and economic power to keep a tight hold over much of their knowledge. Nevertheless, in the case of the export trade in cotton cloth, there is abundant evidence that cloth manufacturers, whether they were weavers, printers, painters, or washermen, absorbed information on demand for cloth, and altered their production systems to satisfy their buyers. In other words, there was no lack of product innovation in the seventeenth and eighteenth centuries.

In the late seventeenth century, cloth printers, for example, in western and southern India began to produce patterns that European buyers presented to them that were seen as suitable for “European tastes.” The actual task of transmitting this information to printers and supervising their work, etc. fell to Indian merchants and agents.

[3] Iqbal Ghani Khan, “The Awadh Scientific Renaissance and the Role of the French: c. 1750-1820,” *Indian Journal of History of Science*, 38 (2003), p. 280.

Similarly, weavers in different parts of the subcontinent altered their looms to produce cloth of dimensions, patterns and qualities that were suitable for the demand of European companies and traders. In the late eighteenth century, for instance, English East India Company servants were constantly changing the specifications for checked handkerchiefs, asking their merchants to alter the colors and sizes of borders, checks and so on. Indian merchants then transmitted this information to their weaver suppliers, who either complied with these requests or gave excuses for why the changes could not be implemented. Weavers, however, shifted from producing for local markets as well as overseas and when they had set their looms to supply local demand, they could be induced to work for Europeans only after they had completed their local orders or with the payment of a hefty premium for their services.

There is also extensive evidence for the standardization of cloth production for export markets. Before the mid-seventeenth-century, and the beginnings of significant European demand, an enormous variety of textiles were manufactured in southern India. By the early eighteenth century, although there were still a dazzling variety of cloths, there was also the emergence of some standardization, particularly in the calicoes that had become the mainstay of European purchases in the south. These came in a number of qualities, but in two standard sizes: salemporis, which were eighteen yards in length and approximately two yards wide, and longcloth, which were the same width, but double the length. These two varieties of cloth had not been produced before the seventeenth century, but by the 1750s were manufactured along a nearly five hundred mile arc from the area which today forms the border between Orissa and Andhra Pradesh to nearly the tip of India. The spread of these varieties may have been in part the product of intelligence, especially weavers traveling from place to place spreading word of the strong demand for these cloths, but it was also undoubtedly the result of cloth merchants asking weavers for these sorts.

The above examples from textile manufacturing indicate that the south Indian textile industry was not caught in a stasis: producers absorbed knowledge and changed their products in order to meet the tastes of buyers. Innovation in the period between the sixteenth and eighteenth centuries, however, was not restricted only to the product, but also included the process of production itself. Some evidence for this comes from iron smelting, copper utensil manufacturing, and ship building.

When the Portuguese sailed into the Indian Ocean they brought with them dramatically different techniques of shipbuilding. Unlike European ships, Indian ships were not caulked. Rather, the timber or planks were joined together by rabetting and other methods. Although oakum was known in the subcontinent and imported for other uses, caulking was not adopted, most likely because of the higher costs it added to ship construction.[4] Nevertheless, for the English one of the strongest arguments in favor of building ships in Bombay was that Indian methods "excuseth all caulking worke, ocum, pitch, and tarr, with the expence of a many carpenters and caulkers."[5]

Although Indians displayed little interest in caulking, they quickly and enthusiastically adopted the use of nails to join together planks. Before the early sixteenth century, this task was done with rope and stitching, but ships manufactured in this way were vulnerable to Portuguese naval attacks. In response, within a decade of Vasco de Gama's arrival in southwestern India, ships began to be built in the Portuguese style, with iron nails and nailing.

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[4] Ahsan Jan Qaisar, *The Indian Response to European Technology and Culture* (Delhi, 1982), pp. 20-23.
[5] English Factories in India, 1688-89, p. 79.

These European techniques were quickly adapted to Indian ships, especially for those engaged in long-distance sailing. The practice of sewing was not displaced completely, but confined to ships constructed for coastal trade routes.

Several other innovations, inspired by European example, were also taken up by Indian shipping, but on a far more limited scale. Iron anchors began to be used in place of the traditional large stone anchors; pitch began to be applied to cables and cordage; pumps for the bailing of water began to be found on board Indian ships; and sheathing began to be increasingly common by the seventeenth century.

A similar process of innovation and technical development in the sixteenth and seventeenth centuries may be found in iron smelting. From the sixteenth century, the Assam region of eastern India became famous for its cast iron cannon. One of its exemplary products was a gun at the Rangpur fort was more than seventeen feet long and the thickness of the metal was nearly eight inches. It is possible that iron casting technology diffused to the region from China. It was possible to achieve higher furnace temperatures in Assam from the blower machines that were used in the area. Rather than bellows, which were used to supply air in the rest of the subcontinent, Assamese iron smelters relied upon blowing cylinders, which were "single-acting or double-acting made of rigid material such as solid piece of wood, turned or bored. Into the ends, discs of wood were fitted by rough dovetailing, the circular joints between discs and cylinder being rendered air-tight with clay. In the center of one disc is a hole of an inch or so in diameter, which allows the air to pass into the tubes or the tuyere." These devices were common in Burma and may have come to eastern India from there.[6]

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[6] Arun Kumar Biswas, *Minerals and Metals in Pre-Modern India* (New Delhi, 2001), p. 111.

The design of furnaces for iron smelting may have also been influenced by Europeans in the sixteenth and seventeenth centuries. An early nineteenth-century account of South Indian furnaces remarks on their resemblance to Stuckofen furnaces of Germany. Arun Kumar Biswas has speculated that there may have been some Dutch influence on the design, especially given the fact that in the seventeenth century the Dutch purchased huge quantities of iron in the region. Biswas makes a similar point about furnaces in southwestern India, especially Malabar, where the furnaces were about ten feet tall.[7]

Iron was not the only metal in which change has been identified. Another example comes from the brazier workers of eastern India, a region that witnessed a dramatic growth in demand for vessels made from copper from 1600 to the 1800s. According to one report from 1810, urban families in Bengal possessed upwards of several dozen copper utensils of as many as forty different designs. Peasant families were known to own as many as three dozens of these copper wares. This is in stark contrast to two centuries earlier, where stocks of these vessels were much lower. The growth in copper utensils took place at a time when there was a dramatic increase in the price of copper in the subcontinent. In response, craftsmen in eastern India created new alloys in which the proportion of copper was much lower, which would have required modifications in smelting and furnace design as well as in forging techniques. Another innovation introduced in the seventeenth or eighteenth century was a belt-driven lathe for the scrubbing and chiseling of the utensil. This device may have been inspired by the

[7] Biswas, *Minerals and Metals*, pp. 106-7.

spinning wheel and it's adoption would have reduced the labor required in the time-consuming finishing processes.[8]

By the eighteenth century, it is possible to trace the development of technology with greater confidence. In part this is due to the greater availability of source material, but it also appears that there was a wider search for new methods of production in the eighteenth century, in part propelled by states and revenue authorities. This was in response to the growing fiscal pressures that rulers in the Indian subcontinent experienced after 1700. Several historians have documented the rise of an Indian military fiscalism as cavalries gave way slowly to infantry and prebendal systems were replaced with standing and mercenary armies.

In response to the fiscal pressures that these military developments created, rulers in several areas of the subcontinent sought to push for significant improvements in systems of production in order to expand the taxable base of their kingdoms. The Rajput state of Kota, for example, embarked upon experiments to improve seed strains and grafting, to breed superior varieties of oxen, as well as to develop new plow designs appropriate for the different soil types found in the kingdom. In the late eighteenth century, a new double-yoked plow, the Konkani, which was better suited for heavy soils than the traditional Rajasthani plow, was also introduced. This led to the expansion of cultivation in to areas that earlier had been too difficult to work. As the name suggests, this plow may have been an adaptation of one found in the Konkan region of western India. The

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[8] Smritikumar Sarkar, "Indian Craft-Technology: Static or Changing—A Case Study of the Kansari's Craft in Bengal, 16th to 18th Centuries," *Indian Journal of History of Science*, 33 (1998), 131-42.

Kota state disseminated this new knowledge through a series of agricultural fairs that it organized in various parts of the kingdom.[9]

Some of the greatest detail on such state activities comes from Mysore in the late eighteenth century.[10] The Mysore state, under Haider Ali and Tipu Sultan, embarked upon an ambitious program of economic development with the aim of increasing the wealth and revenue of the realm. There is extensive evidence for a push towards agricultural improvement, with policies designed to expand irrigation, bring fertile land under cultivation and promote the cultivation of valuable cash crops, including sandalwood, sugar and black pepper. A sophisticated system of revenue incentives was designed to reach these aims. In addition, under Tipu Sultan, efforts were made to improve the breeding of cattle, which were critical not only for agricultural operations, but also for the transport of goods and military supplies.

The push for improvement in Mysore also extended to manufacturing. The European-style military that Mysore sought to create required the expansion of metal working facilities, especially in iron. In the 1780s, orders were issued for the construction of twenty new iron smelting furnaces within the kingdom. Mysore also developed a major armaments industry, which built cannon in both brass and iron, and manufactured enormous numbers of high quality firearms. According to French observers, the quality of these guns was equal to those manufactured of Europe. In 1787 Tipu Sultan returned a shipment of five hundred guns from the French because they were not up to the quality of his own manufactures. From all reports, these workshops used sophisticated technologies of both local and imported

[9] Norbert Peabody, *Hindu Kingship and Polity in Precolonial India* (Cambridge, 2003), pp. 131-2.
[10] See Iran Habib (ed.), *State and Diplomacy under Tipu Sultan: Documents and Essays* (New Delhi, 2001).

design, including a machine to bore cannon that had been installed with the assistance of a French artisan or technician. The machine was designed to be operated with waterpower, but had been adapted to be run on bullock power.[11]

The Mysore state's keen interest in improving the technology of manufacturing was not confined to the production of armaments, but extended to clocks, paper, glass, as well as many other goods. According to Francis Buchanan, Mysore had succeeded in launching a modern paper manufactory where the good was made with wires in the European fashion as well as a cutlery industry.[12]

In the 1780s, a diplomatic delegation to the Ottoman Empire, France and Britain was given the following instructions from Tipu Sultan: "industries and rarities of each city and territory . . . should be written down in front of each of you . . . Requests should be made in the proper and necessary manner to the Sultan of Turkey and the King of France, for obtaining artisans expert in the manufacture of muskets, guns, clocks, glass, mirrors, chinaware, and cannon-balls, and for such other craftsmen as may be there . . . obtaining from them bonds of agreement to come to this Court." In addition, the delegation was to find "good carpenters and ironsmiths, for construction of ships, and other craftsmen that are not available in this country, should be brought from the country of Turkey and of the French King. Similarly, a skilful astronomer, geomancer and physician should also be brought." Tipu Sultan was also most eager that his emissaries send home samples of coal (for which he combined the Persian words stone and

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[11] Francis Buchanan, A Journey from Madras through the Countries of Mysore, Canara, and Malabar (London, 1807), vol. 1, p. 70.
[12] Francis Buchanan, *Journey*, vol. 1, p. 70.

charcoal) and the “services of four expert persons as are skilled in recognizing the presence of (ores of) stone-coal.”

It is interesting that Tipu Sultan issued orders for artisans expert in gun manufacturing despite observing that “there are numerous artisans capable of making muskets and guns under this government,” which suggests that the ruler valued the accumulation of technical knowledge of various kinds as an important end in itself.

This drive to amass knowledge is also reflected in Tipu Sultan’s library, which was located in the palace in the Mysore capital of Seringapatnam. We are fortunate to possess a catalog of this library, which was compiled by Charles Stewart after the British conquest of the state in 1799.[13] The library possessed a very large number of manuscripts in the sciences, including manuscripts that Tipu had purchased, such as the *Jami al Ulum*, a treatise on universal science by the Sufi, Mohammed Ghos of Gwalior. This work included chapters on astronomy geography, physic, music, theology, war, agriculture and horticulture, omens, talismans, chemistry, and the magnet. There was also a Deccani work, *The Complete Equestrian,* which contained instructions on how to purchase horses, their breeding, the management of the stud, and cures for the “several disorders to which they are liable” as well as a “very excellent,” according to Stewart, natural history of animals in Arabic, which had been dedicated to Shah Abbas the second. Mughal works were also found in the collection, including a work on the manufacture of artificial gems, fireworks, and colors and paints of all kinds, to which was appended a work on the art of dying cloths, silks,

[13] Charles Stewart, *A Descriptive Catalogue of the Oriental Library of the Late Tippoo Sultan of Mysore: To which are Prefixed memoirs of Hyder Aly Khan and his Son Tippoo Sultan* (London, 1809).

etc. The author of this text, Zein al Aabidin, had compiled these materials during the reign of Aurangzeb.

There were also several scientific works that Tipu Sultan had commissioned, including a treatise on the art of dyeing cloths and composing perfumes. Tipu had also commissioned the translation of French and English works on natural history and botany. This translation was part of a larger project in which “forty-five books on different sciences were either compiled, or translated from different languages, under his immediate inspection or auspices,” according to Stewart. Unfortunately, further details are not given on these works, but they show that the Mysore state had a keen interest in obtaining knowledge from outside the subcontinent and using it to improve production.

Tipu Sultan’s library also contained treatises on arithmetic and mathematics in Persian and Arabic that covered a wide range of mathematical systems. There was a work on arithmetic, the author of which was unknown, but was described in the catalog as laying out the Hindu system. There was also an “excellent treatise” on mathematics and geometry written in 1681 by Lutif Allah, an engineer in Delhi as well as a work on Euclidian geometry, which had been translated from the Greek. And not surprisingly, there were large numbers of works in Persian and Arabic, some translated from other languages, on astronomy and medicine. On the latter topic, there were translations of the complete London dispensatory and of an English work on electrical and medical experiments.

Indian interest in European scientific and mathematical works did not begin with Tipu Sultan in the late eighteenth century. From the first few decades of the century, if not earlier, Indian scientists and mathematicians had been translating and discussing European findings. William Hunter reported in the late eighteenth century that a Brahmin scholar had shown him Sanskrit translations of "several European works, executed under the orders of Jayasinha [Jai Singh], particularly Euclid's *Elements* with the treatises of plain and *spherical trigonometry*, and on the construction and use of logarithms, which are annexed to Cunn's or Commandine's edition . . . Besides these, the *Pandit*, had a table of logarithms and of logarithmic sines and tangents to seven places of figures; and a treatise on conic sections."[14]

Raja Jai Singh, ruler of a Rajput kingdom from 1722 to 1739, was the patron of large-scale astronomical studies.[15] With his financial support, five massive observatories, with instruments constructed from lime and stone, were built in the five north Indian cities of Delhi, Ujjain, Jaipur, Benares, and Mathura. Jai Singh chose masonry for the construction of his instruments after finding shortcomings in their metal counterparts due to their small sizes and also from expansion and contraction during the hot summers and cool winters of North India. Many of the instruments were conventional measuring devices, including astrolabes, mural quadrants, meridian circles and azimuth circles. However, Jai Singh and his team of astronomers invented three new instruments for the measurement of solar time, solar altitude, and the positions of celestial objects.

The purpose of these astronomical labors was to accurately chart the movement of stars and planets for astrological uses. Jai Singh was also keenly interested in improving the accuracy of the solar calendar, particularly for the prediction of eclipses. These events are important for Hindus and must be anticipated in advance for the proper religious ceremonies to be conducted. Therefore, Jai Singh would have acquired great prestige if he

[14] William Hunter, "Some Account of the Astronomical Labours of Jayasinha, Rajah of Ambhere, or Jayanagar," *Asiatic Researches*, 5 (1799), pp. 209-10.
[15] This section is drawn largely from Virendra Nath Sharma, *Sawai Jai Singh and his Astronomy* (Delhi, 1995).

perfected the calendar. In fact, the astronomical tables that emerged under his patronage were used widely in northern and eastern India through the eighteenth century.

The team of astronomers that Jai Singh assembled consisted of Indians and Europeans, the latter Jesuits mainly from the Portuguese settlement of Goa. Jai Singh also corresponded with a French Jesuit, who was resident in Chandernagore in eastern India. To learn more about European observational methods, Jai Singh sent a team of his astronomers to Portugal from where they returned with instruments, books and astronomical tables.

Jai Singh's interest in European knowledge was not restricted to astronomy, however. He commissioned a translation of a European monograph on perspective drawing, which was designed to aid the work of builders, engineers, technicians, artists, and draftsmen. To make the work accessible to practitioners, the translation was made into Hindustani, in particular the dialect spoken in the vicinity of Delhi and Agra, rather than into Sanskrit or Persian, the languages of high culture and the literati.[16]

In sponsoring such a translation, Jai Singh was continuing in the tradition of Mughal rulers of the seventeenth century. Under Aurangzeb, the Frenchman Francois Bernier was appointed the court physician and the texts that he possessed were translated into Indian languages. There also began a long dialogue between Bernier and North Indians on philosophy and medicine in which Bernier communicated Cartesianism, atomism, and other developments in seventeenth-century European thought and recent

[16] Sharma, *Sawai Jai Singh*, p. 276.

additions to medical knowledge, including the circulation of blood and anatomy.[17]

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This paper began with material from Ananda Ranga Pillai's diary to show that in the early eighteenth century the Indian subcontinent possessed systems for the transmission of useful knowledge: a mobile population, letter writing, and networks of information and intelligence. And with these systems of intelligence and information transmission, there was profound product innovation, especially in textiles. But even more importantly, by the eighteenth century, there were striking examples of innovation in production and the search for new methods, techniques and knowledge.

Much of this push for change in the Indian subcontinent came from states and political authorities. Innovation in production, whether agricultural or manufacturing, was not pursued as an end in itself, but rather as a means to expand and increase state revenue and power. The Mysore state was the best documented and most extensive of these political projects. Of course, it was not only the power of the state that was at stake. As the case of Jai Singh's work in astronomy shows, such scientific projects were supported in part to add luster and prestige to his rule.

The spread of military fiscalism of the Mysorean kind in the subcontinent, however, was premised upon a profound change in the idea of the state. Before the eighteenth century, sovereignty in the Indian subcontinent had been shared, which is captured in the title shah-en-shah, or king of kings, which was given to the Mughal emperor. As this title indicates, the emperor, as did other kings in the subcontinent, recognized that there were many sovereigns and many centers of political authority in

[17] Ghani Khan, "Awadh Scientific Renaissance," pp. 276-7.

the Indian subcontinent. This does not mean that there was no political and military competition within the system, but the idiom in which it was expressed was very different from that found in Europe in the same period. In India, it centered upon alliances. One need not destroy an opponent, but merely overawe him with military displays or signs of higher status in order to establish a relationship of deference and dependence. Of course, with that went regular payments of tribute and political support.

The eighteenth century gave rise to more centralized and unitary state forms that sought to consolidate power and control over resources against all competitors, both external and internal. These political projects spawned a search for knowledge that could help rulers amass the resources and revenues. Therefore, there was a close connection between the generation of useful knowledge and statecraft in eighteenth-century India.

This connection was no less true in western Europe. Francis Bacon made seminal contributions to the development of the scientific method, but he was also an official of the English state, serving as Lord Chancellor. According to Margaret Jacob, "Bacon sought to render monarchical government increasingly effective, to rationalize its operations and to harness science to the service of state building. As a lawyer and politician he turned to natural philosophy as part of his statesmanship."[18]

For Bacon, the linking of scientific knowledge to state power was part of a broader argument on the social utility of scientific advances, which was widespread in seventeenth-century Europe. As Jacob puts it, the social utility argument "appears in a variety of contexts, but always with the same intention. Science can increase the wealth and power (both social and military) of existing elites. It can be a force for social stability, generally not

[18] Jacob, p. 29. Also see Steven Shapin, *The Scientific Revolution* (Chicago, 1996).

for social reform, and its purpose is to increase the prosperity and wealth of the state."[19] It was precisely these considerations that made Colbert "open to Cartesian and Baconian teachings and he was intent on fostering commercial and scientific development, thus he believed enhancing the influx of bullion into the kingdom."[20] Across the channel, the founders of the Royal Society believed that "experimental science might be deployed to control the lower orders; curb the excesses of the great while increasing production, especially food production; and promote good health and commerce."[21]

The development and deployment of useful knowledge, therefore, must be placed in their political and economic context. As the example of Colbert suggests, useful knowledge in Europe was also connected to Europe's place in the global economy, in which adequate stocks of bullion became of critical concern for many European powers. Here also, there are significant differences across Eurasia. There was no bullionist thinking in the Indian subcontinent, where there were no shortages of specie before British rule in the early nineteenth century. In other words, South Asia faced a very different set of pressures and opportunities than did Europe because of the different relationship to the world trading system.

While useful knowledge contributed to dramatic transformations in production systems in eighteenth-century Europe, the absence of these momentous changes in production in the Indian subcontinent should not lead to the conclusion that such knowledge was absent in India. Other factors must also be included in the picture and we must not forget the question K. N. Chaudhuri posed nearly thirty years ago: "Was there any

[19] Jacob, p. 29.
[20] Jacob, p. 47.
[21] Jacob, p. 55.

compelling economic and social reason why India should have embarked on a search for new techniques and production methods at this particular stage of her history?" So does the difference between Europe and the Indian subcontinent lie in useful knowledge or social need or motivation?

In the European case these social needs emanated from both political and economic sources. As this paper has shown, political pressures for the development of useful knowledge grew enormously in eighteenth-century India because of changes in the political sphere. By the early nineteenth century, many of these efforts lay in tatters after the British established their political hegemony over the subcontinent. Libraries of scientific texts that had been established over the previous one hundred and fifty years were dismantled, with the texts dispersed among various British centers in India and transferred to libraries in Europe. Patronage for science was cut off as the British ruled with a strict military and mercantile mentality. And the demilitarization of Indian society meant that many fruitful avenues of enquiry, from metal working to building technology, were no longer pursued with the avidity that they had been in pre-British India.

Because of these developments in the early years of British rule, India by the mid-nineteenth century looked like a culture that was unscientific at its core. And this nineteenth-century culture came to be taken as the essence, albeit timeless, of Indian culture. As has been increasingly realized, however, the culture of colonial India was a new historical product, closely intertwined with political power. No less was it the case in the seventeenth and eighteenth centuries, but the cultural productions of those centuries were far different, much livelier and in the throes of rapid change.