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India's Nationalist Agenda: Religion, Science, Politics

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Abstract

Science is a particular way of understanding the natural world. It is specific to the development of western European culture beginning in the sixteenth century and presumes that our physical environment is regulated by humanly comprehensible laws, can be reduced to constituent parts, and performs predictably. There is no role for interventionist gods. In India, historical obeisance to the metaphysical strictures of the Vedas prevented the development of a non-religious alternative to deconstructing the natural world that, in the West, became science. Nevertheless, India's nationalistic political agenda has attempted to credit the Vedas as providing the conceptual origins of science many thousands of years ago. This may be good politics in India, but it is bad history and misrepresents what science is.

Keywords

India, nationalism, science, religion

1. Introduction

The American cable television History Channel has programming that includes well documented and interesting science and technology-centered historical vignettes that appeal to a broad range of viewers including those with professional academic backgrounds. However, it also provides the more impressionable viewer a steady dollop of conspiracy theories that tie major scientific advances to non-human sources. Such findings are typically embraced by a cast of "ancient alien theorists" including a charming and amulet-wearing fellow sporting hair that appropriately stands on end. It is difficult to envision a major American or European professional academic society hosting papers with conclusions that would be indistinguishable from those of ancient alien theorists. Nevertheless, that is exactly what happens at the annual conference of the Indian Science Congress Association (ISCA).

A century old with over forty thousand members, the ISCA is officially a part of the Ministry of Science and Technology within the Indian Government. The membership is composed largely of academically trained technical professionals, many with doctorates in the hard sciences. At

well-attended annual conferences previously keynoted by the Indian Prime Minister, there is an extensive array of advanced technical presentations covering the gamut of the sciences which would be expected by a country's premier technical association. However, there are also presentations that could well have been scripted by American ancient alien theorists. At the 102nd annual conference in Mumbai in January 2015, a retired pilot trainer presented a paper concluding that "Aviation Technology in ancient India is not a tale of mythology, but it is a total historical document giving the technical details and specifications" (Subramanian, 2015). In assessing who the ISCA invited to deliver papers at the Ancient Sciences through Sanskrit session, "there is definitely place for such a session at the Indian Science Congress", one Indian Institute of Science at Bengaluru Professor commented. "My grouse is that they didn't ask people who do science-oriented work to speak about it. They asked a bunch of jokers with a political agenda" (Abinandanan, 2015). This, however, has not been the only instance when the Indian nationalistic political agenda has employed a religious belief to "document" science in India thousands of years before its commonly accepted appearance. At the 106th ISCA conference in 2019: the vice chancellor of one university opined that the 1500 year old *Ramayana* showed that a demon king had aircraft and landing strips in what is now Sri Lanka; a scientist from a second university announced that Isaac Newton and Albert Einstein were both mistaken and that "Narendra Modi Waves" were responsible for gravity; and the head of yet a third university used ancient religious texts as evidence that stem cell research was first performed thousands of years previously in India (*BBC News*, 2019).

A fundamental part of any culture includes an essential relationship with nature. Each culture's relationship is, nevertheless, largely distinctive. Science is a particular way of understanding the world and presumes that our physical world is regulated by humanly comprehensible natural laws, can be reduced to constituent parts, and can be mathematized. There is no role in this regime for interventionist gods or goblins.

One of the enduring historical puzzles is the failure of the great and ancient civilizations in Indian and China not to develop what we now consider to be science. For much of the past 3000 years, their cultures were more advanced, at times significantly so, than that of Europe in the study of linguistics, astronomy, medicine, mathematics and technologies. The mathematical basis for modern science has its fundamental roots in the Indian development of the concept of zero as well as the decimal system (Abdi, 1999, pp. 50-93); yet India did not develop the concept of deductive logic analogous to that of ancient Greece (Winter, 1975, p. 160). While there is little basis for a deterministic belief that it was human destiny to progress toward modern science, the conundrum is that China and Indian each had many of the necessary early cultural elements to be the civilization that created science; but neither, in fact, did.

This article investigates India's religious history as an impediment to an independently developed modern science and investigates its attempt to misrepresent its historical scientific practice to advance its modern nationalist agenda.

2. Religious Approaches to Nature

Conceptual approaches to nature have existed as long as *Homo sapiens*. However, the development of science as a focused academic discipline is relatively recent. Academic scholarship documents the interrelationship of the cultural elements—such as urbanization, individualism, capitalism—that both shape and are shaped by science and technology. Much has been written which addresses China and Europe, but relatively little scholarship has been produced addressing India. Moreover, much of the literature would seem to have a clear ideological bent attempting either to justify the imposition on "backward" India of British colonial science, or to help legitimize the modern independent Indian nation-state by documenting the ancient "scientific" roots of its culture. In his analysis of the impact of the Vedic texts on the modern Indian approach to nature, Brian Smith stated that "knowledge is never disinterested" (Smith, 1994, p. 323). This could be applied as well to the scholarship addressing the role of science in Indian culture.

Behavior is determined by options that are available for action within the bounds of imagined possibilities. Science creates new opportunities, offering members of society new options to choose from, thus presenting contradictions in value systems that alter the fundamental system of values itself (Mesthene, 2003, p. 628). While Western science is clearly indebted to the ancient Greeks for its initial methodological and philosophical underpinnings, it is also indebted to the biblical tradition for its view of human mastery over nature. As Reijer Hooykaas put it: "whereas the bodily ingredients of science may have been Greek, its vitamins and hormones were biblical" (Hooykas, 1991, pp. 160-161). Unlike the Abrahamic religious tradition, however, Hinduism provided no conceptual space for "rendering unto Caesar" that which was allotted to the secular world. Hinduism provided no potential for separation between science and religion; religion and proto science were inextricable (Prakash, 1999, p. 76). Even for eleventh century Abu Rayhan Al-Biruni, the cultural inability of the Hindus to conceive of the creation of secular space was clear: "Some of them do not pass beyond what their senses perceive; some pass beyond this, but stop at the knowledge of the laws of nature" (Al-Biruni, 2002, p. 14). Al-Biruni further noted that there was no distinction between natural and supernatural, both of which were subject to the whim of the gods (Rahman, 1999, p. 17). According to Max Weber, the different Hindu castes "were as unlike as man and animal. All men, however had equal opportunities, but not in this life...there was no 'natural' order of men and things in contrast to positive social order. There was no sort of 'natural law'" (Weber, 1958, p. 144). Gyan Prakash concluded that during the British Raj, "the British saw empirical sciences as universal knowledge, free from prejudice and passion and charged with the mission to disenchant the world of the 'superstitious' natives, dissolving and secularizing their religious worldviews and rationalizing their society" (Prakash, 1999, pp. 4-5).

Because of China's long and well-documented history, there is a great body of literature. India, however, presents historiographical problems. First, due to its particular cultural ethic, the historical period (a consistent availability of written records) in India begins much later than in the other great civilizations of the world; thus, there are scant written records of its early cultural development. Second,

there has typically been a political agenda, witting or otherwise, in much of the historical analysis. Beginning in the sixteenth century, the literate class was dominated by the Islamic scholars of the Mughal regime, to be followed by two hundred years of writings by the British colonial powers. Unfortunately, much of the scholarship of independent India appears to be a largely unconvincing nationalistic attempt to project its scientific modernity retrospectively onto its Hindu cultural roots. Tying modern science to these imagined roots is an attempt to give a meaning to the *Vedas* that it never had in order to legitimize modern Indian society.

A society's conceptions of nature cannot be divorced from its conceptions of social structure. For India, a pervasive ethic can only be through the Vedic scriptures and the development of the *varna* classificatory system of castes. Although philosophers of science debate the extent to which nature presents us with a fixed physical reality, it is much less debatable that a particular culture's approach to investigating nature is socially constructed. The values and classificatory relationships that are embedded in a particular way of knowing and manipulating nature are crucial to differentiating between religion, magic and what is science.

The roots of Hindu culture came in the second millennium B.C. with the Aryan migration/invasion and the creation of the *Veda* texts. The values of the *Veda* accompanied by the classificatory caste system of the *varna* bounded the creative limits of Hindu imaginings of nature. Brian Smith has argued persuasively that the values inherent in the *Vedas* are the conceptual structure behind the *varna* which had a pervasive impact beyond merely the social (Smith, 1994). Pollock believed that the *varna* arranges "under one basic structure such seemingly diverse realms as the world of the gods, the divisions of space and time, spheres of what we would call the 'natural world' (i.e., flora and fauna), and the realm of revelation or 'scripture'" (Pollock, 1985, p. 511). While this may well be considered a philosophical approach to the conditions in which humanity finds itself, there is little inherent in it that could be considered science. Analytical, perhaps; scientific, definitely not.

Embedded in mainstream western values is the biblical sense that humans are privileged over other animals, plants and inanimate material. This is a classificatory hierarchy governing how to investigate and control nature that is unique to European culture. The Hindu culture has had a distinctly different approach. For India the task becomes an effort to determine what they were attempting to comprehend about the world that they believed was around them. As Pollock termed it, "what is presently at issue is not the veracity of this or that model of the origins and transmission of cultural knowledge, but rather how such things were understood in traditional India" (Pollock, 1985, p. 511).

Modern science attempts to answer questions relating to *how* nature functions. An important aspect of any religion is its quest to understand *why* nature exists and *why* it functions the way it does. Although the how and why questions have largely become segregated into separate ontological domains in the west, this break never occurred on the Indian subcontinent. Hindu conceptions of the origin and evolution of the universe continued to be entirely matters of religion rather than of science (Basham, 1954, p. 488).

In its organization of the physical universe, the Vedic myths also simultaneously created social structures that were parallel in the natural and supernatural worlds, providing an immutably religious basis for the caste system (Smith, 1994, p. 321). With the *Vedas* being recognized as the acknowledged authority for the structure of both the mundane and supermundane worlds, it was unlikely that this same source would be denied authoritative status about the *varnas*. More than the structuring of the physical world, it was the Vedic *social* structuring that provided the largest obstacle in traditional India to the development of the modern ethos associated with science.

3. Śāstra, Science and Nationalism

The words that a society chooses to articulate its concepts not only reflect its cultural values, but also potentially limit its ability to form concepts at variance with its existing social norms. Modern India is a multi-lingual society synthetically interconnected by the English language. Its common conceptual roots, however, originate in the Sanskritic texts of the *Vedas*. For any culture the relationship between language and science is a complex mélange of historical artifacts and cultural imaginings. Perhaps more than any other word, the Sanskrit term *śāstra* underscores the difficulties that are presented in using modern science as a metric for examining the cultural roots of Indian society.

Although *śāstra* is an ancient word associated with the sacred Vedic writings of Hinduism, according to Pollock there was no meaningful definition until the medieval era. Prior to that, *Śāstra* was considered "a verbal codification of rules, whether of divine or human provenance, for the positive and negative regulation of some given human practices" (Pollock, 1985, p. 501). It can generally be understood as meaning a set of rules or precepts, originally as relating to the foundational scriptures of Hinduism. As such, the term has been applied to such various activities as cooking, elephant-rearing, thievery, mathematics, and sexual intercourse (Pollock, 1985, p. 502). Typically, however, *śāstra* is unfortunately translated as "science" in modern Indian academic literature addressing Indian history and culture. For example, *Śāstra Sahitya Parishad* becomes Society for Scientific Literature. While it may be colloquially expedient to translate *śāstra* as science, this translation fails to address accurately what science is, what *śāstra* is not, or the political implications of the Indian nationalist linguistic agenda.

Both *śāstra* and science may be considered as systems of knowledge, as processes for interacting with the natural and social worlds. Yet there are distinct differences. Science is not a general system of knowledge, but one that requires a particular way of approaching nature that includes replication and a process of proofs that specifically excludes divine revelation and supernatural intervention. The *śāstra* of the *Veda* does not meet this standard. A critical element of modern science is independent discovery. However, the Vedic roots of Hinduism present the creation of knowledge as an exclusively divine undertaking; there is no concept of scientific progress, experimentation, or innovation that moves knowledge away from the original immutable Vedic texts (Pollock, 1985, p. 515). Consequently, Pollock is correct in positing that *śāstra* should more properly be translated into English as theory rather than science (Pollock, 1985, p. 511). Science has rules and theories, but rules and theories alone

do not make a science.

Religion is a powerful cultural force. Even for non-religious members of a given culture, their intellectual boundaries can be shaped by a dominant religious ethic. In the Abrahamic tradition, a critical concept for the development of modern science was the "clockmaker" God who created and set in motion a mechanical universe according to discoverable natural laws and then rarely, if ever, intervened. This created the conceptual space in the West for broad agreement on natural laws that is independent of religiosity. In the twenty-first century having a clear ethic of science is now also a marker for recognition as a viable nation-state. This is true of modern India and the nationalist agenda to attempt to tie India's scientific modernity to its cultural Vedic roots (Prakash, 1999).

The British colonial intervention into India was not only a physical occupation, but a conceptual confrontation as well. The Islamic conquerors were not the civilizational threat that the colonial British were (D. Kumar, 1995, p. 270). Prior to the Raj, India did not conceive of itself, nor did it function, as a nation. That idea "was summoned in the time and space configured by colonial modernity." (Prakash, 1999, p. 199). As a means of intellectual resistance, assertion of India's autonomy and entitlement to modern nation status relied upon the universal nature of its cultural tradition (Prakash, 1999, p. 96). In the industrializing world of the nineteenth century, science was perceived by Indian nationalists to be a talisman of sorts to protect their cultural identity through creation of a modern nation-state. As Prakash concluded: "To assert that Hindu culture was equal to Western culture was to also claim that it was the heritage of all Indians…. The definition of India as an embodiment of Hindu science required its signification in other signs" (Prakash, 1999, p. 9).

The path to redefinition of the *Vedas* was also driven by the need for the Brahmins to reconstitute themselves as not only the custodian of knowledge, but also the arbiter of Indian science (Rahman, 1999, p. 12). As the European colonial powers claimed the universal application and truth of modern science, Indian nationalists reinterpreted the Vedic texts as embodying eternal and universal scientific laws that transcended the regional variations in Indian dialects and religious sects (Prakash, 1999, p. 89). Nineteenth century Indian nationalists argued that the ancient Hindus had, in fact, originated scientific knowledge, thereby justifying the modern existence of Indians as a people, as a nation. (Prakash, 1999, p. 86). The net result was to "recover" archaic knowledge that had never existed and to find modern values in the *Veda* that were never even conceived of at the time (Prakash, 1999, p. 111).

To culturally relocate the *Vedas* in modern terms requires an appropriate language. During the British Raj, the status of English was superior to that of the various Indian dialects for articulation of scientific issues. "At stake was the integrity of the Indian languages, which did not participate in the creation of modern scientific discourses but were obliged to incorporate them" (Prakash, 1999, p. 50). One of the markers of this reinterpretation was the transplantation of the ancient Sanskritic term *śāstra* as meaning science in English. The nationalist success in repurposing *śāstra* not only helped to affirm the nationalistic legitimacy of India itself, but also resulted in Western academic scholarship on Indian culture to uncritically translate classical Indian texts in oxymoronic terms such as the "science of

religion" (Rahman, 1999, p. 20). Indian nationalists have successfully politically intervened in their own history to redefine it.

4. Historical Elements Coincident with the Development of Science

Often unstated is that the natural and inevitable course of events for a culture is to progress through a series of "revolutions" beginning with scientific, progressing to technological, and continuing to industrial—all in the context of an adaptation to Western European culture. In some cases, a particular social construct such as urbanization or feudalism is identified with what occurred in Western Europe but is absent in a culture which did not experience the scientific revolution. Conclusions are then reached that the scientific revolution indeed could not have occurred, because of the very absence of this social construct. To some extent, these failings are understandable. As Derk Bodde has pointed out, we are in "the unhappy position of the historian who, presented by the nature of his discipline from proving his hypothesis by means of controlling repetitive experiments, is obliged instead to formulate theories to explain events whose outcome is already known. Faced with this situation, the temptation becomes strong to 'prove' the 'inevitability' of everything that has happened simply because it has happened" (Bodde, 1991, p. 357). However, as one metric to measure whether there was indeed an ancient Hindu science, a detailed examination of several historical elements—status of artisans, urbanization, marriage of theory and practice, information accumulation and transmission, mercantile capitalism, and democratic spirit and individualism—coincident with the development of science is useful.

4.1 Status of Artisans

Artisans or craftsmen have been the social element closest to the practical application of technological innovation through time and across cultures. In ancient Greece and Rome, however, the social perception of the artisan class was quite negative. Plato referred to their "stumped natures" (Plato, 1991, p. 228) and famously admitted that while society could not do without them, "would you let your daughter marry one?" (Plato, 1990, p. xiv). Aristotle declared that a man "living the life of a mechanic" had no virtue. (Aristotle, 1991, p. 228). Cicero described craftsmen as "the very sewage of the state" (Cicero, 1991, p. 229). In fact, artisans in both ancient Greece and in the Roman Empire were typically slaves. Although the status of artisans gradually improved in the West, it is only in modern times that social and political equality has been realized.

In China, the historical incidence of artisans who were slaves is rare (Needham, 1969, p. 29). Yet, despite the large number of artisans working in imperial workshops and arsenals, even senior engineers were not a part of the civil service, and their status was low. (Needham, 1969, p. 29). In traditional India, the reputation of Indian artisans reached as far as the Mediterranean and China for manufactures ranging from cotton textiles to Wootz steel. Nevertheless, despite the low social status accorded artisans throughout the major historic civilizations, only those in India were unalterably locked into their social station. In societies where the artisans were frequently slaves, they could be freed by military defeat,

valorous acts, or the largess of an owner. No such mechanisms existed in traditional India. Even if a Roman slave-craftsman escaped and improved their social position, there was not a penalty in the next life awaiting him as there would be in caste-conscious India.

This Hindu social divide would have adverse repercussions on the advancement of technology which in Europe proved critical to the scientific and industrial revolutions. In India, "scientific activity and knowledge, by and large, remained a preserve of the elite, while arts and crafts remained with the less privileged groups. A result of this division was that the problems generated by technology were not attempted by scientists to widen scientific knowledge and create a theoretical understanding of problems" (Rahman, 1999, p. 28). In a relatively few instances in medicine, the low social scale of the practitioners of human and veterinary medicine was not an absolute barrier to interactions with the Brahmin caste as documented by the occasional technical medical treatise written in Sanskrit by an author, presumably a Brahmin, with a formal education (Thapar, 2002, p. 258).

Although the caste system typically barred Indian artisans from crossing social boundaries, military conquest, trade, and immigration ensured a diffusion of technology across civilizations. "For example, the Chinese prisoners brought to Samarqand started making paper for the central Asian kingdoms. From Samarqand, the paper technology was brought to Sind in the tenth century and later to Kashmir… where it spread to all over India. The second impact related to innovation. When immigrant craftsmen interact with local artisans and craftsmen, it led to innovation in machinery" (Rahman, 1999, p. 243). Nevertheless, India, unlike Europe, did not become a culture driven by the economics of machinery. The *varna* effectively blocked the intellectual and artisan classes from the intimate interactions necessary to the technical context necessary for an industrial revolution.

4.2 Urbanization

Over the millennia, as an increasing human population transitioned from a nomadic to an agrarian lifestyle, urban concentrations slowly evolved. As the human condition improved beyond a subsistence existence, the potential for urban surplus labor facilitated specialization. George Basalla has posited that philosophers, physical and social scientists, and literary figures are among those who have suggested that science and the city have a natural affinity for one another (Basalla, 1984, p. 513). There has been a relentless urbanization in Western culture that has paralleled the rhythm of the scientific and industrial revolutions. Basalla provided historical examples from Plato citing Socrates ("men who dwell in the city are my teachers, and not the trees or the country") to fourteenth-century Islamic philosopher and statesmen Ibn Khaldūn ("within the city the growth of the economy and the population call for the creation of the bureaucrat and administrator in the maintenance of a highly diversified and skilled group of artisans who produce specialized goods for the populace") to an eighteenth century Baltimore gentleman ("liberty, science, and commerce" are "inseparably connected together" and they "always took up their chief residences in cities") (Basalla, 1984, pp. 513-527). In addition, science and technology in an urban setting is woven into the seventeenth century European utopian works of Tomasso Campanella (*Citta Del Sole*), Johan V. Andreae (*Constantinopolis*), and Sir Francis Bacon

(*New Atlantis*). An urban setting for science and technology was even included in Jonathan Swift's dystopian *Gulliver's Travels*.

As early as 2500 B.C. planned urban cities were located in the Indus valley at Harappa in the Punjab and at Mohenjo-daro in the Sind (Winter, 1975, p. 141). Between the seventh and the fifth centuries B.C., urban areas had arisen with a class of well-to-do merchants enjoying comparative opulence (Embree 1988, 43). "With the foundation of the Sultanate in north India about the beginning of the thirteenth century…The old cities took on the form of cosmopolitan urban centres" (Siddiqui, 2008, pp. 22-23). In 1581, the Census of the Mughal Emperor Akbar reported "120 large cities and 3,200 small towns (*qasbas*), each controlling one hundred to one thousand villages" (Rizvi, 1987, p. 204). In the late seventeenth century, there were reportedly "hundreds of prosperous market towns' in northern India (Richards, 2005, p. 194).

So, what does this all mean with regard to the impact, if any, of urbanization on the development of modern science? In Europe, increased population and urbanization occurred simultaneously with scientific and technological innovation. In India it did not. The metaphorical association of science and the city may well reflect that in the West, "scientific activity, dependent on the exchange of ideas, was modeled after the urban exchange of goods and commercial transactions" (Basalla, 1984, p. 523). That is, urbanization might be a necessary, but, certainly in the case of India, not a sufficient condition for a scientific revolution.

4.3 Marriage of Theory and Practice

In today's world, science and technology are inextricably bound. Yet, until the seventeenth century in Europe, technology was conceived without controlled experiment and used with little consideration of what became known as the laws of nature. In other words, until then scientific theory had largely yet to meet technological practice (Bodde, 1991, p. 361). As one of the first documents recognizing the fundamental relationship between science and technology, Robert Hooke's draft for the 1663 charter for the newly founded British Royal Society stated that "the business of the Royal Society is: to improve the knowledge of natural things, and all useful Arts, Manufactures, Mechanick practices, Engynes and Inventions by Experiment—(not meddling with Divinity, Metaphysics, Morals, Politics, Grammar, Rhetorick, or Logicks)" (Bodde, 1991, p. 234). This formally captured what was to become a key British contribution to science and technology through the institutional merging of theory and practice.

There is an additional important distinction between science and technology. In his *Grand Titration*, Joseph Needham pointed out that while many technologies could migrate across civilizations, science—which is intimately related to a specific approach to nature—typically could not (Needham, 1969, pp. 15-16). Needham's logic is that until the modern age, most technology was survival-related and task-specific that was universal in its application. Science, however, is correlated with specific concepts that may not exist in a particular culture. The modern diffusion of science from the West to countries such as India and China was accomplished as a part of a much broader transfer of culture.

In the eleventh century the mechanical clock was invented in Asia. Some 300 years later it was either imported into Western Europe or was developed independently. What is important, however, is that in Europe this development was fundamental to the explosion in science and technology that became the Scientific Revolution. In India and China, no corresponding development took place. This difference can be largely attributed to the European capability to see the clock as a symbol of a mathematical model of nature which can be applied to a mechanical universe. This perceived relationship between theory and practice was absent in Asia (Pacey, 1990, p. 96).

One of the principal usages of early clock devices throughout Asia was for astronomical observations. While both India and China used such observations largely for farming and astrological purposes, in India they were also a central part of the ritual planning process. Yet despite the clear Indian theoretical capabilities in mathematics, astronomy in India was static. Writing in the late eighteenth century, John Mayfair, the eminent Scottish mathematician, wrote that the Indian astronomer "gives no theory, nor even any description of the celestial phenomena, but satisfies itself with the calculation of certain changes in the heavens, particularly of the eclipses of the sun and moon, and with the rules and tables by which these calculations must be performed….He obtains his result with wonderful certainty and expedition; but having little knowledge of the principles on which his rules are founded, and no anxiety to be better informed, he is perfectly satisfied" (Mayfair, 1971, p. 13). Mayfair further estimated the origination of the astronomical tables to have occurred during the pre-Aryan *Calyougham* times of approximately 3100 B.C. (Mayfair, 1971, p. 24). Even if Mayfair had dated the tables four thousand years later, his basic point was demonstrated with regard to the lack of theoretical progress in Indian astronomy.

Improvements in management and organization were clearly key factors in the success of the science and technology revolutions. They were prevalent in places where the revolutions took place, even belated ones such as in Japan, and absent in places such as in traditional India and China where it did not. As Rahman explained, in the absence of theoretical avenues, advancements in India in the development of technology had to rely on trial and error. The "separation of scientists and scholars from artisans and craftsmen," according to Rahman, resulted in "the absence of institutionalization of empirical experience into a research system for the development of technology" (Rahman, 1999, pp. 246-247). The successful industrialization efforts in twentieth century India and China were accompanied by the wholesale importation of Western concepts of management and organization and the critical relationship between science and technology.

Without the application of theory to the everyday practices of the artisans, Indian laborers lagged far behind other countries, even other Asian countries such as China, in increasing productivity through the use of mechanical devices. (Rahman, 1999, p. 247). While there was little significant effort to link the practical and the theoretical, that does not mean that the Indian intellectual tradition was devoid of theory. Indeed, Indian thinking in such theoretical subjects as mathematics ranks as some of the finest intellectual achievements in human history (Winter, 1975, p. 154). However, their theory was entirely

constrained by the limits of the *Vedas*. Pollock concluded that the "*Veda* is the general rubric under which every sort of partial knowledge—the various individual *śāstra*—are ultimately subsumed…There is, in the last analysis, hardly any branch of learning whose texts do not claim authority by asserting a quasi-Vedic status in one way or another" (Pollock, 1989, p. 609).

One area where the Vedic constraints on theory development were particularly evident was in the development of medicine. The first recorded inoculations in the world, called *tikah*, are reported to have taken place in Bengal in the sixteenth century. Yet the scientific advancements were left to the conquering colonial powers. Indigenous proto-scientific knowledge "was the preserve of discrete groups, mostly the Brahmins. It was too theoretical with its philosophy and logic to be of any use in everyday life. Further, the framework of that knowledge did not provide an alternative view of life, other than what was sanctioned by religion" (Rahman, 1999, p. 423). Moreover, the *Veda*-based caste system constrained the Brahmins from the contamination of physical contact with a corpse. Consequently "the scientific procedures of observation and experimentation suffered. The intellectual classes withdrew from active participation in science" (Prakash, 1999, p. 113). There can be no doubt of ancient India's contribution to mathematical theory; however, mathematics is not science. As Nobel Prize physicist Richard Feynman graphically put it, physics is to math what sex is to masturbation (Feynman).

4.4 Information Accumulation and Transmission

Surely one of the major advances in human history is the ability to convey abstract thought from person to person, from place to place, and from time to time—all based on the development and use of simple tools. The two seminal developments were spoken language and written representation. Once a society has made permanent physical record of a particular advancement, there need be no reinvention and no consequent need for new recording. Consequently, the gradual accumulation of knowledge should give a particular culture a sense of progress in the accumulation of its theoretical and mechanical achievements.

Despite neither India nor China making the significant connection between theory and practice that in the west led to the scientific and industrial revolutions, there were distinct differences between the two great Asian civilizations. An indicative area for comparison between India, China, and Europe at the beginning of the European scientific revolution is printing. Even though comparable printing capabilities were available in all three cultures, their applications proceeded along separate paths. China combined its inventions of paper and block printing technologies, and later the Europeans took the initial steps toward a revolution in knowledge by printing books (Rahman, 1999, p. 244). Both India and China had developed the technology of using carved wooden blocks to print textiles; India, however, did not apply this technique to the printing of books whereas China did (Rahman, 1999, p. 246). "Widespread adoption of mechanical printing only began in Bengal under British colonial rule" (Richards, 2005, pp. 288-289).

This lack of readily available printed material describing existing knowledge inhibited Indian culture

from laying the foundations for significant improvements in its material production capability. Helenus Scott, in a 1790 letter from India to Sir Joseph Banks, President of the Royal Society in London, concluded that artisanal knowledge was "never communicated by writing nor printing nor their experience reduced to general laws", and only passed with difficulty from father to son within the same caste on penalty of being excluded from the caste (Scott, 1971, p. 265). Over seven hundred years earlier, Al-Biruni noted that Hindu artisans withheld information, especially "from men of another caste among their own people, still much more, of course from any foreigner…Their haughtiness is such that, if you tell them of any science or scholar in Khurâsân and Persis, they will think you to be both an ignoramus and a liar'" (Al-Biruni, 2002, p. 6).

Much as do modern scholars, a thousand years ago Al-Biruni attributed to the *Vedas* many of these inhibitions against the production and sharing of information. He defined *Veda* as meaning "knowledge of that which was before unknown…They do not allow the *Veda* to be committed to writing" (Al-Biruni, 2002, p. 100). In eleventh-century Hindu culture there was an aversion to committing an important body of knowledge such as the *Vedas* to written form even if it meant losing the information. By contrast, during this same period the monasteries of Europe were employing scribes to preserve and translate important proto-scientific works, and the Chinese had already become masters at keeping detailed records.

There is also reason to believe that the ahistorical, anonymous, and timeless nature of the *Vedas* was directly translated into popular culture. Pollock terms ancient Indian writings as unanchored: "we can read thousands of pages of Sanskrit on any imaginable subject and not encounter a single passing reference to a historical person, place or event—or at least to any that, historically speaking, matters" (Pollock, 1989, p. 606). As Al-Biruni indicated, they believed important words were to be known by heart, not by the written word (Al-Biruni, 2002, p. 3). An oral tradition permits knowledge to be shared only face to face. The written word is freed from being bound to time, place or person.

4.5 Mercantile Capitalism

A host of scholars have supported the thesis that capitalism and its agent, the merchant class, facilitated the scientific and industrial revolutions by promoting the concepts of profit and efficiency as well as fueling the drive toward urbanization and democracy. In Europe technology and economic growth advanced in parallel. (Skolnikoff, 1993, pp. 16-17). Basalla assessed how European capitalism was used as a metaphor to describe the commoditization of the intellect as well as social relationships. (Basalla, 1984, p. 523). Richard Hadden believed that the metaphor encompasses the "reduction of social relations to the value of commodities" (Hadden, 1994, p. xi). Needham concluded that since merchants had need for exact measurements to carry on trade, they found it necessary to finance the initial foundation of what would become modern physics (Needham, 1969, pp. 186-187). Li Wan concluded that "in principle, scientific and technological knowledge can be put on the market as a commodity, and it can be influenced by the market mechanisms" (Wan, 1991, p. 44). Francis Bacon, in *New Atlantis*, dispatched "Merchants of Light" in pursuit of knowledge (Basalla, 1984, p. 521). The

European application of scientific theory to technology revolved about the economic axis of productive efficiency. This economic imperative was missing in India. While the Western world was perfecting new concepts such as division of labor and interchangeability of parts, comparable activity did not occur in India (Pacey, 1990, pp. 101-102). Finally, whether the capitalist motive force was from individual merchants or sovereign governments, Shigeru Nakayama bluntly concluded that: "The only conscious goal that anyone has been able to find in the social processes that led to modern science is capitalist profit" (Nakayama, 1973, p. 67).

Addressing India, the academic scholarship typically focuses on the impediment that the caste system presented in integrating science and technology in the Indian economic structure. Prakash concluded that it was necessary for India to reconstitute itself "through empirical sciences" before it could enter "a grid of modern infrastructures and economic linkages that drew the unified territory into the global capitalist economy" (Prakash, 1999, p. 4). Prior to the colonial dominance of India's economy by Great Britain, western scholars rated the task as unlikely. Weber found that the challenges for India were embedded throughout the entire economic system and included the difficulty in employing caste labor in modern industrial facilities. "A ritual law in which every change of occupation, every change in work technique, may result in ritual degradation is certainly not capable of giving birth to economic and technical revolutions from within itself, or even of facilitating the first germination of capitalism in its midst" (Weber, 1958, p. 112).

In Europe, merchant guilds played a significant role in pressing for improvements in manufacturing through technological innovation. According to Weber, however, there were fundamental differences between the European merchant guilds and the general association of Indian castes within a particular craft. During the development of European merchant guilds in the Middle Ages, apprentices were typically allowed a free choice of a master, permitting "the transition of the children to occupations other than those of their parents, a circumstance which never occurs in the caste system. This difference is fundamental" (Weber, 1958, p. 35). A second important difference is the interaction between the guilds themselves. In Europe, while the competition could, at times, resort to violence, there was considerable social interaction between the guilds and other merchant associations, including cooperation to achieve mutually beneficial political aims. The cultural barriers made such fraternization between Hindus castes improbable (Weber, 1958, pp. 35-36).

It must be remembered, however, that there were two social structures extant in India at the time that the merchant guilds were developing in Europe. In India the vast majority of the population were Hindus and therefore constrained by the particular mores of the *Vedas*. At the top of the power structure and overlaid across Indian society were the Muslim rulers who were not constrained by the *varna* system and who were motivated by the accumulation of material wealth. Iqtidar Husain Siddiqui concluded that "if any merchant came to Delhi, he was honoured at the royal court and treated as a state guest during his stay in the capital" (Siddiqui, 2008, p. 30). Yet this positive attitude toward the capitalist ethic apparently did not percolate throughout the rest of Indian society. That same Hindu

cultural stability that was resistant to the Islamic religion of its rulers was also resistant to their economic ethic as well.

4.6 Democratic Spirit and Individualism

There is extensive scholarship supporting the thesis that democracy, with its concomitant sense of individualism, is a principal ingredient in the development of modern science. While democracy and individualism are not identical concepts, they are the opposite sides of the same coin. For example, Josephson found that "historians and sociologists of science maintain that science operates according to democratic principles" (Josephson, 1996, p. 2). Needham concluded that "there is a fundamental correlation between science and democracy" (Needham, 1969, pp. 136-137). A.C. Graham cited the "seminal rise of individualism." (Graham, 1973, pp. 41-42). The growing sense of democracy and individualism, on the one hand, and the practice of science and technology, on the other, were mutually reinforcing processes.

A major impact of democracy and individualism was to render irreparable the schism between matters of the intellect and matters of the soul. Reinforced by the movement toward capitalism, people were empowered to investigate new concepts as they arose. Needham described it as a "hidden connection between science and democracy, namely the bridging of the gulf between the scholar and the artisan." He documented "the complete gulf between theoretical scientific thought and technical human practice for thousands of years.... With the coming of capitalism, however, all was changed…The scholar, from being the support of the king, becomes the comrade of the artisan" (Needham, 1969, pp. 140-141). Needham ultimately concluded that "democracy might therefore almost in a sense be termed that practice of which science is the theory" (Needham, 1969, p. 145).

Conversely, the practice of science and technology reinforces democracy and individualism. The very nature of modern scientific inquiry is inherently indifferent to the race or socio-economic status of the investigator; it is antagonistic toward cultures which venerate age. Democracy and individualism reinforce the modern practice of science, which in turn present new options for behavior choices that, in a democratic structure, are more easily recognized and acted upon. In India the rigidity of the caste system severely impeded social mobility. Obeisance to democratic ideals is a twentieth century phenomenon in India.

5. Conclusion

There is a broad range of cultural factors that played a role in the historical Indian relationship with nature. These diverse factors include religion, the concept of nature, the role of artisans, mercantile capitalism, urbanization, information accumulation and transmission, the democratic spirit and individualism, the marriage of theory and practice, and the concept of *śāstra*.

The caste system was certainly a critical element inhibiting the development in India of the necessary social context vital to the development of science in Europe. The framework of the caste hierarchy is derived from the *varnas* as laid out in the *Vedas*; as such, it has a canonical status in Hindu teachings. It

is presented as the ideal social order, with violations enforced through the threat of soteriological sanctions (Smith, 1994, p. 319). Much as western scholars attribute the rise of science to specific cultural values in Europe that were reinforced by biblical authority, the *varna* system may well have inhibited the development of these same values in India through the cultural authority associated with the *Vedas*. In the Western world, science became an alternative path for proposing cultural truths which challenged those of the existing religious and political systems. The caste system not only created an inflexible social framework, but also privileged Brahmins—the social group most threatened by change—with the authority for being the final arbiters of both natural and religious truths.

In comparison with Europe, Indian culture was extremely stable. Like China, India succeeded in adapting to military invasion, mercantile capitalism, urbanization, new religious movements, environmental pressures, and the introduction of new technologies in such a manner as to avert challenge to its fundamental cultural values. As Needham concluded during his search for the causal elements of the rise of modern science in Europe, "from the fifteenth century A.D. onwards a complex of changes occurred; the Renaissance cannot be thought of without the Reformation, the Reformation cannot be thought of without the rise of modern science, and none of them can be thought of without the rise of capitalism, capitalist society and the decline and the disappearance of feudalism. We seem to be in the presence of a kind of organic whole, a packet of change" (Needham, 1969, p. 40). Although any culture can certainly be thought of as an organic whole, India successfully resisted those changes that began the transformation of Europe in the seventeenth century.

A careful deconstruction of Indian nationalist literature typically uncovers a systematic cherry-picking of information rather than a comprehensive analysis. In accurately asserting that modern history does not adequately credit Hindu culture for its many mathematical and technological contributions, nationalists make a leap of faith that these meritorious contributions were indeed science. The obvious repurposing of *śāstra* cannot accomplish such historical revisionism. One book on so-called ancient Hindu science concluded that Joseph Needham believed that the history of science for China is incomplete and that India's contribution has not adequately been complied by historians (A. Kumar, 2019, p. 3). While that is certainly accurate, that author does not mention that Needham's many-volume examination of Chinese history and knowledge also concluded that China indeed did not independently develop science. Moreover, while a trained scientist, this author omits a basic analysis of what constitutes the practice of science and whether the translation of *śāstra* as science is appropriate. Such apologists also generally appear to misunderstand that a technological innovation can well involve no scientific understanding. One of the most significant advances in human development was the ancient flaking of stone to make tools. Despite its technological significance, there clearly was no science involved.

Science is a particular way of understanding the natural world. It is specific to the development of European culture beginning in the sixteenth century and presumes that our physical world is regulated by humanly comprehensible natural laws, can be reduced to constituent parts, and can be mathematized.

In India, historical obeisance to the strictures of the *Vedas* prevented the development of a non-religious alternative to understanding the natural world that, in Europe, became science. Nevertheless, India's nationalistic political agenda has attempted to credit the *Vedas* as the origins of modern science many thousands of years ago. This may be good politics, but it is bad history, and misrepresents what science is.

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