The Indian Scientist from Vedic to Modern Times

the Scientific Edge

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ORIGINS OF VEDIC CIVILIZATION

DID ARYAN INVADERS OF INDIA CREATE THE VEDIC TRADITION?

How ancient is the vedic tardition and how did it begin? Was it the creation of a people who invaded India from outside, as many European scholars believed for centuries? Or did it arise among an indigenous people of northern India? In this chapter we will ask where the Vedic tradition originated, and in the next chapter, we will consider when it came into existence. In the third chapter, we will consider its relation to European civilization.

According to the Vedic tradition, the Veda is eternal. It exists within the eternal fabric of consciousness itself. As such it is uncreated. But even so, we can ask, when was the Veda first cognized? And when did the tradition of reciting the Veda begin?

Did Invaders of India Create the Vedic Tradition?

Many myths about the Veda and Vedic tradition have formed that must be dispelled before we can get an accurate picture of its origins. One myth is that a race of lightskinned Aryan peoples invaded India from outside, pushing the dark-

skinned natives, called Dravidians, into the south. According to this theory, the lighter-skinned race invaded India in an incursion that took place, some scholars project, around 1,500 BC. This myth persisted long after an overwhelming body of scientific evidence, and a consensus of archeologists, showed that it is completely untenable. It must be discredited before we can get an accurate picture of the character of Vedic Civilization. As we will see, the Veda was first "cognized," not by invading races from outside India, but by a people who had lived continuously in India for thousands of years. Also, the dates commonly ascribed to the origin of the Vedic tradition are probably off by many thousands of years. Archeologists at Harvard, Oxford, and other top universities in the US and Europe are now widely agreed that there was no invasion of India from outside that displaced the peoples of the Saraswati and Iudus river valleys. This civilization arose within northern India and there is also evidence, which we will consider in the next chapter, that Vedic civilization was either a precursor to the Indus-Saraswati civilization or an early contributor to its cultural and spiritual heritage. Vedic civilization arose in India many millennia before the speculative mythologies of the past suggest.

ORIGINS OF THE INDO-EUROPEAN HYPOTHESIS

Linguistic similarities between Indian and European languages were recognized by the earliest European scholars. In the late eighteenth century, it was observed that Sanskrit, Iranian, and most European languages share many common words and grammatical structures. Early linguists classified Vedic Sanskrit and the majority of European tongues in the same "family of Indo-European languages."

Sir William Jones was the first to show that there are many common cognate words shared by Sanskrit and European languages. Speaking to the Asiatic Society in

Calcutta on February 2, 1786, Jones made a statement which was soon to become quite famous: ...the Sanskrit language, whatever be its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either, yet bearing to both of them a stronger affinity, both in the roots of verbs and in the forms of grammar, than could possibly have been produced by accident; so strong, indeed, that no philosopher could examine them all three, without believing them to have sprung from some common source, which, perhaps, no longer exists.

A quick glance at some of the common cognate words of English and Sanskrit shows definite family resemblances that Jones spoke about:

Common Cognate Words Shared by English and Sanskrit

advocate, adhivaktr
agri, ajira
bind, bandhi
bright, bharajat
brother, bhatr
candle, chandra
cardio, hrd
come, gam
deity, devata
eight, ashta
end, anta
genus, janus
gnosis, gnana
idea, vidya
identity, idamta
immortal, amrta

kalon, kalyana
mega, maha
man, manu
mind, manas
mortal, mrta
mother, matr
same, sama
three, tri
vivi, jiva
voice, vaca
wind, vata
wit video, vid
yoke, yoga
young, yuvan

In nineteenth century, the German linguist Friedrich Schlegel suggested that the main body of European languages were derived from Sanskrit. Schlegel's suggestion was widely rejected, mainly because European scholars did not like to think that their language and culture derived from India. But the early nineteenth century it was widely recognized that all European languages and the Indic languages belonged to a common "family," distinct, for example, from Chinese, African, and American Indian language families and groups. All but a few of the European languages, such as Basque for example, belong to this distinct family of Indo-European languages. Thus, the idea that an Indo-European language was at the root of the family of the main body of European languages came into prominence.

To many European scholars of the nineteenth century (characterized more by their Euro-centrism than by scientific attitudes towards peoples of other cultures), the idea that the family of European languages family could have originated in India was unthinkable. It was just not culturally acceptable

to think that the roots of European language and culture could be traced to darker-skinned peoples indigenous to India. So European thinkers began to speculate about a prehistoric "proto-Indo-European" race who had migrated from somewhere in Western Asia, perhaps around the Black Sea, Eastern Europe, or Russia, to settle in India and in Europe. This, as we will see, was a purely racial and cultural bias, with no basis in archeological fact.

Many European scholars immediately bought in to the "Indo-European hypothesis," which was the stimulus to develop the discipline of historical linguistics. European scholars like Max Muller, Thomas Young, Joseph de Goubinau, Dwight Witney, Sir Mortimer Wheeler, A.L. Basham, George Cox, and John Fiske all adopted the theory of Indo-European origins. They commonly proposed that a people speaking "proto-Indo-European" came from somewhere in central or Western Asia or southeaster Europe, invaded India from the northwest, overran the local culture, and settled in the north of India.

These Indo-Europeans were said to be "Aryans" in race and language, which meant primarily fair-haired and light-skinned people. By the twentieth century they were conceived, mainly by German scholars, as a blue-eyed, blond race that was the stock of the Germanic people-all nicely fitting the cultural-political-racial agendas of Western Europe-and Nazi Germany in particular.

In spite of the large number of scholars of the late nineteenth and early twentieth century who believed the invasion theory, it turns out, as we see below, that there is almost no shred of evidence to support it. It is one of the great myths formed by European scholars to support their bias that outside invaders created early Indian civilization. Anthropologist today find all evidence points to an origin of the Vedic tradition that is indigenous to northern India.

SCIENTIFIC ARCHEOLOGY: THE END OF THE INVASION THEORY

In the 1990s, a new wave of scientific evidence, coming partly from satellite photos, geological study, archeological digs, and other anthropological finds began to seriously discredit the old myth. Once the rubble of false assumptions was cleared away, a far more simple scientific picture of the origins of ancient north Indian civilization began to emerge.

Professor Colin Renfrew, professor of archeology at Cambridge University, in his Archeology and Language: The Puzzle of Indo-European Origins, (1988) gives evidence for Indo-Europeans in India as early as 6,000 BC. He comments: As far as I can see there is nothing in the Hymns of the Rigveda which demonstrates that the Vedic-speaking population were intrusive to the area: this comes rather from a historical assumption about the 'coming' of the Indo-Europeans.

Professor Schaffer at Case Western University writes in "Migration, Philology and South Asian Archaeology" that there was an indigenous development of civilization in India going back to at least 6000 BC. He proposes that the Harappan or Indus Valley urban culture (2600-1900 BC) centered around the Saraswati river described in the Rig Veda and states that the Indus Valley culture came to an end, not because of outside invaders, but due to environmental changes, most important of which was the drying up of the Saraswati river.

Schaffer holds that the movement of populations away from the Saraswati to the Ganges after the Saraswati dried up in about 1900 BC, is reflected in the change from the Saraswati-based literature of the Rig Veda to the Ganges-based literature of the Itihasa and Puranic texts. He also states that the Aryan invasion theory reflects a colonial and Euro-centric perspective that is quite out of date. He concludes: We reject most strongly the simplistic historical

interpretations... that continue to be imposed on south Asian culture history...Surely, as south Asian studies approach the twenty-first century, it is time to describe emerging data objectively rather than perpetuate interpretations without regard to the data archaeologists have worked so hard to reveal.

Anthropologist Brian Hemphill of Vanderbilt University has been studying the human remains of the northern Indian subcontinent for years. He states categorically that his analysis shows no indication of population replacement or large-scale migration. Archaeologist Mark Kenoyer, associate professor of anthropology at the University of Wisconsin at Madison, and co-director of the Harappa Archeological Research project, holds that the invasion theory is completely unsupported by archeological, linguistic, or literary evidence. He writes in an article on the Indus valley civilization:

If previous scholars were wrong about the origin of the Indus people, they also missed the boat when it came to explaining their downfall, which they attributed to an invasion by Indo-Aryan speaking Vedic tribes from the northwest.

Archeological evidence simply does not support the thesis of an outside invasion. Kenoyer argues, "it's likely that the rivers dried up and shifted their courses, altering trade routes and undermining the economy." Kenoyer holds that the Indus valley script can be traced to at least 3,300 BC-making it as old or older than the oldest Sumerian written records.

Archaeologist Kenneth Kennedy writes that no Aryan skeletons have been found in the Indus valley that differ from the skeletons of indigenous ethnic groups. All prehistoric human remains recovered from the Indian subcontinent are phenotypically identifiable as south Asians. Furthermore their biological continuity with living peoples of India,

Pakistan, Sri Lanka and the border regions is well established across time and space.

Scientific archeology, it is now safe to say, no longer gives the invasion theory a grain of credibility. It has lost its supporters among serious scientists.

Also, as professor Renfrew argues, there is no internal evidence from the ancient Vedic literature that Vedic civilization originated outside India. The verses of the Rig Veda, the most ancient songs of Vedic tradition, detail many aspects of daily life of the people. There is no hint in this vast literature of a migration or of a history that lies in a homeland beyond the mountains of northern India. All evidence from archeology, anthropology, and Vedic literature indicate that Vedic civilization was indigenous to northern India. Geological data now explains the demise of the Indus and Saraswati valley civilizations in terms of climactic change, bringing an end to the outsideinvasion theory.

CAUSES OF THE DECLINE OF THE INDUS-SARASWATI CIVILIZATION

Geological and archeological evidence, it turns out, give strong evidence that a long and devastating drought followed by devastating floods led to the abandonment of the settlements along the banks of the Indus and Saraswati rivers in western India, ending an urban civilization that had flourished, archeologists now surmise, sometime between 2,600 BC and 1,900 BC. The Indus and Saraswati valley civilization was vast and widespread, and covered over 250,000 square miles, from north central India in the east all the way to the eastern edge of Iran in the west. There is no evidence to suggest that this vast civilization was destroyed by Indo-European Aryan invaders, but rather, it is now virtually certain that its demise came as a result of widespread climatic changes that occurred in 1,900 BC.

Recent studies by Louis Flam of H. H. Lehman College of the City University of New York have shown that the course of the Indus river changed dramatically around 1,900 BC, probably flooding many settlements along the river and disrupting the Indus valley civilization. Jim Schaffer of Case Western University has found impressive evidence that settlers of the Indus valley migrated at this time east to the plane of the Ganges.

Mortimer Wheeler, the anthropologists who excavated Mohenjo-Daro in the in the 1920s, one of the most well-preserved cities of the Indus Valley civilization, brought to the project an "outside invasion theory." He found unburied skeletons in the most recent layers of the city which led him to think that he had evidence that the civilization was overrun by invaders from outside. More reliable recent evidence has shown that the people of the Indus valley were not victims of invasion and massacre, but that their civilization withered as a result of various climactic changes, including prolonged droughts and extensive flooding, and possibly also earthquakes that changed the course of the rivers.

It was not outside invaders of India who brought an end to the Indus-Saraswati civilization, but a series of climactic changes and natural disasters. The biases of European scholarship caused them to see invaders where there were none. They existed only in the imagination of European scholars.

HISTORICAL LINGUISTICS AND MIGRATIONS OF EARLY CIVILIZATION

The other issue that needs to be considered is language origins. Historical linguistics appears to detect patterns of language change which some think may imply patterns of migration of early peoples, and which may therefore provide a clue to the origins of Vedic civilization.

The original theory proposed by the early historical linguistics who considered these issues was that Vedic Sanskrit conserved the original sound system of the "proto-Indo-European" language most closely, and that Iranian and European languages underwent a systematic sound shift, creating break-away or daughter languages spoken by the people who populated India and Europe.9 According to this theory, Vedic Sanskrit was put at near the trunk of the proto-Indo-European language tree, if not the trunk itself. This theory has been challenged and hotly debated in recent years, most especially by computer linguists. Since the 1990s, it is now common for computer linguists to hold that Sanskrit is not so near the root of the Indo-European language tree, but a subsequent branch. A currently dominant theory is that the original Indo-European language stemmed from an Indo-European proto-language that has since been lost. The first languages to break off from the proto-Indo-European root, according to the dominant contemporary linguistic theories, was Anatolian (the language of what is now central Turkey), followed by Celtic (a language found in nearby Thrace in northeastern Greece, and also Ireland suggesting that there was a commerce or colonization between Ireland and early Thrace), then Greek, and then Armenian. According to these theories, the Indian and Iranian language groups are still later branches off the proto-Indo-European "root."

The linguistic evidence appears to imply migrations of people from the Black Sea area into India, and yet there is no anthropological evidence to support either a migration into northern India, or an invasion. Evidence from skeletal remains, as we saw, as well as pottery and other artifacts, show no cultural replacement at any time in north Indian history. This makes it difficult to conclude that a people speaking a proto-Indo-European root language migrated to India from outside, resulting in a language shift to the daughter language of Sanskrit. The hard anthropological

evidence just does not support such a view. How else, then, can we account for the apparently late evolution of Sanskrit from the proto-Indo-European root language?

Eminent computer linguists caution against drawing conclusions from computersimulated language programs-which may reflect the assumptions of the programmers more than the branches of the linguistic tree. They caution that computer linguists tend to program in assumptions that reflect their own biases and expectations, and therefore the outcomes cannot be any more accurate than the assumptions. Computer linguistics does not necessarily mean unbiased, objective linguistics, but may, on the contrary, program in distinct biases of the linguists.

If linguists start with a theory of an outside invasion, they will naturally bring those biases into their work, and it is not unthinkable that such biases have colored computer and historical linguistic theories. It also needs to be pointed out that if a false assumption is programmed in, then anything at all can come out. Anything at all can be derived from a false assumption. If the assumption that Sanskrit is not the proto-Indo-European language root be false, then anything follows.

MORE ON THE INDO-EUROPEAN PROTO-LANGUAGE

In 1990, Thomas V. Gamkrelidze and V. V. Ivanov, authors of the two volume The Indo-European Language and the Indo-Europeans,13 published an article in Scientific American, in which they state, "The landscape described by the reconstructed Indo-European proto-language is mountainous-as evidenced by the many words for high mountains, mountain lakes and rapid rivers flowing from mountain sources." They note also that, "the [proto-Indo-European language] has words for animals that are alien to Europe, such as "leopard," "snow leopard," "lion,"

"monkey" and "elephant." The authors suggest, on the basis of this and other linguistic evidence, that the homeland of the proto-Indo-Europeans was somewhere in the Caucasian mountains of western Asia near the Black Sea in around 4000 BC.

These same words could be used to make the case that the mountainous terrain, and more especially the elephant, monkey, and snow leopard are more commonly found in the region of northern India and the Himalayas.15 If the words for elephant, monkey, snow leopard, and mountains are in fact more abundant in the Indo-European protolanguage, this would most likely put the proto-Indo-European home somewhere in the Himalayan region of northern India, rather than in the Mountains to the east of the Black Sea.

This would tend to support the hypothesis that the Indo-European protolanguage originated in the region of the Himalayas of northern India and Tibet, rather than in the area of central Turkey, where there are few monkeys and elephants. At present, there is simply not enough evidence to discern the early patterns of migration and language shift that brought about the different language groups. We can say with relative certainty, however, that the Vedic people did not migrate into India from outside, so it is relatively unlikely that the Vedic language came from outside India. Thus the origins of Vedic Sanskrit remain obscure.

Many linguists stress that our "linguistic heritage, while it may tend to correspond with cultural continuity, does not imply genetic or biological descent. There is no more reason to suppose that we, as speakers of an Indo-European language, are descended biologically from the speakers of proto-Indo-European, than that the English speaking population of Nigeria is Anglo-Saxon." It is necessary to be very careful in drawing conclusions about migration patterns and racial origins from linguistic evidence.

RULES OF LANGUAGE TRANSFORMATION

A main tool of historical linguistics is the set of rules of sound and grammatical transformation governing the language change. One language evolves into another due to cultural or geographic separations of peoples due to migrations or other cultural displacements, such as conquest. Using the rules of historical linguistics, it appears to be possible to discern patterns of change and to determine which language has shifted into the other.

One such rule is the softening of consonants over time. Thus, for example, the "v" in the Sanskrit "Veda," meaning knowledge, is transformed into the softer English "w" in "wit," "witten," "wisdom" and the German "wissen," which also means knowledge, and derives from the more ancient Sanskrit root. The Sanskrit "deva" is transformed into the softer Latin "deus," Greek "theos," Lithuanian "dewas," Irish "dia," and Old Prussian "diews."

Using such transformation rules, linguists attempt to reconstruct which languages are earlier and which broke off later in the transmutation of language. Historical linguists assume that these rules are constant over time and that they apply to early transformations as well as later ones.

If we assume that the basic rules of language transformations are constant and do not mutate over time, then these conclusions follow. But could there have been sound shifts in the opposite direction at much earlier times in history? Perhaps different laws applied at the time when Vedic Sanskrit changed from and to other languages. Consider that there are also changes in the reverse direction. For example, the "g" in the Sanskrit "go," (meaning cow) is transformed into the harder consonant "k," to make the German word "kuh" for cow. The English word "cow," pronounced with a hard "k," is a harder, guttural form than the "g" in the Sanskrit "go."

Also, in the case of the Vedic tradition, we have a people who were highly conscious of language and sound and the rules of sound transformation, even from the early Vedanga period. The Vedangas give elaborate theories of sound and its relation to meaning. Ancient Sanskrit grammar has its own rules for the transformation of consonants, internal rules for change, codified in ancient texts on phonology and grammar (Nirukta and Vakaran), both of which express elaborate theories of sound. Such self-reflective theories at an early date may have influenced the direction of language shift and may be anomalous to the rules applied in later linguistic theory. Other hypotheses may explain why Vedic Sanskrit appears to not be the proto-Indo-European root language. One might propose, for example, that an early form of Sanskrit arose in northern India, and that some north Indian peoples migrated west to the Black Sea area, where their language mutated into Anatolian, Armenian, Celtic, and Greek.

Then language change within Vedic Sanskrit, due to self-reflective grammatical theories, have mutated this earlier form of Sanskrit in a direction contrary to the typical rules of linguistic transformation.

Computer simulated models of language change may be simply wrong or misleading. In other words, the transformation "rules" of historical linguistics may not apply to changes as early as Vedic Sanskrit. Or they may reflect more the racial and cultural biases of the programmers. Rather than assume a migration from the Black Sea area into India, which is not supported by anthropological evidence, we must simply acknowledge that we do not have enough knowledge to discern the early patterns of migration of the people who wrote the Vedic literature. The simplest hypothesis to account for the data may be that Vedic Sanskrit is itself is the mother tongue of the proto-Indo-European peoples.

SUMMARY: EURO-CENTRISM AND OBJECTIVE SCIENCE

For years, theories of the origins of the Indo-European people were based on small bits of evidence that were used to make sweeping generalizations. The Euro-centric perspective so heavily biased the discussion that it became necessary for scientists of the later twentieth century to re-examine and re-balance the perspectives in order to remove long-standing misconceptions formed by two centuries of speculative mythmaking. When these misconceptions are eliminated by objective science, no evidence remains that the Veda tradition came to India from outside.

Now we come to our second main question, How long ago was the Veda first cognized? When did the Veda first come to be known in the civilization of India? How far back in time does the Vedic tradition go?

HOW ANCIENT IS THE VEDIC TRADITION?

New Light on the Cradle of Civilization

A SECOND MYTH that dies hard is that Vedic civilization came into existence as recently as 1000 to 1200 BC. Many scholars today have come to think that these dates are ridiculously recent and that the Vedic tradition, meaning the tradition of reciting the Rig Veda and the Vedic literature, is far more ancient. Scholars of the nineteenth century, the highly venerated Max Muller for one, give dates as recently as 1,000 to 1,200 BC.18 These dates, like the Aryan invasion theory, are products of a Euro-centric bias. They were rooted in unsustainable religious, cultural, and ethnic assumptions that were not based on scientific evidence.

Max Muller, one of many Christian missionaries to India, was firmly committed to the Biblical account of creation. Muller accepted the date of creation given in the Bible at 4004 BC and the great flood at 1500 BC. This compelled him

to date the Rig Veda much later in time than an impartial scientist would have done. Muller had to fit the entire Vedic tradition into a time-frame following the great flood, which Biblical scholars held took place in 1500 BC.

Muller wrote a letter to his wife, dated 1886, in which he said "The translation of the Veda will hereafter tell to a great extent on the fate of India and on the growth of millions of souls in that country. It is the root of their religion, and to show them what the root is, I feel sure, is the only way of uprooting all that has sprung from it during the last 3,000 years." These are hardly the words of an unbiased scientist. No matter how great Muller's scholarly reputation, we have to examine his reasons for setting the dates around 1000 to 12000 BC.

Muller recognized that the Vedic tradition had to exist (n part) before Buddha, who lived in about 500 BC and who reacted against the Vedic tradition. Muller and other Germanic scholars also noticed that the Agni Purana (16) and other Vedic texts refer to Buddha, so they felt justified in thinking that the Vedic tradition was just a little more ancient than Buddhism, and they put the dates of the Vedic period roughly two-thirds of way between the great flood (the Biblical limit they accepted) and the time of Buddha. Muller thus set the dates of the Vedic period at 1000 to 1200 BC. Muller reasoned that if Buddha rejected the Vedic tradition, the Rig Veda must have preceded him by at least several centuries, but it had to have started (in his opinion as a Bible scholar) after the great flood.

Even Muller, however, recognized that this was an estimate of a bare minimum of time that lapsed between the beginning of the Vedic tradition and the time of Buddha. However, it became commonplace for textbooks to give the dates of the Vedic tradition as 1,000 to 1200 BC, based on Muller's minimum estimate. Soon these were known as the

dates of the Rig Veda. This fixed Muller's estimate of a bare minimum into an absolute date in the popular imagination.19 The mud of speculation had become sedimented into the brick of common belief. Current evidence shows that the Veda did not began so recently in human history. The references to Buddha occur in very late additions and have no bearings on the far more ancient origins of the Vedic tradition.

Satellite Photographs and Geological Evidence: Dates of the Saraswati River and the Rig Veda More recent scholars, such as David Frawley, Dr. B.G. Siddharth, Dr. S.B. Roy, Professor Subhash Kak, Dr. N.R. Waradpande, and Bhagwan Singh have made a case for much more ancient dates of the Rig Veda. Also B.G. Tilak, P.C. Sengupta, Pargiter, Jagat Pati Joshi, Dikshit, K.N. Shastri, Sri Aurobindo, Hermann Jacobi, Dayananda Saraswati, B.G. Sidharth, among many others, have argued for its greater antiquity. David Frawley and N.S. Rajaram, in Vedic "Aryans" and the Origins of Civilization, put forward an interesting and compelling theory of the origins of Vedic civilization. Drawing upon a large array of evidence from anthropology, satellite mapping, geology, historical linguistic, and literary study, they have helped discredit the old "Aryan invasion theory" to establish that the Rig Veda was of much greater antiquity than Muller had estimated.

One of the strongest bits evidence comes from satellite pictures of an ancient and dried riverbed that is now taken to be the former bed of the Saraswati river. This great river, described in the Rig Veda as a "mighty river flowing from the mountains to the sea," has long since disappeared from the maps of modern India, until satellite pictures revealed the bed of an ancient river running from the Himalayas to the western gulf of the Indian ocean, roughly paralleling the course of the Indus, but lying to the east of the Indus.

Satellite photos and geological field studies show that the Saraswati ceased to be a perennial river and flowed only seasonally, sometime before 3,000 BC. Also, since approximately 1,900, the Saraswati riverbed has been completely dry. This, as we will see, is a key piece of the scientific evidence to establish dates of the Rig Veda. The Saraswati was fed by melt from Himalayan glaciers, after the receding of the last ice age, about 8,000 BC. As the melting glacial waters ceased to feed the river, it changed its course, became a seasonal river, perhaps went underground, and eventually dried up in its former riverbed. Some, like Subhash Kak, hold that the change in the course of the river was due to an earthquake.

This event left the many settlements along the banks of the Saraswati to their fate. As the river dried, without water the agricultural settlements and villages were no longer sustainable. After this time, the towns and cities were re-located to the Indus river valley nearby and still later, after the droughts and flooding that came to the Indus and Saraswati valleys around 1,900 BC, settlers migrated further east to the Ganges river plain.

The Rig Veda mentions the Indus river quite often, and it mentions the Saraswati no less than 60 times. Its reference to the Saraswati as a "mighty river flowing from the mountains to the sea" shows that the Rig Vedic tradition must have been in existence long before 3,000 BC when the Saraswati ceased to be a "mighty river" and became a seasonal trickle. Frawley and Rajaram drew the conclusion that the Rig Veda must have been composed long before 3,000 BC.

Rajaram writes that the "Saraswati described in the Rig Veda belongs to a date long before 3,000 BC." He concludes that, "All this shows that the Rig Veda must have been in existence no later than 3,500 BC."20 He thus places the beginning of the Vedic tradition "long before 3,000 BC" and

its end before 2,000 BC. The Mahabharata, the great epic of classical Sanskrit, describes the Saraswati as a seasonal river. Since the Saraswati dried up by 1900 BC, the Mahabharata would have to be dated at least before 1,900 BC. Since it was still a seasonal river in 3,000, Rajaram and Frawley put the date of the Mahabharata in 3,000 BC.

Evidence from French SPOT satellite and the Indo-French field study have changed this conception of history. By showing that the Saraswati ceased to be a mighty river long before 3,000 BC, they showed that the Rig Vedic civilization must have begun long before the Saraswati became a seasonal trickle sometime long before 3,000 BC. If the Rig Vedic tradition began before 3,500 BC, this would date it earlier the civilizations of Egypt, Harappa, or Mesopotamia.

OTHER APPROACHES TO DATING THE VEDIC TRADITION

In an article entitled, "Birth of a Civilization," in Archeology, January/February 1998, anthropologist Mark Kenoyer sums up decades of scientific research on the archeology of India and argues that the Rig Veda verses were known on the subcontinent sometime before 1500 BC, by communities in the northwest area of the subcontinent. This is, again, a minimal date, not an attempt to fix the time of the Vedic period at 1,500 BC.

Maurice Winternitz, a German scholar and author of the two volume History of Indian Literature, extensively re-examined the evidence for Muller's dates in 1981, a decade before the movement to push back the dates of Vedic civilization that started in the 1990s. Winternitz estimated how long it would have taken for the vast body of Vedic literature to form and develop before the Buddhist revival in 500 BC. He considered each of the major periods of Vedic literature and estimated a bare minimal time for the

incubation of each. His estimate of 1900 years put the beginning of the Vedic tradition at sometime before 2,400 BC as a bare minimum.

The vast literature of the Rig Veda, the Brahmanans, the Aranyakas, the Upanishads, the Vedangas, the Upangas, the Puranans, the Itihasa, the systems of Ayur-Veda, Winternitz argued-each a huge body of literature-required a sustained incubation period that must have taken an extended period of time. Winternitz could not imagine that this had taken place in the short span of time that had been assigned for it to happen between 1,500 BC and 500 BC when Buddha lived. This, it must be emphasized again, was Winternitz's estimate of a minimum time, and was not meant to fix the date of the Rig Vedic beginning.

THE CITY UNDER THE SEA: DWARKA

Undersea exploration of an ancient city about half a mile off the coast of Gujarat in India, in 1981, lead to the discovery a city that had been submerged since 1,600 BC. The city is well established to be Dwarka, an ancient city mentioned in the Mahabharata, the great epic of the late Vedic period of Itihasa. The Mahabharata describes Dwarka as built on land reclaimed from the sea. Boulders have been found under the fortified city walls, showing that it was the result of land reclamation. The Mahabharata also mentions that Krishna warned the residents of Dwarka that the city would be reclaimed by the sea. The discovery of a seal engraved with a three-headed animal at the Dwarka site corroborates a reference made in the Mahabharata that such a seal was given to the city. Seven nearby islands described in the Mahabharata have also been discovered.

Since archeological research shows that the city was submerged around 1,600 BC, this would date the Mahabharata at least before 1,600 BC. Again this is a

minimum time. Pottery found at the site, inscribed with the script of the Indus valley civilization, has been established by thermoluminescene tests to be about 3,530 years old. The Mahabharata was written toward the end of the classical Vedic period. If we accept Winternitz's estimates a minimum of 1,500 years lapsed from the beginning of the Vedic period to the Mahabharata, then since Dwarka was submerged by 1,600, this would set the date of the Rig Veda back to before 3,100 BC. This again marks the minimum date of the Rig Veda, and should not be construed as a fixed date. The body of literature produced by Greece and Rome from Homer to Proclus spans roughly 1,300 years. The Vedic tradition produced an even larger body of literature from the beginning of the Rig Veda to the end of the classical period, so it would probably require at least 1,300 years for the Vedic tradition to generate a larger amount of literature. If we take 1,600 BC as the minimum date of the Mahabharata, this would put the beginning of the Vedic tradition sometime before 2,900 BC. If we take Wintenitz's estimate of at least 1,900 years, this would put the beginning of the Rig Veda before 3,500 BC.

Frawley and Rajaram, as well as many others, now put the date of the Mahabharata war at about 3,000 BC (Maharishi Mahesh Yogi also gives this date in his commentary on the Bhagavad Gita). If we add 1,900 years incubation time as Winternitz estimates, this would put the dates of the Rig Veda back before 4,900 BC.

Astronomical References in the Rig Veda and Other Evidence

Evidence from other sources known since the late nineteenth century also tends to confirm the great antiquity of the Vedic tradition. Certain Vedic texts, for example, refer to astronomical events that took place in ancient astronomical time. By calculating the astronomical dates of these events,

we thus gain another source of evidence that can be used to place the Rig Veda in a calculable time-frame.

A German scholar and an Indian scholar simultaneously discovered in 1889 that the Vedic Brahmana texts describe the Pleiades coinciding with the spring equinox. Older texts describe the spring equinox as falling in the constellation Orion. From a calculation of the precision of the equinoxes, it has been shown that the spring equinox lay in Orion in about 4,500 BC.

The German scholar, H. Jacobi, came to the conclusion that the Brahmanas are from a period around or older than 4,500 BC. Jacobi concludes that "the Rig Vedic period of culture lies anterior to the third pre-Christian millennium." B. Tilak, using similar astronomical calculations, estimates the time of the Rig Veda at 6,000 BC.23 More recently, Frawley has cited references in the Rig Veda to the winter solstice beginning in Aries. On this basis, he estimates that the antiquity of these verses of the Veda must go back at least to at least 6,500 BC. The dates Frawley gives for Vedic civilization are:

- Period 1. 6500-3100 BC, Pre-Harappan, early Rig Vedic
- Period 2. 3100-1900 BC, Mature Harappan 3100-1900, period of the Four Vedas
- Period 3. 1900-1000 BC, Late Harappan, late Vedic and Brahmana period

Professor Dinesh Agrawal of Penn State University reviewed the evidence from a variety of sources and estimated the dates as follows:

- o Rig Vedic Age-7000-4000 BC
- o End of Rig Vedic Age-3750 BC
- o End of Ramayana-Mahabharat Period-3000 BC

- o Development of Saraswati-Indus Civilization-3000-2200 BC
- o Decline of Indus and Saraswati Civilization-2200-1900 BC
- o Period of chaos and migration-2000-1500 BC
- o Period of evolution of syncretic Hindu culture-1400-250 BC

The Taittiriya Samhita (6.5.3) places the constellation Pleiades at the winter solstice, which correlates with astronomical events that took place in 8,500 BC at the earliest. The Taittiriya Brahmana (3.1.2) refers to the Purvabhadrapada nakshatra as rising due east-an event that occurred no later than 10,000 BC, according to Dr. B.G.Siddharth of India's Birla Science Institute. Since the Rig Veda is more ancient than the Brahmanas, this would put the Rig Veda before 10,000 BC. Attempts to date the Rig Veda based on astronomical evidence have some merit, but the conclusions are hotly debated, and probably not entirely free of conjecture. Some contemporary scholars take them quite seriously as a method of dating the Rig Veda, but the evidence is inconclusive at present.

EVIDENCE FROM STHAPATYA VEDA ARCHITECTURE

Perhaps the most interesting evidence for the antiquity of the Vedic tradition comes from architectural remains of towns and cities of the ancient Indus-Saraswati civilization. The Indus Valley Civilization flourished, according to the most reliable current scientific estimates, between 2,600 and 1,900 BC-but there are cities, such as Mehrgarh, that date back to 6,500-7,000 BC. These dates are based on archeological fieldwork using standard methods that are commonly recognized in the scientific community today. Over 1600 settlements have been found in the vast Indus/Saraswati

region that extended over 25,000 square miles. The most well known cities of the Indus valley civilization, Mohenjo-Daro and Harappa, were built of kiln-fired brick and laid out on an exact north-south axis. This means that the main streets of the city ran north-south, and the entrance of the homes and public buildings faced east. The cities were also built to the west of the rivers, so that they were on land that sloped east to the river.

These facts, which may seem trivial on first glance, turn out to be highly significant. The ancient architectural system of Sthapatya Veda prescribes detailed principles of construction of homes and cities. One of the main principles of Sthapatya Veda is that cities be laid out on an exact north-south grid, with all houses facing due east. Another is that the buildings be oriented to the east with a slope to the east and any body of water on the east. Most of the cities of the Saraswati and Indus valley followed these principles exactly.

These early cities were planned and constructed according to exact principles that align the microcosm of human dwelling to the larger cosmos. They applied laws of nature that are set out in Sthapatya Vedic architecture. When the principles were codified into a system is open to question, but since the building and city planning were done according to Sthapatya Vedic principles, it is reasonable to conclude that Sthapatya Veda was known and practiced during the ancient period of Indus-Saraswati valley civilizations. The system called Sthapatya Veda architecture may have preceded this period, or may have been codified later, but the cities were built according to Sthapatya Vedic architecture.

Since these cities were constructed as early as 6,500 to 7,000 BC, this would suggest that Sthapatya Veda may have been known as early as that. This gives another reason to put the origins of Rig Vedic tradition even before that time. This is another bit of evidence, which is not noted in previous

literature, that may establish the great antiquity of the Rig Vedic tradition. Archeological research has shown Indus Valley civilization was an outgrowth of an earlier agrarian civilization. Richard H. Meadow of Harvard University has shown for instance a gradual shift from the hunting of game to the raising of sheep, goats, and cattle called the humped zebu, which were apparently domesticated in the Indus valley.

The city of Mehrgarh, lying to the West of the Indus river near the Bolan Pass, between ancient India and Afghanistan, was first inhabited from 6,500 BC to 7,000 BC by a largely agrarian people who cultivated barley and cattle.26 The Rig Veda frequently mentions barley and milk cattle, and may have come from this agrarian period that was precursor to the Indus-Saraswati valley civilization.

Yoga in the Ancient Indus Valley

There are still other reasons to think that the ancient city of Mohenjo-daro was home to a civilization that knew the Vedic tradition. One artifact from Mohenjo-daro is a seal with a figure of a seated deity, pictured here in lotus posture:

Mark Kenoyer, the University of Wisconsin anthropologist mentioned earlier, describes this figure as "seated in a yogic posture." Kenoyer characterizes it as a deity with three faces, his feet in a yogic posture extending beyond the throne, with seven bangles on each arm, and a pipili plant adorning his head.

Here is further evidence that the Indus valley civilization was not pre-Vedic. Rather than being overrun by "Indo-Europeans" who composed the Rig Veda, the Indus valley was apparently intimately linked to the Vedic tradition, and its kings practiced yoga. If the practice of yoga was known at the time of Indus valley civilization, yoga must have been practiced in India before 1,900 when the Indus Valley settlements were withered by drought.

If the Indus valley civilizations practiced Sthapatya Veda architecture and Yoga, then the Vedic tradition was well established in India during the Indus valley civilization which flourished, archeologists think, around 2,600 BC. The Indus Valley civilization is thus either contemporaneous with the Vedic tradition, or the Vedic tradition was its predecessor; but in no case was the vast Indus Valley civilization, extending over 2,500 square miles and 1,600 settlements, destroyed by outside invaders. The Indus-Saraswati civilization may have been a successor to, or late remnant of, an earlier Vedic civilization, which built their towns and cities on Sthapatya Vedic principles in the Indus valley and introduced yoga. It was the drying up of the Saraswati in around 1900 BC that ended Indus-Saraswati civilization, not Aryan invaders.

The Devanagri Script: Is the Vedic Tradition Pre-Indus-Valley?

Now we consider the Devanagri script in which Vedic Sanskrit is written. For years after Mohenjo-Daro and other settlements of the Indus valley were excavated, the only evidence of a writing script were a few artifacts that were inscribed with characters that appeared to be pre-Devanagri. Devanagri is the language in which both Vedic and Classical Sanskrit are written, so if the script of the Indus valley was indeed an earlier and more primitive script, as it appears to be, this led many archeologists to speculate that the Vedic tradition belongs to a post-Indus valley civilization and that the period came after the end of the Indus-Saraswati civilization. Thus some scholars felt that the Vedic tradition must belong to a period more recent than 1900 BC, when the peoples of Indus and Saraswati settlements apparently abandoned their homelands and migrated east to the Ganges river valley.

This speculation, it turns out, is completely unfounded. Recent digs in western India have unearthed stone

inscriptions in Devanagri, that date from 3,000 BC. This is an extremely important finding. For one thing, we know that the Vedic tradition began as an oral tradition. Recitation of the Vedic hymns employed, as we mentioned, elaborate methods to perpetuate the oral tradition. The Vedic tradition existed before the advent of a written script, and was passed on in an oral tradition long before the advent of a written script.

The Rig Veda was memorized by heart and recited in teams of two pundits, who sang in unison to preserve its purity, precisely because there was no script in which to write it down and preserve it over time. Preservation depended on memorization and passing it on in a formal method of oral recitation.

Since the oral tradition of recitation was a phenomenon that belonged to the period before the advent of a written script, and, since the Devanagri script existed in the Indu-Saraswati valley by 3,000 BC, this would place the origins of the Vedic tradition long before 3,000 BC. The Vedic literature in its entirety is a body of oral literature, passed on first in recited songs, and only later written down, after the advent of a script. If we take Winternitz's estimated time for the incubation of the Vedic period, which is 1,900 years, this would put the beginnings of the Vedic oral tradition sometime before 4,900 BC.

New Light on the "Cradle of Civilization"

Textbooks on the origins of civilization commonly state, even today, that the "cradle of civilization" was in Mesopotamia, in the flood plane between the Tigris and Euphrates rivers. Mesopotamian artifacts have been dated as far back possibly as 4,500 BC, and Egyptian, Assyrian, and other ancient civilizations extend back possibly as far as the early fourth millennium BC..

The discovery of cities such as Mehrgarh in the Indus valley, which dates from 6,500 to 7,000 BC, puts the Indus valley settlements much further back in time. Exactly how long ago the Rig Vedic tradition began remains unfathomable, but there are far more ancient cities in the Indus-Saraswati valley than have been found in the middle-eastern civilizations of Mesopotamia.

How long ago did urban civilization begin in India? The most reliable answer is that we don't know. More importantly, the Vedic tradition may have begun before the advent of the written languages and the building of brick towns and cities. The appearance of a written script and building of cities may have come after the decline of the oral Vedic tradition. Moreover, there is evidence of a long period of human activity in India long before the earliest appearance of towns in the Indus-Saraswati valley around 7,000 BC

Archeological evidence shows that at 40,000 BC, during the last ice age, groups of hunter-gatherers lived in central India in painted shelters of stacked rocks. There are also sites with rock windbreaks in northern Punjab in India dating from this time. As early as 100,000 BC, there were humans with 20th-century man's brain size (1,450 cc), and as early as 300,000, Homo Sapiens roamed from Africa to Asia. Evidence of human use of fire dates to 360,000 BC. There is also evidence that hominids occupied the Punjab region of northern India as early as 470,000 BC. Stone hand axes and other primitive chopping tools found in northern India have been dated to 500,000 BC. Other stone artifacts found in India have been found dating from two million years ago. Remains of the genius "Homo" were found in Africa that are dated between two and a half to three million years ago.

How far back in time, then, does the Vedic tradition go? The most sure answer is still at this point in time that we

simply do not know. At present there is not enough evidence to determine, except we can venture that it is far more ancient than has been commonly supposed. The Rig Vedic civilization almost certainly dates from long before 3,000 BC, and possibly before 6,000 BC.

However, in dating the Rig Veda, the range of possibilities must not be considered too narrowly. We must not arbitrarily assume that Vedic tradition originated at any given date. Its origins may go back in time tens of thousands of years, or even longer.

Since it is an oral tradition, it left no footprints in stone. What is certain is that the Aryan invasion myths and the dates given by Muller and other nineteenth century scholars came from wild speculations that served nationalist, religious, and racist agendas, not from scientific considerations.

INDIA AND THE WEST

The Flow of Science and Mathematics from India to Arabia and Europe

The European scholars who postulated the Aryan invasion theory were biased, unscientific-and ultimately wrong. The Rig Veda was cognized by a people indigenous to India, probably sometime long before 3,000 BC. So we move on to the next question. How did the Vedic Civilization of India influence the civilizations of the Middle-East, Egypt, and Europe?

Evidence from a variety of sources shows that an influence of Vedic civilization flowed west to the continent of Europe. As we will see, science and mathematics originated in India and came to Greece centuries later. Science and mathematics were probably introduced into Europe and Egypt from India, possibly through Persia, Arabia, and Mesopotamia, although possibly also directly.

Vedic and Indic Influences on Persian and Greek Civilization

The Zend-Avesta of Persia took many names of deities from the Rig Veda, most notably Indra, and included Vedic deities in its pantheon. An archeological excavation in 1907 found clay tablets from early fourteenth century BC in Boghazköi, near the site of the ancient city of Troy on the eastern edge of the Mediterranean, in what is now northwest Turkey. These tablets invoke the names of four Vedic deities-Indra, Mitra, Varuna, and Nasatyau-in sealing a treaty between the Hittites and the Mitani.27 A Vedic influence was definitely in eastern Mediterranean prior to the Trojan war, which occurred about a century later. This site is just up the coast from the Greek city states where the Pre-Socratic philosophers of Greece sprang up about eight hundred years later.

Indications of a Vedic influence in the Zend-Avesta in Persia are found earlier than 1,600 and a Vedic influence was in Greece as early as 1,400 BC. But there is much evidence of a link between the early Greeks and the more ancient Vedic civilization of India, suggesting that Vedic culture flowed west to Persia and Europe. Many of the Greek gods and goddesses are highly similar to those of the and those of Vedic civilization, suggesting a strong historical connection. Both Vedic Indra and the Greek Zeus, called king of the gods, were associated with the unbounded and called by the appellation "Thunderbolt." Saraswati and Athena, female goddesses of sacred wisdom, both had similar roles as representing wisdom and nurturers of the creative arts.28 The Vedic Pushan and Greek Dionysus were both associated with youth, goats, and wine. Pushan was described as "goat-born," Bacchus "half-goat." The tenth Mandala of the Rig Veda relates that the young god Pushan stole the cattle of Indra, herded them backwards into a cave, and hid them somewhere inside in a mountain. Homeric hymns from

the ninth century BC attribute exactly the same feat to the young god Dionysus, who put false feet on the cows, pointed backwards, and then herded them into a mountain cave, so the gods could not find them.

The Katha Upanishad of the Vedic tradition relates a metaphor in which the self is the lord of the chariot, the intellect the charioteer, the body the chariot, the horses, and the senses. "He who has no understanding..." the Upanishad say, "his senses are out of control, as wicked horses are for a charioteer."30 Exactly same metaphor is found in Plato's Phaedrus, which uses the image of a chariot moving through heaven and falling to earth when the self, the charioteer, allows the horses, representing sense and appetite, to get out of control. The Vedic practice of performing sacrificial rites also has echoes in the religious practices of Greece and Israel. In the Odyssey, Odysseus makes sacrificial offerings of a bull to the gods, and in Israel, in the Old Testament, there are many descriptions of burnt offerings of animals to the gods. These practices have their roots in more ancient Vedic rites.

Fragments from Empedocles' book on Purification give the same definition of health that the Charaka Samhita of the Vedic tradition did more than two thousand years earlier. Heraclitus defines "health" as a balance of the fundamental elements (earth, air, fire and water) in all parts of the body, each part having the proper proportion that is right for it. Plato's Timaeus defines health in the same way. This is how it is defined in Charaka Samhita.

Ancient legends in Greece speak of the early Pre-Socratics as traveling to India. Thales, Pythagoras, Empedocles, Democritus, and Plato were all fabled to have made the journey (although the legends are rarely given credibility). Commentators on the early Greeks from around the first and second century passed BC on these legends. While these

journeys may or may not have taken place, it is not unthinkable, for there were well established commercial routes between India and Greece along the Silk Road, protected by Persian king, as well as between ports on the Red Sea that linked Greece with India in a thriving spice trade.

Plotinus in the third century AD set out from Alexandria (a city famed for its esoteric knowledge) on an expedition to India to gain more experiential knowledge of the transcendent. The expedition never completed the journey, so that Plotinus never arrived in India, but Plotinus believed that it was the place to learn about the transcendental unity of Being.

If anything specifically Vedic brought the Greek awakening that occurred in the early sixth century BC, it was not ideas or concepts from India, but the introduction of a technique of transcending to experience pure consciousness. Plato writes about a "fair word" that a physician of Thrace gave to Socrates to enable him to become immortal and gain self-knowledge.

Ancient India: A Lighthouse for Scientific and Mathematical Discovery

India remained a lighthouse for the advance of civilization long after the classical Vedic period. Our modern zero-based number system (the place-value number system) was first developed in India. Called 'Arabic numerals' in the West, they actually originated in India and were passed into Europe through Arabia, whence they derived their name in the West.

In Arabia, mathematics was called the "Indian Art," and the numerals used in Arabia were called "Indian numerals." Arabic scholars knew that mathematics had come into Arabia from India and not vise versa. It was also in India that the

counting numbers were first invented. This inspired Albert Einstein to say, "We owe a lot to the Indians, who taught us how to count, without which no worthwhile scientific discovery could have been made."

The following chart shows the evolution of the numerals from the early Indus-Saraswatic valley script to Devanagri to the Arabic to the present: Evolution of the "numerals" which are mistakenly called "Arabic numerals" in the West. In fact they came into Arabia from India. In ancient Arabic, these numerals were called "Indian numerals" and mathematics was called the "Indian art."

The value of "pi" was first calculated in India by Budhayana (conservative scholars put him at least in the sixth century BC) long before it was known in Europe. Budhayana was also first to introduce a mathematical way to calculate the hypotenuse of a right triangle. The Shulba Sutra (the Budhayana) written prior to the eighth century BC in India, used the theorem about two centuries before it was introduced by Pythagoras into Greece in the sixth century BC. The wording of the theorem in the Shulba Sutras is exact: "The diagonal chord of the rectangle makes both the squares that the horizontal and vertical sides make separately."

Major centers of learning operated in ancient India. The World's first major university and trade school was in Taxila (Takshila) then in northwestern India, around 700 BC (some scholars estimate). It boasted a thousand students from all over the known world who studied 60 disciplines taught there. The University of Nalanda, established in the forth century BC, was also a major center of learning in the ancient world.

The Indian astronomer and mathematician Bhaskaracharya in the 5th century BC (this is an estimated date that may be too recent), calculated the time taken by

the earth to orbit the sun to nine decimal places. Algebra, trigonometry, and calculus were first set forth in ancient India. Aryabhata the Elder (476-550 AD) gave a summary of Indian mathematics that covers astronomy, spherical trigonometry, arithmetic, algebra and plane trigonometry. Aryabhata also gives a formula for finding the areas of a triangle and a circle. His main work, the Aryabhatiya, contains continued fractions, quadratic equations, sums of power series and a table of sines. Aryabhata gave an accurate approximation for "pi" of up to 3.1416 and was one of the first to use algebra.35 His most important achievement was the invention of the "0," which enabled the development of the place number system.

Aryabhata also wrote an text on astronomy, the Siddhanta, which taught that the apparent rotation of the heavens was due to the rotation of the Earth on it axis. Aryabhata gives the radius of the planetary orbits in terms of the radius of the Earth/Sun orbit as essentially their periods of rotation around the Sun. He believed that the Moon and planets shine by reflected sunlight, and he taught, incredible though it may seem, that the orbits of the planets around the sun are ellipses. This was a thousand hundred years before Copernicus and Kepler came up with the same discovery in Europe. He also correctly explained the causes of the eclipses of the Sun and the Moon and calculated the value for the length of the year at 365 days 6 hours 12 minutes 30 seconds. This is a slight overestimate since the true value is less than 365 days 6 hours. His work, written in 121 stanzas, gives a remarkably accurate view of the structure of the solar system.

Brahmagupta (598-670 AD, again an estimated date that may off), head of the astronomical observatory at Ujjain, the foremost mathematical center of ancient India, developed algebraic notation and gave remarkable formulas for finding the area of a cyclic quadrilateral and for the lengths of the

diagonals in terms of the sides. Brahmagupta also studied arithmetic progressions, quadratic equations, theorems on right-angled triangles, surfaces and volumes, and calculated the length of the year at 365 days 6 hours 12 minutes 36 seconds.

Quadratic equations were first discovered by Sridharacharya in the 11th century. Then Bhaskara (1114-1185 AD) reached an understanding of the number systems that solved equations which were not solved in Europe until several centuries later. Like Brahmagupta before him, Baskara was head of the astronomical observatory at Ujjain, where he developed a sophisticated understanding of 0 and the negative numbers. The art of navigation was invented 6,000 years ago by navigators of the Indus river. The English word navigation is derived from the Sanskrit word 'Navgatih' and the word navy from the Sanskrit 'Nou.' The first known reservoirs and dams for irrigation were also built in India.

Ayur-Veda, the earliest known system of medicine and surgery, was developed in the Vedic period in India. Sushrut, the father of surgery, developed surgical procedures including cesareans, cataract removals, setting fractures, removing urinary stones and even plastic and brain surgery. Over 125 surgical tools are named in the ancient Sushrut medical texts. Anesthesia was also well known. Detailed texts on anatomy, physiology, etiology, embryology, digestion, metabolism, genetics, and immunity date from Vedic times.

Sometime around 444 BC, Empedocles introduced a medical system into Greece modeled on the then ancient Ayurvedic system of India. Empedocles' book on Purification gives, as we saw, the same definition of health as the Charaka Samhita. It bears repeating: health is the balance of the fundamental elements (earth, air, fire and water) in all parts of the body, each part having the proper proportion of each that is right for it. Empedocles adopts this definition from

the Vedic tradition. Plato's Timaeus defines health in the same way.

Joseph Needham, the eminent physicist and cultural historian, comments that, "Future research on the history of science and technology in Asia will in fact reveal that the achievements of these peoples [of India] contribute far more in all pre-Renaissance periods to the development of world science than has yet been realized."37 The first pioneer of wireless communication was Jagdeesh Bose-not Marconi as commonly taught in the West.

India's most substantial gift to world civilization was, however, the discovery of pure consciousness and the mapping out of the architectonic structure of pure knowledge. All other achievements derive from this great awakening of knowledge that took place in ancient Vedic India.

SUMMARY AND CONCLUSION

The Vedic heritage of India has been grossly miscalculated, misunderstood, and under-appreciated. The light of Vedic knowledge burned brilliantly in Vedic India long before is spread into Iran, the middle-east, and Europe.

It appears that Rig Vedic civilization originated in northern India, definitely before 1,900, and probably before 3,000 BC. The Vedic tradition may have originated before 6,500 BC. Passed on from father to son in unbroken tradition of pundits who recited the Vedic verses, it is still sung by pundits in India today. Imagine if Homeric bards were found today who could still chant the Iliad and Odyssey according to the oral tradition handed down from Homeric times! This would be heralded as a monumental event. Yet the Vedic tradition was possibly as ancient to Homer when he lived as Homer is to us today.

The Vedic tradition lives in the songs softly chanted by pundits today that may have originated ten thousand or

more year ago, or even further remote in time. The Rig Veda and the Vedic literature were preserved by a tradition of chanting, with self-correcting feedback methods, always involving two pundits reciting the verses together. Other methods of self-correction were used, so the authenticity of the tradition is well preserved. The written Veda did not emerge until the Devanagri script was invented, and that was post-Indus-Saraswati civilization.

The Vedic civilization, far more ancient than the Greek, spread from India to Europe, via Anatolia, Thrace, and Greece, and from there into Western Europe. The direction of the flow was from India into Arabia and then to Europe. Evidence shows that the Vedic tradition entered into Europe sometime before the early fourteenth century BC. The Rig Vedic tradition and its literature almost certainly came into existence sometime long before the earliest civilizations of Mesopotamia, Sumeria, and Egypt. These were relatively late events in the history of civilization and probably owe their existence to the earlier civilization of Vedic India.

It is necessary to reiterate that the origins of the Vedic tradition are still obscured in the fog of time, but it is necessary to shift it much further back than Muller's contingent of scholars put it. A more balanced view of the Vedic tradition might place it as follows:

1. Before 6,500 to around 3,000 BC-early Rig Veda to Itihasa period38
2. 2600-1900 BC, Mature Harappa civilization
3. 1900-1000 BC, late Vedic and Brahmana period
4. 500 BC, Shankara's revival

Because we don't know yet how ancient the earliest verses of the Rig Veda are, we have to abstain from any dogmatic pronouncements, but we have seen reason to think that they are far more ancient than Europeans scholars

previously estimated. The ancient Vedic tradition was indigenous to the land of India, possibly overlapping the Indus and Saraswati valley civilizations and extending into the Himalayas, where the tradition continued unbroken for perhaps tens of thousands of years.

The Rig Veda extols the Indus rivers in the oft repeated refrain, "Flow Indus to Indra"-a metaphor for the flow of individual awareness into unbounded universal awareness. The whole tradition, as we see in the following chapters, is about the experience of awakened consciousness, or enlightenment.

The refrain, "flow Indus to Indra" is also a reference to the Indus civilization that lived along the banks of the Indus river since 6,500 BC. It was this awakening of consciousness that cradled the ancient Vedic civilization of Vedic India-long before civilization emerged in Europe. As the river of civilization flowed from India westward, one of its main tributaries was the civilization of ancient Greece and Asia Minor. Greek civilization possibly resulted from the spread of techniques that passed on the enlightenment tradition from India into the Eastern Mediterranean basin. The Vedic tradition gives a much deeper meaning to the word "tradition" than has been known before. Nothing in the West approximates it. For thousands of years, the Vedic tradition expanded, and grew richer in detail, commenting on itself and expanding by knowledge of itself. Each contributor built on what the previous had done, cumulating in a systematic exposition of the structure of pure consciousness.

Techniques to gain enlightenment were developed, cultivated, and passed on generation after generation. The techniques sustained the tradition and gave it substance through making the experience available.

Vedic civilization centered around the discovery of pure consciousness and the delineation of its structure. The

Rig Veda and the Vedic literature gave a monumental depiction of this structure of eternal consciousness. These remarkable works give a complete science of the structure of pure knowledge that exists within the self of everyone. It was from this cognition of the structure of Veda and the Vedic literature that the civilization was born.

In the West, by comparison, there was no sustained theme of enlightenment remotely comparable to the Vedic tradition. There was no sustained tradition of knowledge based on the experience of consciousness. The early history of western Europe, including the glory of ancient Greece, are sparks, brilliant though they be, from the great fire of knowledge of Vedic India.

WHAT IS THE VEDA AND THE VEDIC LITERATURE?

The next question is, what is the Veda and the Vedic tradition? Since the Veda and the Vedic tradition have extremely ancient roots going back at least to the third millennium BC and probably much further, we now want to ask, what is this Rig Veda and the Vedic literature? What is the Vedic tradition really about? It is as if we have been on an archeological dig on an ancient site in the Indus valley and we find a treasure room of vast extent, filled with books that are about an ancient science. As we decipher these ancient codes, we discover an ancient body of knowledge more advanced than any science known today. This is the excitement of the rediscovery of the Veda.

If the European scholars got the dates of the Vedic tradition and the invasion theory entirely wrong, neither did they understand anything of what was going on in the Vedic tradition. Again, we cannot expect that they can give an penetrating answers to the question of what the Veda is. The answer must come from those who know the Veda from direct experience.

The Veda itself is said to be knowledge. Veda means knowledge. It refers to the kind of knowledge that comes from transcending activity to experience the knowledge structured within the inner silence of consciousness itself. Veda is the self-knowledge consciousness of itself, consciousness knowing its own nature. This knowledge exists deep within everyone, deep within our own consciousness, but we are out of touch with it because we have lost the ancient knowledge of how to go within. By diving deep within the self, and beyond our own individual consciousness, to the universal allpervading consciousness, when consciousness is still and deeply silent, we too can experience the Veda. It is this experience from which all Vedic knowledge comes. On the basis of this experience, we can know the structure of the Veda that exists eternally in consciousness.

The Veda is the expression of the knowledge gained during transcending, or going beyond active mind and finite mind, to experience the infinite consciousness that lies at the basis of all created things. This experience gives knowledge of the eternal consciousness that pervades all creation. It is not localized to individual awareness. It is universal all-pervading consciousness. Anyone can gain access to this consciousness by transcending activity to experience the infinite, unbounded silence at the basis of creation.

The infinite silence is not seen, as one sees an object separate from the self. Infinite silence is what the seer becomes when he or she is deeply silent. The Vedic seers discovered that when the mind is deeply silent and still, it expands from individual mind to infinite mind. One becomes infinite mind and the structure of this infinite mind is what one experiences when one sees the Veda.

The greatest Vedic scholar and seer of all ages is undoubtedly Maharishi Mahesh Yogi. Maharishi is a great genius who has brought to light the deeper meaning of the

Veda on the basis of the direct experience of the Veda itself. Since the Veda is structured in consciousness, the consciousness which is not individual but universal and all-pervading, it exists within everyone. Every individual consciousness grows out of the vast ocean of universal consciousness which is the Veda. By diving within our individual consciousness, and beyond, to the infinite sea of universal consciousness, we can experience the eternal, all-pervading sea of consciousness and its self-interacting dynamics by which the world is created within the eternal sea of consciousness. This is to witness the mechanics of creation. Veda is this mechanics of creation.

The Vedic tradition grew out of a discovery of a way to go within consciousness and directly experience the Veda which exists deep within consciousness. It is only through this experience that there can be genuine knowledge of the Veda at all. It is for this reason that Maharishi brought out a technique to directly experience the silent level of consciousness within everyone. This technique makes the eternal Veda accessible to everyone on the basis of personal experience.

It is the foundation of the knowledge of the Veda. The name of the techniques is the Transcendental Meditation technique. It is the method that opens the direct experience of universal consciousness and the Veda to anyone. It is thus the method of knowledge that makes universal knowledge of the eternal field of pure consciousness accessible to everyone. It is the method of exploration of consciousness by which anyone can gain access to the silent, unconditioned, universal consciousness that underlies and pervades all manifest objects in the physical world.

Thus, the only solid foundation for knowledge and understanding the Veda is the exploration of the fundamental level of inner silence, the inner silence of pure consciousness

itself, where the Veda is structured. Only through experience of this level of reality-the silent foundation of universal consciousness-can anyone be prepared to know and understand the Veda. The Veda is the reality of consciousness and the knowledge of consciousness that is accessible through this experience; the Vedic tradition is the tradition that carries that knowledge over time; and Vedic civilization is the civilization that was built on this knowledge that existed in India at least three thousand years and probably more before the Christian era began.

As we will see, the Rig Veda and the Vedic literature are a systematic expression of consciousness and the knowledge of consciousness. The Veda tells us something about our own consciousness, about our human potential to be in and to experience a universal field of consciousness that underlies all created things. The essential meaning of the Veda escaped Western scholars for two centuries, but we now are rediscovering its meaning and coming to directly experience and know the Veda through direct experience through the guidance of Maharishi. This method brings knowledge more advanced than any other approach available in the world today, and as we will see, it has practical applications far greater than any other method of knowledge. In this and the following chapters, we will see that the Veda is a lasting expression of deep knowledge that has survived over many thousands of years in virtually perfect condition, and that it holds the secret to unlocking new knowledge and a new approach to knowledge that will enhance our own civilization more than any other discovery in history.

WHAT IS VEDIC COGNITION AND HOW IS IT PASSED ON?

The Rig Veda was not "created" out the human imagination, as works of poetry or literature are created. Unlike poetry or literature, the Veda is experienced and

then the experience of the Veda is recited in hymns that directly express the experience of the Veda. This is called Vedic cognition.

Cognition means that the Vedic rishis or seers heard what is there in the universal field of consciousness and they sang out the sounds that they heard. They were not making up poems, hymns, theories, or world-views, but they heard the sounds in the field of pure consciousness and saw the flow pure knowledge within it. Their experience came from being established in the deepest level of the mind. This experience is what the recited sounds of the Veda express. But the hymns of the Rig Veda are not about the Veda, as if the expression were something different from the Veda itself, which they were describing.

The rishis heard the Veda and saw its structure, and this sound itself is expressed in the hymns of the Rig Veda. The experience of the Rig Veda flowed through the rishis into the hymns of the Rig Veda. The hymns of the Rig Veda sought out those rishis who were fully awake and made themselves known to them, and the rishis passed on these hymns in a long unbroken tradition that endures to the present.

The Rig Veda, the most ancient hymns of the Vedic tradition, has been preserved over time by a method of memorization and recitation passed these hymns on from father to son in an unbroken sequence over vast stretches of time. By two pundits chanting the hymns (and by chanting them forwards and backwards) a method of ensuring their purity was established that allowed these hymns to be passed on over thousands of years without loss. The Veda we possess today, unbelievable as it may seem, is thus an expression of the sounds heard many thousands of years ago. It was only in relatively recent times, probably around 3000 BC, that the Veda and Vedic literature, were committed to writing. Before that Veda was an oral tradition.

The Vastness of the Veda and the Vedic Literature

Maharishi identifies 40 distinct branches of the Veda and the Vedic literature. These forty branches include, first and foremost, the Rig Veda samhita, and of equal importance, the Sama Veda, Yajur Veda, and Atharva Veda. These four bodies of sound are what is meant by the Veda.

In addition to the Veda, the Vedic literature includes 36 branches, all based on the Veda itself. These include the six branches of Vedanga, six branches of Upanga, and six branches of Ayur-Veda, for example. All branches of Vedic literature are considered, like the Veda itself, uncreated or eternal structures of knowledge.

The extent of the Veda and the entire Vedic literature is vast, huge-much larger, for example, than the remaining body of literature of all of ancient Greece and Rome. There are ten volumes of the Rig Veda alone in one of the best editions available in English (the Wilson translation). There are 54 books of Kalpa, just one of six branches of the Vedangas. There are 18 books of Puranas.

The Itihasa includes the Ramayana and the Mahabharata, the later of which is printed in an English edition which has 20 volumes. There are thus, for example, over a hundred volumes in just these four branches of the Veda and the Vedic literature.

Maharishi sees this vast body of the Veda and the Vedic literature as a systematic body of literature that has a detailed, intricate structure in every part, and all systematically related in a whole. It is systematic in the sense that is not a random collection of books that were written over vast stretches of time, but it forms a complete whole, with a comprehensive organization and structure. Each of the books of Vedic literature relates in a systematic way to all the others and each forms an essential part of the whole of Vedic literature.

Where is the Veda and How is it Known?

The Veda is expressed in sounds that are recited and heard, but the Veda itself exists in the unmanifest field of unbounded pure consciousness, called parame vyoman. This is a universal silent field of consciousness that pervades everything in the universe.

Since it is all-pervading, it pervades the body and mind of every individual. It exists on the most subtle, or fine scale, of activity. It is smaller than the smallest particle of the atomic nucleus. It is on a scale smaller than the smallest quark and lepton. It is the field of consciousness in its least excited state.

Everything in nature is an excitation of this field. All particles of matter and force are excited states of this one all-pervading field. To know the Veda, which is everywhere at the most subtle foundation of the world, we have only to take our awareness from the excited states of consciousness to the least excited state of consciousness.

By taking our awareness from the active, gross level of activity to the silent field of pure consciousness, we allow our individual mind to become settled and stilled and in that state of wakeful silence, and in that state, the mind spreads out to identify with the all-pervading field of consciousness. On that level of awareness, the entire Veda and Vedic literature can be directly experienced as the fabrics of our own consciousness.

We simply dive from the surface level of activity to the silent all-pervading depth where consciousness is eternally awake within itself. On that level of all-pervading nature, consciousness is eternally interacting within itself. This self-interaction of consciousness as its flows from unity into diversity is the Veda. It is the eternal reality at the foundation of everything that exists in the observable manifest world.

STRUCTURE OF THE VEDA

The Veda has a structure. It is structured in the form of mandalas, or circles. The structure of the Veda and the Vedic literature is a flow of knowledge, not a static, frozen structure. As the eternal consciousness flowing within itself and knowing itself, it flow, and creates within itself a structure that is dynamic and flowing. This flowing structure of Veda is an eternal flow of pure knowledge of the self as it unfolds knowledge of itself. It is the flow of consciousness as it knows itself and flows from unity to diversity. It is the flow of self-knowledge within consciousness, giving rise to the entire diversity of creation. It is the flow of the oneness of eternal pure consciousness into the many formed unity of the Veda, and from there to the forms and phenomena of the manifest universe, the visible material world.

The first flow of knowledge of the Veda is the flow from the One into the many. The eternal oneness of pure Being or pure consciousness knows itself. And in knowing itself, it breaks itself into many. The infinite One collapses into a point, and into infinitely many points. These points of consciousness are finite, separate, isolated points of individual consciousness. But they are all ultimately points of the one infinite whole of consciousness. Each is a collapsed point of the infinite whole, and in the process of returning to wholeness, the finite points of consciousness expand back into the infinite One from which they began. This is the fundamental process of creation that is expressed in the Rig Veda and in the Vedic literature.

The Rig Veda expresses this process in sound. The Rig Veda is essentially this sequence of vibrations that manifest as the process of consciousness knowing itself. It unfolds out of the process of consciousness knowing itself. This entire process is a necessary sequence of sounds that unfold the pure knowledge of consciousness to itself. It is the eternal murmuring of consciousness to itself.

The Rig Veda does not describe the process in articulate language, using descriptive terms, the way a scientist might describe an object of nature. The vibrations of consciousness as it moves within itself create unmanifest sounds in the unmanifest field of pure consciousness, which manifest as the sound of the Veda, and these sounds within the infinite field of pure consciousness become the vibrations that manifest in the forms and phenomena of physical creation.

COLLAPSE OF INFINITY TO A POINT: THE APAURUSHEYA BHASHYA STRUCTURE OF THE VEDA

The basic process of consciousness knowing itself takes the form of a collapse of the infinite whole of pure consciousness into infinitely many finite points of consciousness. This process of infinity collapsing to a point, and the points expanding into infinity, is the basic process that structures the Veda. It is the process by which the eternal Oneness of pure consciousness knows itself. Infinite wholeness collapses to a point and the point expands to infinity. Out of this process all creation comes.

Maharishi has discovered that this process and its structure is expressed in the first syllable of the Rig Veda, in the first line, in the first verse, and in the first mandala, each expression being a more elaborate commentary on the collapse of infinity than the previous. This structure Maharishi calls the Aparasheya Bhasha structure of the Rig Veda. Maharishi was the first to discover and bring it to light.

Maharishi discovered that the Rig Veda has a marvelous structure in which each of the parts reflects the structure of the whole. Thus, for example, the First Mandala of the Rig Veda, which gives the meaning of the Veda as a whole, has 192 suktas. The Tenth Mandala has the same number of suktas, mirroring the gaps between the suktas of the First Mandala. This is not an accidental structural parallel, but

an indication of the intricately interlocked structure of the Veda as a whole. This kind of structural identity is reiterated in many places throughout Vedic literature.

Maharishi sees the first syllable of the Rig Veda, Ak,40 as containing the whole Rig Veda within itself. It represents the collapse of the continuum of flow of infinite wholeness to its own point. The "A" sound represents flow or continuum, and the "k" sound represents the stop, or collapse of the flow. This sound is actually the process of the infinite whole of consciousness collapsing to its point values.

This first syllable of the Rig Veda is elaborated and commented on in the first 24 richas (verses), which are further elaborated in the corresponding 24 padas (phrases) of the next eight richas, giving 192 of the meaning of the syllable Ak. These all emerge from the 24 sandhi (gaps) of the first richa. From the 192 gaps between the 192 akshara (syllables) of richa 2-9, emerge the 192 suktas of the First Mandala of the Rig Veda. The 192 sandhi between the 192 suktas of the first Mandala give rise to the 192 suktas of the Tenth Mandala, a circular structure that precisely fills the gaps of the First Mandala. Similarly, the gaps between the nine richas of the first sukta are elaborated in Mandala 2-9 of Rig Veda, unfolding the total Rig Veda with all its ten Mandalas.41 The whole of the Rig Veda has a marvelous and intricately interwoven structure that is beyond the capacity of the human mind to create. It was not created, but cognized by the seers of ancient India. This is part of the reason that Maharishi recognizes the tradition that the Veda and the Vedic literature "eternal" or uncreated.

THE THREE-IN-ONE STRUCTURE OF PURE KNOWLEDGE

There is one other structure of the Veda that is basic to understanding the Veda. In the process of knowing itself, the

infinite pure consciousness, which is eternal knows itself. In knowing itself, pure consciousness creates a division within itself of knower, known, and process of knowing. This is necessary for it to know itself. It is both eternally one, and yet it is eternally three-knower, knowing, and known-making a three-in-one structure of self-knowing consciousness.

This is another fundamental feature of pure consciousness that it is both eternally one and eternally many. From the threefold structure of knower, known, and process of knowing, consciousness continues to reflect on itself, giving rise to many more reiterations of itself, until the one has evolved into the diversity of the entire Veda. This threefold structure of pure knowledge, that it is one and three at the same time, Maharishi calls the three-in-one structure of pure knowledge. It is expressed in the Veda in the terms rishi (knower), devata (process of knowing) and chhandas (known). Every sukta of the Rig Veda has a structure of rishi, devata, and chhandas, which is announced at the beginning of the hymn. There are infinitely many values of rishi, infinitely many values of devata, and infinitely many values of chhandas. These provide the basic key to understanding the structure of the Rig Veda, as well as Sama, Atharva, and Yajur Veda.

Not only the Veda but all of Vedic literature reflects this structure of knower, knowing, and known. Each branch of the Vedic literature flows out of the mechanics of self-knowing consciousness. The Vedic literature, with its six-fold organization, reflects the process of movement from rishi, to devata, to chhandas, and from chhandas back to devata and rishi. This process is the basic process that structures the entire Rig Veda and the entire Vedic literature. It is the process of self-knowing consciousness. In the following chapters, we will rediscover the structure of the entire Veda and Vedic literature. This is an immense voyage of discovery into a new world of knowledge that has been lost for thousands of years. It is a journey into the fabric of our own

consciousness. It is regaining lost knowledge of our own infinite Self.

SCIENCE THROUGH THE AGES

Science as something existing and complete is the most objective thing known to man. But science in the making, science as an end to be pursued, is a subjective and psychologically conditioned as any other branch of human endeavour-so much so, that the question 'what is the purpose and meaning of science?' receives quite different answers at different times and from different sorts of people.

The scope and ambit of scientific knowledge has undergone sea changes since the colonial era. This is mainly due to the influence of the East India Company during that period. Today how we do perceive science or scientific knowledge was not there in days of yore. Then, what is "science" all about? In the broadest sense of the term, "science" refers to any organized knowledge, especially when obtained by observation and testing of facts, about the physical world, natural laws and society; and it is a study leading to such knowledge (Hornby, 1994, p. 1130).

However, scientific endeavour does not cease here. It goes to a much deeper level of scientific enquiry and scientific analysis, and, thus, it has earned a special niche in the society. Scientific endeavour has touched the zenith in the human society, to a great extent. Thus, both society and science are interrelated. As Marx famously put it, "Science is a social creation". We live in a world of unprecedented opulence, of a kind that would have been hard even to imagine a century or two ago. There have also been remarkable changes beyond a uni-polar worldview of scientific enquiry. In order to have a better understanding of this radical transformation of science and technology, we need to divide it within the purview of the issues and perspectives

involved, the science and technology status on the eve of the conquest, problems relating to technological adaptations, the growth of scientific institutions and the different shades of Indian response to the introduction of modern science or scientific knowledge.

The present piece, however, aims to explore the nature of the reception by the Indian intelligentsia of the scientific ideas and technological practices in the context of the inherited socio-cultural milieu that originated in the modern West. Further, the purpose is to study the incorporation of the modern scientific and technological ethos in the theoretical frame of nation building as envisaged during and after the freedom movement.

Particular attention should be paid to the formulation and implementation of science policy and their consequences for building scientific organizations. Emphasis must be laid on the critical debates that reflected the different perspectives and visions on the interface between science and technology on the one hand, and the nation-both as a cultural and political category on the other.

The social context of the origins and development of science and technology from antiquity through colonialism to the modern period needs to be analyzed. The two-way interaction between science and society has to be focused or understood. That is, how specific social and cultural factors led to the emergence of specific scientific and technological knowledge systems and institutions that transformed the very social conditions that produced them. The role of pre-colonial trading circuits and other institutional factors in transmitting scientific and technological knowledge from India to other civilizational complexes should be analyzed and explained emphatically. The role of modern science and technology should be emphasized in the consolidation of the British Empire in India.

The phrase, "science" in a colonial context, refers to a pursuit that necessarily involves emphasis on exploratory activities (e.g., flora, fauna, topography, minerals, etc.) and the introduction of new techniques. Both were encouraged with an eye to economic gain. Basic research was simply not on its agenda. A. Rahman stressed the need to assess the nature of processes and impacts unleashed during colonial rule for the proper understanding of the present state of affairs in India. He is of the opinion that the problem has many dimensions and each requires to be identified and examined objectively. Almost all scientific activities in British India began under the aegis of the British Army. This raises an important question. The question is: Is bureaucratization of science in contrast to science being a social and economic movement in Europe, part of the legacy of these early movements? The medical and engineering corps were part of the army, so were the surveys, which were carried out by army personnel or under their guidance. The impact of this feature on organization, institution building and the tradition that was developed, requires to be studied.

The second dimension of the activities of the British would be evident from the study of the Asiatic society, which was established in the 18th century. To begin with, it undertook to carry out translations of Sanskrit, Arabic and Persian scientific and technical texts into English. The policy was, however, changed a few years later, where by and large, religious, philosophical and other texts came to be translated. It would be interesting to study this shift in the wake of growing British power in India and the political policies being evolved as a result of the latter.

The third dimension of the British impact is evident from the reactions of Indians who came into contact with the British and the knowledge they began to acquire from them. The establishment of Scientific societies, Translation societies, Native Masters Associations and other such organizations

and their activities indicates this. These aimed at dissemination of newer information and knowledge. The origin as well as the impact of these societies has yet to be studied. There is considerable evidence in a number of areas of the desire to know and acquire new knowledge as well as technology. There is also considerable evidence that the new science and technology was opposed vigorously. Science and technology, Christianity, economic exploitation and European conquerors were put into one package and the whole package was rejected by those who aimed to fight foreign domination. Consequently, a large number of institutions were established which were supposed to continue the tradition of classical medieval education and technological traditions in contrast to those that were established by the British. This division of society between those who accepted European domination, cultural and social modes, and systems of education and those who opposed them and aimed at the continuation of technical systems require to be studied in depth, as it has considerable import for the evolution of the contemporary ethos of the society.

Taking a step forward, Deepak Kumar tried to locate a plausible meaning of the term, "colonial science" amidst the vast data of India's colonial experiences. Colonial science is a dependent science wherein the result-oriented research in applied science supersedes the curiosity-oriented research of pure science. George Basalla calls it, maybe euphemistically, the spread of Western science to the non-Western world, and tries to explain the phenomenon with the help of a triangular model. During phase I, the non-scientific society provides a source for European science. Phase II is marked by a period of colonial science, and phase III completes the process of transplantation with a struggle to achieve an independent scientific tradition or culture. Basalla, however, cautions against the use of colonial science as a pejorative term, implying the existence of some sort of scientific imperialism

whereby science in the non-European nation is suppressed or maintained in a servile state by the imperial power.

MacLeod disagrees with him, but warns against confusing social science, with its sense of structures, institutions, precepts and boundaries with scientific colonialism, a term, which implies a process, even a deliberate policy, with objectives, and means to achieve those objectives. He makes a further distinction between metropolitan science and colonial science. Metropolitan science was not only the science of Edinburgh or London, Paris or Berlin but also a way of doing science, based on learned societies, small groups of cultivators, certain conventions and certain priorities. Colonial science, on the other hand, was, by definition, practised in the non-European hemisphere. It was imperial science seen from below. It meant "derivative" science, done by lesser minds working on problems set by savants in Europe, and was, in the eyes of the metropolis some sort of a low science, identified only with fact gathering. In sum, what was the precise nature of scientific activities in colonial India, its purpose, successes, limitations, etc.? Examples drawn from the Geological Survey of India point to the economic "taproot" of imperialism.

In "Science and the Colonial Empire, 1895-1940", Michael Worboys denies that science was ever organized or practised on an empire-wide basis. Truly, there was no Imperial Science. At best, it found echoes only in rhetoric. Its implementation was neither possible nor perhaps desirable. But, in the colonies, administration was more centralized and here Worboys finds the "actual expression" of the two important characteristics of modern science-utility and universalism. Utility involves the questions of scientific knowledge in the context of colonial development. Only selective experiments were undertaken and they invariably carried the prefix tropical. Tropical disciplines, whether medical or agricultural, were metropolitan constructions and their content and

approach were determined by metropolitan interests. He cites examples from the attitude and policy of the Colonial Office and other metropolitan instructions in relation to the colonies in Africa. On the other hand, universalism refers to the politics of colonial science. In this respect, science in the colonies, Worboys argues, both reinforced and mirrored the basic contradiction of the so-called dual-mandate, i.e., the attempt to produce economic and technical change without any socio-political transformation.

The next part deals with the state of affairs on the eve of the conquest. The period is slippery and the vision tends to get blurred. In this context, Satpal Sangwan, in "Why did the Scientific Revolution not take place in India?" asks the very disconcerting question: Why did the scientific revolution not take place in India or in any other Asiatic country like China? The question assumes greater significance when one considers the fact that in the field of science and technology, knowledge and thought, the Asians were on the aggressive down to the time of Newton's Principia.

But, the phenomenal development of science and technology in the 17th and 18th centuries in the West changed the whole course of human history. It made Europe both a source of new knowledge and centre of global power. What impeded a possible scientific breakthrough in India during this period is the main focus of Sangwan's query.

The scientific revolution became a subject of study in Europe ever since its inception. However, Sangwan is of the opinion that before delving into the socio-economic and politico-commercial limitations of Indian society, which discouraged a scientific breakthrough, it is important to understand the ideological aspect of Indian science and scientific thinking. By the 17th century, Indian science was reduced to a tradition of the distant past, revolving around the classical trio of mathematics, astronomy and medicine,

depending upon age-old theories. A spirit of enquiry does not seem to have inspired the Indian intelligentsia to challenge established theories. The ideological climate and prevailing system of beliefs seem to have discouraged scientific investigation in India. Modern science is essentially an elite phenomenon to which professional education contributes to a great extent. The founding of universities in Western Europe during the 17th century not only generated new ideas but also helped in preparing a new generation of professional academicians who remodeled the structure of science and scientific thinking. The system of education in India was, however, hardly conducive to any scientific revolution. It was defective on account of its nature, scope and organization. Another factor, which impeded a scientific breakthrough in India, is that Indian science was individualistic rather than institutionalized. There was no internal organization in science.

The origin and development of science and technology is a subtle and complex phenomenon. It involves various factors, viz., the empirical, philosophical, cultural, social, economic and political. It goes through many stages under different circumstances and reflects different shades of a particular phenomenon. One common consequence of such "why not" questions is the need to study the nature and scope of the existing scientific knowledge within the framework of socio-economic and cultural conditions. Hence, to answer such a challenging question, one must use the techniques and knowledge of a scientist, a philosopher, an economist, a sociologist and a historian. But, most Indian historians are not science-oriented, nor are the scientists of India history-oriented. Both categories are unable to appreciate their relationship and mutual obligations. Not only socio-economic and politico-commercial limitations of Indian society which discouraged a scientific breakthrough, but it is also important to understand the ideological aspect of Indian science and

scientific thinking. Only then can one sketch an explanatory model to tackle the above question.

However, the most important aspect of the present theme lies in the response of the Indian intelligentsia to the new scientific and technological activities. Not much work has been done on the scientific ideas between different cultures. Kapil Raj, in his "Knowledge, Power and Modern Science: The Brahmins Strike Back", tries to illustrate how knowledge conceived of within the epistemological framework of one culture is received, adapted and absorbed by another culture. Raj is taking the Brahmins as the Indian elite. He emphasizes the way the Indian elite, the Brahmins for example, perceive modern science needs to be explored. Raj conjectures or hypothesizes that perhaps the Brahmins found in it an image of their own self, an image of what they stood for, i.e., clean knowledge. In as much as it was the monopoly of the elites, this knowledge came to play a triple role:

- It downgraded popular knowledge;
- It legitimated the socio-economic-political-cultural system within which it developed;
- Through the first two roles, it consolidated the position of the Brahmins themselves.

The ability to behave appropriately in social situations (practical savoir faire) was looked down and so was popular knowledge. Brahminical knowledge was prejudiced as "clean" and was equated with power. This knowledge-power equation was gradually sidelined by the Islamic rulers. Under the British rule, the new elite, viz., the Brahmin, the Baidya and the Kayastha, sought to restore the power of the Brahmins by replacing classical knowledge and the traditional practices of knowledge within modern Western ideas and Western science. But, while the old Hindu knowledge was "clean", Western science gave equal importance to experimentation and soiling of hands. The Indian elite would not accept the

latter. And, for this, Raj argues that it is only because of India's particular epistemological tradition that the Indian elite has been unable to cope with such modern science.

Meanwhile, the British also believed that Indians lacked an aptitude for techno-scientific training. But, that is not the question. The questions are: Was it a myth deliberately projected so that the Indians could be excluded from enjoying such education? How did they react and how the demand grew for technical and science education? In this context, Aparna Basu, in her "The Indian Response to Scientific and Technical Education in the Colonial Era, 1820-1920", provides a broad survey. Science education had no place in the Macaulayan scheme. Later on, a few professional colleges were opened mainly to train for sub-ordinate posts like assistant surgeons, overseers, etc. Indians make a success of whatever little opportunities were given to them. But, they had to contend with a foreign medium of instruction, shortage of funds, and racial prejudices. By the turn of the 20th century demand for more technical education reached the pinnacle of science and technology. It soon became a major plank of the national movement, and later the British Raj had to recognize that India must become self-reliant scientifically and industrially.

The search for a separate Indian identity had begun long ago. The stirrings one can notice in 1860s and 1870s or even earlier. In "Promoting Science and Its World-view in the Mid-Nineteenth Century India", S. Irfan Habib writes about three totally indigenous scientific bodies, which tried to popularize science through Urdu, viz., the Aligarh Scientific Society, the Bihar Scientific Society and the Delhi College. Habib is of the opinion that modern scientific ideas and techniques came to India in the wake of British conquest, but they faced three major limitations. First, the scale of implantation and the degree to utilization was limited to suit the policies of the rulers. Secondly, the teachings of science

were introduced merely to provide training in various branches rather than creating an appreciation of science as a tool of intellectual and social transformation. Thirdly, science was introduced in English. Consequently, instead of playing the role it did in Europe, it became isolated. It did not react with different strata of society, but leaned heavily for its growth on the government and became an intrinsic part of the policies of the rulers. Yet, there was a section of the Indian intelligentsia, which believed that the basis of British civilization represented a new approach to life, and that therein lay the hope for the future emancipation of India.

Chittabrata Palit writes on Mahendra Lal Sircar who virtually personifies the herald of what one may call National Science. The Aligarh and Bihar Scientific Societies were formed in the late 1860s. Sircar started the Indian Association for Cultivation of Science in 1876, and it was no mere coincidence that the Indian National Congress (INC) was born in the year 1885. A section of the Indian intelligentsia had immense appreciation for modern science and technology. Habib argues that the Delhi College, for example, achieved something qualitatively different from the contemporary "Calcutta Renaissance". The students here showed a clear inclination towards scientific rather than literary education. Scientific societies were established at Aligarh and Muzaffarpur by Syed Ahmed Khan and Imdad Ali respectively.

The aim was how to obtain wide diffusion of knowledge, and the main emphasis was on bringing the Western arts and sciences within the reach of high and low through translations in the local medium of Urdu. In the absence of relevant data, Habib finds it difficult to measure with any amount of accuracy the contribution of these Societies, but there is no doubt that these were pioneering attempts. Both the Societies were short-lived, only Sircar's Indian Association

for the Cultivation of Science could manage to survive. Sircar was a man of unusual drive and determination.

In the August 1869, issue of the Calcutta Journal of Medicine, Sircar wrote an article entitled, "On the desirability of a national institution for the cultivation of science by the natives of science in India". He wrote, "We want an institution, which will combine the character, the scope and objects of the Royal Institute of London and of the British Association for the Advancement of Science. We want an institution, which shall be for the institution of the masses... And we wish that the institution be entirely under native management and control." Sircar felt that the underdevelopment of India was due to its backwardness in science. Indians had the potential to master modern science; they had shown themselves Master of Science in the past. This could be achieved through self-help. He desired that Indians should cultivate science not only for "economic betterment but also for their regeneration". The Association, as visualized by him, was an institution for the masses with full "audience" participation, where one lover of science could come and work the way it was felt necessary by the scientist. Being a national association created entirely by private donation, the Association would have no government control. But, it met with some resistance. The Hindu orthodoxy thought that the Association was attacking the traditional Hindu teachings, whereas a large section of the public felt that this kind of pursuit of abstract science had not meaning for a poor country like India. The cry of the day was Utilitarian Science, but Sircar's answer was: without scientists how can one have science?

Technological adaptations both during and after the freedom movement have to be understood from a critical perspective. More importantly, one has to look at the response of the local people to the new scientific and technological activities. Not much work has been done on the transmission

of scientific ideas between different cultures. One has to understand and illustrate how knowledge conceived within the epistemological framework of one culture is received, adapted and absorbed by another culture. For the Indian elite, science was experimental only in theory. The theoretical bias still continues. This is because of India's particular epistemological tradition.

The British also believed that the Indians lacked an aptitude for techno-scientific training. Was it a myth deliberately projected so that the Indians could be denied such education? How did they react and how the demand grew for technical and science education? Science education had no place in the Macaulayan scheme. Later, a few professional colleges were opened mainly to train for subordinate posts like assistant surgeons, overseers, etc. Indians made a success of whatever little opportunities were given to them. But, they had to contend with a foreign medium of instruction, shortage of funds, and racial prejudices. At the beginning of the 20th century, demand for more technical education reached a new height. It soon became a major plank of the national movement, and later the British Government had to recognize that India must become more self-reliant scientifically and industrially.

In this manner, science has been shaped since the colonial period. Down from Raja Rammohun Roy, science education has been encouraged in our country. Rabindranath Tagore advocated for the spread of scientific education in India. Meghnad Shah and Homi Bhabha also took scientific enquiry to a special niche. Influenced by the scientific achievements of the then USSR, Jawaharlal Nehru, the first Prime Minister of free India, talked of scientific temper. He tried to shape India by a scientific and technological fashion. Of course, the science C. V. Raman talked of was quite nationalistic. But, these should be judged or evaluated in terms of their political affiliations or political allies. Nevertheless, the spread of

science education has been confronted with umpteen numbers of hurdles even today. As such, we have to look at how Indian scientists respond to the introduction and application of modern science in the Indian context. In this process, the views and perspectives of Indian scientists, their political allies, Science Policy Resolutions since 1958, and ultimately, a critique to modern science should be looked at from a critical perspective.

A LITTLE INDIAN SWAMI

On Space Flight and Spiritual Knowledge

His Divine Grace A. C. Bhaktivedanta Swami Prabhupada (1980) founded the International Society for Krishna Consciousness in America, and represents the ancient mystical tradition of the Vedic teachings of India. The title Swami means "who is one with Self." In a conversation with a modern physicist, Dr. Gregory Benford, the Swami argues that scientists should study the natural laws in order to prove that there is God. The Swami goes on to make the most amazing claims concerning the nature of human consciousness and the possibilities for human experience:

Swami:... Now, you are a scientist-physicist or chemist?Scientist: Physical.Swami: So, by your study of physical laws, if you try to prove there is God, that is your success.Scientist: It can't be done.Swami: Then that is your imperfection.... When you can come to understand Krsna (God) by studying these physical laws, then your science is perfect. Because He is the ultimate source of everything, if you can come to God by studying your physical laws, that is your perfection. Therefore, our proposition is that you remain a physical scientist, but you should try to explain Krsna (God).... That is real scientific discovery-to find out Krsna. Find out how God is working in the physical and chemical laws, how His brain is working. Everything is working by His brain. There are chemical and physical

energies, but everything is going on by God's brain. These chemical and physical laws are acting in such a subtle way that we see everything as coming automatically. There are chemical and physical laws, but how these laws are working you do not know....Scientist:... you cannot find out anything about God by studying science....Swami: There is nothing but Krsna. There is nothing else except God.

The Swami is indeed a scoundrel. He claims that all the physical and chemical laws of the universe (and he would include biological, cosmological, and psychological laws), are operating within the mind or brain of God, and that these laws must be understood in this way if we are to perfect science! Of course, in modern science, we never look at the world in this way. How could we relate the laws of science to the God hypothesis? Dr. Benford assumes that "It can't be done," although he has not seriously considered scientific theories from such a perspective.

Dr. Benford points out to Prabhupada that scientists now understand the nature of matter-such as the make up of the grass on which they are sitting on. He points out that we know what kind of molecules compose the grass and what forces of nature hold it together. However, the Swami is not impressed and he questions the significance of such knowledge-in that the grass grows with or without this understanding. We could take any subject from a material, analytic point of view and compile many books on it. Prabhupada argues:

> *"... you would rather study the insignificant grass than the God who has created everything. If you could understand Him, automatically you would study the grass. But you want to separate His grass from Him, to study it separately. In this way you can compile volumes and volumes on the subject, but why waste your intelligence in that way? The branch of a tree is beautiful as long as it is attached to the main trunk, but as soon as you*

cut it off it will dry up. Therefore, what is the use of studying the dried up branch? It is a waste of intelligence."

In Prabhupada's view, the study of any part has to be taken in relationship to the whole, which ultimately is God. We should study the physical laws of nature and of life but not detach them from the main trunk, the mind/brain or being of God. Everything is working as a result of metaphysical causes and therefore, science needs to approach nature in this way. According to the Swami, the supreme knowledge is self-knowledge, or "atma-jnana." At one point, he questions Dr. Benford about the scientific knowledge of the spiritual self. Benford notes that there is really "no scientific knowledge of the spirit soul." The Swami does not realize that modern psychologists and scientists dismissed the ideas of spirit and soul long ago. Instead, Prabhupada responds by stating simply that: "Therefore there is actually no advancement of scientific knowledge."

The Swami explains that there are many departments of knowledge, including the medical study of the body, the psychological study of the mind, and ultimately, the study of the spiritual and transcendental nature of the human being. In his view, the body and mind are simply coverings of the spirit soul, just as the material body is covered by clothes. Knowledge of the body and the mind is compared to knowledge of an individual's garments, while knowledge of the spirit soul is knowledge of the real person. It certainly would be silly to study a person's clothes thinking that this is what he or she really is. Obviously, that would not constitute an advancement of knowledge! The Swami continues in this vein, making the wildest claims about the nature of human beings and science:

Swami: You should try to understand this science of God consciousness.... everyone has dormant consciousness of

God.... It simply requires proper education to awaken it. However, this education is not given in the universities. That is the defect in modern education.... Because our government does not know that life, especially human life, is meant for understanding God, they are supporting all the departments of knowledge very nicely except the principal department, God consciousness.... Reasons there may be many, but the principal reason is that this age is the Kali-yuga (dark age). People are not very intelligent, therefore they are trying to avoid this department of knowledge, the most important department of knowledge.... You do not know so many things.... (pp. 7,19)

The swami claims that we all have dormant consciousness of God which can be awakened through education. Further, there is a "science of God consciousness," which the Vedas and other esoteric teachings elaborate. From the Swami's perspective, there is something fundamentally fraudulent about modern materialist science: scientists ignore the most important issues of self-knowledge and the spirit-soul, and study the parts taken out of relationship to the whole. Scientists study the physical laws, but ignore the underlying metaphysical causes.

The Swami's comments pose many enigmas and issues, which most scientists would dismiss out of hand. The scientist can point to the material benefits of modern science as evidence that at least the scientific method works, whereas the mystical or religious method seems to be simply a matter of faith or delusion. Scientists can split the atom and penetrate matter with particle accelerators, describe the origin of the universe, and explore the outer cosmos with telescopes and space vehicles. Humankind has landed men on the moon, builds space stations, and is exploring the other planets of the solar system through probes, and the universe through telescopes. How could the Swami ignore such advances of scientific knowledge and technology?

As it happens, Prabhupada claims that advanced yogis can acquire far more profound powers and abilities by observing the practices and disciplines of the science of consciousness and the attainment of self-knowledge. In a book Easy Journey to Other Planets, the Swami notes:

Even if a materialist wants to enjoy developed material faculties, he can transfer himself to planets where he can experience material pleasures much more advanced than those available on the earth planet.... one can transfer himself to other planets in the material sky by utilizing yogic powers. The playful spaceships of the astronauts are but childish entertainments and are of no use for this purpose.... In the higher planets of the material world, the yogis can enjoy more comfortable and more pleasant lives for hundreds of thousands of years, but life in those higher planets is not eternal.... the gross materialists... reside on this seventh-class planet "Earth." (1977, pp. 28/21).

Prabhupada dares to describe humans' spaceships as childish entertainments and claims that yogis can develop far more advanced mystic powers through this science of consciousness! Not many scientists or psychologists are likely to consider such claims seriously. The easier and more reassuring course is to simply dismiss the Swami as being just another religious fanatic. However, if there is any truth to the Swami's remarks, then mystical science would indeed be more advanced than modern science. We can barely reach the moon, the closest of all cosmic bodies to our planet, yet alone explore distant planets in the material or spiritual sky. Imagine being able to travel within the spaces of the larger solar system, and beyond. To do this, the yogi does not blast off with rockets, polluting the Earth and costing billions of dollars. Instead, he or she achieves these amazing feats through knowledge of Self and awakening within the inner cosmos of consciousness.

Prabhupada views scientists' materialist and reductionist philosophy as limiting their approach to knowledge. Their refusal to acknowledge any causal agent other than material processes has blinded scientists to the most essential aims of acquiring self-knowledge and developing spiritual consciousness. If they were to undertake the methods of self-perfection and self-realization, the Swami argues, they would open themselves to awesome and profound realms of experience and reality. Of course, it is easy to dismiss the Swami as a lunatic, but perhaps he is in touch with truths that are beyond anything that scientists even imagine-an ancient yet secret science

2

HISTORY OF INDIAN SCIENCE

Indian literature provides us with considerable layered evidence related to the development of science. The chronological time frame for this his-tory is provided by the archaeological record which has been traced in an unbroken tradition to about 7000 BC. Prior to this we have records of rock paintings that are believed to be as old as 40000 BC. The earliest textual source is the Rig Veda which is a compilation of very early material. There are astronomical references in this and the other Vedic books which recall events in the third or the fourth millennium BC and earlier. The recent discovery that Sarasvati, the preeminent river of the Rig Vedic times, went dry around 1900 BC due to tectonic upheavels implies that the Rig Veda is to be dated prior to this epoch. According to traditional history, Rig Veda is prior to 3100 BC.

Indian writing goes back to the beginning of the third millennium BC. The later historical script called Brahmi evolved out of this writing. The invention of the symbol for zero appears to have been made around 50 BC to 50 AD.

VEDIC SCIENCE

Briefly, the Vedic texts present a tripartite and recursive world view. The universe is viewed as three regions of earth,

space, and sky which in the human being are mirrored in the physical body, the breath (prana), and mind.

In the Vedic world view, the processes in the sky, on earth, and within the mind are taken to be connected. The Vedic seers were aware that all descriptions of the universe lead to logical paradox. The one category tran-scending all oppositions was termed brahman. Understanding the nature of consciousness was of paramount importance in this view but this did not mean that other sciences were ignored. Vedic ritual was a symbolic retelling of this world view.

Knowledge was classified in two ways: the lower or dual; and the higher or unified. The seemingly irreconciliable worlds of the material and the conscious were taken as aspects of the same transcendental reality. The idea of complementarity was at the basis of the systematization of Indian philosophic traditions as well, so that complementary approaches were paired together. We have the groups of: logic (Nyaya) and physics (Vaisheshika), cosmology (Sankhya) and psychology (Yoga), and language (Mimamsa) and reality (Vedanta). Although these philosophical schools were formalized in the post-Vedic age, we find the basis of these ideas in the Vedic texts.

The Sankhya and the Yoga systems take the mind as consisting of five components: manas, ahankara, chitta, buddhi, and atman. Manas is the lower mind which collects sense impressions. Ahankara is the sense of I-ness that associates some perceptions to a subjective and personal experience. Once sensory impressions have been related to I-ness by ahankara, their evaluation and resulting decisions are arrived at by buddhi, the intellect. Chitta is the memory bank of the mind. These memories constitute the foundation on which the rest of the mind operates. But chitta is not merely a passive instrument. The organization of the new impressions throws up instinctual or primitive urges which

creates different emotional states. This mental complex surrounds the innermost aspect of consciousness, which is called atman, the self, or brahman.

PHYSICS AND CHEMISTRY

The Vaisheshika system considers nine classes of substances, some of which are nonatomic, some atomic, and others all-pervasive. The nonatomic ground is provided by the three substances ether, space, and time, which are unitary and indestructible; a further four, earth, water, fire, and air are atomic composed of indivisible, and indestructible atoms; self (atman), which is the eighth, is omnipresent and eternal; and, lastly, the ninth, is the mind (manas), which is also eternal but of atomic dimensions, that is, infinitely small.

The atoms combine to form different kinds of molecules which break up under the influence of heat. The molecules come to have different properties based on the influence of various potentials (tanmatras).

Heat and light rays are taken to consist of very small particles of high velocity. Being particles, their velocity is finite.

The gravitational force was perceived as a wind. The other forces were likewise mediated by atoms of one kind or the other. Indian chemistry developed many different alkalis, acids and metallic salts by processes of calcination and distillation, often motivated by the need to formulate medicines. Metallurgists developed efficient techniques of extraction of metals from ore.

Geometry and Mathematics

Indian geometry began very early in the Vedic period in altar problems as in the one where the circular altar (earth) is to be made equal in area to a square altar (heavens). Two

aspects of the "Pythagoras" theorem are described in the texts by Baudhayana and others. The geometric problems are often presented with their algebraic counterparts. The solution to the planetary problems also led to the development of algebraic methods.

Binary Numbers

Binary numbers were known at the time of Pingala's Chhandahshastra. Pingala, who lived about the fifth century BC used binary numbers to classify Vedic meters. The knowledge of binary numbers indicates a deep understanding of arithmetic.

Astronomy

Using hitherto neglected texts, an astronomy of the third millennium BC has been discovered recently. Yajnavalkya (1800 BCE ?) knew of a 95-year cycle to harmonize the motions of the sun and the moon and he also knew that the sun's circuit was asymmetric.

Astronomical numbers played a central role in Vedic ritual. Part of the ritual was to devise geometrical schemes related to the lengths of the solar and the lunar years. The organization of the Vedic books was also according to an astronomical code. To give just one example, the total number of verses in all the Vedas is 20,358 which equals 261 x 78, a product of the sky and atmosphere numbers of the Vedic ritual!

The second millennium text Vedanga Jyotisha of Lagadha went beyond the earlier calendrical astronomy to develop a theory for the mean motions of the sun and the moon. This marked the beginnings of the application of mathematics to the motions of the heavenly bodies. An epicycle theory was used to explain planetary motions. Later theories consider the motion of the planets with respect to the sun, which in turn is seen to go around the earth.

COSMOLOGY

The doctrine of the three constituent qualities: sattva, rajas, and tamas, plays a very important role in the Sankhya physics and metaphysics. In its undeveloped state, cosmic matter has these qualities in equilibrium. As the world evolves, one or the other of these become preponderant in different objects or beings, giving specific character to each.

The recursive Vedic worldview requires that the universe itself go through cycles of creation and destruction. This view became a part of the astro-nomical framework and ultimately very long cycles of billions of years were assumed. Indian evolution takes the life forms to evolve into an increasingly complex system until the end of the cycle. The categories of Sankhya operate at the level of the individual as well. Life mirrors the entire creation cycle and cognition mirrors a life-history.

Cosmological speculations led to the belief in a universe that goes through cycles of creation and destruction with a period of 8.64 billion years. Related to this was the notion that light traveled with a speed of 186,000 miles per second. Since these numbers were not obtained throught experimentation, the accuracy of these figures must be seen as remarkable coincidence.

GRAMMAR

Panini's grammar (5th century BC) provides 4,000 rules that describe the Sanskrit of his day completely. This grammar is acknowledged to be one of the greatest intellectual achievements of all time. The great variety of language mirrors, in many ways, the complexity of nature and, therefore, success in describing a language is as impressive as a complete theory of physics. It is remarkable that Panini set out to describe the entire grammar in terms of a finite number of rules. Scholars have shown that the grammar of

Panini represents a universal grammatical and computing system. From this perspective it anticipates the logical framework of modern computers.

MEDICINE

Ayurveda, the Indian medicine system, is a holistic approach to health that builds upon the tripartite Vedic approach to the world. Health is maintained through a balance between three basic humors (dosha) of wind (vata), fire (pitta), and water (kapha). Charaka and Sushruta are two famous early physicians.

Indian surgery was quite advanced. The caesarian section was known, bone-setting reached a high degree of skill, and plastic surgery was known.

THE MEDIEVAL PERIOD

Astronomical texts called siddhantas begin appearing sometime in the first millennium BC. According to tradition there were 18 early siddhantas of which only a few have survived. Each siddhanta is an astronomical system with its own constants. Some of the famous astronomer-mathematicians that arose in India's long medieval period are listed below. Aryabhata In his book Aryabhatiyam, Aryabhata (born 476) sketched his mathematical, planetary, and cosmic theories. The parameters of Aryab-hatiyam have, as their origin, the date of Friday, 18th February, 3102 BC. Aryabhata took the earth to spin on its axis; this idea appears to have been his innovation. Aryabhata was aware of the relativity of motion as is clear from this passage in his book,"Just as a man in a boat sees the trees on the bank move in the opposite direction, so an observer on the equator sees the stationary stars as moving precisely toward the west."

Brahmagupta Born in 598 in Rajasthan, Brahmagupta wrote his mas-terpiece, Brahmasphuta Siddhanta, in 628.

His school, which was a rival to that of Aryabhata, has been very influential in western and northern In-dia. Brahmagupta's work was translated into Arabic in the eighth century at Baghdad and it became famous in the Arabic world as Sindhind and it influenced Islamic astronomy.

One of Brahmagupta's chief contributions is the solution of a certain second order indeterminate equation which is of great significance in number theory.

Bhaskara Belonging to the Karnataka region, Bhaskara (born 1114), was an outstanding mathematician and astronomer. Amongst his mathematical contributions is the concept of differentials. He was the author of Siddhanta Shiromani, a book in four parts:

(i) Lilavati on arithmetic,

(ii) Bijaganita on algebra,

(iii) Ganitadhyaya,

(iv) Goladhyaya on astronomy.

He epicyclic-eccentric theories of planetary motions are more developed than in the earlier siddhantas. Madhava Subsequent to Bhaskara we see a flourishing tradition of mathe-matics and astronomy in Kerala which saw itself as a successor to the school of Aryabhata. Of these, Madhava (c. 1340-1425) developed a procedure to determine the positions of the moon every 36 minutes. He also provided methods to estimate the motions of the planets. He gave power series expansions for trigonometric functions, and for pi correct to eleven decimal places.

Nilakantha Somayaji A very prolific scholar who wrote several works on astronomy, Nilakantha (c. 1444-1545) found the correct formulation for the equation of the center of the planets and his model must be considered a true heliocentric model of the solar system. He also improved upon the power series techniques of Madhava. The methods developed by

the Kerala mathematicians were far ahead of the European mathematics of the day. Another noteworthy contribution was by the school of New Logic (Navya Nyaya) of Bengal and Bihar. At its zenith during the time of Raghunatha (1475-1550), this school developed a methodology for a precise semantic analysis of language. Its formulations are equivalent to mathematical logic.

THE MODERN PERIOD

Entering its modern era with the arrival of the English, India in the last two centuries has witnessed a renaissance of its science and a proper appreciation of the past achievements.

Some of the most important scientists born in the 19th century who made international mark are Jagadish Bose (1858-1937) in electromagnet-ics and plant life, Srinivas Ramanujan (1887-1920) in mathematics, Chandrasekhar Venkata Raman (1888-1970) in physics, Meghnad Saha (1893-1956) in astrophysics, and Satyendra Bose (1894-1974) in quantum theory. More recent contributions of Indian science are part of the story of the contemporary world science.

3

VEDIC AGRICULTURAL AND SCIENTIFIC PRACTICES

Heritage of most Indians begins with the Vedas, which were compiled by the Aryan sages. Some of the Indology scholars of the 19th century, such as Max Müller, placed the age of Vedas around 1500 BC. The world accepted that date and continues believing it. Recent archaeological and other studies place the age of Rigveda, the oldest Veda, around 3700 BC. The Rigveda (Sontakke and Kashikar, 1983) has served and will serve as an encapsulated source of knowledge concerning almost all aspects of life in India, including the sciences.

The Vedic thread can be seen in all the advancements that took place in India in the past. Vedic values continue to guide Indians even today. In this article, we have made an effort to very briefly summarize the developments in sciences from ancient through the modern times. We have placed relatively more emphasis on agriculture, as the food security for India will be a major issue in the future.

OVERVIEW

There is a general perception about India that its heritage is primarily religio-philosophical and there is hardly anything to mention about India's scientific and technological past.

The reasons for this impression are due to the fact that references to science and technology are scattered in several different published works written in Sanskrit and Pali languages that are not currently in use. Moreover, the ancient knowledge is often in a very condensed form, which could be understood only by experts in those languages. In recent years, organizations like Vijnan Bharati (Mumbai) and Asian Agri-History Foundation (Hyderabad) have attempted to translate the ancient scientific literature into English. Information on scientific knowledge and technology in the fields of agriculture, architecture, astronomy, chemistry, mathematics, medicine, metallurgy, physics, shipping and navigation, textiles, numismatics, and design and layout is now widely available (Vijnan Bharati, 2002).

In developing science and technology, ancient Indian universities have played an important role. To name a few: Takshashila (Taxila) (800-540 BC) in the Northwest corner of the subcontinent (now near Rawalpindi, Pakistan) was the earliest. It provided education in a wide variety of subjects and used to host conferences in medicine and other fields that attracted scholars from Babylon, Syria, Arabia, Phoenicia, China, and Persia. This university had to face the brunt of attacks and invasions from Persians, Greeks, Parthians, Shakas, and Kushans. In c. 450 AD the Huns from Central Asia razed the institution.

The university at Varanasi (Banaras) has maintained a continued existence and reputation as a place of learning for over 3000 years. There were many other institutions of learning in ancient India and the name of Nalanda University, located in Bihar state of India, must be mentioned. Great scholars such as Chanakya, Nagarjuna, Buddhaghosha, Aryadeva, and Jyotipala taught at this university. It is said that there were 10,000 students and about 1500 teachers at Nalanda, thus having a student-teacher ratio of about 7:1. The University Library was so large that it was housed in

three big buildings. This university also fell victim to the invading hordes of Bakhtyar Khilji in the 10th century. We will briefly focus on mathematics, medicine, and agriculture, which are some important branches of science and technology in ancient India.

Mathematics

Scientists of ancient India made a remarkable contribution to science of Mathematics. Ancient India's greatest gifts to the world of mathematics are the concept of zero and the elegant place value system of numeration. Reference to the concept of zero is found in the works of the great Sanskrit grammarian Panini (500 BC) and Pingala (200 BC) who produced the science of Prosody. Early evidence to zero is also found in Bakshali manuscript (300-400 AD). The manuscript written on 70 leaves of birch bark was discovered in Bakshali village near Peshawar (now in Pakistan) in 1818 AD. It was translated into English by R Hoernal and is now kept in the Oxford University Library. The Decimal Place Value System, expressing all numbers by ten digits including zero and assigning to each an absolute value and place, is the most profound contribution of India to the world of mathematics, even to mankind. One of the greatest mathematicians, Pierre Laplace of France wrote: "It is India that gave us the ingenious method of expressing all numbers by ten symbols receiving a value of position, as well as an absolute value. We shall appreciate the grandeur of this achievement when we remember that it escaped the genius of Archimedes and Appolonius." Leonard Fibonacci Pisano introduced this system to European mathematics in 1202 AD. In Yajurveda, Ramayana, and other texts, separate names are given for numbers 1 to 10 power 53.

The Harappans developed standardization of weights and measures. Jain mathematicians (500 BC-100 AD) invented the perception to treat mathematics as an abstract

discipline. The Sthanagana Sutra lists the topics studied by them, which included concept of geometry, fractions, equations, square, square root, cube and cube root. The concept of indices and logarithms, permutations and combinations was also introduced by Jain mathematicians (Bhagvati Sutra-300 BC). Some great Indian mathematician-astronomers were:

- o Aryabhata (476 AD) gave the value of 3.1416 for pie. He was the first in India to postulate that the earth is round, that it rotates on its axis creating day and night, that moon shines due to sunlight, and finally, that eclipses are due to shadows cast by earth and moon.
- o Varahamihira (490 AD) is remembered for his revised version of Indian calendar. His contribution to mathematics was mainly in the area of trigonometry.
- o Brahmagupta (598 AD) is said to be the founder of numerical analysis. He made several original contributions to algebra and trigonometry.
- o Mahavira's (815 AD) contributions were in the area of fractions, permutations and combinations, and the right-angled triangle.
- o Sridharacharya's (latter half of 10 th century) work was in the area of arithmetic, mensuration, and geometry. He was the first one to solve the quadratic equation in one variable.
- o Bhaskaracharya (1114 AD) is known for the solution of the indeterminate equation of second order by the Chakravala method and his path-breaking work on cyclic quadrilaterals.

SCIENCE OF INDIAN MEDICINE (AYURVEDA)

According to the legend, Brahma the creator of the universe propounded Ayurveda, an upveda (sub-Veda) of

Atharvaveda; Daksha Prajapati learned Ayurveda from Brahma and passed it on to the celestial physician twins, the Ashwins. After handling by few more sages, the science of Indian medicine, the Ayurveda, was developed into three schools by the sages, Charaka, Sushruta, and Kashyapa. The celebrated Samhitas (compendiums) are known after these sages. Ayurveda has eight branches, namely general medicine, surgery, psychiatry, geriatrics, ophthalmology and ENT, toxicology, pediatrics, and sexual disorders. These medical practices were common in the Indus Valley Civilization (c. 3000 BC).

Ayurveda takes cognizance of individual's constitution based on tridosha (three humors). This is the basic concept of Indian medicine. It helps the physicians as well as the common man. A person's constitution is classified into seven categories:

(1) Vata,

(2) Pitta,

(3) Kapha,

(4) Vata-Pitta,

(5) Pitta-Kapha,

(6) Vata-Kapha, and

(7) Vata-Pitta-Kapha.

Each type of constitution results in specific ailments and can be treated accordingly. In the Indian medicine, the body is considered the vehicle of equilibrium, being the dwelling place of consciousness and comprising the sum of modifications of the five elements, i.e., sky, air, light, water, and earth.

The anatomy deals with the structure of body, the soul (atma), the location, size, and shape of various parts of the body, and the mind. Anatomically, Ayurveda divides the

human body into 19 parts (for detailed references see "Science and Technology in Ancient India" published by Vijnan Bharati, 2002). Sharir-Kriya (physiology) describes the biological and psychosomatic functioning of the living body and the biological components are divided into four categories: vital constituents, tissue components, biochemical transformers, and excretory materials, and have been described in great detail.

In Ayurveda, the pulse of the patient is checked by the doctor with his bare hands, without any instruments, and several aspects of the patient's medical conditions are inferred. The science of formulating medicinal preparations (pharmacology) and techniques to make medicaments from fresh herbs for internal and external use were very well advanced in ancient India. Plastic surgery was performed on regular basis. Rules for healthy living habits and diets were also well recognized. It is not surprising that Ayurveda still is a respected alternative medicine in India.

AGRICULTURE IN ANCIENT INDIA

Most of us grew up believing that Vedic Aryans from West Asia invaded the subcontinent around 1500 BC and destroyed the "Indus civilization" or the "Harappan civilization". Aryans were then supposed to have colonized northern India and pushed out the original inhabitants (Dravidians) to southern India. However, with recent archaeological investigations, this theory of Aryan invasion has been seriously questioned. Information obtained thus far indicates that the Vedic civilization flourished in the northwestern (India and Pakistan) parts of the subcontinent more than 6000 years ago along the banks of the river Saraswati.

This river dried up gradually over the years and the population living on its banks then slowly shifted westward towards Indus, giving rise to the Harappan civilization, and

eastward towards and along the banks of the Ganges, and to the southern part of the subcontinent.

Archaeological findings have revealed that rice was a domesticated crop grown along the banks of the Ganges in the sixth millennium BC. Later, it extended to other areas. Several species of winter cereals (barley, oats, and wheat) and legumes (lentil and chickpea) domesticated in Southwest Asia were grown in Northwest India before the sixth millennium BC.

Archaeological research also revealed cultivation of several other crops 3000 to 6000 years ago. These include oilseeds such as sesame, linseed, safflower, mustards, and castor; legumes such as mung bean, black gram, horse gram, pigeonpea, field pea, grass pea (khesari), and fenugreek; fiber crops such as cotton; and fruits such as jujube, grapes, dates, jackfruit, mango, mulberry, and black plum. Animals, including livestock, sheep, goats, asses, dogs, pigs, and horses were also domesticated (Mehra, 1997).

Despite destruction of ancient libraries by invaders, some literature did survive and is available to us to this day. This literature includes the four Vedas, nine Brahmanas, Aranyakas, Sutra literature, Sushruta Samhita, Charaka Samhita, Upanishads, the epics Ramayana and Mahabharata, eighteen Puranas, Buddhist and Jain literature, and texts such as Krishi-Parashara, Kautilya's Artha-sastra, Panini's Ashtadhyahi, Sangam literature of Tamils, Manusmriti, Varahamihira's Brhat Samhita, Amarkosha, Kashyapiya-Krishisukti, and Surapala's Vrikshayurveda.

This literature was most likely to have been composed between 6000 BC and 1000 AD. We find information related to biodiversity and agriculture (including animal husbandry) in these texts. Specifically, in the Puranas (300-750 AD?) we find names of Shalihotra on horses and Palakapya on elephants, as experts in animal husbandry. For instance,

Garudapurana is a text dealing with treatment of animal disorders while the classical work on the treatment of horses is Ashwashastra. One chapter in Agnipurana deals with the treatment of livestock and another on treatment of trees. The science of arbori-horticulture had developed well and has been documented in Surapala's Vrikshayurveda.

Forests were very important in ancient times. From the age of Vedas, protection of forests was emphasized for ecological balance. Kautilya in his Arthasastra (321-296 BC) mentions that the superintendent of forests had to collect forest produce through the forest guards. He provides a long list of trees, varieties of bamboos, creepers, fibrous plants, drugs and poisons, skins of various animals, etc. that came under the purview of this officer (Shamasastry, 1961).

According to Manu (Manusmriti, 2nd century BC), the preservation of wild animals was encouraged and hunting as a sport was regarded as detrimental to proper development of the character and personality of the ruler (Dwivedi, 1959).

There is more to learn from our ancient literature; for example, we learn about the biodiversity of flora. The four Vedas mention more than 75 species, Satapatha Bhrahmana mentions over 25 species, and Charaka Samhita (c. 300 BC)-an Ayurvedic (Indian medicine) treatise-mentions more than 320 plants. Sushruta (c. 400 BC) records over 750 medicinal plant species (Krishnamurthy, 1991). The oldest book, Rigveda (c. 3700 BC), mentions a large number of poisonous and non-poisonous, aquatic and terrestrial, and domestic and wild creatures and animals. Puranas mention about 500 species of plants.

Farm Implements

Ancient literature of the subcontinent did not miss out on farm implements. Vedas describe a simple bullock-drawn wooden plow, both light and heavy, with an iron bar attached

as a plowshare to open the soil. Krishi-Parashara (c. 400 BC) gives details of the design of the plow with Sanskrit names for different parts.

This basic design has hardly undergone any change over centuries. Even today the resource-poor farmers use a similar bullock-drawn plow. A bamboo stick of a specific size was used to measure land. Vedic literature and Krishi-Parashara also mention disc plow, seed drill, blade harrow (bakhar), wooden spike tooth harrow, plankers, axe, hoe, sickle, supa for winnowing, and a vessel to measure grain (udara). Pairs of bullocks used for plowing in ancient days varied from one to eight.

Forecast of annual monsoon rains. Since crop production depended almost entirely on seasonal monsoon rains, it was imperative that methods of predicting rainfall were developed. Indian knowledge base in mathematics, astronomy, and astrology was strong. Krishi-Parashara (c. 400 BC) and Brhat Samhita (Bhat, 1981) give, what today one could describe as, simple astrological models for predicting rains in a particular season. Parashara's main technique of forecasting rain was based on the positions of the Moon and the Sun in the sky. Varahamihira (505-587 AD) in his Brhat-Samhita considered lunar mansions in predicting seasonal rainfall. It is noteworthy that even today a large number of farmers in India, carry out farm operations based on the local variations of these old models.

Kautilya in Arthasastra indicates primitive models for optimum rainfall for most crops. It is significant that the great poet, Kalidasa (c. 500 AD) in his immortal poem, Meghdoot, described the course of monsoon clouds from the Bay of Bengal through central and northern Indian plains to the Himalayas. It is remarkable that this accurate knowledge was obtained without the aid of modern instruments.

Types of Lands

Rigveda identified productive and non-productive soils (Sharma, 1991). The Amarkosha (c. 400 BC) (Jha, 1999) described 12 types of lands in its chapter on Bhumivargaha, depending upon the fertility of the soil, irrigation, and physical characteristics. These were: urvara (fertile), ushara (barren), maru (desert), aprahata (fallow), shadvala (grassy), pankikala (muddy), jalaprayah (watery), kachchaha (land contiguous to water), sharkara (full of pebbles and pieces of limestone), sharkaravati (sandy), nadimatruka (land watered from a river), and devamatruka (rainfed). In the chapter on Vaisyavargaha, soils based on suitability for specific crops are mentioned. For example, vraiheyam (vrihi rice and corn), shaleyam (kalama rice), yavyam (awned barley), yavakyam (awnless barley), tilyam (sesame), mashyam (black gram), maudginam (mung bean), etc. are crops mentioned in relation to the soils. Sangam literature (200 BC to 100 AD) of Tamils in southern India provides information on soil types (Bedekar, 1993). For example, in Tholkappiyam, written by a poet named Tholkappier (200 BC), four types of land are mentioned. These are mullai (forest), kuringi (hills), marudham (cultivable), and neithal (coastal land). Surapala's Vrikshayurveda (c. 1000 AD) (Sadhale, 1996) mentions three types of land-jangala (arid), anupa (marshy), and samanya (ordinary)-further subdivided by color into black, white, pale, dark red, red, and yellow and by taste into sweet, sour, salty, pungent, bitter, and astringent. Samanya land was considered suitable for all kinds of trees. It is important to note that one of the most sustained land use practices, since the days of Kautilya, has been the use of river beds for raising cucurbits throughout India.

Manures

Importance of manures in obtaining high crop yields was fully appreciated in ancient India. In Krishi-Parashara, it is

stated that crops grown without manure will not give yield, and a method of preparing manure from cowdung is described. Kautilya mentioned use of cowdung, animal bones, fishes, and milk as manure. In the Kural (1 st century AD) (Aiyar, 1952), it is stated that manuring is more beneficial than plowing.

Agnipurana (Gangadharan, 1986) recommends application of "excreta of sheep and goat and pulverized barley and sesame allowed to be soaked in meat and water for seven nights" to increase flowering and fruiting of trees. In Varahamihira's Brhat Samhita, growing of sesame to flowering stage and then incorporating it as green manure is recommended. Surapala (c. 1000 AD) describes the "ancient" practice of preparing liquid manure (kunapa) prepared by boiling a mixture of animal excreta, bone marrow, flesh, and dead fish in an iron pot and then adding to it sesame oilcake, honey, soaked black gram, and a little ghee (or clarified butter). No fixed quantities of materials were required to prepare kunapa. This liquid manure was mainly used in raising trees and shrubs.

Irrigation

Archaeological investigations in Inamgaon in Maharashtra, India (1300 BC), revealed a large mud embankment on a stone foundation for diverting floodwater from the Ghod River through a channel. Rigveda mentions irrigation of crops by river water through channels as well as irrigation from wells. Buddhist literature (500-300 BC) provides evidence of building small tanks for irrigation (Randhawa, 1980). Artha-sastra of Kautilya refers to sluice gates of tanks and mentions that "persons letting out the water of tanks at any other place other than their sluicegate shall pay a fine of six panas; and persons who obstruct the flow of water from the sluicegate of tanks shall also pay the same fine." It is further stated that "the water of a lower

tank, excavated later on, shall not irrigate the field already irrigated by a higher tank and the natural flow of water from a higher to a lower tank shall not be stopped, unless the lower tank has ceased to be useful for three consecutive years." Costs were levied on irrigation water, regardless of the source.

Extensive tank irrigation systems were developed in Sri Lanka and southern India during the first two centuries of the Christian era. Availability of irrigation made it possible to extend cultivation of rice to large areas, and thus improve food security. Sri Lankan knowledge of tank irrigation technology was most advanced. They could build large tanks and control release of water by 3 rd century BC. For the maintenance of tanks in southern India, a committee of villagers called erivariyam was appointed. The committee ensured repairs and desilting of tanks and distribution of water.

Irrigation from wells was practiced throughout India in ancient times. Bullocks pulled a leather bag with ropes to draw water from wells for irrigation. The socalled "Persian wheel" used for drawing water from wells was first developed in northern India prior to invasions by Turks. Seed and sowing.

Ancient scholars showed awareness of the importance of good seed; i.e., selection of the apparently healthy seed from a ripening crop, preserving it safely in storage, with or without treatments, and sowing the good seed, again with or without some treatment. About 2000 years ago, Parashara recommended:

(i) proper drying of seed,

(ii) freedom from the seeds of weeds,

(iii) visual seed uniformity,

(iv) storing seeds in strong bags, and

(v) storing seed where white ants would not have access and at a location where seed would not come in contact with substrates that would allow molds to grow such as cowshed wastes, damp spots, or leftover foods.

Kautilya in Arthasastra indicated that decision to sow seeds of specific crops should be taken on the basis of known rainfall patterns. He recommended that rice be sown first and mung bean and black gram later. He also suggested some seed treatments (e.g., cowdung, honey, and ghee) to ensure good germination. Manu mentioned that a professional farmer (the Vysya) must be able to determine the quality of seed. The most significant recommendation by Manu was severe punishment to a trader selling spurious seed. Varahamihira recommended pelleting of seed with flours of rice, black gram, and sesame and fumigating them with turmeric powder to ensure good germination. Surapala listed several botanicals such as seed treatment materials for shrubs and trees. Even today cowdung, suggested by Kautilya in the 4th century BC, is used for treating cotton and some other seeds by a large number of farmers.

The art of sowing rice seed in small areas, i.e., in nurseries, and transplanting of the seedlings is not a recent practice. It was first perfected in the deltas of Godavari and Krishna rivers in the 1st century AD. Pests and their management. One of the earliest references to birds as pests is found in Rigveda.

In the Kallavagga, Buddha pointed out when a disease called 'mildew' attacked a rice field, the latter would not produce grain. Likewise, sugarcane would be adversely affected if a disease called 'blight' affected it. Parashara (Randhawa, 1980) listed white ants and a number of other pests such as the gandhi bug and stem borer of rice. Parashara used the word "disease" in Sanskrit (vyadhi) to differentiate from visible pests. He even listed goats, wild boars, pigs,

deer, buffaloes, parrots, and sparrows as pests. However, no remedies except chanting of a mantra to ward off pests were indicated.

Agnipurana states that if fruits were destroyed, a paste of horse gram, black gram, mung bean, barley, and sesame should be applied after sprinkling the affected areas with cold water. In a later period, Varahamihira wrote a chapter on treatment of trees. He mentioned that trees are vulnerable to disease when exposed to cold weather, strong winds, and hot sun; consequently, their leaves become pale white, sprouts scanty and sickly, branches dry, and their sap oozes out. It seems Varahamihira laid the foundation of classifying tree diseases based on humors such as vata, pitta, and kapha, which were formalized in later centuries in Surapala's Vrikshayurveda. Varahamihira describes cleaning of "ulcers" on trees and treating those with application of paste of vidanga (Embelia ribes), ghee, and silt. Premature destruction of fruits of a tree was to be controlled by application of water and milk (boiled and subsequently cooled) with powder of seeds, as mentioned in Agnipurana.

Surapala's Vrikshayurveda, which deals with arbori-horticulture, gives considerable information on topics such as importance of trees, soil types, classification of plants, seed, sowing, planting, plant protection recipes, nourishment, types of gardens, locating groundwater, and bioindicators for suitability or otherwise for raising crops and animals. Surapala gave description of disease symptoms associated with the three humors, vata, pitta, and kapha. In addition, he described disorders caused by excessive heat and wind, fire, lightning, drought stress, physical injury, ants (and other insects), excess water, bird damage, and possibly phanerogamic parasites. For treatment of disorders, he suggested use of a number of botanicals (many of which have antimicrobial properties) including mustard paste and milk. It is interesting to note that Surapala's reference is largely

to those plant species, which originated in the Indian subcontinent, confirming thereby that plant introduction had occurred to a very limited extent. He described a method of dwarfing trees in situ to create the "bonsai" effect.

Horticulture and Arboriculture

Excavations at Harappa have indicated that people were familiar with date palm, pomegranate, lemon, melon, and possibly coconut. Emperor Ashoka (274-237 BC) encouraged arbori-horticulture (Randhawa, 1980). Commonly grown fruit trees were plantain, mango, jackfruit, and grapes. The Sangam literature (Bedekar, 1993) refers to jackfruit, coconut, date palm, areca nut, plantain, and tamarind. Agnipurana (Gangadharan, 1986) mentions many trees; it has a separate chapter on horticulture, which formed the base of treatises that followed. Varahamihira wrote a chapter on "treatment of trees" in his Brhat Samhita. One of the highlights of Varahamihira's writing (Bhat, 1981) is specific reference on grafting to be done on trees such as jackfruit, plantain, jambu (black plum), kapittaha (wood apple), lemon, and pomegranate. A method of grafting described was what is known today as "wedge grafting" (Bhat, 1981).

Surapala's Vrikshayurveda provides excellent information on arbori-horticulture in the northern part of the Indian subcontinent. The text mentions 170 species of plants including trees, shrubs, and a few herbs and deals systematically with raising of orchards; procuring, preserving and treating seeds and planting materials; selection of land; preparation of pits for planting; methods of irrigation and ways to locate groundwater; nourishment and fertilizers; disorders of plants and their protection; laying out gardens and orchards; and growing unusual trees (Sadhale, 1996). Woodland gardening was a developed art. Layouts included designs such as mandapa (canopy), nandyavarta (quandrangle with an opening to the west), swastika (design of religious

significance to Hindus), chaturasra (square), sarvatobhadra (a square enclosing a circle), vithi (line), nikunja (arbor), and punjaka (cluster). The text recommends layouts for the "pleasure gardens" (Sadhale, 1996).

Amarkosha mentions gardens such as griharamah (house garden), vrikshavatika (garden of ministers or prostitutes), aakrida (royal garden), and pramadavanam (garden for harem) (Jha, 1999).

Cattle Management

Right from Vedic times, owning cattle meant possessing wealth. Rigveda is replete with references to cattle and their management (Nene and Sadhale, 1997). References can be found on grazing of livestock, provision of succulent green fodder and water to drink from clean ponds, and livestock barns. Dogs were used to manage herds of cows and in recovering stolen cows. Killing of cows was discouraged though Vedic people had no objection to eating beef. In the Vedic period, cows acquired sacredness and Buddha protested against cow killing. That finally led to total ban on cow slaughter in that period.

In Krishi-Parashara (c. 400 BC), a description of a cattle shed is found. Cleanliness of the shed was emphasized. To protect animals from diseases, cattle sheds were regularly fumigated with dried plant products that contained volatile compounds (Bedekar, 1993).

Several texts indicate treatments for curing livestock diseases such as those affecting the horns, teeth, buccal cavity, and human diseases/disorders such as sore-throat, carditis, lumbago, rheumatism, atrophy of muscles, and acute dysentery. Plasters were used to treat broken bones. Many other treatments were prescribed (Randhawa, 1980).

The Arthasastra mentions a government officer called the superintendent of cattle whose exclusive duty was to

supervise livestock in the country, keep a census of livestock, and see that they were properly reared. Livestock was classified as calves, tame steers, draft oxen, bulls that were to be trained to yoke, stud bulls, livestock reared for meat, buffaloes and draft buffaloes, female calves, heifers, pregnant cows, milch kine, barren livestock (either cows or buffaloes), and calves, that were a month or two old as well as those that were still younger and branded them all along with those livestock which had remained unclaimed for a month or two, and registered the branded marks, natural marks, and color (Shamasastry, 1961).

The Arthasastra directed that all cattle be supplied with abundant fodder and water and gives an elaborate description of ration that a bull, cow, or buffalo should be supplied with. Maintenance of pastures around villages was encouraged. Manu presented that "on all sides of a village, a space of 100 dhanus or three samya throws (in breadth) shall be reserved for pasture." Fodder crops were cultivated and processed into silage-an old process in the Indian subcontinent as the word suyavasa in the Rigveda indicates. Cultivators also provided hay for their stock.

In Agnipurana, kings were encouraged to preserve the breed of the cattle in the country. Fishing. Rigveda makes a general mention to fishes, but not as an item of food. Yajurveda mentions capturing fish by sedating them in a pond by treating the water with the bark of some trees. The fish culture or pisciculture originated in China almost 2500 years ago. Manusmriti mentions two fishes, rohu and pathen, suitable for food.

In Surapala's Vrikshayurveda (c.1000 AD) two kinds of fish, saphari (a tiny shining fish) and rohita are mentioned. It is believed that fish culture came to Bengal from China, via Myanmar or Thailand. The Chalukya king Someshwara Deva (1127 AD) described methods of fattening fish and cited 34 kinds of fishes (Randhawa, 1980).

Honey

Honey was an important commodity in ancient times. Honey has been mentioned in Rigveda (Nene and Sadhale, 1997). It was an important item in food and medicine. The demand for honey was adequately met from natural hives until recently.

Support to Agriculture

Agriculture in India was almost always supported by the multitudes of rulers because the sages impressed upon these rulers that prosperous agriculture was the base of strong kingdoms/empires. The tradition had been to impose minimal tax on farmers, rarely exceeding one-sixth of the produce. A couple of examples from the epics Ramayana and Mahabharata will illustrate the point. In Ramayana, Rama asks his brother Bharata in Chitrakoot, "Dear Bharata, have you ensured that all those engaged in agriculture and animal husbandry receive your special care and attention?" In Mahabharata, the grand old man, Bhishma, advises King Yudhishthira in "Shantiparva": "Agriculture, animal husbandry and trade are the very life of people. Have you ensured that the cultivators are not forced to deserting the country because of the exaction imposed by you? It is indeed the cultivators who carry the burden of the king on their shoulders and also provide sustenance to all others." Do we recognize this today? We probably need to continuously remind ourselves the wisdom of our ancestors.

PERCEPTION OF INDIA'S SCIENCE AND TECHNOLOGY

As discussed in the previous section, during the era from Aryabhata to Bhaskara (5 th to 12 th centuries AD) India enjoyed a state of science that was advanced compared to that in Arabia or Europe. Scholars like Al-Biruni visited India to study Sanskrit so that they could translate the

Indian works like that of Brahmagupta and others into Arabic. Europe during the Dark Ages had nothing comparable to offer. The interesting question therefore is: Why India could not maintain its momentum in science?

There are various reasons for this. Rote learning practices were followed during ancient and medieval India. Knowledge of Vedas was passed down from one generation to next through oral tradition. So the teacher would have learned them by heart as a student and would pass them on to his disciples, along with commentaries, when he opened his own school. This method of teaching had limitations in stimulating original thinking (Narlikar, 2003). The other obvious reason is repeated invasions form West Asia that led to destruction of institutions and libraries after 1000 AD, followed by the Mogul and European colonization. Another reason was limited patronage to science during 10 th through 18 th century, during which India did not receive the same level of patronage to science as for literature, arts, and music. Poets such as the great Kalidasa flourished because of royal patronage. Later in the Mogul era, Emperor Akbar's court boasted of one of the greatest musicians, Tansen.

There were many artists in the courts of Rajput kings and the Mogul emperors, but very few scientists. Moreover, the social structure also contributed to lack of drive to innovate and create. The caste system with its four major divisions placed the thinkers, teachers, and priests at the apex, followed by the rulers and warriors, then the farmers and traders and finally those who provided service. This stratification, though was done to have an orderly society, deprived a large section of people of education. The result of all these developments was that existing knowledge in science became unavailable to later generations. After the British consolidated their hold on India, the Indian educated section started looking up to Europe for scientific information. New discoveries, especially in medical sciences and chemistry, with the availability of

antibiotics, vaccines for small pox, cholera, etc. also led people to reduce faith in ancient science of medicine. Some of the most significant highlights of science in the 20 th century pre-independent India are:

- o Srinivasa Ramanujan's work on highly composite numbers (numbers with a large number of factors) started a whole new line of investigations in the theory of such numbers.
- o Megha Nath Saha's ionization equation (c. 1920), opened the door to stellar astrophysics.
- o S N Bose's work on particle statistics (c. 1922) clarified the behavior of photons (the particles of light in an enclosure) and opened the door to new ideas on statistics of microsystems that obey the rules of quantum theory.
- o C V Raman's discovery that molecules scatter light (c. 1928) became known as the Raman effect. It is used to study the internal structure of molecules.
- o G N Ramachandran's work in biology; he is considered one of the founders of the rapidly developing molecular biophysics.
- o J C Bose's basic work in plant physiology.
- o Homi Bhaba's work on atomic energy, which lead to presentday successes of nuclear sciences in India.

We shall now discuss the post-independent (1947 onwards) scenario of India. Science was given priority in the economic development five-year plans in India. Within two months of India becoming a republic, the Planning Commission was set up to prepare a blue print for India's future, roughly once in five years. The Tenth Plan (2002-07) targets a GDP growth of 8% a year. In addition to setting up the University Grants Commission, the Government established some outstanding institutions, which have

promoted science and technology; for example, the Council of Scientific and Industrial Research (CSIR) and the Atomic Energy Commission. The seven Indian Institutes of Technology (IITs), the first set up in 1951 in Kharagpur (West Bengal) and others later on in Chennai (Madras) (Tamil Nadu), Mumbai (Bombay) (Maharashtra), Delhi, Kanpur (Uttar Pradesh), Guwahati (Assam), and Roorkee (Uttaranchal), produce some 2000 graduates each year and are one of the main sources of technical manpower. Among the IITs internationally known alumni are Victor Menzes, Managing Director, Citibank; N A Rajat-Gupta, Managing Director, McKinsey & Co; Vinod Khosla, a partner in Kleiner Perkins and the co-founder of the Sun Microsystems; Arun N Neteravali, President-Research, AT&T Bell Lab; N R Narayana Murthy, Chairman, Infosys Technology Ltd. The list goes on.

Information Technology

Exports from the Information Technology (IT) industry in India are worth US$ 10 billion, which is about 20% of India's exports. During the last 20-25 years, this industry has changed the world's perception of India that it is not a country of only snake charmers. The company Moser-Baer, located near New Delhi is the world's third largest optical media manufacturer and the lowest-cost producer of CDs. This company has acquired Capco Luxembourg, a firm that owns 49% of a Netherlands-based CD distributor. It has set up Glyphic Media Inc. in the United States for markets in North and South America. Similar advances in technology have been made in various sectors, especially in the automobile industry and pharmaceuticals.

India is among the three countries in the world that have built supercomputers on their own. Trained manpower in the fields of science and technology in India is being looked upon as a research hub by many multinational companies

(MNCs). Over 70 MNCs including Delphi, Eli Lilly, General Electric (GE), Hewlett Packard, Heinz and Daimler Chrysler have set up R&D facilities in India. The GE's John F Welch Technology Centre in Bangalore is the largest outside the United States, with an investment of US$ 60 million and employs 1,600 researchers. The Indian center devotes 20% of its resources to fundamental research having a 5-to 10-year horizon in the areas of nanotechnology, hydrogen energy, photonics, and advanced propulsion. All this has caused "OUT SOURCING" as a major issue of contention in the United States.

Space Research

In the three decades of its existence, the Indian Space Research Organization (ISRO) has thrust India into an exclusive space club of a handful of nations by building over a dozen sophisticated satellites, beginning with pioneering Aryabhatta, named after the ancient Indian astronomer, in 1975 for communications, weather prediction and mapping natural resources, telecommunication, and television broadcasting, and boosted India's missile program. With a budget of only US$ 450 million a year-one-thirtieth of NASA's (The National Aeronautics and Space Administration) US$ 15.5 billion budget-India has 13 satellites in the orbit, produces some of the world's best remote imaging satellites, and is planning to send a satellite to the moon by 2007 (Abdul Kalam and Pillai, 2004).

The space program is entirely oriented toward applications for the national development. Example is found in the Majhawan Karan village in Uttar Pradesh, where using satellite imagery, technicians have helped 175 villagers reclaim 40 acres (16.2 ha) of barren land in an area long haunted by hunger. This has changed the lives of subsistence farmers. Another example of space program is seen in Lucknow, capital of Uttar Pradesh, where doctors in the

basement of the main public hospital chatted over live satellite link with doctors in rural hospitals hundreds of miles away.

Agriculture

Following independence in 1947, India received considerable technical assistance through the United States Agency for International Development (USAID). Rockefeller Foundation, Ford Foundation, Fulbright, and others trained a large number of Indian agricultural scientists in USA. Through joint technical programs with land grant universities in the US, agricultural universities were set up in India. This resulted in the "Green Revolution" in the 1970s. Early in the 20 th century, India had faced many famines and deaths due to starvation. Even in early 1960s, famine was looming over India and millions of tons of wheat had to be imported. The then Prime Minister of India, Mr Lal Bahudur Shastri, appealed to the nation to skip a meal every week. In 1966-67 India imported 20 million tons of food grains because it could not feed its 480 million people. After introducing new seeds of wheat from Mexico and rice seeds from the International Rice Research Institute (IRRI) in the Philippines, India produced 17 million tons of wheat in 1967-68 and 71 million tons in 2003. India is now self-sufficient in food grains production and is facing postharvest storage problems. The use of better seed, double cropping, and easy availability of loans saw the food grain production growing by 70% in a decade. About 40% of our people live below the poverty line today. They face problems of day-to-day existence, with not enough money to buy simple food items. Still, the situation is much better than what it was during many periods before independence and even later till the 1960s. Today's teenagers would not know about the near-famine conditions that prevailed in certain regions of the country before independence and even later, and particularly about our dependence on American wheat in the 1960s.

THE FOOD CRISIS AND INDIAN SOCIETY

Prof S K Sinha, an eminent Indian agricultural scientist who led the Food and Agriculture Panel of the Technology Vision was often fond of quoting the following:

> *"It is also important to recall the experience of C. Subramaniam, the then Union Minister of Agriculture during the critical years of 1965-66 and 1966-67. He stated that we had to import 10 million tons and 11 million tons during these two years-that was a danger signal; you can't depend upon imported food-grain at that level, particularly when it came from 12000 miles away. During the second year of that critical period of drought, the US President Johnson, because of certain international policies he had adopted, was releasing food grain in driblets. At one point, we reached a stage when the stocks existed for only two weeks and there was nothing in the pipeline." (Swaminathan, 1993)*

This crisis gave the country's leadership an opportunity to resolve to become self-sufficient in food grains. This period also coincided with a breakthrough in technology at international centers for improvement of rice and wheat varieties. India took advantage of these technologies, experimented with them, and launched large-scale agricultural extension services, instead of viewing these technologies merely as research curiosities. Within three years the production of wheat doubled. This led to food grain self-sufficiency in the 1970s when we developed rice and wheat varieties that were acceptable to our people. Later when two of the worst droughts of the century occurred in India in 1979 and 1987, the world did not take note of them because no food aid was asked for.

The country now has a buffer stock of about 35 million tons of food grains. The 1990s have seen a certain degree of diversification of agriculture and exports of various

agricultural products including wheat and rice. There is also a growth in the agriculture-based processing industry.

Future Needs and Capabilities

So can we rest our oars, comforting with the belief that there are no more problems on the food front? Will there be no possibility of a repetition of the humiliation and stress the country and our people had to go through from 1965 to 1967? It seems India may have to import about 14 million tons of food grains by 2010 and then imports will grow at the rate of 2% every year. Along with many others who have studied these issues in depth and thought about possible solutions, we believe that we need not accept these projections at all since India has enormous potential for increasing food grain production. India either already has the necessary technologies or can develop them easily. Our people and our farmers are exceptionally entrepreneurial, and have proved it repeatedly. But we can belie the gloomy predictions only if we resolve to work hard with a long-term vision.

Challenges to Indian Agriculture

Thus the growing demand for food grains, vegetables, fruits, milk, poultry, and meat as well as cash crops will present newer challenges to agriculture. Let us not forget that our existing food security has been mainly brought about by the increase in irrigated agriculture and the introduction of high-yielding varieties of crops. Current stability in production is through wheat, largely a winter crop. However, the rainfed areas, which account for 70% of the cultivated area of the country, have not benefited from the modern developments in agriculture. Of this 70%, about 30% area is under dryland agriculture where annual rainfall is only up to 400 mm.

The problems in areas with rainfed agriculture need to be understood. Lesser the rain in an area, greater is the

trouble for the farmers and villagers. During many seasons, it was rare to find even blades of grass. Now in some areas in arid Rajasthan, one is struck by the change brought about by irrigation waters of the Indira Gandhi Canal. The change in the quality of the people's lives is something that gives immense satisfaction and one visualizes India with many such canals-big and small-connecting different river systems and water bodies, and well-managed water harvest and watersheds, thus benefiting the poor.

What is to be done with the rainfed regions till then? Leave them to the centuries-old toil of their farmers? Or neglect them with the hope that we may be able to make a breakthrough in newer technologies so that India can achieve whatever we want from the current 30% irrigated, relatively affluent agricultural zones? There have been several successful small experiments in different parts of both the rainfed and dryland areas of the country. For example, there has been considerable success in some pockets of Maharastra in conserving water, planting of trees, developing village-level grazing lands and regulating water use by the community. This has helped in raising suitable crops and livestock and in creating a viable market system. We should recall how the Green Revolution took place. Several farmers from the irrigated regions of India were given opportunity to visit other parts of the world. Should we not as a country extend similar opportunities to the farmers in the rainfed and dryland regions of our country, at least to visit other places within the country (and if possible to go abroad too) to observe for themselves the successes of farmers there who have overcome similar adversities to increase productivity?

Our people and farmers are all integrated into one huge market. All concerned need to be educated about another important scientific fact through observations, discussions, and mass contacts; i.e., the agro-ecological considerations. The drylands of Central India cannot have high productivity

rates of rice and wheat, which are the major food grains relished by Indians. Therefore, agricultural activities in the Central Indian drylands can be focused on pulses, oilseeds, vegetables, fruits, and livestock. Wheat and rice can be concentrated in more suitable regions. Each state should concentrate on agricultural products most suited to its agroclimatic conditions, as it cannot hope to be self-sufficient in all the essential commodities. Suitable marketing and transportation systems can be evolved to facilitate the exchange of commodities. In addition, special attention should be given to agriculture in the eastern region of India through increased productivity. Large parts of eastern India, though blessed by excellent agroclimatic and water resources, have a very low productivity. This situation has to change if India aims at food security and economic prosperity.

There is a need for multi-pronged action. Merely having better seeds or better irrigation will not suffice. The tasks involved today are much more complex than they were during the Green Revolution.

ENVIRONMENTAL PROBLEMS AND INTERNATIONAL PRESSURES

In the coming years we cannot address our agricultural problems in isolation. The General Agreement on Trade and Tariffs (GATT) and the obligations to the World Trade Organization (WTO) have implications for the future course of agricultural research and development and other initiatives we may take. These relate to giving market access to other countries in selling their products in India. This will place a demand on quality and efficiency in our own agricultural operations. Limits will be also placed on how much domestic support we can give to our agriculture.

Restrictions in terms of sanitary and phytosanitary measures, both for import and export of agricultural commodities, will be imposed. This means there will be

demands that residues of pesticides and chemicals be reduced to the internationally acceptable standards.

If we say that we would adopt these standards only for exports and not for our own domestic markets, then our own people, starting with environmental activists, will insist that we should also adopt international standards as otherwise the health of our people will be in danger. Thanks to the presentday information technology, the demand for stiffer environmental standards in any one part of the world soon becomes a global issue. Thus the use of agrochemicals and fertilizers has to often conform to international specifications. There are also other considerations of "equal national treatment" under the WTO. In other words, we cannot have one standard for Indian business and another for a foreign entity.

Serious implications arise from various international obligations for the protection of Intellectual Property Rights (IPR). This means far greater commercial restrictions in the use of technologies developed elsewhere in the world. Even our own research cannot be based on mere imitation of foreign technologies.

For example, we cannot assume easy availability of better seeds as we had obtained through the Mexican high-yielding varieties at the beginning of the Green Revolution. The well-known Basmati rice controversy between the United States and India is witness to the current trend of foreign scientists and technologists attempting to patent an agriculture-related invention.

If a number of them do import, many companies in developed countries will resort to selling food grains as a business. (Even now they do through ways that are not too obvious.) Once we depend on imports to provide food for our people, foreign companies and government can use this issue politically to derive many trade and political advantages. It

is also likely that they will resort to conditions, which will perpetuate the dependence.

An environmental concern that is likely to have implications for Indian agriculture is the emission of gases like methane and carbon dioxide. These are calculated as based on various models. India will be told that we contribute so much and there may be some penalties on those who emit more than an internationally established limit. Some of the concerns could be real but some could be an outcome of complex geopolitical motivations. The latter can assume various forms to mask pressures. In any case we have to learn to make our own models and counter geopolitical motivated pressures. Further, since climatic changes will affect agriculture, we should also be able to filter out facts of scientific relevance and take advance action to protect our agriculture.

Emerging Technologies

In addition to representing the national will and organizing a large-scale national effort, technologies play a crucial role in achieving food security for the country. We would naturally start with biotechnology as it deals with many aspects of basic inputs to agriculture: seeds, plants, soil treatment, etc. It is crucial to food security, if we take the right steps. An important technology is the production of transgenic plants, i.e., plants that are "human-made" and are tailored to meet the desired objectives by transfer and expression of the desired type of gene to a target plant. Transgenic varieties of crops are being produced around the world. Satellite imagery and remote sensing are making rapid progress.

Some developed countries monitor crop yields of other countries to help their own exports. India is strong in the area of remote sensing technologies. We have our own high-resolution remote sensing satellites whose pictures are used

all over the world commercially. We also have excellent capabilities in utilizing remotely sensed data for various applications: groundwater targeting, soil salinity assessment, crop yield estimates, and so on.

In addition, space technology can be used very effectively to assist extension work: disseminate success stories to farmers, educate them with do's and don'ts, and help them ask questions through talk-back facilities that can be made available through satellite. A number of experiments conducted by ISRO in this regard in Maharashtra and Madhya Pradesh have to be extended to other states in a major way. Our farmers should and can be given facilities to keep pace with advances in agricultural technology. Yes, it is a lot of effort. But we have plenty of talent and also the resources.

Vision

It is difficult to express this vision and action in few words. However, to focus on crucial issues, we have attempted to list a few important items below:

- o India to aim to be a major player in the world in the agricultural sector and a leading exporter of grains and other agri-products.
- o Eastern India to become a major producer of wheat.
- o Rice-producing areas to use hybrid seeds on a large scale.
- o Central India to be made a center of vegetables, fruits, pulses, and coarse grains.
- o More emphasis on tuberous crops.
- o Water as a national resource and water management as the key to agricultural prosperity.
- o Core postharvest technologies to be mastered and disseminated.

- o Steps to educate farmers about what is happening elsewhere, if needed by providing them the opportunity to travel, and use of space technologies to facilitate interaction and encourage farmers to ask questions and share experiences.

"Let noble thoughts come to us from all sides." R.V. 1-89-1

Plato mentions in his Laws (174-f) and also in Utopia that in an ideal state the range of economic disparities should be within 1:16. If the range of disparity increases marginally, the state is less ideal. However, if it increases considerably, the state is either a Democracy or an Oligarchy. The rulers in both tend to be tyrannical, corrupt, and hypocritical. In his metaphysics, Plato says that the soul of virtuous people becomes lighter and goes toward heaven by moving upward after death and that of the non-virtuous, being heavier, stays near the earth and is the cause of rebirth. On rebirth, people may be born in families professing different faiths, religions, as well as in the different regions of the earth. Plato thus becomes one of the few ancient philosophers who gave a perfect philosophical theory on secularism and universal brotherhood.

In an ideal state, which he described as Republic, divine guidance is the maximum and in Tyranny it reaches its minimum and world dissolution comes when that divine guidance is totally withdrawn. Plato's observation of 1:16 immediately connected my thought process with the philosophical views of Mahatma Gandhi who used to say that in an ideal state i.e. Ramrajya, the income disparities between the rich and the poor should be between 1:10. The actual disparities in India are now much beyond 1:1000 and still going up. If this trend continues in India, his Ramrajya will remain a utopia. Aristotle did not suggest any such ratios but like many other Greek philosophers recommended

the concept of " golden mean ". Buddha had already advised the " middle path ". The Vedas and Bhagavad-Gita strongly advise moderation for an ideal way of life to achieve perfection.

This drift from political philosophy to metaphysics continued till we came across vastly different six Schools of Indian philosophy popularly known as the Sad Darshana and found that all these Schools are based on Vedic metaphysics and Upanishads thus creating unity in diversity. During this search from political philosophy to the Vedic metaphysics one wonders whether these lovers of wisdom like Socrates, Plato, Immanuel Kant, Yajnavalkya, king Janaka of Videha, Sankracharya, Ramanujam and many others were ordinary human beings or devas (shining ones) as mentioned in the Vedas.

Throughout my life we avoided reading the scriptures, fearing that I might become a fanatic or fundamentalist or live in a world of hallucination. However, we would read the celestial song Bhagavad-Gita occasionally, as we did not find any organized religion there. It is a didactic book mainly on spiritual science containing an ethical social philosophy relating to nishkam karma-action without any self-interest and sankhya yoga-path of knowledge.

After retirement, we made an attempt to study certain other scriptures particularly the holy Koran in Urdu script (Roshan Chiragh) and its English translation by N.J. Dawood one of the Penguin classics. Other scriptures studied were Old and New Testaments, a few Upanishads, Patanjali's Yoga Shastra and four Vedas (English translation by Arya Pratinidhi Sabha and also a few volumes translated by Swami Satya Prakash Saraswati). A large number of other books on philosophy and metaphysics were obtained from various libraries in India and U.S.A. Most of the didactic books of Hindu dharma and Sikh religion mentioned that the highest scriptures are the Vedas. Adi Grantha-the sacred book of

Sikh religion says, "asankh garantha mukhi Ved path". It literally means there are countless scriptures but the most sacred is the study of Vedas.

Vedas are derived from the root Vid-*i.e.* knowledge. Vedas thus means, "store house of knowledge" and Vedic dharma is the spiritual science based on knowledge described in a large number of hymns in four Vedas. In book X1X section 22 and 23 of Atharva Veda, knowledge is described as study and complete understanding of bhutas (elements), matter, society and social organisations physical and social sciences, primordial subtle matter, divine Nature Prakrti, Soul, spirit and God. Surprisingly none of the scriptures and the books on philosophy and metaphysics refers to various types of religions now being practiced in India and abroad. Probably the soul of the scriptures is now missing in these ritualistic and organized religions prevalent throughout the world. The study of Vedas would reveal that the Vedic religion is a spiritual science and it contains all the major material, spiritual and divine thoughts/guidelines conveyed in all the other scriptures of major religions of the world.

However, Vedas contain some additional knowledge not available in other scriptures like, certain permanent truths/ findings of physical sciences, mathematics, state and society, medicine, role of a ruler, bureaucrats, scientists, industrialists, economics and many others. Being scriptures for the welfare of mankind, no specific religion is mentioned in Vedas.

Although the roots of Hinduism lie in the Vedic dharma and metaphysics, a close scrutiny would reveal a wide deviation. Vedic concepts like Rta-cosmic laws of social and moral order, "Idd Nan Mmam"-nothing for self, all for the society, the role of supreme Mother Prakriti-the divine Nature in the creation of animate and inanimate life under the supervision of God and many others, are hardly seen in the

organized Hindu religion today. In the Vedas, the God is Ajo (unborn) i.e. there is no incarnation of God as a human being, no worship of God through idols, being formless, omnipresent and ineffable. The Vedic metaphysics has a striking resemblance with the holy Koran and Grantha Sahib. The most sacred scripture of the Sikh religion Grantha Sahib says,"Ved, Kitab kaho mat jhoote, jhoota woh jo na vichare." Do not say that the Vedas and the holy Koran are not true scriptures; the individual who does not study them is an untruthful person.

Ishta theory of Vedas describes paths could be different so long as End is the welfare of mankind and other animate and inanimate life. Vedas do not consider matter as inert and explain in a large number of hymns that matter has unsuspected vitality. All paths, religions should aim at unity in diversity i.e. should lead to universal brotherhood (viswa bandhutva), global family of the same One God (vasudhaivan kutumbkam), global trade and global market for the material and spiritual welfare of mankind. God being formless, ineffable and self created avoid explaining God through categories, substance, activity, quality and relationship. HE is beyond cognition, perception of human senses, logic of mind and intellect. Words recoil to explain the Supreme Reality. Only true and harmonised material, spiritual and divine knowledge (para jnan) can unite all religions to compete with each other for the welfare of mankind.

The study of various scriptures of Hindus revealed that the most sacred scriptures are the Vedas. Next in importance are the Upanishads, Brahma Sutras, Smritis, Puranas, Ithasa or epics i.e. Ramayana and Mahabharata and the lastly the Tantras and a large number of minor later scriptures like, Hanuman Chalisa, etc. This precedence of importance is not uniform for all the Hindus as for some Ramayana or Mahabharta could be more important than Smritis and Braham Sutras. Bhagavad-Gita is partly based on the Vedic

metaphysics; hence some learned Hindus consider it as one of the Upanishads.

However, by and large the authority of all the Hindu scriptures is thus subordinated to the Vedas which as a whole are Karma Marga i.e. path of selfless action-nothing for self all for society. The Vedic metaphysics is Jnan Marga i.e. the path of knowledge. This knowledge brings out clearly the ultimate significance of all material and spiritual things. The Vedic Rsis and Munnies (metaphysicists and wandering sages) had found the substantial essence of all these things in the scheme of Reality, thereby unifying the absolute Truth. Vedas have a concept of absolute and perfect truth based on a-priori knowledge against material and imperfect truth influenced by our outward looking mind and physical senses. Material truths being imperfect are never permanent and vary considerably amongst individuals.

The Vedic science of Axiology covering idealistic, ideational and sensate values is entirely based on permanent truths in the form of Rta, which are the cosmic laws of social and moral order. Yajur-Veda 7-14 clearly brings out that the noble thoughts made the culture of the Vedas the first and foremost foundations of the edifice of universal values. Through the Vedic mantras (poetical hymns) homage is paid to the Rsis of the yore, path makers and pioneers (R.V 10-14-15 and A.V 18-2-2). Mundaka Upanishads 1-1-3 mentions that having known Vedanta, all other knowledge will stand revealed to us.

Vedas are thus the acme of human thought and the metaphysics reaches its summit in the Vedantic philosophy contained in the fourth and last part of the Vedas in the form of pure idealism and absolute monism. Vedas are also known as Shruti-the heard. Most of the modern Hindus believe that the Vedas were directly revealed by God and were not fabricated as later the ancient dreaded materialists Charvakas found and criticised these divine revelations.

Adi Grantha says, " Omkar Ved nirmaye." It literally means Omkar (God) revealed Vedas.

Vedic wisdom covers the Cosmic working at all levels, from micro-cosm to macro-cosm. It covers material, temporal, secular, spiritual, and divine knowledge by blending both the inner and outer worlds. In the concept of Brahma as the only Reality, the highest metaphysical ethics is reached, as all else is Maya (appearance or phenomenon but not exactly mirage). Maya is His Creative Art (R.V 6-45-16 and 6-47-18). Isvaraya Upanishad explains this as the illusory but blindingly brilliant disc, which appears real to human senses. Holy Koran also confirms that life in this vast ocean of matter-the material world is an illusion of comfort. Plato held largely similar views in his theory of Forms and Ideas. Immanuel Kant described the phenomenal material world as phantasmagoria.

However, the great Indian saint and philosopher Sankracharya explained this concept of subtle Prakrti (Nature) and gross universe as Maya in great details in his Brahma Sutras. First he made a clear distinction between para jnan (higher knowledge) and apara jnan (lower knowledge). He called the knowledge of senses, matter, physical body and the outer world as lower knowledge or Avidya. With this knowledge the entire universe looks "real." Individuals with lower knowledge will find a lot of arguments in favour or against the existence of God. He called it a peculiar phenomenon of human senses. Many atheists like ancient Charvakas, though not believing in the existence of God, describe the unforeseen cosmic power as Adrsta-not seen. For the theists with intellectual knowledge, multiplicity of gods is seen in the form of idols, icons and incarnation of God as a human being. Some such individuals even find God/god as partly a man and partly a woman (Ardhanari Iswaran). Any individual who starts moving towards higher knowledge, all arguments start and end at One formless and

ineffable God who is Sat, Chit, Anand-the only reality, supreme consciousness, and bliss.

The material and intellectual knowledge of the outer world through our sense perception throws us in perpetual Flux. In the present age the concept of para jnan has virtually disappeared. Priests, fake gurus and even various cults to amass enormous wealth now freely utilize the sensual and intellectual knowledge and camouflage it as higher knowledge. In some cases their coffers are already bulging out with lucre, gold and real estate. With the spread of this sensual knowledge in many areas including science and industry, man is finding himself in wilderness and is running hither and thither to seek peace of mind. Taking full advantage of this wilderness, there is a mushroom growth of gurus, saints, swamis and even cults through out the world. As most of them try to combine both para and apar jnan, so a strange kind of spiritualism not contemplated in the Vedas is now spreading fast. Ignorance/ne-science (ajnan) is now freely parading as divine knowledge in sacred places of pilgrimage and the various headquarters of gurus and cults.

In the social science of Axiology, Vedas contain trinity of values Trivarga. To help forging chaos into unity, there is a need to follow the Vedic metaphysics with its total perspective. The Vedas survey life in its entirety and are most suited to the present age of materialism. The hierarchical and organised religions of today is not able to define the ideal life, highest virtue, goodness, gentleness and many other noble concepts. The treasure of such a noble knowledge is freely available in the Vedas. The philosophy contained in the Vedas can certainly help in taking out the cobwebs created by various religions through mythology, unscientific rituals, ostentatious and proxy worship, blind faith and hallucination apart from certain weeds of the mind, like destructive, revengeful, selfish and other wild thoughts.

The eternal philosophy of the Vedas, with its social and spiritual messages remains always as fresh and blooming as flowers. The Vedic metaphysics not only help us to find our roots, but also answers hundreds of our doubts which most of us have. Why and how this world was created? Who am I? Where did we come from and were shall we go? Why I am here? Do I come back or just become manure for the earth? What is an ideal way of life? Think of any material, spiritual or philosophical question, the Vedas have answers to all such questions. The ancient wise sages, who did speculative transcendental research to find permanent truths, came to the conclusion that any effort to change or modify them will rebound. Such truths are a-priori, being directly from the immortal human soul. Only empirical knowledge based on sense experience like physical and social sciences gets modified with the passage of time. The root of greatest error in metaphysics lies in projecting our sense experience and perception, criteria and even preferences into objective universe, which leads to the concept of good and evil relative to each individual. This results into various human beings ascribing different attributes to God. For some, God is saguna Brahma with a form and finite number of attributes and for others an impersonal God who is ineffable and formless i.e. nirguna Brahma. For them God is "That" and not He or She and is described in Vedas as Tat Tvam Asi i.e." Thou Art That".

The study of the Vedas would reveal that the discoverers of permanent moral and spiritual truths were from both sexes. They were Rsis and Rsikas (male and female seers), Munnies (wandering sages), Rudrais and Adityas, who had studied till the ages of 36 and 48 years respectively. In the Vedic education system, a student at the age of 8 years would start learning elementary knowledge of matter, spirit, soul and Brahma-the ineffable and formless God. Rudrais achieved the specialization of Brahma Jnan (the supreme

knowledge) latest by the age of 36 years. Adityas achieved the highest specialization between the ages of 44 to 48 years. Some of the learned wise men and savants mentioned in the Vedas are Vashishta, Aiterya, Viswamitra and others. The female Rsikas (sages) were Vishvara, Gauri Veeti, Archana, Aiterya, Lop mudra, Godha and others. There is no mention that the Vedic truths contained in various hymns/mantras were discovered by them. The very fact that various hymns are attributed to them probably indicates that these hymns were first interpreted by them and translated from the Vedic bhasha (language) to Prakrit bhasha, a precursor of the present Sanskrit language.

The Vedic hymns as parts of social engineering describe nature, properties and action of all material and non-material things. The names of those male and female seers, metaphysicists and wise men, who did research to discover various Vedic truths and emptied out all their knowledge in the Vedas in various hymns, are not mentioned. Their aim was perhaps Moksha (salvation)-a stage of permanent bliss not for themselves but for the entire humanity. Thus they became the silent, unknown pathfinders and pioneers for the entire mankind of all ages. The Vedic scriptures are meant for the mankind of all ages and not for any particular time. Period, religion, sect or cult It is a separate matter that some learned Indians, Germans, Greeks and others have taken inspiration from Vedic metaphysics.

We aer too small to comment whether the Vedas are directly from the God as Shruti or revealed to the Rishis and Munnies during their transcendental research or these are apriori principles and truths. However, the fact remains that the Vedic hymns have come to us in their original form after passing through various civilizations, benevolent to highly authoritarian governments, with all possible diverse interpretations in the six major schools of Indian Philosophy known as Sad darshna. The dreaded materialists like

Charvakas even used vulgar and abusive language against Vedic seers and went to the extent of saying that the future promises of good life are the promises of cunning priests and bearded sages. During the long journey of over 5,000 years, the Vedas were respected, worshipped and even criticized by people of various temperaments, nature and ideas. While the materialists like, Charvakas challenged the Vedic truths, Advaita Vedantists like, Sankracharya found the highest ethics in the Vedic metaphysics. The Vedic truths have been challenged, criticized but never proved wrong. The long history of over 5,000 years is a clear indicator that the Vedas, which are the acme of human thought, should be studied with an open mind and without any bias. Bhagavad Gita describes the study of the Vedas as the highest virtue (16-1 to 3).

For the study and understanding of any philosophy and metaphysics one can utilise either inductive or deductive approach. Any other approach can lead to hallucination, biased imagination and even highly unscientific outlook. This third approach has already crept in certain sub-religions having roots in Vedas and taken away the spirit of Vedic metaphysics particularly philosophy of idd nan mmam-nothing for self all for society. Due to this unscientific and biased approach and lip sympathy to the study of Vedas the social evils are increasing rapidly.

The scientific method to study scriptures could be either inductive or deductive. Inductive approach may appeal to many intellectuals, as it needs some kind of material proof of metaphysical concepts. However, we have seen that material discoveries based on scientific principles, laws and concepts do undergo change with the passage of time. Twentieth century particle physics has greatly modified Newtonian classical mechanics. In the inert atom of scientists of the earlier centuries, some vitality has been observed in this century and some metals e.g. steel feels "fatigue" like

human beings. The deductive method of finding common and permanent truths contained in various scriptures, philosophies, metaphysics and other didactic books will never undergo any change. These truths are for the guidance of all human beings in all ages. The deductive approach would certainly help to know Vedic metaphysics without any religious or personal biases and all kinds of hallucinations like seeing the inner light of the soul during mediation etc; would disappear.

The study of Sama Veda would reveal that the focal point is Brahma-the impersonal God. However, in the other three Vedas, particularly Rig-Veda, the focal point is the individual, or rather-the "Self", which is the divine principle of the body. When the immaterial "real self" and the gross body are in harmony, you are at peace with yourself; otherwise you become your own enemy. Senses in the human body when get independent of "self" become like wild horses not knowing where to go, what path to tread and when and where to stop. Thus these senses independent of "self" (manifested soul) take a person on the path of ruin. For the harmony of body and soul Vedas advise the pursuit of matter on the path of Rta and Dharma i.e. by observing the cosmic laws of social and moral order and righteous conduct. Such a pursuit does not create any ill effect in society. The only paradigm of achieving a perfect society as well as ecological sustainable development is to grow around the pivot of need-based living with simpler life styles based on the principle of moderation.

What is admirable in the Vedas is that their powerful and comprehensive philosophy was created for all ages and for the entire mankind. This philosophy was made available at a time when most parts of the world had hallucinations of ghosts getting out of dead bodies, when shadow was interpreted as the soul, spirit, ghosts, and the soul was considered to be getting out of the body at night during dreams. It was the period when the concept of inner and

outer world was highly confused. Out of fear complex the ancient man worshipped snakes, animals, plants, and clouds by creating millions of gods with form. When in most parts of the world the religion of animism was wide spread, the Vedic metaphysics was getting developed in the areas which now lie in the states of Iran, Iraq, Afghanistan, Georgia, Pakistan and some Northern parts of India. Arya Vrata was the land spreading up to Parshavas (Persia), Ariana (later Iran) and this land was not a fairy tale country, since the Vedas nowhere describe mythology as part of metaphysics.

Vedic hymns accord different importance to 33 devas (beings of light) of divine Nature (Prakrti). These devas have no form and represent various attributes of Prakriti.. Indra deva represents power and strength of Nature, Agni deva signifies energy, Usha devi represents time, discipline and dawn, Prithvi (benign mother earth) as self less service, Surya as light, Savitar as supreme knowledge, Ashvinau deva represents both physical and spiritual characteristics of the entire matter in the gross universe. Because of this, scientists in the Vedas are described as Ashvinaus. Rsis and Munnies discovered the treasures of Vedic metaphysics and cosmic laws probably at different periods of time and also at different locations widely apart.

Perhaps this is the reason that in the Vedic hymns importance accorded to 33 formless devas varies considerably. In Rig Veda Indra, Varun, Mitra devas are more important and in Atharva Veda Agni deva is given more importance and is even described as "lord of vows". However, all the four Vedas confirm that the sum total of the attributes of these 33 beings of light are the attributes of Prakrti described as supreme Mother of all animate and inanimate things/life. These devas are the physical forces of the divine Nature which has epithets like Aditi, Devaki and also Daivi. These epithets have certain meanings. Owing to vastness she is Aditi (infinity), she is also the mother of all 33 formless devas

and supreme mother of all of us, hence Devaki. Being divine She is given the epithet Daivi.

In the absence of regular script and printing material the Vedic metaphysicists and wandering sages kept the Vedic hymns alive for a few thousand years by highly scientific techniques. First, they converted these truths into hymns and poetical mantras for easy chanting and memory. Thereafter they devised a system of Yajna. All the students were to participate in this Yajna and recite Vedic mantras over the holy fire (Agni). Agni deva in the Vedas is mentioned as " lord of vows" and symbol of purity and energy. Gayatri mantra is the mother hymn through which we pray to God to provide us perfect knowledge during our three states, i.e., awakening, sleeping, and even during our dreams. The spirit behind this prayer is that we spread this knowledge, so that we could also shine like Savitar-deva, representing the Sun. Various hymns/mantras for Yajna describe Brahma-the impersonal God, Prakrti and Rta-cosmic laws of social and moral order.

Many of these hymns end with the words Swaha and also Idd Nan Mmam i.e. nothing for self, all for the society. The word "swaha" has a great significance as it means that we have understood and appreciated the meaning of the mantra and we shall follow it in true spirit in our day-to-day life. With the word swaha those attending the Yajna offer some samagri (fragrant material) and splinter of wood each time to Agni (holy fire), confirming to the lord of vows that we shall follow what we have spoken and appreciated (R.V 1-97-1, Y.V 8-13). Atharva Veda 4-39-10 enjoins that offer the splinter of wood only when you feel cleansed by heart and spirit i.e. when you sincerely want to pursue the path of knowledge.

In this way the Vedic hymns and philosophy contained there in, continued to be followed with all sincerity and

devotion for a long period till a regular script and language along with some writing material became available. Most of the hymns containing metaphysics were compiled as Rig-Veda-the oldest of all the four Vedas. Those hymns relating to meditation, prayer and stuti (praise) of Brahma (the only Reality) were compiled in Sama Veda. Vedic Rsis continued finding more permanent truths, which were compiled in the Yajur Veda. Some metaphysical concepts and also certain hymns are repeated in the four Vedas probably due to the fact that these were compiled at different periods of time and also at different locations. Gayatri mantra-the mother hymn is repeated seven times in the different chapters of Vedas.

The main pillars of the Vedic philosophy are:

(a) Idd Nan Mmam, nothing for self, all for society,

(b) Rta which literally means divine Laws, are the cosmic laws of social, moral and physical order,

(c) trinity of values-dharma, artha and kama.

(d) four purushartha which comprehensively cover trinity of values (trivarga) and moksha-perfect bliss.

So, the Vedic dharma is just not a theology, but covers morals of the individuals, ethics for society and creation of material wealth for the mankind.. The Vedas do not advise any creed or cult but good and virtuous conduct for a happier and better society. Thus the Shrutis (divine revelation) aim at a social, spiritual, and moral ethics apart from the natural ethics of materialism. Whatever does not lead to social good is not intelligence but avidya or ignorance and if virtue is not achieved, it is not wisdom. Vedas are against fetishistic religion of spirits, images, idols, and toteism of sacred animals. It is more like the religion of Lao-Tse i.e. the Tao or the WAY. It aims at binding yourself to the laws of God.

A large number of hymns are relating to artha-Vedic economics as part of four pursharthas i.e. dharma, artha,

kama and moksha. These four noble pursuits should be followed in harmony and under the guidance of Vedic dharma (scientific faith in righteousness based on true knowledge). Vedic economics is for the creation of material wealth for the mankind and not for any individual or section of individuals. The entire mankind belongs to the same One Life-the spirit of God. The Vedic artha refers to production, distribution and consumption on the firm belief that matter is not inert and has unsuspected vitality and so it its utilization should be need based on the principle of moderation.

One hardly finds any life negation, asceticism or paganism in the Vedas as commonly believed. Vedic hymns tend to show that they recognize matter more like a knife-both useful and destructive. Its destructive power due to anartha (material economics bereft of spiritual science) lies in creating greed, lust and desire to hoard tons of money, exploitation of human beings, animals, and even the mother earth. Extreme lust and greed lead to doubting the existence of one universal God, soul and even manas-inward looking mind. Then gross body and sense pleasures become everything. Such an outlook and attitude become the cause of lack of compassion for other human beings. Vedas also recognise the usefulness of matter. There are a large number of hymns with prayers to God to provide all types of material welfare (corn, children and prosperity) to all members of society. All the individuals are trustees of the material wealth/things and not their owners. Thus the emphasis is not on life negation but need-based living, non-craving, non-attachment to material things, right livelihood on the principle of "golden mean". Vedas are not otherworldly; rather their concern is the individual, society and the entire world, animate and inanimate life. The Vedic metaphysics thus creates a lordly realm and open to us all the secrets and puzzles of the Cosmos. These are omniform (Vishwa rupa) R.V. 1-72-2 and universal in their reach.

These Shruti deal with a large number of subjects including education, physical, social and military sciences, various duties of elected ruler/king, queen, commander in chief, bureaucrats etc, apart from many metaphysical concepts, a few subjects along with their spiritual discoveries can be briefly mentioned. Vedas refer to five classes (Panch Kshtinam) based on professions in any society. Four classes or varnas are based on divine professions and the fifth class (kshtinam) is that of avarnas, vritras, kimidin etc., who follows non-divine professions and spread social evils in the form of hydra headed corruption in society. The corruption in the Vedas is described as having nine heads and as such is hydra headed and enters through 99 sources in the gross body (Sama Veda 913). Those individuals, who do not follow the Laws and Commandments of God described in Vedas as Rta, constitute the fifth non-divine class.

These laws are also explained as laws of necessity, laws of Nature, cosmic laws of social and moral order. The members of this 5th kshatinam tend to exploit all animate and inanimate life on this earth and are always in pursuit of tons of money, power, status and are insensitive to the creation of social disorder in society. In their anti-social activities, the four well harmonized noble pursharthas (pursuits) disintegrate and artha tends to move towards anartha (material economics).The ideal societies have less of the fifth non-divine class and more of those individuals who follow divine professions for the welfare of all the members of society as well as the mankind.

No society can become an open and transparent and flourish without the predominance of four divine varnas/ professions which are allotted to the individuals through a comprehensive Vedic education system extending till the age of 48 years based on merit, capacity and aptitude but not on birth. The allocation of various divine professions (varna) is based on the success or failure in the examinations

held at different ages under this education system. Those who do not perform the duties assigned to them after the result of their performance in various examinations constitute non-divine class of vritras and avarnas as they spread evil in society. The ruler's (elected President or hereditary king); duty is to keep this class of avarnas away from the individuals following divine varnas. The celestial Golden Age or Vedic Krita yuga is the one where the 5th non-divine class does not exist at all.

The Dark Age or Kali yuga has the predominance of avarnas and vritras. In this Age owing to spread of only material and intellectual knowledge bereft of divine and spiritual knowledge, the predominant features are superstitions, unscientific outlook, blind faith, hypocrisy, naked selfishness and wide spread corruption. Fake gurus and god-men who get hallucination that they are the incarnation of various gods/God on this earth multiplies. Thus Vedic metaphysics meant for the guidance of human beings of this Dark Age is largely ignored. However, the study of Vedas would reveal that Vedic gurus (Gu-darkness and Ru-to dispel) are the dispellers of both inner and outer darkness. They are more like Socrates, Mencius, St Augustine, Immanuel Kant, Sankrachrya, swami Daya Nanda and Gandhi ji and do not bear any resemblance to the modern god men, gurus, babas, tantriks and swamis.

The real "self " of the individual described in Vedas as Jivatma (manifested soul) has no sex. It is only the gross body, which is described, as "body self" is either male or female. While the subtler than the subtle human manifested soul is imperishable, the gross body is perishable. All our good or bad actions, desires and thoughts create subtle atoms (kanu) and particles (tanmatras) which go on accumulating like, iron files on the magnet on the human soul and become cause of rebirth till one achieves Moksha-the stage of eternal bliss. This stage can be achieved by proper understanding

of the Vedic metaphysics. While the soul (atma) is consciousness and a subtle particle of God, the spirit (jiva) in all animate and inanimate life/things is part of the cosmic energy. No hymn could be located in the Vedas which tend to indicate that soul is found in all the billions of living cells of human beings, animals, birds or fishes etc., while the spirit is found in all kind of animate and inanimate life. It is due to the presence of spirit in the subtlest part shuniya (void) that even inanimate things are also not inert.

The Vedas accord a very high status to women in an ideal Vedic society. She is the first preceptor (guru) of her child till the age of five years. Both male and female children are entitled to similar kind of education. As women are also to get complete knowledge of military science, Vedas enjoin that during the war if the king is injured or dies the queen should become the chief and guide the commander in chief of the defense forces. As regards marriage she has a noble right to choose her life partner. A few Vedic hymns strongly recommend the institution of Svayam vara (self-choice) for the bride to select the bridegroom. Love marriage is advised which is Gandharva marriage and if both parents also agree to their son and daughter's love marriage, then it is the highest form of marriage i.e. Brahma vivah (marriage blessed by God). Marriage of bride and bridegroom of almost equal intelligence, education and merit is advised.

During the later periods of ancient Indian history, there had been a large number of women who became Rsikas (female metaphysicists and lovers of wisdom). In the 8th century B.C rsika Gargi was one of the most prominent female metaphysicists during the benevolent rule of philosopher king Janaka. Incidentally Bhagavad Gita refers to king Janaka as the most perfect and ideal king. Amongst 33 Prakrti devas, who are formless "beings of light", a number of them are mentioned in the Vedas as female devis (shining ones) like, Usha (dawn), Prithvi (mother earth), Saraswati

(in-charge of education and music), Agni (holy fire) and others. A number of hymns in Rig-Veda 1-73--3, 3-53-4, 1-66-5 refer to Agni as female by describing deity Agni as spotless like the spotless wife, loved by her husband. Most of the other hymns in the Vedas describe as Agni deva. Based on different attributes Agni is mentioned either deva or devi. Since they are only "beings of light", sex is not important in describing them.

For describing hydra headed corruption and other social evils, there are a large number of hymns describing the harm these evils do in society. Rig-Veda 1-104-3 refers to corruption in the form of bribery and other evils as misappropriation of public funds or what results in the reduction of state revenues. Rig-Veda 1-43-3 says, bribe takers are thieves and they are therefore, avarnas-the followers of non-divine activities and professions. Sama Veda describes corruption as a social disease, which goes on increasing with all material treatment and makes the power of the soul weaker. Yajur Veda 30-22 advises the ruler that such people of low character, evil minded and corrupt in their actions, should not be allowed to mix with others to avoid spread of their vices in society. Rig-Veda and also Bhagavad Gita mention that all those individuals who lead life of material excesses are sinful and have corrupt minds. The ruler is advised to limit their material possessions. Rig-Veda (2-2-12) even mentions that all such corrupt persons face gloom through their children. Some later scriptures of Hindus also mention about corruption and the gestation period of this evil is about ten years, when the poison spreads in the gross body, mind and later also in the family.

There are a large number of hymns regarding the duties of Ashvinau (scientists) and Ribhus (manufacturers and industrialists). The joint efforts of both should be welfare of mankind, which constitutes one Global Family (Vasudhaiva kutumbkam or Vishwa kutumbkam). There are hymns, which

mention about the maximum speed possible for ships moving on the waters of vast oceans and aircraft flying in the air. The ships if designed after proper knowledge of the properties of various elements, water and air, can traverse the entire earth in eleven days and from one main ocean to another in three days. The aircraft can go round the world three times a day. Probably this speed has not been achieved so far both by ships and aircraft. There is also some mention of distance between the Sun and the earth, moon and the earth, the movement of the earth around the stationary Sun, force of gravity, magnetism, electricity hidden in water, telegraphy and particle physics. There is life in the gross atoms and particles, as the spirit of God is present in all animate and inanimate life. There are a large number of hymns in the Vedas particularly in Rig-Veda relating to medicines, toxicology, physical sciences, agriculture science etc. It is necessary to provide a separate chapter in this book on Vedic science and scientific outlook.

Another very important subject covered comprehensively in the Vedic metaphysics relates to MAYA, which is the cosmic illusion of this material and phenomenal world. Most of the Upanishads, Bhagavad Gita and metaphysics of seers like Sankracharya, Ramanajum and a few schools of Indian Philosophy (sad darshana) deal in great details about Vedic Maya. The ancient Greek objective idealist Plato also found the material world as a phenomenon and not absolutely real. The pure idealist of Germany Immanuel Kant described the world as phantasmagoria. There is only One ineffable and formless Supreme Reality, all else is Maya. The personal God Isvara with a large number of attributes is the God of the phenomenal world of Maya, which leads to many gods (Isvaras) all compatible with the Supreme Reality but lesser deities. Iswara is the god who rewards, punishes and arbiters on your past and present karma for your successive births, which take place in the realm of Maya. The Vedic metaphysics

advises to get your "self" released from Ishvaras and get absorbed in Brahma-the formless Supreme Reality. These Ishvaras help the individuals on the path of knowledge (jnan Marga), in their movement towards One God, who is merciful and benevolent. This One God is Vedic Brahma, Guru Nanak's "Ek Om Kar", holy Koran's Allah and Bible's Father in Heaven.

Based on the degree of material, spiritual and divine knowledge one has acquired, the Vedic metaphysics is understood differently by different people. It is perhaps for this reason that six schools of ndian Philosophy explain the Vedic metaphysics differently. There is absolute monism and pure idealism in the metaphysics of advaita Vedantists. There is subjective idealism in the philosophy of qualified monists popularly known as vashisht advaita Vedantists and complete dualism in the paramarth of dvaita Vedantists. Some learned persons even find traces of atheism in the Sankhya and Mimansa darshana as these two schools of Indian philosophy tend to give more emphasis to Nature-the supreme Mother as in Sankhya Darshana and scientific rituals, ceremonies along with complete knowledge of Nature in the Mimansa philosophy. These two schools find God as "Adrsta"-the unseen Cosmic Force. Yog Shastra of Patanjali tells us that Vedic God is only a supreme and first preceptor (Guru) who helps us in learning faster the yogic concept of Kaivalya-knowing your self. On self-realisation at the stage of Kaivalya, a person can even communicate with his / her soul. Even without reaching this stage of kaivalya, many modern gurus, their disciples and followers claim that they see the inner light and can communicate with their souls while under the vehement effect of Maya. It is nothing but hallucination-a stage when a person gets into utter darkness.

The Vedic metaphysics give great emphasis to Prakrti-the divine Nature, which is the supreme mother of all the animate and inanimate life. The inanimate life is not inert

except that it has not even one indriya (sense) like plants and trees, which are animate having one sense of touch. Most of the germs, protozoon, amoebas etc., have two senses. Animals have five senses. While human beings have also five senses but they have in addition divine soul that makes the man as "divine animal". However, the supreme mother Prakrti provides all the five-mahatatva (main elements) of water, air, fire, ether and earth to all animate and inanimate life along with the spirit of God, which is the energy principle of all kinds of life. It is this energy, which is subtle in form and stays in "Shuniya"void of all particles (tanmatra) and atoms both subtle and gross (kanu and anu) and provides the properties and characteristics to all elements (bhuta). Incidentally Vedas mention 720 elements (bhutas) in the universe. So far physical scientists have found less than 150 elements on this earth.

Prakrti being effable has a large number of attributes unlike God who is ineffable. For easy understanding of the attributes of Prakrti, Vedic metaphysics has provided 33 sets of Nature's attributes and made one deva / devi as incharge of one set of attributes. Vedas have 33 formless devas like, Agni incharge of heat and electricity energy as holy fire and "lord of vows". Savitar deva is incharge of knowledge, brilliance, Surya deva as Sun incharge of light energy and provider of all kinds of food, happiness etc. Prithvi devi the mother earth is having attribute of selfless service and others include Indra, Varun, Mitra, Yama, Ashvinau etc. These devas are thus 33 forces of Nature.

When a person starts moving towards Jnan Marga-path of knowledge, he/she passes through various stages of theism, atheism, agnosticism, pluralism, dualism and some time even animism etc; but God helps him/her movement towards One Supreme Reality. Thus there are personal gods/isvarsa in this world of phenomenon and their number goes on multiplying during the various stages of ignorance. Material

and intellectual knowledge bereft of spiritual and divine knowledge is ignorance (avidya) in the Vedic metaphysics. It is only when one finds One Supreme Reality, which is Absolute Truth and Perfect Love; he/she comes to know that wise men of entire world have given to the nameless God, a large number of different names. Vedic metaphysicists named Him Brahma as He is manifested behind Brahamand-the ever-expanding universe and cosmos. They also named Him Visnu-One who pervades everywhere in the Vishwa (Universe) and also Shiva-the most pure and auspicious.

Since He is Formless, the sages and seers of yore discovered Him through their transcendental research in the cosmic Word-O.M and described this Word as Shabad Brahma. There after the Vedic rsis and munnies gave one of the most important hymns in the Vedas "Om Khamma Brahma" (Y.V.40-17). OM Thy name is God. While the epithets of God as Brahma, Vishnu, Shiva appear in some of the hymns, the cosmic Word O M appears a few hundred times. Vedic metaphysicists have thus conveyed their permanent findings to the human beings that God is available to us only through Shabad Brahma O M and not through idols, icons, statues and stone carvings. Since He pervades everywhere as Vishnu and also lives in the subtlest part of the human heart, the gross human body provided by supreme Mother Prakrti (divine Nature) is the temple of God. The Vedas enjoin that keep gross body always neat and clean with noble thoughts, selfless desires, and activities for the welfare of mankind and other animate and inanimate life. The metaphysical logic takes us further to need based living, get rid of all non essential rituals and ceremonies, avoidance of all kinds of pollution, environmental hazards and not treating the mother earth as quarry for exploitation.

All the 108 Upanishads have been derived from the later parts of Vedas. Bhagavad Gita, six schools of Indian philosophy, later Brahma Sutras of Badarayna, Sankracharya

and others also contain mostly Vedic metaphysics. I have taken certain ideas and thoughts from these scriptures as well. These scriptures are not theoretical constructs, but born out of spiritual experience and transcendental research of the ancient seers, sages, pathfinders and metaphysicists. Their aim was more to guide the mankind towards noble and virtuous path than their own welfare.

Through Vedas and other Vedic didactic Books and Brahma sutras these lovers of wisdom gave us perfect models of open and transparent society, religion as a spiritual science and many other models. Later Vedic Dharma became a spiritual adhesive to which a large number of sects, cults, religions, panths, minor groups and societies, philosophies, thoughts, ideas steadily got glued and formed a vast Hindu religion. Hindu religion and Hindu dharma are vastly different. While Hindu dharma has its roots in Vedic/ Upanishad metaphysics, Hindu religion hardly bears any resemblance to this.

A few other Vedic concepts can be described briefly. Purpose of life is to fulfill the mission of God based on His commandments/laws (rta). We are all co-workers for the prosperity of mankind. Life is a gift of supreme Mother Prakrti (divine Nature), beautiful life is the gift of harmonized divine, spiritual and material knowledge. When the trinity of this knowledge is broken, even divine or spiritual knowledge becomes ignorance/ne-science. The highest charity (daan) is charity of knowledge as it saves human beings from degeneration and helps in opening the eyes of individuals towards spiritual brotherhood of the entire mankind belonging to same One Life. Man is both social and divine animal. Following a-priori knowledge known to the partly omniscient manifested soul in human beings makes him/her as divine animal. This manifested soul (jivatma) is the cause of individualism. The spirit (jiva) in the human beings enables a person to become social animal and assists a person to

develop universal friendship (viswa bandhutva) and universal family of one God (vasudhaivan kutumbakam).

There is also a prayer in Vedas "O, God give me wrath against social criminals and non divine people (avarnas) who obstruct in the development of universal brotherhood. Many hymns refer to transparency during elections, develop subtle thoughts with inner linkage and do not depend solely on the logical thoughts with outer linkage i.e. cognition based on sense perception. Such logical reasoning leads to multiplicity of thoughts, ideas and materialist philosophy in any society. The power of vivek (discernment) starts diminishing as confusion about the concept of right and wrong spreads everywhere. Avoid searching of God through images. Many other concepts like duties of parents, children, husband, wife, members of society etc are mentioned in sufficient details. In regard to food it is advised in Vedas that develop taste in mind and eat to ensure nourishing of body and spirit. Eating for nourishing your body only is sinful. Strictly avoid eating food purchased out of filth lucre/tainted money obtained through nine kind of hydra-headed corruption like bribery, exploitative profit, hypocrisy, speculation, gambling etc. Develop firm belief in the non-violence of the strong and help those who are physically, spiritually and morally weak. Many other concepts, which human beings should know for their own and others welfare are mentioned in these scriptures.

Vedas also describe in great details the models of ideal education system, human conduct, science of Axiology with idealistic, ideational and sensate values, welfare economics, global trade, ideal polity etc. In view of the perfect knowledge contained in these Shrutis, Shatapatha Brahmana rightly says that the highest sacrifice, worship and prayer to God, is the sacred study of Vedas. Rig Veda 1-72-2 and 8 mentions that the greatest service to God is to spread the spirit of Vedas with honesty, straight forwardness, without deceit of

any kind, for all to enjoy true and spiritual happiness. Utilising the philosophy, metaphysics, knowledge and various models contained in the Vedas, we can perhaps find viable solutions to our present social, economic, political and religious problems.

Certain comparable thoughts, expressions and concepts, I have also taken from the eminent philosophers, learned individuals, writers and others, some times without mentioning the original source as these were mentioned in "Sat Sang"-spiritual gatherings, discourses on divine knowledge and even in certain news papers and magazines. My lapse apart from my ignorance, is due to having got these ideas, thoughts and precepts during spiritual assemblies, religious discourses at many places in India and abroad and particularly the "Sacred Space" of the Times of India-a popular English Daily published from New Delhi. A few sacred thoughts were finalised after my talk on Vedic metaphysics on 28th April 1997 in the California State University at Fullerton (Orange County) Los Angeles (U.S.A.). This talk was followed by about one hour session of questions from the audience consisted of students from U.S.A. Japan, Korea, Mexico and other countries and Dr. Saddiqi a learned Doctor of Philosophy. The questions mostly related to Hindu religion as perceived by the West i.e. highly ritualistic, unscientific in outlook, belief in 330 millions gods, human sacrifices, tantrik philosophy, idol worship etc.

Thus this book has in reality most of the contribution from others both in India and abroad. In fact, it is the other individuals' contribution, particularly my wife (seeker of spiritual knowledge through Raj Yoga, mediation and studies of scriptures) and a few close friends who helped me in making my thoughts on Vedic metaphysics more clear and precise within my limited capacity and ability. However, we have also tried to give references and quoted relevant sources to the extent possible within my knowledge and capacity.

For my limitations, ignorance and lapses the great metaphysicists, philosophers, savants, learned writers of the ancient, medieval and modern times in India and abroad wherever they are, should pardon me.

Since in the Vedas the focal point is the individual and material prosperity is also important to him, I have taken the chapters relating to Vedic society, Rta-the cosmic laws of social and moral order, Vedic science and scientific out look, Hydra headed corruption in the beginning. The chapters relating to spiritual knowledge i.e. Prakrti-the supreme Mother and Maya-the Vedic phantasmagoria have been taken after wards. The chapter relating to divine and spiritual knowledge Atma, Jivatma and Jiva (soul, manifested soul and spirit) has been taken before the last chapter i.e. "The Supreme Reality". While I consider that all the chapters contain to a certain extent material, spiritual and divine knowledge, the scheme of distribution of chapters to that extent is arbitrary.

As earlier brought out that Vedas were compiled later and for over thousand years for want of regular language and printing material, over 17000 mantras, riks and hymns remained known to seers, sages, students and even certain members of society. When compiled certain hymns got repeated completely or partially like, Gayatari mantra-the mother hymn is repeated seven times in the four Vedas. A close study of such hymns would reveal that the repetition had certain purpose to harmonise divine, spiritual and material knowledge of the various subjects relating to society, physical sciences, body and soul, Nature, matter and spirit. It is for this reason some repetition might be perceived by the readers in a few chapters of this book. This has been deliberately done to harmonise daivic, adhyatamic and bhautic jnan of Vedas mentioned in Book X1X of Atharva Veda. It is considered necessary to ensure that the spirit of Vedic knowledge remains in all the chapters.

The study of Vedas also reveals certain other salient aspects like, man is both social and divine animal, philosophy of life confirmation and not negation, no fetishistic religion, analytical and synthetic approach and need for developing scientific temper. The importance of "We feelings" in society has been mentioned in a large number of hymns in the four Vedas along with the need for universal out-look in social ethics. The food and land ethics described in these scriptures is as certain as mathematics. Since the matter bereft of spirit is the cause of human misery, sufferings and transitory pleasure, the Vedic metaphysics tend to combine spirit with matter in many of the hymns, while retaining the focal point as the individual. Thus their metaphysics is not otherworldly and also it is meant for the present Kali Yuga-the Dark Period of the celestial Age.

The analytical details of various concepts while inquiring into their values, ideal possibilities of matter, spirit, ontology, philosophical and material psychology, role of divine Nature, inward looking mind "manas" and outward looking turbulent mind "etani", both divine and false ego i.e. "I" becoming part of the whole or when whole becomes part of the real self "I" and many other, give us complete epistemology along with comprehensive divine, spiritual and material knowledge. Even the abstract metaphysical concepts relating to Time and Space (Kala and Dis), human life is too short and insignificant in time and space and need to get detached to matter by avoiding material excesses has also been brought out.

In the present age of naked materialism based on the belief that matter is inert, extreme selfishness and highly unscientific outlook, Vedic knowledge is not the requirement of a certain section of people in blind pursuit of money. However, there are a number of fence sitters having doubts, queries and keenness to know the right path and conduct. They could to some extent benefit from this Vedic knowledge,

which has survived a few thousand years of criticism, doubts, controversies and even religious fanaticism and still remains unaffected being an absolutely true and perfect knowledge for the mankind of all ages.

After the study of Vedic metaphysics, it may be observed that what other scriptures of all the major religions in the world describe divine, spiritual and material knowledge, Vedas had already told the then mankind. However, Vedic economics, science, state and society, education system, universal brotherhood, global trade and many other concepts for the welfare of mankind are rarely found in other scriptures. There is a need to study Vedas as a humble pupil of rsis of yore than as a judge over their transcendental discoveries. This approach is necessary with a view to avoid any distortion coming in the understanding of their ethical metaphysics. Most surprisingly Vedas allow further improvement after discussion in Vidhata-spiritual assembly of human beings of all faiths and religion. It is a separate matter that after Atharva Veda no further improvement/modification has been made to Vedic metaphysics.

SCIENTIFIC TEMPER AND VEDIC SCIENCE

In the Vedas the focal point is the human being and the knowledge contained there in is for the welfare of the entire mankind. This knowledge also helps the human beings to develop scientific out look. The Vedic science is only in the context of his/her material and spiritual welfare. Unlike the present day, physical sciences are part of Vedic metaphysics, which unequivocally explain that physical sciences pertain mostly to the external world that is objectively real and not absolutely real.

To get a feel of Vedic physical sciences, reference to a few hymns are given in the very beginning. The Sun never sets or rises and it is the earth, which rotates (Sama Veda121).

The gravitational effect of solar system makes the earth stable (R.V.1-103-2, 1-115-4 and 5-81-2). The axle of the earth does not get rusted and the earth continues to revolve on its axle (R.V. 1-164-29). The science of Time and its subtle nature is described in (R.V.1-92-12 and 1-95-8). The need to study the properties of water, air and fire for discovering and manufacturing aircrafts, ships and other vehicles capable of moving in the firmament, land and water are mentioned in Rig Veda 1-3-1,2, 1-34-1, 1-140-1 and many other hymns. Reference to infinite number of both gross and subtle atoms and the energy principle as spirit of God in each atom is given in R.V. 5-47-2 and Sama Veda 222. Atoms and sub atomic particles are not inert and have unsuspected vitality owing to this energy principle. Physical sciences relating to agriculture, medicine, astronomy mathematics particularly algebra, toxicology etc. are described in R.V.1-71-9, 4-57-5, Sama Veda 121 and many other hymns.

However, the greater emphasis is on the development of scientific temper amongst the members of Society with a view to curb spread of blind faith, hypocrisy, miracle and ostentatious worship of God. Thus the knowledge of Vedic sciences is meant to save the human beings from falling in utter darkness as Isa Upanishad and the last chapter of Yajur Veda caution us. The unity in diversity is the message of Vedic physical and metaphysical sciences. While matter is the cause of diversity owing to three primordial subtle particles of purity, activity and passivity present in it, the spirit (jiva) provides the necessary unity.

The physical sciences have traversed a long journey of over two thousands years independent of Vedic metaphysics. During this long journey they came to certain contradictory conclusions. Many scientists held that the Sun is moving and the earth is static and vice versa. The gross matter and its atoms are inert as observed by the scientist of classical mechanics and now in the 20th century particle physics have

found that atom is no longer inert and matter also experiences "fatigue" and many more contradictions. The Vedic science remained consistent during all this period. However, science is now itself proving in the laboratory some of the Vedic scientific truths.

In the 20th century with the bursting of atom into pieces through particle physics, faith in the Vedic science has grown stronger. The atom is no longer inert and has unsuspected vitality. Vedas had already mentioned about 4 to 5 thousands years ago the existence of "spirit" (Jiva) as energy principle in all gross and subtle atoms. Chhandogya Upanishad says, "From this engenderment beams of light shot up and down, gross matter was formed and Prakrti-the divine Nature too expanded in all ten directions, as the Sentient One spread Itself every where-high, low, here and beyond." Rig-Veda (5-47-2) refers to infinite number of both gross and subtle atoms born from the Eternal Cause. The subtle primordial matter is the cause of origin of gross matter and spread itself every where like the light of the Sun and go round the earth and sky.

Vedas thus in a metaphysical language tell us the existence of rays, waves, wavicles and even subtle particles in gross atoms and all consisting of subtle primordial matter of three gunas. It is the Creative Force-the spirit, which hides behind animate and inanimate things/ life, moves us, move the planets and moves the Universe. Sama Veda 222 describes the same scientific truth as; "HE keeps His wonderful form in every atom and pervades earth, middle region and the sky." Rig Veda 1-81-5 and 1-83-2 mention about the subtle cause of this vast Universe in the form of various kinds of atoms and particles. The atoms follow the eternal laws described as Rta in the Vedas. Rig Veda 1-22-18 says, " HE ordains these laws". Vedas even refer to subtle particles (tan matras), which are more powerful and fast moving than gross atoms, and particles. Such subtle atoms

and particles are found in ether, light, Time and Space in the outer phenomenal world and also exist in the inner world of divine instruments. Thus such subtle particles are found in manas-the inward looking mind, buddhi-intellect etc. These finer atoms and particles are not seen through sense organs, or any material instruments.

It has taken over 4000 years for the scientists to find out in the laboratory that gross atoms are not inert, which Vedic sages and seers had already found through their transcendental research. It may perhaps take another a few thousands of years more to find subtle atoms and particles but certainly the scientists will not find these in laboratory with the help of gross instruments. The "Ashvinaus"-the epithet for scientists in the Vedas, have to utilize their inner divine instruments for the welfare of mankind on the principle of Idd Nan Mmam-nothing for self all for society. The ignorance of scientists, economists and even religious leaders about the subtle atoms has now become the major cause of over exploitation of the earth as a quarry, leading to all kinds of pollution, environmental hazards and other moral and social degradation. Finding no divinity in matter, man's ego exploitation continues and he finds even a sense of pride in this negativity, duly supported by modern physical sciences bereft of any spiritualism.

While some of the Greek philosophers observed four main elements, Vedic metaphysicists had found five maha bhuta i.e., earth, air, fire, water and ether. There is life in the gross atoms of maha bhuta though an ordinary person bereft of spiritual knowledge cannot visualise. Lucritus explains this phenomenon beautifully. When you see fighting men at a distance or from a height, you will perceive them at rest owing to limitations of our sense perception. Same way we find block of steel at rest. The inner life of steel, human beings cannot perceive. What philosophers in the West and Vedic rsis and munnies in the East, found a few

thousands years ago was found in the laboratory only in the 20th century. An eminent Indian scientist Sir Jagdish Chander Bose proved this metaphysical finding. He found with the help of gross instruments in the laboratory some kind of "fatigue" in metal just like human beings. Gross atoms even in an inanimate thing are born, develop and lose vitality and die. They have mind of their own.

In the early 20th century scientists went on experimenting and finally made the gross atom burst into pieces under the impact of particle Physics and Chemistry. Since then science is changing very fast and too frequently. Biology is changing rather fast from one certainty to another. One day it is all environments and another day is hereditary and next day both combined. Psychology which refuted consciousness which in the Vedas is due to the presence of divine soul in the gross body, has started feeling its existence but without linking it with the manifested soul (Jivatma). The eminent scientist Eddingnton's proposition says, "recognizing that all the physical world is entirely abstract and without actuality, apart from its linkage to consciousness-even time and space are spun out of consciousness." In atom a large number of sub-atomic particles have been found, including some waves and wavicles and no material nuclei at the bottom. Unlike Vedas where science is part of metaphysics, the modern scientists are largely resisting its merger with the science of soul, beauty and virtue, which Bhagavad Gita describes as the sovereign science.

Today, a large number of scientists, engineers, doctors, physicians, surgeons in India and abroad are in search of their inner world through various cults, god men, swamis and sub-religions but still feel hesitant in openly declaring the urgent need of merging science with spiritual knowledge and metaphysics. Many of the Indian scientists still argue that the existence of Vedic knowledge about atoms, electricity, aircraft, space ships etc.; is not a reality but at best a scientific

fiction, mythology or a fairy tale. Their argument is highly superficial, as Vedas nowhere mention that such devices actually existed in the ancient Vedic period ranging from about 3000 BC to 1000 BC or even later. The Vedic hymns only advise the Ashvinaus (scientists) to continue their research in the laboratory as well as in their inner world; they will succeed in such discoveries and inventions for the prosperity of entire mankind. They should do their research on the philosophy of Idd Nan Mmam, which is Vedic enlightened liberalism, i.e. nothing for self all for the society.

As regards the creation of earth and life on it the modern scientists are coming to new discoveries that all life came out of inanimate things. The world itself came in to existence owing to Big Bang or intense energy but still would not like to call it Cosmic Energy of the God. In the beginning there was no life of any kind but after millions of years some rudimentary life emanated, sperms, protozoon, bacteria or any other type of life from inanimate things. Plants that could move for food became animals and animals that could stand on their legs became human beings. Prima facie all scientific conclusions are moving towards Vedic science and metaphysics. Since modern physical sciences have inherent limitations of sense perception and intellectual outfit of human beings, scientists are not sure whether to link their scientific conclusions, discoveries with Vedic science. However, the fact remains that scientists know less about matter today what they thought about a century ago. In the Vedas Creation is linked to Cosmic Word "OM", which caused immense cosmic energy. This Energy got converted mass as Hiranya-garbha (Cosmic golden Egg) When it opened/burst, subtle primordial matter of three gunas started appearing and when the same joined in appropriate proportion, gross universe was created in stages.

Scientists are now doing their best to know the complete properties of all the elements on this earth as known to them

today. However, they have not succeeded in the laboratory to know how these elements got their properties, what is the cause of various scientific laws and many other a priori principles of the divine Nature? It is in these areas that Vedic metaphysics help the ashvinauas and ribhus-scientists and manufacturers to get together for various scientific discoveries. There after they should move together or the manufacture of equipment, goods and other items for the welfare and prosperity of mankind throughout the world in the spirit of Vishva Bandhutva, which is Vedic terminology for universal brotherhood.

Some of the Vedic hymns tend to show that in the ancient societies there would have been a general atmosphere of superstition, mysticism, sorcery, animism and other negativities, which was perhaps creating an evil effect on the members of certain closed societies. It is perhaps for this reason some of the then metaphysicists, social reformers and preceptors did their long years of transcendental research with the help of their divine instruments of their inner worlds. Their sincere dedication and urge to fight the social evils savagely and effectively led to certain discoveries of permanent scientific truths. For a common man it would appear that God directly revealed these truths to those pathfinders. Hindus largely consider these Vedas containing these revelations as Shruti-directly heard from God. Guru Nanak-the founder of Sikh religion based on Vedic Dharma had observed, "Om kar Veda Nirmayi". God (Om kar) revealed the Vedas, so that one could distinguish between right and wrong, sin and virtue.

The ancient lovers of wisdom and pathfinders through their intuitive and speculative research found that material instruments like senses, sense organs, etani-out ward looking mind in any human body, give distortion to our sense perception. Under their influence we can mistake rope for a snake and vice versa, see big stars and planets as too small,

conch shells in water look like silver etc. Sankracharya observed, "He and His spirit can not be accounted for any logical reasoning or material sciences as our minds are limited by the finite world of phenomenon and illusory senses." Vedic rsis and munnies went into deep meditation, concentration and contemplation and discovered a large number of permanent laws pertaining to physical sciences.

For a common man to understand and apply these laws they devised a perfect model of education system to get dedicated scientists and manufacturers. Till the age of 5 years of a child, mother is the teacher. Between the ages of 5 to 8 years father is the teacher. From the age of 8 years to 48 years learned rsis and savants who were mostly the preceptors or gurus. Guru word is from Gu-darkness and Ru-to dispel. Thus Vedic gurus were dispellers of both inner and outer darkness of the students who are mentioned in the Vedas as Brahmachari-seeker of Brahma's knowledge. A number of qualifying examinations is mentioned at various ages of the students, but the first-degree examination is at the age of 24 years. Those who qualify this examination are fit to become rulers, officers in the Army and Navy, bureaucrats, scientists, etc. In the Vedas, there is no mention of Air Force any where as aero planes did not exist at that time. The next major examination is at the age of 36 years. Those who qualify are awarded the degree of Rudrais who are highly learned persons in various subjects including physical sciences and metaphysics. The last examination is at the age of 48 years and those who qualify are Adityas and they are akin to Prakrti devas (shining ones) of the Vedas.

At each stage of education the aim is to create scientific outlook amongst the students so that all superstitions, blind faith and conviction could disappear in society. The followers of non-divine professions like economic and social exploiters, tricksters and other evil minded persons only studied material sciences from false gurus and these students are described

as the students of ne-science. These students belong to the categories of Yatudhani, Kimidin, Vritras, Avarnas, etc., and their education under the guidance of false gurus is the cause of lack of scientific outlook in society. To save society from the spread of evils of blind faith, unscientific outlook and physical sciences bereft of spiritual science and metaphysics, the rulers have been advised to segregate such people from others who are followers of divine and noble professions.

In the Vedas scientists are described as men and women of absolute self-control, truthful with scientific outlook and destroyers of miseries (R.V., 1-3-4). With the help of these scientists one could travel far on the earth and also in the sky through conveyances, which run and touch the middle region (R.V., 1-3-1, 6-22-2 and 1-22-2). Such scientists from both the sexes go across to distance places quickly like the mind and electricity (R.V., 1-71-9). In this hymn aircrafts and even space ships are hinted. These ashvinaus should be well versed in Physics, Agricultural sciences (R.V. 4-57-5), Medical sciences (R.V. 5-74-3), Astronomy (S.V. 121) and other sciences. Ashvinaus have been advised to learn thoroughly about Prakrti (Nature), characteristics and various qualities of water, air, fire, electricity and heat and sound energy. Other sciences mentioned are Toxicology and use of various kinds of medicines and drugs (R.V 1-191-14), science of Time (Kala vidya) that starts with dawn (Usha). R.V. 1-95-2, and 10, refers to use of time for mathematics. There is a mention of infrared rays, study of Algebra (Rekha di ganit vidya), sound as a medium of knowledge for various sciences, diseases like bile, cough, jaundice and others and their treatment etc. The relevant hymns in this regard are in Rig-Veda 1-185-2, 1-12-1, 2, 1-22-1 to 4, 1-2-3, 1-95-1, 1-101-1 and many others.

The Vedas combine science with metaphysics and clearly mention that it is God who is the giver of knowledge of all

sciences as "Sahstra sam " (R.V. 1-10-11). The scientists are advised to study cause and effect of all material elements and also how the objects are produced and there after utilize these properly (R.V. 5-47-3). By following these guidelines they can alleviate much sufferings of the people (R.V. 5-77-4). Without the knowledge and practical application of physical sciences, it is not possible to eradicate poverty and attain prosperity (R.V. 1-34-1 to 5).

The philosophy of Advait Vedanta or absolute monism is more like modern science. The universe is made of one substance i.e., matter whose form is perpetually changing. While the sum total of the entire energy in the Nature remains always the same, explanation of things in the entire substance are to be found within their own nature. No external beings or existence are required to explain what is going on in the universe with its corollary of a self-existence universe. Modern physical scientists now concede that the sensory and intellectual outfit of the scientists inviolably limits science. There is some thing beyond gross atoms but human senses and material instruments have not succeeded in finding these out. Thus there is indirect confirmation of the scientific version of the concept of Vedic Maya (phantasmagoria). Amongst the Indian metaphysicists, Advait Vedantist Sankracharya explained this concept of cosmic illusion in great details in his various commentaries and Brahma Sutras. In the West, Plato and later Immanuel Kant also observed this world of phenomenon perceived as real by human senses. Sankracharya had thus anticipated the modern scientific notion that we get only glimpses of the world and the universe owing to our inherent limitations.

Mind only interprets whatever is fed by the senses and owing to inherent limitations of knowledge, gives a distorted picture of the categories of the subject, time and space. Bhagavad Gita distinguishes two kinds of mind, i.e., Etani and Manas. Etani is outwards looking mind influenced by

the senses and external phenomenal world and as such has inherent limitations. Manas is inwards looking mind and gets a priori and a posteriori knowledge both from the outer and inner world. Since the modern scientists do their research based on the data obtained from the external and phenomenal world without the help of their inner divine instruments, their findings very often get modified. Particle physics is vastly different from the classical physics. Newton's laws of motion stand greatly modified with Einstein's theory of relativity. The matter of Tyndall and Huxley was inert and indestructible, but now it is no longer inert and has a mind and spirit in itself as per the metaphysicists and "energy" as found by particle physics scientists.

Vedas bring out that every thing material/immaterial, every form contains the spirit of God, and all else is illusion while Sankracharya prefers to use the word delusion. This Vedic knowledge is the basis of Vedanta school of Indian philosophy and particularly Advait Vedanta of pure idealists like Sankracharya and Badrayana. It is only such scientists who can do their research based on self-control, scientific out look, truthfulness and can be destroyers of human miseries as mentioned in Rig Veda (1-3-4). Thus according to Vedas the physical and natural sciences are part of the over all design of God. This metaphysically explains that in spite of the Vedic findings in regard to physical sciences being ignored, questioned, challenged and criticised without actually knowing these, but till date these have not been proved wrong. The truths contained there in are being proved in stages.

Gautma Rsi and other seers and sages of Nyaya School of Indian philosophy who based their metaphysics on Vedic knowledge consider the Sristi (Creation) as Leela (cosmic play) of God, who has fashioned the universe by His "Will" out of ever existing atoms. God being divine Will, divine Desire, omniscient, immanent and formless, produces motions

in atoms by His Will and the entire process of Creation and Dissolution (One Cosmic Cycle of Sristi and Pralaya) of the universe starts. Laboratory tests of the scientists of the ancient, medieval and modern periods are steadily moving towards the above spiritual truth of the Vedas. If we consider Newton and Tyndall's atom as inert, we may call it only as material truth of that age or in the Vedic metaphysical concept as impure and imperfect truth.

It was not a spiritual truth as those scientists overlooked Vedic "spirit" of God in the void of all gross atoms. Vedas even mention the presence of this spirit as energy principle in "tan matras", which are subtle particles. This energy principle first entered the primordial subtle matter in the form of three gunas of purity, activity and passivity and spread thereafter in different five maha tatvas and 720 tatvas (five main elements and 720 elements). Thus the Supreme Being spread Himself in all directions upwards, down wards, here and beyond. Incidentally out of 720 elements in the entire gross universe mentioned in Vedas, scientists have so far found about 150 elements on this earth.

Rsi Kanad of Vaisheshika School of Indian philosophy entirely based on Vedic metaphysics, had already observed the phenomenon of Flux. Einstein has, now confirmed in the laboratory, the Flux observed both by rsi Kanad and later by Buddha.

According to Einstein most of the particles in the sub atomic world live for short period of a small fraction of a nano of a second and change to other particles, while some of those behaving like waves and wavicles. This flux in atoms is a continuous process. Einstein also made certain metaphysical observations in regard to this flux in atoms, like God does not play dice and in all probabilities God has kept some "hidden variable" responsible for this activity. Einstein could not find out this hidden variable during his

lifetime and left a major scientific question for future particle physicists and advised them to continue doing research to find this variable.

This research has led to electron clouds, waves, quarks and even inter connected events "Quaritian Foam" in the atoms and universe. James Jean has gone to the extent of saying that objective reality of atoms and sub atomic particles is only events. When these events inter-connect gross atoms get formed. This scientific truth now found out, tends to show that there is some thing subtle like events on which the gross universe is formed and the subtle invisible power is more real than gross atom and universe. It is this subtle power which gives properties and characteristics to atoms of various elements. The hidden reality always remains real and atom is only illusory and part of the great flux in this phenomenal world. The laboratory test are moving towards that direction which Nyaya School said that the spirit of God or His divine Will living in void (shuniya) produced motion in all atoms. It is a separate matter that the physical scientists are still hesitant to describe the atom as an illusion/delusion of Vedic Maya.

As brought out earlier the physical sciences in the Vedas are part of the Design of the God, who is described also as "Vishwa Karma"-the supreme designer and architect of the universe. All these designs are based on Rta that are permanent truths and are His laws of social, moral and physical order. Through these Rta the physical sciences and the ideal human conduct are inter-connected since the focal point in the Vedas is the individual and his/her welfare. The Vedic Rta tells us that all human activities relating to love, hatred, affection, anger, desires, selfish and selfless actions have a circular motion. According to Vedic metaphysics these actions contain non-material subtle particles and their movements are in circular motions and come back to the individual with a bigger force. Thus all movements of the

material and non-material (love, hatred, etc.) matter are in a circular motion. While gross atoms are the cause of Flux, the accumulation of subtle particles on the manifested soul (Jivatma) of the individual is the cause of one's rebirth. This movement of births and rebirths of the manifested soul of an individual continues till one reaches the outer biggest Divine Circle. Thus the subtle particles of love, selfless service, truthfulness and other positive karma take a person towards Mukti, which is the final liberation, or salvation towards bliss.

Those individual who move towards the outer and bigger circles are normally more straight forward, as even the straight line is part of a bigger circle. It is the subtle primordial matter of inactivity, untruthfulness, hatred, hypocrisy and anger, which make the individuals move towards smaller and smaller circles. It is not possible to get any straight line there and hence such individuals are crooked, hypocrites, ungrateful, deceitful and avaricious. They even acquire many other negative qualities. This circular motion is also in the case of gross particles, atoms, earth, moon, planets, etc. Only those individuals with positive virtues and having complete knowledge of Vedic metaphysics and apply the same in their day-to-day conduct reach the outer most divine circle and attain bliss and even avoid rebirth in this phenomenal world. Material and intellectual knowledge bereft of spiritual and divine knowledge leads to mundane desires, blind pursuit of money, power, status, etc., which make the persons move towards smaller and smaller circles necessitating innumerable births and deaths, misery and sufferings.

Both the Vedas and Bhagavad Gita say that spread of the knowledge contained in these scriptures i.e. Vedic metaphysics and Sciences, which help in bringing scientific outlook amongst the individuals, is the greatest service to God. In the absence of this knowledge and outlook, individuals continue to move towards smaller and self-centered circles.

These persons have vague concept of society, spiritual brotherhood and their love, service and even worship of God is more a ritual and ostentation than their yearning of the soul. In the phenomenal world of matter, the material concept of three sets of circular wheels for the airplanes (Viman), 4 wheels for Ratha, i.e. vehicles moving on the ground and circular movements of the moon and planets is mentioned in many Vedic hymns.

For better appreciation of the Vedic science and various scientific truths mentioned there in and discovered by the ancient pathfinders and metaphysicists through their intuitive knowledge and transcendental research, can be mentioned in brief. Since number of hymns relating to Vedic science is in hundreds, this would only give the feel of Vedic physical sciences, including mathematics. Rig-Veda contains a number of hymns relating to sun, explaining both its physical and metaphysical characteristics. As regards the physical science, it is stated that the Sun never sets nor rises and it is the earth that rotates (Sama Veda 121). Rig Veda describes that the earth moves round in space and revolves around her pitram-the Sun. Pitram in the Vedas means father. Metaphysically Usha (dawn) and Prithvi (earth) have been mentioned as the daughters of Sun god (Suriya deva). In the Vedas the word deva relates to formless beings of light or the shining ones. The word god is not the exact translation of deva though it is the closest English word for deva.

Owing to the absence of Vedic knowledge in the Western part of the world, the scientists and astronomers of the ancient and medieval periods considered the Sun as moving and the earth as static. They modified their findings only during the 15th and 16th century when Copernicus put forward a novel theory that planets including the earth revolved around the Sun. The great astronomer Gallileo was even kept under house arrest for supporting Copernicus's theory. Even much before Copernicus, the Indian astronomer

Aryabhatta independently with the help of material instruments in his laboratory confirmed like a true Vedic ashvinau (scientist) that earth revolves around the Sun and confirmed scientific truth mentioned in Rig and Sama Vedas. Incidentally astronomy is a major science in Vedas and astrology independently is nowhere mentioned as part of physical sciences.

Through the scientific methods of decoding certain astronomical code hidden in Rig Veda, Dr. Subhash Kak-a computer scientist at the Louisiana State University has found the mention of distance between Sun and the earth as well as moon and the earth. According to this finding Rig Veda mentions as a part of its cosmic science this distance as 108 times Sun Diameter in respect of Sun and the earth and 108 times moon diameter between moon and the earth. Modern astronomical studies have found the actual distance as 107.6 and 110.5 times respectively against 108 times mentioned in the Vedas. A news item published in the Indian Express dated 31-3-1993 (Ambala edition) about this remarkable accurate value can be referred to.

Owing to this Vedic rsis and munnies have observed some divinity in this number 108. The ancient sages have compiled the Vedic metaphysics into 108 Upanishads. Some of the more important Upanishads are Katha, Keno, Mundakaya, Iso, Chhandogya, Brihadarnayaka, Isvarya and Aiterya. mongst the Vedic Hindus, the term Shri 108 is used for those spiritualists, preceptors and other highly learned and divine persons who have read and understood 108 Upanishads. Later certain Rsis (sages) devised a Vyjanti mala (rosary) with 108 beads/stones for keeping count of mantras (hymns) during the worship of God. Litany or Jap Yagna-a set form of prayer mentioned in the Vedas are OM Khamma Brahama (OM Thy name is Brahama), Ayam Atma Brahama (my soul is a part of God), Ekam Tat (God is One), Tat Tvam Asi (Thou art That) and many others including

the mother hymn i.e., Gayatri mantra-prayer to God to provide us His divine, spiritual and material knowledge.

In the astronomical code hidden in Rig-Veda, solar year was calculated as 364.24675 days. This figure is very close to 365 days with adjustment of one day in a leap year. Considering that time was not calculated in hours, minutes and seconds as at present, the accuracy of calculation by Vedic rsis assumes greater importance. The hidden code in the Vedas leading to above calculations has been worked out by two computer experts Dr. Subhash Kak of Lousiana State University and Mr. David Frawley of the American Institute of Vedic studies (Times of India dated 8-5-1993). Rig Veda mentions that all calculations in mathematics are made i.e. duration of the year; month, day and four cosmic periods based on Sun. Mathematicians and astronomers are advised in the Veda that all calculations of time should start from the divine and brilliant Usha (dawn). Formless being of light Usha devi is described as the brilliant daughter of the glorious Surya deva (Sun). She represents dawn and time in Prakrti. Even the calculation of Pralaya and Sristi (dissolution and creation) of the universe are based on Dawn and also the Sun, after taking into consideration the gravitational effect of the entire solar system (R.V. 1-115-4). Rig-Veda 1-95-2 refers to ten directions based on the rays of Sun, with four main directions i.e. East, West, North and South. Obviously Vedic seers divided directions into an angle of 36 degrees, each which led to the discovery of the Sun watch used in ancient India.

It is the sun which upholds the earth, which rotates very fast all the time owing to Sun's gravitational force and it makes the earth stable (R.V., 1-103-2). Savitar is the alter Ego of the Sun (Surya) that controls and provides energy to the earth by itself remaining stationary. It makes the earth move, provides light and even its rays are the cause of lightening in the clouds apart from providing gravitational

force to the earth (R.V. 5-81-2). The earth revolving and going round the Sun like a calf following the mother is mentioned in R.V 1-169-9 and 1-190-7. Earth surrounded by air on all sides, revolved on its axle and measures the set path. Lightening and energy are its main manifestation; its axle does not get rusted. R.V 1-164-29. Ether is the ocean of sound waves. Sun, stars, earth, other planets and the entire Nature exist on the basis of indestructible syllable "OM" which is the cosmic Word described as shabad Brahma in the Vedas. There is a mention that human beings should spread this Word OM in the sky/ether which helps in making the earth stable and free from environmental hazards, pollution and other evil effects. Reading and reciting the Word OM as well as litany (Jap Yagna) i.e. OM Khamma Brahma (OM thy name is God) has been advised by the Vedic rsis.

In many hymns the Sun as a source of energy is mentioned. Rig Veda 1-62-2 advises the scientists to use solar heat energy for conveyance. Solar radiations are invoked to kill the disease producing germs (A.V., 2-32-1 and 2-31-1). Sun is mainly referred in he Vedas as the source of light, knowledge, fire, heat energy, seven colours of light, killer of harmful diseases affecting plants, human beings, animals etc., Sun is a source of knowledge both for the physical scientists and metaphysicists. Sama Veda 121 says that the earth which revolves round itself with a great speed and also around the solar system does all this peacefully without giving any jerks to all animate and inanimate life and thus links physical sciences with metaphysics. It also says that this is not the property of matter bereft of spirit.

It is due to the spirit of God pervading both in the Sun and the Earth and also due to gigantic Design of Brahma the only supreme Reality. The human beings should protect the earth revolving very fast like a deer by observing and following the permanent laws of social, moral and physical

order ordained by God and described as Rta in the Vedas and other scriptures of the Hindus. Such brave people who observe and follow these Rta help in the preservation of land (earth) (R.V 5-75-11). The science of Time is also linked with the Sun and his daughter Usha devi (R.V 1-92-12). Each dawn reduces life span of the matter in all animate and inanimate life and it reminds the human beings to set a proper timetable from morning to night. Owing to its subtle nature Time should never be wasted. All mundane, material and spiritual duties should be discharged punctually as per the timetable fixed with reference to the dawn (R.V 1-95-8).

In Rig-Veda 1-139-10, various physical sciences are compared to rain water. The progress of mankind is only possible through various physical sciences which are like rain water and extremely useful for the prosperity of entire mankind. Human beings should accept only truth and give up untruth (R.V 1-139-2). Scientists like other learned people should be twice born (Dwi jati). The second birth is by wearing the sacred thread in the presence of Agni deva (holy fire) by taking a pledge to serve the society (R.V 1-140-2). Agni deva is the epithet for holy fire and he is described as " lord of vows " in the Vedas. Since these devas and devis are formless beings of light their description as male or female is only symbolic as some hymns did give the impression that holy fire is both Agni deva and devi. Thus it is futile exercise to examine the epithets given to devas/devis by Vedic rsis in regard to sex as he or she. These 33 devas may be accepted as only " that "formless beings.

There are a large number of hymns through which the scientists have been advised to do further research and discover various kinds of conveyances, which could move in firmament, earth and the sea (R.V 1-34-1). Scientists in the Vedas are learned persons. They should be provided with house, bright and splendid conveyance and other facilities (R.V 1-140-1). Aeroplanes, machines, cars, vehicles, ships

etc., are very useful for rapid movement and for the development of trade across the globe and for enjoyment of mankind. For discovering such vehicles, the scientists should study the properties of water, fire, and air (R.V 1-3-1, 2). Those who understand the characteristics and various properties of air can discover vehicles for quick movement like airplanes (R.V 1-5-3). For the manufacture of vehicles moving in he air, need for nails, 12 fellies (ores), wheels, three axles, fire and water are mentioned in R.V 1-164-18. For achieving higher speed three sets of wheels are advised (R.V 1-34-1, 9). The term used is "Viman deye neshu" for such fast moving vehicles and for airplanes or any other kind of air craft moving in the middle region, the word "viman" has been used in a number of hymns. Go in the air and come back with ease like a bird.

Scientific knowledge is needed for enlightened life and good enjoyment (R.V 1-85-7). In Vedic metaphysics the word " good " is both material and spiritual and is part of social ethics and morality. Good does not apply to just enjoyment by senses as part of transitory pleasure. Rig-Veda (5-48-2) advises all human beings should make efforts to be in the company of the enlightened savants and obtain the knowledge of all kinds of physical sciences. A scientist should be master of true virtues, noble actions, good temper and both spiritually and materially wealthy. He should be able to go across the path leading to distant places quickly like the mind and electricity with the help of aircraft, space ships etc. He should be self-reliant R.V (1-71-9).

Ribhus (industrialists and manufacturers) as well as ashvinaus should jointly manufacture aircraft and other vehicles for movement in firmament, earth and sea. They should perform this noble job of manufacture without any pride based on the philosophy of Idd Nan Mmam-nothing for self all for society, which is Vedic concept of enlightened liberalism akin to Aristotle's enlightened selfishness and

mutual harmony (R.V 1-87-2). When wind, water and pieces of earth (steel, iron and other elements and alloys) are used methodically in the vehicles and driven by truthful artisans of righteous conduct and nature, wonderful results are achieved, like mother arranging every thing for a child who is source of a great joy (R.V 1-116-1). In all the hymns relating to physical sciences, inner and outer worlds of the scientists and industrialists are harmonised. Building of ships and aeroplanes are a source of national wealth, comfort and for going across the world (R.V 1-116-3). These vehicles bring prosperity for the people of the country of manufacture and also for the people in other parts of the world. The fast movement to distance places is described in Rig-Veda 1-71-9. Thus by harmonising materialism with spiritualsim, the physical sciences in the Vedas continue to remain part of metaphysics described in Bhagavad Gita as the divine and supreme science.

Though it may look rather strange and unbelievable in the first reading of certain hymns that Vedas mention about the aircraft, ships and space ships but also their achievable speeds. This is in spite of the fact that Vedas no where mention that such fast moving "Rathas" moving in the firmament, surface of the earth and all kinds of water, sea, oceans, rivers etc; ever existed there. Through the transcendental and intuitive research the ancient seers and pathfinders found certain likely maximum speed of ships, aircraft etc. Rig-Veda 1-116-4 mentions a speed, which can enable a ship to cross one main ocean to the other in 3 days and 3 nights. For going around the entire globe by sea and crossing all the oceans, the duration of 11 days and 11 nights is mentioned (R.V 1-34-11). Four boats should be tied to the ships for safety (R.V 1-82-6). Aero planes could fly in the firmament and acquire a speed to go across the world in four hours i.e. thrice a day (R.V 1-43-2). In this hymn if day is translated to 24 hours, then the duration of going across the

world by aeroplane is 8 hours. From these hymns it is apparent that ships and aircrafts can acquire still higher speeds if the scientists continue their research in this regard. In R.V 1-116-6 there is a mention of spaceship going in the firmament and other planets. R.V 1-118-12 even suggests that aircrafts should be tri-columned and with three sets of mechanical wheels. Ribhus should manufacture these aircrafts and other vehicles in such a way that sweet waters, food and other requisite articles are kept in these vehicles (R.V 1-118-1).

A few guide lines have been given to Ribhus and Ashvinaus to have a peaceful disposition, humility, self control, truthfulness and be devotees of God, obedient and disciplined (R.V 1-116-7). They should learn about such vehicles from savants who are either Adityas or Rurais. After learning they should aim at making the entire mankind happy and prosperous (R.V. 1-132-5). Those businessmen and traders who use these Rathas and Vaj-gatau (very high-speed vehicles and aircrafts) for spiritual and material profits bring material prosperity to the country.

Science of agriculture is mentioned in Rig-Veda 4-57-5. Canals full of water should have fresh and flowing water useful for he crops and for prosperity (R.V. 1-112-2). Concept of good seeds, regular weeding of the plants, scientific worship and performance of Yajnas with fragrant herbal material for the formation of clouds and consequent rains and other concepts are mentioned as part of Vedic metaphysics and also in the hymns relating to Rta and Brahamanas. A large number of Brahamanas based on Vedic scientific rituals and ceremonies have been separately compiled like Shatapatha, Aiterya, Kausikta and other Brahamanas.

Medical science and research is briefly indicated in R.V 1-141-5 and science of sound in R.V 1-144-7. Truthful medical researchers develop spiritual power. In the military

science use of lead in the manufacture of weapons and missiles is mentioned (A.V. 1-162-3). The king and other rulers should encourage medical sciences and assist those ashvinaus who help in making the gross bodies of people without physical diseases. The individuals should keep away from those scientists who are ignorant of the properties and characteristics of water, fire, electricity and other subjects relating to physical sciences. Individuals are advised in Rig-Veda 5-74-3 and 3-35-5 to avoid the company of those who do not encourage the scientists and also scientific outlook in society. Rig Veda 1-2-7 refers to the property of rusting the base metals due to the presence of oxygen in water and the pure energy in water is Kinetic energy.

Atharva Veda 2-5-12 refers to two kinds of electricity i.e. positive and negative along with its friendly and destructive use. The electricity is hidden in water and when it comes out, it spreads light and provides energy(R.V 1-16-5). Its use in weapons and telegraphy are also mentioned (R.V. 1-85-5 and 188-1). Because of heat energy in the electricity, there is need to have various precautions against electricity.

For electricity the words used in Vedic bhasha (language) are "Viduat Raksha." Viduat in Sanskrit is electricity and Raksha is protection. Agni (holy fire) also contains energy and electricity (R.V 1-45-5). Electricity protects people and should be used as destructive energy against wicked persons and enemies with the help of weapons, which work on electricity (R.V 1-86-9). A scientist who knows the nature of Time and all the properties and characteristics of electricity can accomplish his/her work very fast (R.V 1-95-8). Seven flames of fire are mentiond in Mundaka Upanishad (1-2-4). Without fire and air no substance in the material world can be sustained (R.V 1-26-1). Ashvinaus are advised to study all the proprties of water, air and fire.

The ashvinaus who know veterinary science comprehensively should be honoured (R.V 6-53-9). Owing to their research and knowledge, the animals can be well fed and they grow well. The cattle wealth thus increases (R.V 6-5-10). In the science of Toxicology the use of drugs which convert poison into ambrasia and removes the effect of poison in the human body, is also described with some details in Mandala 1 and Suktam 191 of Rig-Veda.

A few hymns in Atharva Veda (1-11-1 to 7) are devoted to childbirth like, foetus is surrounded by natural elements that move the child in the womb and prepare the woman for giving birth. A few more scientific guidelines are given in this connection. Rig Veda 1-85-2, 1-12-1, 2, 1-22-1 to 4 and many other hymns both in Atharva and Rig Vedas are devoted to description of various kinds of physical diseases in the gross body and their cure particularly bile, phlegm, cough, jaundice, head ache etc., The Vedic system of treatment of physical diseases popularly known in India as "Ayur Veda " has its origin in these scriptures.

The study of six schools of Indian philosophy based on Vedic metaphysics, reveals that atoms and their immense hidden power was known to ancient rsis and munnies and atomis theory in some details is mentioned in Nyaya Vaisheshika darshana. There are countless and infinite number of atoms each with their own "visesa," or particular qualities. Due to these visesa characteristics of the atoms even the movement of needle towards magnet occurs. It is due to combination of atoms with their particular qualities that phenomenon like mass, weight, fluidity, viscosity etc., occur in various bhutas and maha bhutas containing 750 elements and five main elements i.e. air, fire, earth, water and ether. Physical scientists have found so far more than 130 elements both natural and man made. If research continues on the philosophy of enlightened liberalism and with the sole aim of human welfare, more and more elements

will be discovered. There is every likely hood that some more elements are there in the earth, below the oceans and also in other planets. In the Vedic metaphysics atoms are described as "energy balls" as the spirit of God providing these atoms specific properties, prevails in them in their inner most part "shuniya" or void which is not gross. Only those scientists who firmly believe in the harmony of spirit and matter will finally prove in the laboratory more of the Vedic truths.

Rig-Veda lays great emphasis on the study of mathematics and particularly Algebra "Rekha-di ganit vidya vigyaya" (R.V. 1-95-1). Ten formed the basis of enumeration. Visnu Purana partly based on Vedas refer to the concept of time up to 3.1104 X 10 raised to the power 12. By decoding astronomical concepts like zero sign, decimal place, various values of digits, use of minus sign and letters to denote unknown quantities in algebra, various distances between earth and Sun, earth and moon, duration of each Kalpa (one cosmic cycle of four Yugas or celestial periods) of about 4.3 million years have been mentioned. Bhagavad Gita even refers to 2000 maha yugas i.e. equal to 4.3 X 2000 million years (B.G. 8-17 to 19). Buddha in his early education reported to have named 10 raised to the power 50 (Discovery of India-p.97, 98). Division of time was up to ... of a second and smallest linear measures approximately 1.37 X 10 raised to the power (-) 7 inches. Yajur Veda numbers up to trillion, which Bhagavad Gita also mentions. Arya Bhatta (b. 476 AD) who was an eminent astronomer, metaphysicist and scientist worked " pi " value up to 3.1416 against 3.1415926.

But more than science Vedas give greater emphasis to the development of scientific temper, which all members of society should acquire. In the Vedic metaphysics there is no love for magic, miracles, curses of the agitated and angry rsis, saints and sages, inauspicious or auspicious day, month, year or time for laying foundation stone of a project, its inauguration, or specific auspicious time for taking any oath

required under the Constitution of any state by the President, Prime Minister or other public servant and any other social or family functions like marriage etc. The drift from Vedic metaphysics can be seen in the two major mythological epics (Itahasa) Ramayana and Mahabharta, in the religious fairy tales in Puranas, Tantras and even Kalidasa's most famous mythological literary drama "Shakuntala".

The whole drama cum story has been built on the curse of an angry and highly agitated rsi for no major reason. Vedas are also against sorcery and use of tantrik knowledge in the cure of diseases by yatudhani, kimidins and other sorcerers and magicians. While tantriks philosophy relating to awakening of kunadalini power (the welfare of mankind is mentioned, its misuse is part of non divine activity and hence sinful. Rig Veda 10-87-3 and 2-14-3 and many other hymns describe the professions and activities of sorcerers, magicians, all those who spread mythology for vested interests and other non scientific blind faith as the followers of non divine Varna and they are described as avarnas and vritras. Unfortunately owing to distortion of spiritual knowledge contained in Vedas for certain vested interests of gurus, babas, tantriks, godmen and priests etc., many of the non divine activities mentioned there in are no longer considered as evil and sinful by many Hindus.

The study of Artha Shastra of Kautilya-the philosopher Prime Minister of the first Indian emperor Chandra Gupta Maurya, would reveal that to protect the emperor from any likely revolution from the masses, he deliberately devised a very large number superstitions and also spread the same to keep the people occupied. Thus Kautilya saved the emperor from any revolt from the hostile section of the people. The emperor was once an ordinary village boy from a poor family who was trained by Kautilya in administrative, military, political and other matters so that he would take over as the future king of Patliputra (Bihar). Kautilya was keen from

a very young age to replace the corrupt Nanda dynasty rulers. Most of the superstitions then created about 2300 years ago, along with many others are still continuing in one or the other sections of Hindus leading to perpetuation of blind faith and unscientific outlook. The various effects of these superstitions and unscientific outlook are now commonly found amongst many Hindus. Amongst the rich and materially prosperous Hindus, proxy and ostentatious worship is very common to gain social recognition.

Through out India the daughters-in-law are blamed if a number of female children are born amongst many Hindu families and sometimes even the husbands also blame their wives for begetting number of female children. This is in spite of the fact that Vedas say differently. There is a clear mention that the sex of the child is dependent on the seed, which is a male aspect and not dependent on mother which is Prakrti aspect, like the mother earth. The scientists have now proved this Vedic truth in the laboratory. In spite of the Vedic truth and its scientific proof in the laboratory, many Hindus are not convinced and have not accepted the truth gracefully. The social evil of dowry and wide spread dowry deaths in many parts of India is hanging like a Sword of Damocles over their heads and not allowing them to accept the scientific truths.

At present over 20 millions girls are missing in India mostly in Tamil Nadu, Haryana, Panjab, Rajasthan and other states. This unscientific outlook is perpetuating girl infanticide, dowry deaths, devdasi system but also obnoxious Sati evil. It is a socially forced suicide by many harassed widows of young age to avoid their remarriage and payment of higher amount of dowry. Hindu godmen, gurus, priests, swamis and babas have done nothing for ages to arrest this and other social evils not supported by Vedas and modern science. It is apparent for their vested interests they are not keen to spread scientific outlook and Vedic knowledge

amongst Hindus. However, the Vedic science helps in distinguishing between truth and falsehood and dispels the darkness of ignorance.

Vedas advise the scientists to acquire complete knowledge of ten pranas (vital breaths), soul and spirit along with ten physical sciences. Prana and Apana-inhalation and exhalation process is a complete science in Vedas for attaining physical and spiritual strength and also for destroying and eradicating various diseases of the mind and body. Patanjali's Yog Shastra to a certain extent is based on the science of vital breaths of ten kinds of pranas in the human body. Many individuals are now trying to use this science as a lucrative profession bereft of its spiritual aspect of the welfare of mankind and also the metaphysics contained in the Vedas and Upanishads.

Rig Veda 6-75-2, refers to Dhanav Vidya pertaining to bow and arrows, which are symbols of all weapons and missiles. Many savants refer to this part of Rig-Veda as Dhanur Veda. The term dhanvana is used for bow, weapon and missiles. All these weapons are to be used if absolutely necessary and not for gaining unjust victory over the enemy with the idea of gaining territory. These weapons should be used when all other peaceful and righteous methods have failed and non-divine persons create obstructions in the spread of Vedic knowledge and for protecting those persons who follow ChatvarVarna Ashram system of four divine professions in the society

For human beings physical strength and vigour, a kind of herbal Soma juice has been prescribed. It is a herbal sweet juice extracted from Soma plant and is red in colour. For vigour it should be taken with milk or curd. Being slightly intoxicant, its use during mental depression is mentioned in many hymns. With the passage of time and decline of Vedic knowledge, particularly its metaphysics contained in the Upanishads, Soma drink got a distorted meaning as a highly

concentrated alcoholic drink. Now hardly any swami, guru, priest or any other person amongst Hindus knows from which herb or plant this juice was extracted. However, Vedas clearly make a distinction between Soma drink and Asura. While Soma ras is meant to be used by the followers of four divine varnas both men and women, Asura being a hard and concentrated alcoholic drink is meant for the vritras, avarnas, yatudhani and other followers of non divine activities like bribe takers, speculators, smugglers and evil minded persons.

For a better appreciation of Vedic science, a few terms used in he original Vedic bhasha (language) as contained in the mantras/riks are mentioned. Viman diye neshu for vehicles like aircrafts (RV 1-34-1, 9 and 1-85-7). Vaj gatau-very high-speed vehicles in the air (R.V 6-60-12). Rekha di ganit vidys vigyaya-the science of Algebra (R.V 1-19-1). Surya Vidyau tau-knowledge of the Sun and electricity. Indr-agani-power, energy and electricity (R.V 6-60-12, 13), krishna garbha-knower of Algebra (R.V 6-75-2). Vidyamadi bha vidyut vidyante yashate-in which electric telegraph wires have been arranged (R.V 1-88-1).

Many other terms and words relating to physical sciences can be found in these hymns like kanu, anu, bhutas, maha bhutas, tatva, maha tatva etc., The other terms have been used like Ratha for vehicles moving in the firmament and middle region, on the surface of the earth and over the water, ashvinau for scientists, anu and kanu for gross and subtle atoms, tan matras for sub atomic particles sponda for sound etc. Few other words are amritasya nidhi-ambrosia (R.V. 1-186-3), Brahamand pinda i.e macrocasm and microcasm. In Yajur Veda 18-24 and 25 many terms relating to addition, subtraction, division, square, cube, square root, and cube root have been used. Yajur Veda 18-22 and R.V. 6-22-2 also refer to certain other terms of the physical sciences.

The Vedic seers and sages have made it clear through their metaphysics that physical sciences are not about the " real " world but pertain to the phenomenal world of Maya- the cosmic illusion as phantasmagoria. Once a person understands this distinction between the real and phenomenal worlds, the physical sciences merge with the supreme science described in Bhagavad Gita as the science of soul and by Vedic metaphysicists as Parmartha. Incidentally the phenomenal world is not an unreal world as mentioned by Sankracharya and for this reason he has preferred to use the word delusion and not illusion.

It is certainly not a mirage. This delusion stay during the stage of ignorance that includes only material and intellectual knowledge bereft of spiritual and divine knowledge. The Vedic knowledge is the harmony of these three kinds of knowledge i.e. jnan, vijnan and ajnan of Bhagavad Gita and Brahma vidya, Adhyatmic vidya and Bhautic vidya of Vedas. In the absence of these three kinds of knowledge, the physical scientists in the phenomenal world are hemmed in their assumptions and cannot survey an intellectual world of all and diverse possibilities. Only a spiritual cum material scientist or a Vedic ashvinau can move from temporal to an eternal perspective. It is for this reason that the ancient path finders and lovers of parmartha who discovered through their transcendental knowledge the laws of physical sciences and also military science did not develop any destructive weapons and had complete faith in the power of divine knowledge and considered the entire mankind as part of a global family (Vishva kutumbkam or Vasudhaiva kutumbkam) and all human beings as spiritual brothers and sisters.

Vedas also recognise that our outward looking mind (etani), has its inherent limitations and can not conceive how the gross matter, elements, atoms, particles, waves etc., get their different kinds of properties and characteristics. No

such limitations would exist to the inwards looking mind (manas) in the study and understanding of physical sciences as part of metaphysics. For every thing there is a cause in this phenomenal world and this cause is before any effect. Every change precedes the previous change and this phenomenon is common in all kinds of flux in Prakrti--the divine Nature. Both Bhagavad Gita and Vedas clearly bring out that to conceive the cause of first change is not easy for the uncontrolled human senses and turbulent outwards looking mind. To know the cause of first change, the Vedic seers used their divine instruments of the vast inner world within their gross bodies. They communicated with these divine instruments like Buddhi (Intellect), spirit (Kundalini as the coiled energy and part of Jiva), human manifested soul (Jivatma), through metaphysical inquiries in the form of dialectics and also perhaps exchanged their findings with each other.

Patanjali in his Yoga Shastra has described in some details the methods and techniques to communicate with your divine instruments. There is a mention in Yoga Shastra that by contemplating continuously on the Sun, one comes to know about the entire universe, its functions and even those secrets that human senses cannot conceive. According to Vedic metaphysics if we go on contemplating "Why these laws of God, laws of gravity of the earth and Sun, laws of electricity, water, fire, Time and Space; some answers will start emerging through your divine instruments. For this contemplation with dedication and sincerity, mediation, concentration and other siddhis have been explained in the six Indian schools of philosophy. By this dialectical method, one can arrive at the cause of first change and other permanent truths. Buddha applied some such technique and found independently the cause of Flux in Prakrti and did not feel the need to know more about God and soul. Prakrti is an adequate cause for all further knowledge needed by the

human beings. Kapila Rsi of Sankhya darshana found this first cause in Adrista-the unseen cosmic power and based his metaphysics without invoking God. Advait Vedantists had found the first cause in the Supreme Reality and named the nameless as Brahma who is manifested in Brahamand-the ever-expanding universe. Vedic rsis also named Him Vishnu-the one who pervades everywhere in this Viswa (Universe).

While in the various cults, organised sub-religions and panths, having roots in Vedas, constituting the present Hindu Dharma, these epithets like Brahma, Vishnu, Shiva, Adrista, Prakrti, etc., may have different meanings but in Upanishads and metaphysics these tend to move towards Unity and are one and the same spiritual and divine concepts. This Unity in diversity is the main Vedic metaphysical science. Once a person comes to know the first cause with the help of his divine instruments, all other phenomena in this world of Vedic Maya like Flux, atoms of different kinds, their properties, knowledge of birth and death, Sristi and Paralaya-Creation and Dissolution of the universe etc., become clear to such individuals. Vedic physical sciences thus cannot be isolated from metaphysics and as soon as these are isolated, the destructive properties of matter over take by suppressing the nobler qualities meant for the welfare of the entire mankind and other animate and inanimate life.

In the Vedas, it is in this background that discovery and manufacture of air crafts, ships, vehicles moving on the surface of the earth are mentioned for material and spiritual prosperity of all human beings. In the modern physical sciences there is growing tendency to isolate the inventions and discoveries from metaphysics. The excessive use of air conditioners by rich individuals, production of Basmati rice for commercial purposes during summer by using much needed drinking water (it requires drinking water during summer period equivalent to the need of about 200 persons to get one kilogram of Basmati quality rice in Panjab and

Haryana and many other scientific discoveries have created miseries for the poor, apart from pollution of all kind in the atmosphere as well as environmental hazards.

The modern scientists are doing research without getting them selves fully integrated with Nature and grossly ignore the Vedic noble philosophy of Idd Nan Mmam-nothing for themselves all for society. Many individuals now feel insecure as the scientists with the help of manufacturers have produced atom bombs, hydrogen bombs and other destructive weapons which could destroy the human life on this globe and modern economics and commerce which are more like Vedic anartha have created gross imbalance of all kinds of excesses in richness, poverty, life style, distortion in spiritual knowledge, human exploitation, etc.

Shakespeare in his famous drama Julius Ceaser had written, "... the fault of dear Brutus lies not in our stars, but in our selves." Due to lack of divine knowledge, blind faith and unscientific outlook, pursuit of material knowledge based on sense perception, many persons go on accumulating material objects to satisfy their uncontrolled senses, false ego and also as a part of their vulgar consumerism. When they do not find satisfaction in this aimless negativity of blind pursuit of matter, money and status, they run after astrologers, palmists, tantriks and finally go to the clutches of professional godmen, babas, gurus and swamis, who are very often ignorant of Vedic knowledge. Some of them run to temples at odd places to seek blessings of mythological gods and goddesses for getting peace of mind, cure of their physical and mental diseases and for getting children particularly sons.

Failing to get their desires and wishes fulfilled they even go to fake dealers of hope dwelling in magic, miracles, sorcery and many other non-divine activities. Thus there is no link between the material and intellectual knowledge bereft of

spirit and scientific outlook. Many scientists amongst Hindus do not have any scientific outlook. In India there are hundreds of physical scientists, biologists, engineers, medical practitioners and others who will be found running after babas, swamis and godmen. None of them can convincingly say against girl infanticide, production of Basmati rice by depriving the scarce drinking water to the poor, misuse of electricity by the rich, bride burning, bribe taking and other corrupt activities, various other social evils including exploitation of Nature and the earth. Hardly any Hindu scientist runs after the acquisition of supreme knowledge contained in he Vedas to which they owe allegiance as their supreme scriptures. They prefer non-Vedic knowledge through most of the fake gurus and godmen and get bigoted, self-virtuous, fanatical and some times even cruel.

Vedas advise the scientists to continue doing their research with scientific outlook and find out all possible laws of physical sciences, properties of all gross and even subtle atoms like ether. They should keep in mind that these properties and characteristics to all elements and their atoms are given by the spirit living in the substratum Shuniya-the inner most vacuum not visible to material instruments. Scientists cannot give any property to these atoms but can find out those properties for future discoveries and inventions for the welfare of entire mankind. According to Vedic metaphysics and also Patanjali's Yog Shastra, these properties of atoms are highly predictable for the dedicated yogis, seers and scientists who are keen to bring prosperity for the mankind. For ages the utility of stars was limited to children's fairy tales mostly in poems like "twinkle, twinkle, little star....." and now scientists have found that all elements that the earth has and which also form our gross bodies, were manufactured deep in the cores of the stars through the process of trans nuclear fusion and ejected through stellar explosions. Even this scientific fact should make us careful

not to overuse the various elements on this earth. The supreme Mother Prakrti goes on making elements and other food articles for us which are enough for human needs and certainly not enough for our greed.

This law of Nature was discovered by Gandhi ji as part of his philosophy. Based on this law of Nature, Gandhi ji propounded his ethical theory of need-based living and also to go on reducing your needs so that enough is available to others for their living. Thus in any society where individuals do not have enough for their minimum need based living, that society is largely a sinful society as some individual would be excessively using the Nature's bounties based on greed based living. Only a person of scientific outlook and vision can think and propagate such noble concepts. In case of Gandhi ji, he not only made this concept as part of his philosophy but also followed the same during his life time. This metaphysical theory was earlier promulgated in the Vedas as part of their concept of moderation, by Greek philosophers as Golden Mean, by Buddha as Middle Path and in Bhagavad Gita as avoidance of all excesses. Even the ancient Chinese lover of wisdom Lao Tse had said, "He who possesses moderation is lasting and enduring. Too much always is a curse most of all in wealth."

The renowned English scientist of 17th century, Sir Isaac Newton in spite of his so many discoveries relating to light, gravitation, laws of motion, certain mathematical laws etc., and also finding matter as inert, was still having a feeling that some thing was missing in his discoveries. He wrote in the Optick p.344, " ... does it not appear that there is a supreme Being, incorporeal, living, intelligent, omnipresent who in infinite space sees the things themselves intimately and thoroughly, perceives them and comprehends them wholly by their immediate presence to Himself." Newton's writings would thus appear more like Vedic metaphysics. Einstein found what Newton was having a feeling of some

thing missing, in the 20th century. The findings of matter being inert by the 17th and 18th centuries scientists in their classical mechanics was modified by the 20th century celestial mechanics of Einstein and other particle physicists. Even these scientists have a feeling that there is some thing beyond sub-atomic particles in the atoms that make these tiny invisible balls to move at a great speed and that too without any rest.

Thus scientists with scientific outlook and attitude produce highly constructive and positive results. Unfortunately many Hindu scientists who consider Vedas as their supreme scriptures, are found loaded with amulets given by tantriks, swamis and also by temple priests either directly or through their parents and do not have a scientific courage to take them out for fear of some unknown calamity and misery. The most unscientific attitude amongst many Hindus including some scientists is that relating to non-vegetarian food particularly beefs, pork, etc. If poor persons take this kind of food, they are looked down upon and even ostracised but if rich persons of the developed nations like United States of America, European countries etc., they are sought after and eating and living in their company is great achievement and matter of pride. Hundreds of Hindus can be seen taking beefs, pork and other kind of non-vegetarian food in U.S.A. and other countries and also in India in the company of foreigners and their social and official parties, luncheons etc. Many of them would not like to admit this owing to their unscientific outlook and attitude towards food.

Spreading blind faith and hypocrisy is now becoming a major money earning profession through television, cinema and commercial exploitation of religious beliefs. The more miracles, magic, mythology and blind faith are shown in the Indian movies or television about Hindu gods / goddesses and their cosmic powers, the more popular these serials,

soap operas and movies become and fetch enormous money to their producers and financiers. Thus message is being conveyed that God's main role is to create magic and miracles beyond any scientific explanation. Thus a large section of Hindus are being brain washed by gurus, godmen, swamis and even economic exploiters of the Indian movies, producers of television serials and many others. Taking advantage of this highly confused religious atmosphere at present, many cults, tantriks and even priests periodically predict for the last about five decades the total destruction and dissolution of the entire universe.

During 1962, many swamis and cults predicted the dissolution-Pralaya and very large number of Hindus including highly learned individuals did not sleep inside their houses and many remained awake through out the night. A number of special prayers, Pooja and Yajnas were performed to protect the mankind. Even in India, Muslims, Christians, Sikhs and followers of other religions excluding Hindus did not take this prediction seriously. This blind faith not covered by the Vedic metaphysics made even many swamis, priests and others still bolder to claim that the entire mankind was saved owing to their special Pooja, dedicated prayers and number of Yajnas performed. Many cults even openly propagate that individuals who are their followers will escape this cosmic Destruction Pralaya and will be the originators of next celestial Cycle of mankind and also their pathfinders.

It is because of this blind faith and extremely unscientific attitude that in 1995 thousands of Hindus including scientists, medical practitioners, engineers and other learned persons in India and abroad, ran to temples where idols of lord Ganesa were installed. The purpose was to feed milk to the idols, icons, statues and even pictures of lord Ganesa. All kinds of claims were made that the idols accepted milk from certain individuals and refused from others. This all started

when some individuals with vested interest to make a lot of quick money spread the rumour after experimenting the effect of surface tension and sucking of small quantity of milk with a spoon by any idol. Lord Ganesa name was used to exploit commercially the love for miracles and blind faith of Hindus. Later some Hindus tried the same with the idols of other gods and goddesses.

Their idols also accepted small or large quantities of milk. Many temples and their custodians made a lot of money and made some economic exploiters and bribe takers believe that they are the true and loving children of God as idols accepted milk from them. In Delhi alone owing to this man made phenomenon a large number of infants, children of the poor people and some physically sick person could not get milk as the price of even adulterated milk sky rocketed. On the other side the milk flowed like a small stream originating from the idols and going finally to the drains. Majority of the Hindus called it a divine miracle, a few attributed it to the principle of surface tension in Physics and very limited number of Hindus described it as a joking deception.

Rig-Veda 1-3-4 clearly says that people with scientific outlook do not resort to such practices and they are the real destroyers of diseases and sufferings of others. Many Hindus who ran to temples to feed precious milk to the idols of mythological gods / goddesses were not aware that their most sacred scriptures Rig-Veda 1-2-4 aims at bringing out scientific temper in them. The stones, bronze and clay statues and idols of mythological gods have no role in Creation, Preservation and Dissolution of the earth. This hymn of Rig-Veda tells us that it is the Sun which supports the earth and its gravitational force makes it firm. Again Rig-Veda 1-2-5 further makes it clear that it is the formless and ineffable Brahma who Himself is the upholder of Sun. Thus any prediction by the cults and their leaders or other members,

swamis and tantriks about the dissolution or Pralaya is more to create fear psychosis amongst Hindus which would make them run to temples, gurus and other religious leaders of hope. To a great extent owing to blind faith, unscientific outlook and ostentatious worship of God, the present organised Hindu religion has considerably deviated from the Vedic metaphysics.

If the Vedas mention that stars are the bounties of God for the human beings and other animate life, it was for the scientists to prove in laboratory about their utility for our existence. It has now been proved by physical sciences that almost all the planets (Greek word meaning wanderers) are moving with high speed but always at safe distance from the Sun to avoid being burnt or frozen to death. While physical sciences can only find out actual distances between them and the Sun, their speed, maximum and minimum temperature or whether these planets are suitable or not for the human beings to live there, but only metaphysicists can explain why this safe distances from the Sun? Metaphysics can even tell why these planet like the earth moving all the time with a very high speed round itself and also the Sun and still not giving jerks to animate and inanimate life. Science of astrology (if at all it is a science), astronomy, Time and Space, Physics etc., may be able to predict accurately collision of Comet Shoe maker "Levy" with Jupiter or a particular day, time accurate to the last second and place for lunar and solar eclipses, but metaphysics can only explain the noble Design of God in maintaining balance and equilibrium in the entire cosmos.

According to Vedas even the earth quakes, hurricanes, avalanches, storms, floods etc.; are the grace of God, necessary for the maintenance of equilibrium. Vedas ordain "O, man assist your supreme Father Brahma and supreme mother Prakrti in this wondrous and grand Design." It is rather unfortunate that instead of assisting God, many individuals

tend to disturb His grand Design by using the earth as quarry, atmosphere as a huge porous bin for absorbing all types of poisonous, lethal and toxic gases created due to extremely selfish activities of theirs. Even the activities of theirs relating to sound waves are now effecting the ether. All this is happening as science is fast divorcing itself from metaphysics and is getting more associated with economics and commercial activities by losing its higher status. Commerce to day boasts of engaging thousands of scientists and engineers and working for it rather than for science itself.

By isolating from metaphysics and association with commerce in the subordinate position, the discoveries of science are leading to more and more social tension, economic disparities, environmental hazards and distortion in the spiritual and divine knowledge. Though eminent scientists like Einstein and Hoffman believed that the wondrous Creation could not be explained to "chance" and that there was some spirit behind it, yet economics and commercial outlook of man is forcing many modern scientists to ignore their findings that were akin to Vedic metaphysics. Einstein even said that every matter in the universe is conglomeration of sound waves or wavicles in the mass sea of waves i.e., the entire universe. This primal energy is bottled up in the form of velocity of light-Bubble in the calm and homogeneous state in the procreation stage. That bubble was caused by some cosmic energy that caused movement and whirling leading to "sound."

This scientific statement of Einstein appears more like Vedic metaphysics that refers to cosmic energy as the sacred syllable O.M or A.U.M. This cosmic word is mentioned as shabad Brahma in the Vedas and the Word in the Bible. It is shabad Brahma, which led to primordial waves in the form of sound (sponda) and these waves expanded and the gross cosmos along with this universe and other worlds where six

more communities of men live, also emerged. These six communities of men consist of devas, angels, gandharvas, pitries, karma devas etc. Thus it is due to shabad Brahma that subtle Prakrti and gross Universe were created. All the worlds below Brahma lok, which is the abode of God, are subject to appearance and disappearance. Bhagavad Gita explains these concepts in chapter 8 verses 16 and 17 and also in chapter 9 verses 10.

The Vedic metaphysics and also some Upanishads refer to the relative existence of the universe and the continuous cosmic dance at the sub atomic level. The quantum physics and celestial mechanics in the modern science have proved the same in the laboratory. The vacuum in the innermost part of the atom, sub-atomic particles, quarks etc., is the reservoir of energy and is the cause of Flux in the Nature. If Upanishads refer to the never ending cycle of creation and dissolution of the universe, as a manifestation of the ultimate reality, quantum physics refer to single unified field which existed within nano second of the Big Bang as a glimpse of the ultimate reality.

Vedas and also some of the Upanishads, particularly Taittriya Upanishad explain emotional, psychological, physical and other scientific phenomenon pertaining to human sense perception like hot, cold, pain and pleasure, colour, touch and other to five coverings or sheaths in the human body. Vedic term for sheath is Kosha. In the inner most covering lives the immortal self or the manifested soul described as Jivatma. This innermost sheath is the subtlest of the subtle Kosha. The other four sheaths are moving towards subtle to finer and the grosser sheaths. The outer most sheath is Annomaye Kosha and it is the food covering and consists of only gross elements. It is our outer body, which is dependent on our intake of food and perishes due to old age, sickness or fatal accident. The other three sheaths are pertaining to mind, vital breath and intellect. These

three Koshas consist of partly gross to finer and subtle atoms and particles. Only human beings have five Kosha and animals have four Kosha as they do not have the immortal soul like human beings. The numbers of sheaths become still less in the case of ants, plants, trees etc. An aerobic bacterium has only one sheath i.e. food covering only. The modern science of psychology has almost come to the conclusion that consciousness is only in the human beings without naming it as soul. However, Vedas clearly mention the manifested soul is the cause of consciousness in the human being and dwells in the body in the 5th inner most Kosha.

To develop scientific outlook, Vedic rsis, munnies and metaphysicists developed certain scientific techniques. Through the word Swaha at the end of many riks, mantras and hymns and some times in between also, they ensured that students and common men having belief in the Vedic metaphysics understood and appreciated the correct meaning, significance and spirit of the those hymns. They also applied these meanings in their day to day conduct and behaviour towards other individuals, animals, plants etc;. and even inanimate life. The word Swaha is a confirmation and promise to "deva of vows " in the Vedas i.e. Agni deva. Many hymns also end with the words Idd Nan Mmam, which literally means nothing for self. Metaphysically it is the Vedic enlightened liberalism i.e. nothing for self all for society. Through the philosophy of Idd Nan Mmam the individuals are advised to refrain from selfish activities and make all dedicated efforts to form an ideal society. Each individual has to act and even pray to God for the welfare of others and thus his / her own welfare is also achieved. This concept is also akin to Greek philosophers' enlightened selfishness.

While Vedic God is formless and ineffable, Prakrti has a large number of attributes. For easy understanding of these attributes of divine Nature who is our supreme Mother, Vedic metaphysicists divided these attributes into 33 sets.

For each set of attributes of Prakrti, they symbolically made each deva / devi-formless beings of light as in-charge. This scientific division helps even a common man to know all the attributes of Prakrti. Some of these "shining ones" are Prithvi devi-the mother earth with attribute of selfless service, Usha devi-dawn, representing discipline, beginning of the day and knowledge pertaining to science of time, Agni deva-holy fire which represents the attribute of purity, heat energy, electricity in Prakrti. Surya deva-the Sun incharge of providing light, food, energy of various kinds etc. In Rig-Veda Indra deva is an important being of light who represents power, destroys followers of non divine professions, bribe takers, adulterators of food, medicines and other evil minded persons.

He represents power and strength of Prakrti. Even his name is derived scientifically from two words "Indha and Ra." Indha is fuel and Ra is transforming energy, a kind of cosmic fire. Indhra or Indra is thus power, energy and strength which provides constant fuel in the Nature and destroys those who creates obstructions in his noble activities. Since Atharva Rsis were worshippers of holy fire, in Athava Veda, Agni deva incharge of holy fire and its attributes became the most important deva. He was also made lord of vows. Thus all promises of good conduct, behaviour, protection and care of wife and children, following the path of enlightened liberalism, maintaining the air, water and atmosphere free from pollution, etc., are made before the holy fire. In this manner the Vedic metaphysicists provided divinity to Prakrti and described her as the supreme Mother so that human beings refrain from exploiting her bounties beyond their actual needs. This scientific method also helped in the understanding of all the attributes of Prakrti.

Now majority of Hindus have forgotten that divine Nature is their supreme mother and also the significance of these 33 formless beings of light. Most of them need the blessings

of gurus, priests and swamis to continue their activities of excessive exploitation of the mother earth, pollution of the atmosphere, air, water and even the society and are extremely pleased with those individuals who can distort the Vedic spiritual and divine knowledge to suit their blind pursuit of money and vulgar consumerism. In the Vedas the veneration and even worship of these 33 devas was more to develop the scientific outlook in the society and was not meant for any ritualistic or blind worship for ostentation or social recognition. Even Vedic cosmic laws of social moral and physical order described there in as RTA, which can be known and understood from the functioning of Nature, are meant to develop scientific and healthy social outlook amongst the entire mankind, so that all human beings on this earth could live in harmony with Nature, society, other animate and inanimate life and start moving towards perfection. However, one clear message emerges from the study of Vedic metaphysics that that any scientific discovery or invention which contradicts the laws of Nature or Vedic Rta and social and moral righteousness or Vedic Dharma, should be re-examined for the material and spiritual welfare of mankind.

4

DEMOCRATIZING SCIENTIFIC KNOWLEDGE

This note, from the sociology of science perspective, argues that during the colonial regime, the colonizers, on the one hand and the cultural elite in India on the other, introduced science education to the people of India. Whereas scientific knowledge was introduced in India in order to keep the vested interests of the colonial government alive, a section of the Indian intelligentsia, in contrast, tried to democratize scientific knowledge through building scientific institutions in nineteenth century India. The present study is a modest attempt to understand the dialectic between science-for-its-own-sake and the application of scientific knowledge in the society.

> *'... To assume one basis for life and a different basis for science is a priori a falsehood. ... Natural science will in time incorporate into itself the science of man, just as the science of man will incorporate into itself natural science: there will be one science'.*

The fundamental tension of science studies, as I see, is the dialectic between science-for-its-own-sake and the production of scientific knowledge that has an immediate utilitarian value affecting the worldviews, meanings, values, interests, attitudes and the corresponding actions of the

scientific community, which one can empirically observe. Sociology of science, as a specialty, has been concerned in exploring this dialectic. Sociology of science is a specialty that examines how and to what extent various socio-cultural factors, both internal and external, to the world of science influence the production of scientific knowledge and its application.

The literature suggests that the earlier conception that science is autonomous having its own dynamics unconnected with the external forces, is no longer sustainable. Rather, science and technology have been influenced by various factors-social, economic, political, cultural, legal, ethical, institutional, ideological, and so on. The divide between the internal and external worlds of science is, therefore, not rigid but porous. As Bloor put it, 'All knowledge, including scientific knowledge, is socially caused'. Restivo and Bauchspies pointed out, 'The term "social" is not only in the "external" social and cultural milieu or context of science, but in the social organisation of science, indeed in scientists themselves. The 'social' in this sense is pervasive, and no more transparent than quantum or gravitational forces'. The social is historically and democratically constituted, and hence varies over time and across space.

The term, 'democratization' refers to the way democratic norms, institutions and practices evolve, and are disseminated both within and across national and cultural boundaries. Equality of opportunities to do science and the degree of access to do science, equality of opportunities to evaluate any knowledge form, the degree of access to scientific knowledge for application and the freedom to dissent constitute democratic norms, both external and internal. In this context, there has been a relationship between the 'social responsibility in science', on the one hand, and the mainstream of political and social debate and action, on the other. The concept, 'social responsibility in science' came into

the literature on sociology of science in the context of the Second World War.

Historians and sociologists of science use this term both in the context of war and ethics. In particular, we must begin to see the central place of the institutional and ideological role of science in maintaining and/or transforming the most basic features of our democratic, non-democratic or anti-democratic society. However, democracy cannot be figured out simply on its own terms, in terms of either its argument or its vision, howsoever important these might be. Democracy seeks to connect the universe of values with the realm of power, and it is essential to see what is involved in this. It may also be useful to try to place this problem of connecting one with the other in its modern setting. Once we have begun to see, all of us must decide what, if anything, s/he is going to do about maintaining, reforming or transforming the present order of society, starting with the institutional mechanisms in which s/he is most directly involved-laboratories, departments, colleges, communities, etc. The present note, from the sociology of science perspective, attempts to provoke a debate and action on these questions, keeping in mind the context of the building and growth of scientific institutions and universities in nineteenth century India.

There is a need to engage oneself with studies on historical contexts that shaped the building and growth of scientific institutions in India towards democratizing the production of scientific knowledge. As Mills put it, 'Unless one assumes some trans-historical theory of the nature of history, or that man in society is a non-historical entity, no social science can be assumed to transcend history. All sociology worthy of the name is "historical sociology" '. Abrams stated, 'In my understanding of history and sociology, there can be no relation between them because, in terms of their fundamental preoccupations, history and sociology are and always have

been the same thing. Both seek to understand the puzzle of human agency and both seek to do so in terms of the process of social structuring. Both are impelled to conceive of that process chronologically; at the end of the debate the diachrony-synchrony distinction is absurd.

Sociology must be concerned with eventuation, because that is how structuring happens. History must be theoretical, because that is how structuring is apprehended. Historical sociology is thus not some special kind of sociology; rather, it is the essence of sociology'. Giddens wrote, 'What distinguishes social sciences from history? I think we have to reply as Durkheim did ... nothing-nothing, that is, which is conceptually coherent or intellectually defensible'. Thus, the present study employs a historical-sociological perspective. It is against this backdrop that the tension of science studies in the Indian context would be explored. The term 'social responsibility in science' has involved four sorts of issues:

(a) the social, economic and political context of science;

(b) the sources of scientific research and its funding;

(c) the use and abuse of sciences in technology, war, social control and ethics, and

(d) the social system of science itself.

Those concerned with these issues have made studies, instituted reforms and involved themselves in various kinds of direct action and protest. In contrast, there has been relatively little activity in the science movement, which has addressed two central issues:

(a) the role of science and the ideal of scientific rationality in maintaining the established order of society; and

(b) the hierarchical and antidemocratic structure of the institutions in which scientists work.

The first point raises the general issue of science versus democracy, and brings us into the mainstream of social and political debate. The second point brings the problem of social action directly into our immediate professional context and makes us face the challenge of creating direct democracy in the institutions in which we find our-selves now.

THE PROCESS OF DEMOCRATIZATION OF SCIENTIFIC KNOWLEDGE

As mentioned earlier, the term 'democratization' refers to the way democratic norms, institutions and practices evolve, and are disseminated both within and across national and cultural boundaries.

This term is best understood as a long-term, dynamic and open-ended process extending over generations. Democratization of scientific knowledge involves an attempt to critically focus on who benefits and loses under specific regimes of knowledge production and consump-tion in specific social contexts and to provide normative frameworks for minimizing inequalities in the dissemination of scientific knowledge. Equality of opportunities to do science and the degree of access to do science, equality of opportunities to evaluate any knowledge form, the degree of access to scientific knowledge for application and the freedom to dissent constitute democratic norms. Democratic environment is both an antecedent to and consequence of the production of scientific knowledge and its application.

Rapid accumulation of knowledge, which has characterized the development of science since the seventeenth century, had never occurred before that time. The new kind of scientific activity emerged only in a few countries of Western Europe, and it was restricted to that small area for about two hundred years. Since the nineteenth century, scientific knowledge has been getting institutionalized by the rest of the world. And, India was no

exception to this. It has occurred through the diffusion of the patterns of scientific activity and scientific roles from Western Europe to other parts of the world.

INSTITUTIONALIZATION OF MODERN SCIENCE IN COLONIAL INDIA

The institutionalization of modern or Western science in India began with the establishment of the Great Surveys-the Geological, the Botanical and the Trigonometric-under the inspired impetus of the Asiatic Society of Bengal, inaugurated in 1784. This was followed by the establishment of universities in the port towns of Bombay, Calcutta and Madras in 1857. This period saw the consolidation of British rule in India, especially with the failure of the First Indian War of Independence of 1857. The British rule in our country was primarily based on its improved mode of production-improved technology, organizational abilities, etc. It was important for the colonial government to maintain its superiority, if it were to continue its rule. Colonization is always inimical to any organized development of creativity amongst the colonized. As India was a large country to be governed, the British realized that it was important to have a cadre of well-trained Indians in all areas, including science and technology.

Therefore, the British set up a small number of universities loosely based on the British pattern in the nineteenth century. In fact, till 1850, India had only one university, founded at Serampore near Calcutta in 1818 by a group called The Danes; it was primarily a theological university. Between 1850 and 1900, five more universities were set up at Calcutta, Bombay, Madras, Allahabad and the erstwhile-undivided Punjab, intending to cover the entire country. The first two medical colleges were set up at Madras and Calcutta in 1835. The first scientific research organization set up by an Indian, Mahendra Lal Sircar, was the Indian

Association for the Cultivation of Science (IACS) at Calcutta in 1876. At the end of the nineteenth century, India had a total of six science-related societies (including the Asiatic Society of Bombay, set up in 1804), out of which two were professional societies: the Agricultural and Horticultural Society of India (1820, Calcutta), and the Bombay Natural History Society (1883). However, we must remember that modern science was not introduced in a vacuum, that we had a rich tradition of knowledge systems, including positive sciences and that some of them like ayurveda and astronomy were more democratized than perhaps modern science, then or now.

The colonial government started building scientific organizations to use the knowledge generated by the institutions for gaining better understanding of the territory, climate, flora and fauna of the colony to administer the colony and perhaps exploit the resources in a more efficient manner. It is against this background that the first generation of nationalist scientists attempted to build scientific institutions and democratize science without taking any support from the colonial government. Enthusiasm was shown by a section of our elites to embrace modernity; modern science may also be construed as an attempt to get closer to the colonial rulers. On the contrary, those who were suspicious of things Western or modern, including modern science, cannot be viewed as being opposed to democratization of knowledge or of society, at large. Some of them at least did perceive modern science as a part of colonial dispensation and as an alien imposition. It was the policy of the colonial government that did not allow Indian scientists to occupy higher positions, though many of them were competent. It thus hindered the process of democratization of scientific knowledge in India. It is against this backdrop that the nationalist scientists attempted to build scientific institutions to democratize science.

Most of the research about perceptions on and reception of modern science in nineteenth century India focused on the Bengal province and North India. However, it does not imply that Indian intelligentsia did not respond to modern science in other regions. For example, the Madras Presidency had instruments, but no observatory. The East India Company had established an observatory at Madras in 1870.

According to Kochhar, 'It was the first modern public observatory outside Europe and to use today's term, the first modern research institute in India'. The Company had declared that the purpose of the Madras Observatory was to encourage the advancement of the knowledge of astronomy, geography and navigation in India. There were other more important things than doing science, such as increasing the Company's revenue by improving irrigation facilities. Several astronomical observations were carried out by John Goldingdham and his deputy, Warren, both of whom were trained astronomers. While the British East India Company was reluctant to encourage observatories in India, the establishment of the Nizamia Observatory in 1908 in the Hyderabad State, shows that the Nizam's regime was receptive and favourable towards the establishment and continuation of the astronomical observatory. This was partly because Hyderabad State was never under any colonial regime (S. Mallick, M Phil dissertation, University of Hyderabad, 2004, unpublished). However, democratization of scientific and technological development remained a myth for the millions of the country. Only certain social groups of the society were able to receive and respond to the introduction of modern science and technology to the Indian soil.

RECEPTION OF MODERN SCIENCE IN COLONIAL INDIA

Now the question arises: 'Which social groups were the first who received and responded to the introduction of modern

science in India?' Of course, not much work has been done on the transmission of scientific ideas between different cultures. An attempt has been made to understand as to how knowledge conceived of within the epistemological framework of one culture is received, adapted and absorbed by another culture. In the first half of the nineteenth century, both Hindus and Muslims had their own elites.

However, paradoxically, it was only the Hindu elites drawn naturally from the upper castes, principally the Brahmins, the Baidyas and the Kayasths in the Bengal province, who made contact with the British and eagerly sought after modern science, which took roots in Europe as a legitimate knowledge.

Amongst the Bengali Muslims, there was a much larger socially and economically inferior stratum and a correspondingly smaller aristocracy than amongst the Hindus. This fact in itself does not explain the almost complete lack of response of Muslims to English education in nineteenth century Bengal nor were the explanations based on religious outlook for the Muslim response different elsewhere in the country. For instance, between 1876-77 and 1885-86, 51 Muslims and 1338 Hindus took the BA degree at Calcutta. In 1870, only two Muslims, both of whom failed, wrote the BA examination, while in the same year, 151 Hindus sat for the examination of whom 56 received their degrees. In the North-western Provinces, Bihar, Orissa and Oudh, although Muslims were in a minority, the community-wise education pattern was quite opposite to that in Bengal.

Modern scientific ideas and techniques came to India in the wake of the British conquest, but they faced three major limitations. First, the scale of implanta-tion and degree of utilization was limited to suit the policies of the rulers. Secondly, the teaching of science was introduced merely to provide training in various branches, rather than creating

an appreciation of science as a tool of intellectual and social transformation. And, thirdly, science was introduced in English. Consequently, instead of playing the role modern science did in Europe, it became isolated. It did not interact with different strata of society, but leaned heavily for its growth on the government and became an intrinsic part of the policies of the rulers. Yet, there was a section of the Indian intelligentsia that believed that the British civilization represented a new approach to life and nature and that therein laid the hope for the future emancipation of India.

One aspect of this intellectual realisation was the thirst for knowledge. This led to the formation of scientific societies and institutions by Indians to provide access to modern science. Most of the Indian intelligentsia or the cultural elite felt the need of imparting science education to Indians for exploring the new horizons of knowledge about nature and life. In contrast, it must be noted that when the British introduced Western education, they did not introduce science and technology in the curriculum. Rather, they focused on literature, law, grammar, etc. In this context, it is worth mentioning that in 1875, Sir Richard Temple, the then Governor General of Bengal, wrote a letter to Sir John Laird Maire Lawrence, the then Viceroy, on the rising discontent in India. In this, Temple lamented, 'But this arises partly from our higher education being too much in the direction of law, public administration and prose literature, where they may possibly imagine, however erroneously, that they may approach to competition with us. ... But we shall do more and more to direct their thoughts towards practical science, where they must inevitably feel their utter inferiority to us.'

The native intellectuals were quick to take note of this fact, and of which they were aware throughout the nineteenth century and even the beginnings of the twentieth century. They had two options before them: the first option was to

convince themselves that the best products of modern science were already anticipated by what they considered to be the national philosophy of India, namely the Vedanta. Such an effort aimed at internalizing an alien system of knowledge on the one hand, and exhibiting rational and empirical significance of the Vedantic thought which was treated at best as ethnophilosophical by the Western philosophical world, on the other. It is this concern which has been expressed in the works of Vivekananda, Aurobindo and many others.

The second option was to build an indigenous tradition of modern science by establishing scientific institutions for pedagogy and research. The second option is sociologically significant, and deserves to be discussed in detail. In this context, scientific institutions like Hindu College (1816), Delhi College (1825), the Aligarh Scientific Society (1864), the Bihar Scientific Society (1868), and the IACS figure the most. These institutions were initiated mostly in the second half of the nineteenth century as a part of the process of not merely popularizing but also democratizing scientific knowledge in India by creating opportunities for Indians to pursue science education.

BUILDING SCIENTIFIC INSTITUTIONS IN NINETEENTH CENTURY INDIA

The Hindu College

To start with, the only people committed to introducing Western education into India were the missionaries, particularly the evangelicals, who wanted to use Western arts, Western philosophy and Western religion to rid the Hindus of the moral depravity that, according to them, was the cause of their degeneracy. These attempts did not receive the expected enthusiasm from the 'Hindu subjects of Great Britain'. In addition, there was not a way of going about imparting new ideas to the latter. The Hindu upper castes

could not be convinced of almost any of their shortcomings, but they could not be called morally depraved. Attempts by both Orientalists and missionaries received no measure of official approval. Consequently, these attempts made little headway.

In sharp contrast, however, a native gentlemen community rose to the occasion. These gentlemen were better known as the Bhadralok. They had an inclination towards the acquisition of Western ideas and Western science through English language education. Indeed, education itself became the hallmark of Bhadralok status. The Simon Commission Report observed, 'The school is the one gate to the society of the Bhadralok'.

Within the colonial framework, the conflict among the different systems of knowledge was also a conflict among the value systems. However, for those sections of the Indian society that first seriously took up science as a profession (for example, the Bengali Bhadralok), the process of cultural redefinition automatically began. Cultural redefinition implies a prerequisite for the legitimation of the new knowledge system.

In continuation of the reaction to the attempts of both Orientalists and missionaries, the Bhadralok had established the Mahabidyalaya (better known as the Hindu College) in Calcutta in 1816. The purpose was to cultivate 'European literature and European science' without any assistance from the government. The original curriculum comprised not only reading, but also instruction in history, geography, chronology, astronomy, chemistry and other sciences. The college was managed exclusively by the Calcutta Bhadralok. It was open only to sons of Hindu families. There lies a sense of caste discrimination and gender bias. Despite this, its enrolment figures had touched 400 by 1828. And, within two decades of the opening of the Hindu College, the demand for

English education had led to the creation of a respectable number of English schools 'originating with the natives and deriving resources exclusively from them'.

Thus, the Hindu College was set up and run by the Bhadralok as a scientific institution that would not only introduce the application of modern science and technology to the Indians, but also show them new horizons of life as a whole, thus extending the opportunities to pursue science education and a career in science.

But, the British were not interested to introduce science education into the Indian soil as a part of democratization. They opened a Sanskrit College in Calcutta in 1824 to teach Sanskrit, rhetoric, sacred literature, law and grammar to Bengali children. However, this was not what encouraged the new elite. In this regard, the name of Raja Rammohun Roy figures first. It is clear that the colonial government was not inclined to introduce science education and inculcate a scientific temper among the natives, whereas attempts on the part of the native intelligentsia were to promote precisely the activities which the colonial government was not interested in.

No account of India's development to modern times would be complete without a mention of Raja Rammohun Roy, an aristocrat from Bengal, whose social reforms in the eighteenth and nineteenth centuries contributed towards narrowing the gap in attitude towards science and technology among the Indians. A term that is used these days but which was not used during Rammohun's era, though he advocated it in many of his speeches and works, is 'scientific temper'. This teaches us to sift the available evidence objectively and base our actions on a rational approach. Rammohun was a rationalist in his advocacy of reason and freedom of thought. His criticism of the existing religion and its rigid practices and caste barriers was inspired by his desire to make religion

consistent with the changing world of his times. That attitude is even more relevant today, as the influence of science and technology on our lives is increasing rapidly.

When the British went on opening Sanskrit Colleges, Rammohun, in his all-too-famous address of the 11 December 1823, pleaded for the instruction of European sciences. He penned: '... as the improvement of the native population is the object of the Government, it will consequently promote a more liberal and enlightened system of instruction, embracing mathematics, natural philosophy, chemistry and anatomy, with other useful sciences which may be accomplished with the sum proposed by employing a few gentlemen of talents and learning educated in Europe, and providing a college furnished with the necessary books, instruments and other apparatus.'

And, in 1827, the Hindu College introduced into its curriculum mechanics, hydrostatics, optics, astronomy, mathematics, anatomy and medicine, all in English. Then almost half of its 91 students opted to study these, though they were not compulsory subjects. In addition, on the whole, Hindu students trained in the traditional manner did not have any difficulty in responding to the Western course work.

And, indeed, the curriculum seems to correspond closely to the Bhadralok ideal of education. It refers to a fusion of the traditional Sanskritic studies of rhetoric, sacred literature, law and grammar with those of Western literature and science. However, knowledge of Sanskrit was essential to their being.

The Northern Province: The Delhi College

In this section, I look at the pioneering efforts made by the Delhi College in the early nineteenth century. This college played a significant role in the dissemination of modern

science. Delhi College, originally established as Madrassai-Ghaziuddin by Nawab Ghaziuddin Firoz Jung in 1772, was rechristened Delhi College in 1825. The college was set up to translate scientific books into local languages in general, and Urdu, in particular. The Oriental Department of the College carried out studies in modern education through the medium of Urdu. In 1835, when the new British policy veered away from the concept of modern education through Indian languages, Delhi College took a bold stride in the reverse direction.

The Educational Committee was created to translate into Urdu, scientific books then taught in European schools. The English faculty of the College launched 'The Society for the Promotion of Knowledge in India through the medium of Vernaculars', which subsequently came to be known as the Delhi College Vernacular Translation Society. It translated as many as 125 books. These included chiefly Greek classics, Persian works and scientific treatises into Urdu. All these were translated in the space of about twenty years. The Society fostered a rich and multifaceted education and transformed Urdu from a language of poetry to the transmitter of Western scientific ideas.

The new emphasis on Western science attracted several young minds and in a short span, Delhi College had produced a few geniuses like Master Ram Chandra. His work on differential calculus was published and noticed in Europe. Master Ram Chandra was not only an erudite scholar of Delhi college, but also became a prolific teacher at the college. He started a paper in Urdu called the Fawaid-ul-Nazarin, which played an important role in the dissemination of modern science in India. He also edited two more of Delhi's earliest Urdu newspapers, viz. the Mohabbe-Hind and the Kiran-us-Sadain. The former aimed at a wide readership, whereas the latter published various articles on scientific subjects.

Delhi College had a well-defined school curriculum, which included a local language. On to this were grafted European philosophy and science. Students at Delhi College showed clear-cut inclination towards a scientific rather than literary education. In Bengal, a sudden literary enthusiasm for the newly discovered English novelists and poets swept everything else before it. For translations into local languages, some European teachers like Boutros, a Frenchman, and Sprenger, a German, will be remembered for their sense of involvement. Probably, this was the reason why learning in English was not, as in Bengal, regarded as vitally important. In fact, Delhi College made a laudable and pioneering effort in the dissemination of modern science through the medium of local language. This had immediate effect of increasing the accessibility to modern science to those who did not have exposure to the English language. We may compare the situation to sixteenth century Italy, where several academies were established as alternatives to the existing universities to replace Latin by the vernacular language. This was made possible in an atmosphere where people were not prepared to readily accept the principles of modern science. Master Ram Chandra has referred to the first open conflicts of the new learning with the old. He wrote:

> *'We commenced a monthly magazine at the cheap rate of four pence a month in which notices of English science were given. Not only were the dogmas of ancient philosophy exposed, but many of the Hindu superstitions were openly attacked. The result of this was, that many of our countrymen condemned us as infidels and irreligious.'*

The Aligarh Scientific Society

An attempt in the direction of democratizing modern science was made by Sir Syed Ahmed Khan. The attempt was in the form of establishment of the Aligarh Scientific

Society in 1864. It was not only an attempt in imparting scientific knowledge, but also an effort in the direction of sociocultural change in India. Sir Syed started his career as a clerk with the East India Company in 1838. He qualified three years later as a sub-judge and served in the judicial department at various places. Sir Syed had a versatile personality, and his position in the judicial department left him time to be active in many fields. His career as an author (in Urdu) started at the age of 23, with religious tracts. In 1847, he brought out a noteworthy book, Athar Assanadid ('Monuments of the Great'), on the antiquities of Delhi. Even more important was his pamphlet, The Causes of the Indian Revolt. In this booklet, he ably and fearlessly laid bare the weaknesses and errors of the British administration that had led to dissatisfaction and a countrywide explosion.

Widely read by British officials, it had considerable influence on British policy. The supreme interest of Sir Syed's life was education, in its widest sense. He began by establishing schools at Muradabad (1858) and Ghazipur (1863). A more ambitious undertaking was the foundation of the Aligarh Scientific Society, which published translations of many educational texts and issued a bilingual journal in Urdu and English.

The Aligarh Scientific Society was set up in 1864, within a certain context. During the nineteenth century, the government's education policy had a predominantly literary bias. In schools and colleges, the teaching of sciences and of technical and vocational subjects was almost neglected. The emphasis was merely on the study of literature and logic, politics and philosophy. There was a deliberate attempt to keep the Indians bound to traditions and superstitions. Fruits of technological development were a myth for the Indians. Sir Syed Ahmed Khan was acutely conscious of this move of the British. He wrote:

> *'Up to the present time the indigenous education of the country has been (like that of Europe at no very distant period) confined to the study of language and metaphysics, which though it undoubtedly serves to increase the mental acuteness of the learner, gives rise to none of those practical results which have been the fruits of the study of positive science amongst European nations.*

Besides this, the people in general, and Muslims in particular, were averse towards English education and modern European sciences. This was particularly true in the case of the Northwest-Province, the home province of Sir Syed Ahmed Khan. In his own words, 'This Presidency is hitherto much behind in the race of diffusing the light of knowledge among the people occupying it, when compared to the other more enlightened and prosperous presidencies of Bengal, Bombay and Madras'. Sir Syed was convinced that 'It requires to make strenuous efforts and throw strong inducements in the way of the people to regenerate them, by repelling and overcoming the many difficulties that defend the present gross ignorance of the people from the useful sciences and arts, and that retard the progress of their mental and social improvement. The declared aim of the Society was 'causing the blessed morning of civilisation to dawn on the night of ignorance and darkness which for ages has retarded the advance of this country. The objects of the Society were:

(a) To translate into such languages as may be in common among the people, those works on arts and sciences which being in English or other European languages are not intelligible to the natives;

(b) To search for and publish rare and valuable Oriental works. No religious work will come under the notice of the Society. Subsequently, in 1867, two more clauses were added to this section;

(c) To publish, whenever the Society thinks it desirable, any newspaper, gazette, journal, periodical or magazine which may be calculated to improve the native mind;

(d) To have delivered in their meetings from time to time, lectures on scientific or other useful subjects, illustrated when possible by scientific instruments.

From these objectives, it is clear that the Society was highly secular in outlook. It completely eliminated religion from its purview, which was something rare during the nineteenth century. The Society also had certain political objectives. It sought to foster and encourage the growth of an enlightened public spirit.

The Society also wanted to introduce improved methods of agriculture in India, so that the economic conditions of the people might improve. The activities of the Society may be classified into four parts, viz.

(a) Translation of Western literature into the local Indian languages;

(b) Practical attempts to popularize and democratize mechanized farming;

(c) Delivering lectures on topics of common interest;

(d) Highlighting the socio-political problems of the country.

The main thrust of the Society's activities was towards the translation of various European works-relating to basic and applied sciences-into local languages and importing into them the concepts of Western learning.

The Society translated around forty European books dealing with history, political science, geography, meteorology, electricity, algebra, geometry, calculus,

hydrology and agriculture. It selected only those books which would be beneficial for the people in developing a sense of historical perspective, interest in science and technology, and make them capable of managing their affairs and enable them to evolve a form of government best suited to themselves. In this regard, Sir Syed wrote:

> *'If the creation of a good vernacular literature and the introduction of European science through the medium of the vernacular are impossible, then the Society may as well cease to exist. It has no raison d'etre.'*

The Aligarh Scientific Society had a library and a reading room of its own. The books were mainly donated to the Society by different Indian as well as foreign gentlemen. Sir Syed himself donated a large number of books to the library. The Society subscribed to forty-four journals and magazines in 1866. Of those, 18 were in English and the rest in Urdu, Persian, Arabic and Sanskrit.

It exchanged its publication with similar societies like the Society for the Diffusion of Useful Knowledge founded by Pandit Harsokh Rai at Lahore and the Mohammedan Library Society founded by Moulvi Abdul Lateef Khan at Calcutta. It also exchanged its journal with the publications of the Bengal Asiatic Society, Calcutta.

The Bihar Scientific Society

Similar efforts were made by Imdad Ali to democratize European science in India. He had a firm faith in the efficiency of local languages and believed:

> *'England, France and Germany would never have attained that exalted degree of civilisation, which they now enjoy if the works of science originally imported from Rome and Greece in Latin and Greek, were not disseminated among the people by means of their own vernacular.'*

Imdad was not opposed to English education, but he emphasized that the Society should not bring in religion into the scope of its inquiry. He was a Deputy Collector. He had started publishing pamphlets and then a regular journal attacking Tahzib-ul-Akhlaq and calling on Muslims to boycott Syed Ahmed's reform movement.

Imdad was of the opinion that Indian students did not acquire properly the knowledge of Western science and technology, when it was taught through the medium of foreign language.

Consequently, they failed to transmit adequately their newly acquired scientific knowledge to their countrymen for lack of suitable expressions in the Indian languages.

For the purpose of spreading European scientific knowledge through the Indian languages, Imdad Ali founded an association in 1868 at Muzaffarpur called the British Indian Association. Later the name was changed to the Bihar Scientific Society.

The principal aim of the Society was diffusion of all kinds of knowledge throughout India. The emphasis was on bringing Western arts and sciences within the reach of even the lowest denominations of the society through translations in the local medium of Urdu, thus creating equality of opportunities to learn science in a stratified society. The Society also started a fortnightly Urdu newspaper called Akhbar-ul-Akhyar, which dealt with the educational subjects and aimed at improving 'the moral, intellectual and social condition of the people'.

As such, the Society entrusted the translation of many books on sciences to Maulvi Zakaullah and M. A. Rahim. The subjects in which books were translated included trigonometry, materia medica, optics, animal physiology, chemistry, dyeing, geography, botany, mechanics, algebra,

agriculture, zoology, arithmetic, law, hospitals, mineralogy and masonry. The Bihar Scientific Society also established five schools at different places, in which Western sciences were taught through the medium of Urdu. The schools were opened at Saran, Narban, Jaitpur, Hari and Sitamarhi in the vicinity of Muzaffarpur.

Apart from this, the Society suggested to the Senate of the Calcutta University that 'the standard prescribed for the University examination be adopted for the Vernacular examination and science be taught in Urdu or Hindee'. Thus, the Society made a meaningful contribution in the diffusion of modern scientific ideas, despite the step-motherly treatment of the Education department, which unjustly rejected the Society's publications to make room for their own book.

In the nineteenth century, it was really a Herculean task to advocate the cause of education based on reason and scientific vision. In addition, such scientific institutions as the Delhi College, the Aligarh Scientific Society and the Bihar Scientific Society were not established merely to impart modern scientific education, but to emphasize the need for a socio-cultural change in contemporary Indian society.

For this, men like Sir Syed Ahmed Khan, Hali, Master Ram Chandra, Imdad Ali and others had to face virulent criticism and opposition from the more orthodox, who included the leading 'ulemas' and 'moulvis' of the country.

THE INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

In Victorian England, the Royal Institution of London served as a scientific home for a host of scientists like Davy, Faraday, John Tyndall, and Huxley and, after Faraday's death, James Dewar. It was also a place for visiting scholars who spent short periods as workers in its laboratory. The

Royal Institution of London was one of the important components of the institutional infrastructure for science in Victorian England. On the other hand, Calcutta had no such institution during the nineteenth century.

Thus, even while science evoked interest in the capital of British India, there was not yet an institutional ambience that would induce Indians to practice science. The reputation and character of the Royal Institution of London had, however, secured the imagination of at least Dr Mahendra Lal Sircar. Sircar was born in the same year (1835) in which Rammohun died.

He was patently a legatee of the new learning. He studied at Hindu College. Later, he entered Calcutta Medical College in 1855, which had established a formidable course of studies in the sciences. Sircar truly became the torchbearer of the spread of scientific education after the demise of Rammohun. Sircar was, thus, a product of the College that had borne witness to the event of learning science education. He obtained, first, a licentiate in medicine and surgery in 1860 and then, in 1863, the degree of doctor of medicine, a rare achievement for an Indian at the time.

In 1869, Sircar began broaching the project of a national science association to the public through pamphlets, letters to the editor of the Hindu Patriot and public addresses. In 1876, he founded the IACS. Being Sircar's brainchild, the IACS enjoyed the State patronage, private donations and his own life's savings. It was financed from public subscriptions, and had the support of Sir Richard Temple, the Lieutenant-Governor of Bengal.

The IACS had an eventful life as well. During that period, the Indian League had already been founded. It opposed its preference for general science and advocated applied science for the economic development of the country and job generation. But, the IACS survived despite such hostilities

of the Indian League. In the August 1869 issue of the Calcutta Journal of Medicine, Sircar wrote an article entitled, 'On the desirability of a national institution for the cultivation of science by the natives of India'. He wrote:

'We want an institution, which will combine the character, the scope and objects of the Royal Institute of London and of the British Association for the Advancement of Science. We want an institution, which shall be for the instruction of the masses ... And we wish that the institution be entirely under native management and control.'

Sircar felt that the underdevelopment of India was due to its backwardness in science. India had the potential to master modern science. The Indians had shown themselves to master science in the past. This could be achieved through self-help. He desired that Indians should cultivate science not only for economic betterment but also for their regeneration. Of course, after persistent efforts, he succeeded in establishing the IACS in 1876.

Later, the IACS evolved into a world-famous research institute. It had a lecture hall by 1884 and a laboratory was constituted in 1891 with donations from the Maharaja of Vizianagaram. It organized a series of lectures by Prafulla Chandra Ray, Jagadis Chandra Bose, Asutosh Mookerjee, Pramatha Nath Bose, Father Lafont and many other distinguished scientists. It is best known for its sponsorship of the work of C. V. Raman, a physicist, who was later awarded the Nobel Prize for the discovery named after him, the Raman effect.

A critical overview of the activities of all these scientific institutions shows that both the Aligarh Scientific Society and the Bihar Scientific Society were short-lived. Only Sircar's IACS could manage to survive. This shows how a man of unusual drive and determination Sircar was! The IACS grew from strength to strength, and celebrated its centenary

in 1976. As the national institute of science, it remains a monument to the memory of Sircar, who died in 1904. The Association, as visualized by him, was an institution for the masses with full audience participation, where any lover of science could come and work the way it was felt necessary by the scientist. Being a national association created entirely by private donation, the IACS had no government control. But, it met with some resistance.

The Hindu orthodoxy thought that the IACS was attacking the traditional Hindu teachings. A large section of the public also felt that this kind of pursuit of abstract science had no meaning for a poor country like India. The cry of the day was utilitarian science, but Sircar's answer was: without scientists how can one have science?

CONCLUDING REMARKS

As I see it, the historical survey indicates that democratization of scientific knowledge in terms of access to modern scientific knowledge, creation of equal opportunities to do science, etc. in the colonial period began to occur not because of the colonial government but in spite of the colonial government.

Intelligentsia drawn from different religious groups realized the significance of modern science for material and cultural transformation of India, and attempted to democratize science in their own way by establishing scientific institutions and using the local or vernacular language as the medium of democratization.

Here, I would like to see the building of such scientific institutions by the cultural elite during the colonial period as a part of the process of democratizing scientific knowledge, rather than popularizing science. In postcolonial India, the whole responsibility of democratizing science was, by default, taken over by the State. It is due to the fact that the scientific

institutions and societies have partly relegated this inescapable task, which they had carried out with enthusiasm and pride during the colonial period as a part of the nationalist struggle against imperialism. Democratization of science in India is an unfinished task even now.

As such, modern science is being critiqued from the point of view of environment (genetic engineering research) and human rights. The process of democratization ought to address these questions. Democratization may be institutionalized in the process of science policy making that should be a broadbased, democratic, transparent and participatory process, as there is a Chinese saying: 'Tell me and I'll forget; show me and I may remember; involve me and I'll understand'.

5

THE ANCIENT INDIAN ART OF SELF DEFENCE

This chapter has not been the result of the strict empirical research. But the point of depart has been of the practical nature.

HISTORICAL BACKGROUND

Although the legends of Asian martial arts derive the secret of self defence from India, for a long time the knowledge about Kalaripayatt in the West has been second to none. In the book Martial Arts-the Spiritual Dimension, written a half century ago by Peter Payne, the author says only several words about stick fi ghting between two exponents of Kalaripayatt, a little known art developed in Kerala, Southwest of India.

"Although India may have been the cradle of the spiritual martial arts-he adds-contemporary Indian systems of self-defence are not wide-spread and much of the knowledge has died out or is taught only secretly" [18, p. 7].

That line of presentation is still alive. Although the role of Indian combat training has not been underestimated by military experts of the West, the "exotic secrets" prevail in many descriptions. The publishers of The Martial Arts Encyclopedia [4, p.72], issued in the United States not much

later after the book mentioned above, translated the term Kalaripayatt as "gymnasium exercises"-from the South Indian malayalam root, the language of old Dravidian origin proclaimed as the offi cial one in Kerala State after the Independence. On the same page we read some words of the explanation: "The ancient Southern Indian art of self defence is centered in Kerala, and still secretly practiced today. It is sometimes called the "Indian Karate". There are four stages to kalaripayatt. "Metoxhil" are the calisthenics to build strength and develop quick refl exes. "Kolthari" are wooden staff exercises performed alone or with partner.

"Agathari" are exercises with a sword, shield, and a dagger. "Verumkai" is unarmed fi ghting for health and self defence. A fascinating story relates how a kalaripayatt master chalked the tip of his sword during demonstration and then whirled it around at the spectators. Ten of them received the mark on their necks" [ibidem].

The Western adventure with Indian archaeological discoveries has been full of surprises. Many legends turned up to be sheer tale stories of "Indian ninjas". On the other hand, in the account of some serious Indian scholars, Sharada Srinivasan and Srinivasa Ranganatham, met during my researches as a visiting professor in the University of Bangalore (Department of Archaeology), we may fi nd the real trace leading to the source of the oldest art of swordmanship and swordsmiths in the world evidenced in archeological excavating situated near to the traditional kalaripayatt training region: "According to some reports of travellers to the East, Damascus swords were made by forging small cakes of steel that were manufactured in Southern India.

This steel was called wootz steel. It was more than thousand years before steel as good was made in the West.

Wootz was fi rst high-quality steel made anywhere in the world" [25, p.1].

Some other works confi rm the exemplary status of several ancient Indian practices indirectly. In a book Indian Mathematics and Astronomy which I brought back to Poland after my trip to India sponsored by The Indian Council for Cultural Relations, there is a message about up-to-date usage of the ancient handbook of mathematics compiled about two thousand years ago by the famous astronomer Bhaskara. A the beginning of the 20th Century it has been published in sacred language of old India, sanskrit, and then in modern hindi version, to reappear in some Western languages quite recently.

As it has been translated into Polish with the same title, Lilavati, we know that is the best-known ensemble of mathematical puzzles for thousand years used to train the mind. If we look into the text of The Scientifi c Edge. The Indian Scientist from Vedic to Modern Times we shall fi nd there the information about continuity of the scientifi c secrets for several thousands years-that is the real age of some ancient Indian Academies.

If we look for some other evidences, we fi nd out the famous Mogul iron pillar in New Delhi, made from unknown kind of blend never subjected to corrosion and therefore-in some spectacular theories-maintained to be a kind of UFO relict. More sound is the practical evidence-the popularity of stick fi ghting all over India-elements of various systems called dandi have been used by the Indian police and the Indian army since the colonial times of the British Raj. Looking for the ancient roots of these practices we may analyse the performing arts in the most important creations of sacred folklore-Ramayana and Mahabharata.

Their batalistic infrastructure has been founded on methodology and axiology known all over as Dhanur Veda.

The aims of this system are so deeply rooted in the Indian tradition as the practice of Ayurvedic healing. One can trace them in the illustrations of Roy Craven's History of Indian Art; the oldest are the sculptures from the temple of Kanchipuram near Madras (today named Chennai)-the confl ict of two ancient dynasties have been resolved on the ground of martial arts.

About the secret knowledge of combat practiced for some thousand years wrote Stephen Cohen in his book The Indian Army. Such refl ections have been verifi ed in some ancient reports of the Chinese pilgrims traveling to India for Buddhist studies in the seventh century. According to their accounts the best Indian soldiers have been recruited from the bravest warrior

Archives of Budo

clans, for many generations specialised in particular kinds of arms. If we look into the description found in Mahabharata, the epics known for more than two thousand years, we shall fi nd the same weapons attributed to particular heroes of legendary war [15, p. 217-248].

If we consider, that India's caste system preserved the secret knowledge of combat within the framework of dharma of the professional warriors (kshatriyas), we cannot be surprised to fi nd some texts on the art of war even in Three Jevels of Buddhism (triratna).

Buddha pacifi ed charging elephant and "paralysed" a famous robber Angulimala (this name means "a rosary of fi ngers"-of his victims) who jumped out on pilgrims. About thousand years later the monk Bodhidharma, established the Shaolin tradition, the famous system of combat self realisation practiced widely in China. The continuation of this path can be traced in the Japanese Zen: in 1985 Trevor Legett compiled a book entitled The Warrior Koans to

emphasize the historical connection of meditation line with martial arts beginning from Siddhartha Gautama who was a knight (kshatriya) before becoming Buddha.

Several thousand years before it, Arias, the brave conquerors of Indus and Ganga valleys, made their offerings to Indra, invincible god of war addicted to sacred drinking of soma. Most of ancient gods of Hinduism have been the experts of martial arts-Krishna, Siva, Kali. One of the heroes of Ramayana was Hanuman, the expert on Indian wrestling. The mythic fi gures of Mahabharata derived their specialised skills in particular arms from their forefathers-the gods of Hinduism.

In TV version of these sacred epics the stuntmen have been selected from kalaripayatt gyms Another trace leads to Yoga. According to some accounts the brahmans of the North had some knowledge of mallavidya, the science of combat. Beginning from the 10th century they have been training a very dangerous form of boxing known as the "diamond fi st" (vajra mushti), associated sometimes with a way of Tibetan Buddhism (Vajrayana).

For some religious regions they performed in some villages very dangerous fi ghts of warrior ascetics. Although the opponents attacked only the head and upper part of a body, many fi ghters have died during these festivals. Such tradition survived, particularly in Gujarat. But there are special events reviving "sacred battles" during some holy festivals of special importance. One of them is associated with Kurukshetra, the area known by heroes of Mahabharata.

The general interactions of combat arts and meditation have been analysed in the classical book of Selvarajan Yesudian Yoga and Sport.

The yogic structure of the Indian martial arts has been described by professor Luis Frederic in his Dictionnaire des

arts martiaux where kalaripayatt is explained as "chemin du champ du bataile".

He writes of "art martial indien, originaire du Kerala, il comprend des techniques sans armes (suvasu) quelque peu analogues à celles du karate et de l'aikijutsu, et des techniques avec armes-ces dernieres sont otta (sorte de masue pointue en bois dur), modi (poignard double fait avec les cornes du gazelle), urimi (un sarbre à la lame fl exible a deux tranchants), les lances, batons, poignards, petits boucliers ronds en osier ou en metal, etc." [8, p. 138].

And he adds: "Les mouvements sont accompagnée d'exercices de respiration controllée (pranayama) et visent à fraper les points faibles (marman) du corps de l'adversaire, reputé etre au nombre 108. Ce style de combat rituel (il est dedié à la deese Kali), serait, selon la legende, celuila meme que Bodhidharma introduit en Chine, au Shaolin. Aussi appellé vajra mushti, "poing de diamant"" [ibidem].

There are also some detalic accounts. In the article Marman et les arts martiaux indiens Arion Rosu compares the vital points of combat (marman) with yogic chakras and nadis. "Ayant tiré profi t de Ayurveda-he wrote-et attiré par la drogue d'immortalité, brahmans adopté quelques practiques psychophysiques des arts martiaux".

The word "marman" has been found already in most ancient Veda (taken from sanskrit root mr-to die). Patanjali handbook Yogasutras reports in several contexts about "marmasthanas", the knowledge of vulnerable points. This knowledge has been widely applied in yogic healing and therapeutics, cherished particularly by sivaists and tantrists.

Another evidence of the most ancient origins of the Indian martial arts can be found in the dimension of classical dances. In his collection of documentary fi lms presented in Poland

in 1979 Nicola Savarese has shown Martial Dances of Malabara, combining the message with the debate about the sanskrit theatre Kathakali.

In a book Performing Arts in Asia [3, p. 17] Kapila Malik Vatsyayan talks about "amazing continuity of tradition and tenacity with which dance forms have survived at various levels of social strata".

From the very beginning the actors of Kathakali theatre in Southern India have been the Nairs derived from the jati of kshatriyas. Their fundamental postures have been connected with kaparipayatt training.

For more than 10 hours of the traditional spectacle they keep upright position staying on the external parts of their feet. For Westerners that is possible for no more then several minutes if you do not take into consideration the spectacular movements of Indian actors.

Kalaripayatt-the Ancient Indian art of Self Defence

If we study performing art forms of Kerala and the infl uence of kalari on them, like thayyam and padayani, or even more sophisticated forms like kudiyattam or kathakali, we fell that the steps and the hand gestures perhaps owe something to the kalari fi ghter and the training procedures the goes through.

"Thayyam is one of most colourful and ancient forms of ancestor worship practiced in the northern districts of Kerala even today-wrote Narayana Menon in his essay The Performing Arts. A Defi nition-The ritualistic and extravagant art form, designed to coincide with the festival periods, has imbibed several traits from the kalari system.

It is worth mentioning that kalari asans also come from these areas Authorities such like K.N. Kurup categorically stated that thayyam dancers obtain martial skill from the traditional acrobatics known as kalaripayattu" [1, p.53].

"Many rural and urban art forms, sophisticated and unsophisticated-he ads-have drawn elements from Kalaripayattu. Kudiyattom is one such important art form. In Attaprakaram, a work which deals with the movement and gestures of the actor when he portrays a character in Kudiyattom, the infl uence of Kalaripayattu is evident. Take Patapurappadu. This is done either when a chasracter prepares for a combat or when he has nostalgic memories of a combat already won. All the details related with it are depicted in a style similiar to that of Kalaripayattu.

In Krishnanattom, another form of temple theatre art. this infl uence is again evident particularly in the kalasams of male characters especially those of Krishna, Balarama, Narakasura and Murasura. In Swayamwara, which depicts the marriage of Draupati, the fight between the Krishna and Kalayavana, is like an adaptation from Kalaripayattu. Kathakali, it is believed, has borrowed from Kalaripayatt. Some of the physical training methods used in Kathakali were adopted from maipayattu of kalari vidya.

Terms used among Kathakali asans, like kal visal, kai visal, suchikikidal, thozhuthu kuthal, kuninju visal, prove this. The poses described in Kalaripayattu for the elephant, horse, lion and fi sh have been adopted by Kathakali perforemers.

Other dance poses in Kathakali have their basis in the Akkachuvadu and Neekkachuvadu followed by kalari experts. The infl uence of Kalaripayatt is clear in relatively the new art forms like in the Chavittu Natakam. The performing art of a more martial nature known as Velakali clearly shows elements taken from this ancient physical training system" [ibidem].

The presence of martial training is evidenced in many aspects of Indian life. It can be traced in relics of Hanuman cult in small temples situated on the banks of Ganga river

(the priests are the wrestlers), as a performing art it is a part of Indian festivals, dances, movies.

Description of combat training of very old roots can be found in such classical British accounts of military training like The Sepoy written by Edmund Candler, the book on Martial Races of India published by general George Mac Munn, and Saint Nihal Singh's book entitled India's Fighters. Some other aspects have been analysed in The Self Defence of India a book compiled by P. S. Sivaswamy Ayer.

The vast information about the Indian combat training can be found in the sacred books, legends, tale stories. The best known are epics Ramayana and Mahabharata. Transformed in TV serials they have begun to be the best evidence of Indian martial art background.

If we analyse the temple painting and sculpture, we soon fi nd the source of inspiration for many Indian movies still feeding the imagination of Bollywood producers. One has to be cautious, though, the images and symbols of Indian martial arts have been mixed up there with other systems of Asian combat sports.

For more detailed information we suggest the book of M.D. Raghavan, Folk Plays and Dances of Kerala. A manuscript entittled Kalarividya discovered some years ago was published by the Manuscriot Library of the University of Kerala in 1956. In the introduction to it Vijaykumar points out the existence of another manuscript of Marma Vidya-the most secret aspect of Kalaripayattu. It has not been published yet. The Marma Vidya is written in Vattezbutthu and it is in is in the collection of the University of Calicut.

Training of Kalari

If we consider Kalaripayatt as the ancient Indian performing art we have to be cautious. This kind of

understanding can be misleading. Performing arts live only with music and dance but this is not a fi lm but the theatre: the music is in our body, not necessarily in the hearing.

We have to reconsider the background of Asiatic martial arts beginning from sacred body language, prayer or meditation so well described in a book The Ritual Theatre of Far East.

There is an old saying in Malayalam (the language of Kerala) which lays down the rule that for fencing exercices-the whole body mus become the eye.

In other words, the whole muscular structure must be made as sensitive, responsive and alert as the human eye. This is the fundamental principle on which the Kalari system is designed.

Training is leading to balance, control, and fl exibility of mind and body. Psychophysical integration become the foundation for self-awareness, leading to exceptionally effective performance.

The pupil is enlisted on auspicious day, usually at the age of seven. After offering dakshina to guru he gets his fi rst lesson. The process of learning is conceived as a system of initiations. Though the elaborate training is designed for the males, females are not completely barred from admission. We guess it from the stories of kalari queens described in the ballads (for example Unniyarcha).

Kalari gym has very ancient design. It generally measures 42 feet (in the eastwest direction) by 21 feet. The hard level surface is prepared six feet below the ground level and it has a gabled roof of plaited cadian leaves.

The smaller gyms usuallyhave the length from 18 to 12 feet. The deities of kalari rqange in number from seven to

twenty one, the number depending on the local status of teaching Guru (Gurukkal) entittled with the same reverence as the Gods. But the presiding deity in all cases is the Kalari Bharadevata (or Bhadrakali).

The south-west corner os considered his sacred seat, several steps lead to a tiny raised platform. The idea of training is strictly connected with the notion of joint family, the smallest unit of the social structure of Kerala in the middle ages.

Before starting the movements student touches the floor of the training ground with reverence-with his right hand. Then he places it on his forehead in a form of salutation.

Afterwards he prostrates himself at the feet of Guru. The warming up is associated with various methods of massage. They are all used with a view to giving maximum fl exibility to the body. With the special movements, they serve more than one purpose of maximum affectivity in fi ght. They also have therapeutic value and are adopted for the treatment of physical ailments.

The training can be divided into three different periods. The first phase is the period of steps, kicks and blows which remind the techniques of karate and jujutsu.

The most important is the balance of body and soul. Techniques are applied with special support of yogic breathing. During the second phase the trainee is taught various movements using a stick. Here the combat between the two opponents begins.

The third and last phase of training employs more intricate and dangerous weapons, After the fencing lessons with a stick of different lengths the student begins to learn the techniques of the sword, the dagger, the spear. Among

them is the otta-kind of curved dagger having a strong guard of the first.

Manoeuvres with these weapons need perfect mastery and skill. The secrets of successful swordsmanship are taught only to these disciples of the Guru in whom he has perfect confi dence. The most dangerous strokes are directed to the 64 kulamarmans, the most vital parts of the body. All together there 104 marmans which the master of Kalaripayatt must know. For that reason some of them become famous healers. They use herbs, massage and special movements for a treatment.

In spite of many dimensional practice of kalaripayatt, the system is basically invented for self defence. The basic principles remind the foundations of karate and aikijutsu, the advanced knowledge has been founded on very elaborate science of fencing.

It is seen clearly at the age of mass media, when the science of South Indian combat-a the whole world of Asiatic self defence-has been subjected to TV impact. Kalaripayatt is often the guest of satelite channels, particularly in Kerala region. Fundamental techniques are taught in fi lm studios, I have seen it in India.

But the mastery of this art has always been a secret, most advanced training is a mystery reserved to best students. For many reasons this kind of self defence is worth to study. Combined with studies of Buddhism and Hinduism, it may develop the deeper understanding of the most important foundations of all martial arts and bring about new understanding of Indian performing arts.

CONCLUSION

Kalaripayatt is the art of self defence with very ancient roots. At the same time, it is one of the most effi cient system

of developing the awareness of body and mind for dangerous situations. This art, in earlier days, was given the same importance as reading, writing and arithmetic's. For many centuries it has got a special status in ritual dimension. Like the cricket today, it was a "new religion".

For some higher jatis it has been considered as the important part of dharma. Sword, stick, and spear were done afternoons, reading, writing, and arithmetic's-every morning. The sacred texts talk about the secret weapons and effi cient systems of the great danger. They often were the gifts of powerful Gods, like the weapons of Arjuna.

With the outcome of the modern times the knowledge about Indian systems of self defence decreased to such extend, that only a few knew about their special status and ancient background.

The question arises why the tradition of Indian self defence survived fully mainly in the South. For the inhabitants of Kerala the answer is very simple. Only the South preserved the Indian soul. Kerala is more Indian than other Indian states. Only Kerala and Tamilnadu avoided the impact of islamisation at the millennium of Arab, Turkish and Mogul rules in India.

A the time of the Great Moghuls, the dynasty extending power to the Kalaripayatt-the ancient indian art of self defence boundaries of the entire subcontinent for several centuries-from Babur Shah to Aurangzeb, these two states were the independent territories, not subjected to the transition bringing in consequence the "mixed culture".

Although it is not obvious for everybody, the survival of Kalaripayatt owes much to the strength of traditional attitudes towards the Hindu rituals of Indian self defence.

Although the roots of the practice of Kalaripayatt are very ancient, the very idea seems to be modern in the dimension of self defence.

It favours fl exibility of the body and awareness of the spirit, not the strength of muscles, claims for high technical standards before any other skills.

It has strong connections with Ayurvedic healing and the "tuning in" of Yoga. For some thousand years it has been tested in the military practice. Recently, it has been applied for police purposes.

For these reasons, the experts of universal self defence at the age of globalisation conceive the Kalaripayatt as the system worth of careful analysis and comprehensive studies.

6

AYURVEDA: THE TRADITIONAL INDIAN MEDICINE SYSTEM AND ITS GLOBAL DISSEMINATION

In this essay we introduce the ancient Indian medicine system (Part I) and also describe its global dissemination (Part II). Through Buddhist monks the Ayurveda spread to Tibet and China. So many Chinese scholars visited India and even studied in the ancient Indian universities. After Alexander's invasion, the contacts with the Greek and Persian worlds got intensified. In medieval times, during the period of the Arab Caliphs, the Arab world became a hub of international science and medicine. In its institutes, like the medical academy at Jundishapur, both Greek and Indian savants taught and translated major medical works. We would therefore go into greater detail about the Indo-Arab contacts during this period in the Part II.

Part I

Probably all life forms are afflicted with disease. Disease is the basic problem faced by humans too since prehistoric times. Evidence for the existence of well-organised system of medicine in India can be traced back to the archaeological remains of Harappa and Mohenjodaro, from where even

Silajit has been reported. Ayurveda is the oldest Indian indigenous medicine system, probably with its roots in the Indus Civilisation. In the Vedic period, the Osadhisukta of the Rigveda is the oldest documented knowledge about plants and herbal medicines.

The term Ayus means duration or span of life, veda means unimpeachable knowledge. The common translation of the Ayurveda is 'science of life'. In his book Kris Morgan says that literally Ayurveda means 'science of longevity', but because of its divine origin, it is also called the 'medicine of the God'. Tradition says that Brahma (the creator) was the divine source of this science, which was brought into existence before the creation of mankind. The knowledge was passed from him to the god Daksapati, then to the two celestial physicians (the twin Asvina Kumaras), later to Indra the god king, and finally to Bharadvaja, the semi-divine sage. Such traditions need not be taken literally but they only indicate the great antiquity of Ayurveda.

LITERARY EVIDENCE

The earliest-recorded knowledge about Ayurveda is found in the Rigveda and the Atharvaveda, both of the second millennium BC. The Atreya Samhita is perhaps the oldest medical book in the world; it survives from Taksashila University, going back to the mid-I Millennium BC. The Atharvaveda lists eight divisions of Ayurveda: internal medicine, surgery of head and neck, ophthalmology, surgery, toxicology, psychiatry, paediatrics, gerontology or science of rejuvenation and the science of fertility. At about 500 BC in the University of Banaras, Susruta, a surgeon, who developed the operative techniques of rhinoplasty (plastic surgery), wrote the Susruta Samhita, which describes a highly developed surgery. The physician Caraka revised and supplemented the Atreya Samhita; his book, the Carak Samhita is a vast work on internal medicine.

Susruta Samhita: According to Susruta Samhita the purpose of Ayurveda is not only to cure illness and affliction but also to preserve health and ensure a long happy life. Susruta Samhita deals specially with the therapeutic branch of Ayurveda. It contains one hundred and twenty chapters, distributed in five divisions: Sutrasthana (fundamental postulates cover 46 chapters), Nidanasthana (pathology, covers 16 chapters), Sarirasthana (embryology and anatomy cover 10 chapters), Cikitsasthana (medical treatment covers 40 chapters), Kalpasthana (toxicology covers 8 chapters) and Uttaratantra (specialized knowledge covers 66 chapters) respectively.

Caraka Samhita: Caraka Samhita is an exhaustive work on medicine. It is said that Caraka's original was the Samhita of Agnivesa, a disciple of the medical sage Atreya. Long passages in the Caraka Samhita are in the form of questions and answers between Atreya and Agnivesa. Caraka is a class title of a school of physicians, existing from Vedic times and also the personal title of a physician in the court of King Kaniska. (There is no unanimity about Caraka's date yet). The subject matter of the Caraka Samhita has been divided into 8 sections and 120 chapters. The total number of chapters (120) probably refers to the maximum life span (120 years) of man because the ultimate object of treatise is to promote longevity.

More then 600 drugs of animal, plant and mineral origins are used in the Caraka and about 650 in the Susruta Samhita. Susruta mentions more then 300 different operations employing 42 different surgical processes and 121 different types of instruments. The Samhitas divide Ayurveda into 8 different branches: Salyatantra (surgical knowledge), Salakyatantra (treatment of diseases of the ears, nose, eye, tongue, oral cavity and throat), Bhutavidya (knowledge of mental diseases, supernatural origins diseases), Kaumarabhrtya (care of children and infantile disorders),

Agadatantra (toxicology), Rasayanatantra (syrup, tonic knowledge) and Vajikaranatantra (knowledge of virility).

Ayurveda deals with the medical subjects like genetics, gynaecology, aetiology, surgery, physiology, biology, diet, ethics, personal hygiene, social medicine, allied subjects like animal biology, botany, cultivation, pharmacognosy, chemistry, cosmology, etc.

AYURVEDIC CONCEPT OF IDEAL HEALTH

According to the philosophical concepts on which Ayurveda is based, all bodies-material, living, conscious and unconscious-are evolved out of Prakrti (the ultimate ground) by the subtle influence of the Purusa, the absolute or the primal self conscious principle and every component of the human organism is created out of the tattvas (fundamental compounds) as evolved out of the Prakrti. When all the eleven indriyas (mind, the five sense organs and the five organs of motion and action), the three dosas (the air, radiant energy and water), the agni (digestive fire), the malas (excretions), the kriyas (like sleep, elimination, respiratory, etc.) and the seven dhatus (elementary stuff) are in normal state and in equilibrium then the health is in an ideal state.

The main aims of Ayurveda include maintenance of this equilibrium, and its repair in case of any imbalance and derangement. Ayurveda attempts this process by the application of all spiritual and material resources available to man.

PHILOSOPHY OF AYURVEDA

There is a remarkable theory in Ayurveda to the effect that man is a miniature form of the universe, a 'microcosm' of the macrocosm. The material contents of man and universe are constituted of the same five primal elements: prthvi (solid component to both), apas (the liquid), tejas (the radient

energy, body heat, digestive fire), vayu (air), and akasa (the orifices and empty spaces inside the body).

AYURVEDIC DEFINITION OF HEALTH

In Ayurvedic medicine, health is defined as soundness of sarira (body), manas (mind) and atman (self). Each of these must be nurtured if the individual is to have good health.

CONCEPT OF DISEASE

Ayurveda is basically a humoural medical system and conceives of three essential humours, which cause disease if they become imbalanced. These three humours are: vata (air), pitta (bile) and kapha (phlegm), occasionally in the surgical tradition a fourth humour-blood-was also added.

Vayu: Vayu is self-begotten, eternal, all pervading and all-powerful in its action and control over all space. It controls the creation, growth and disintegration of all living organisms. According to location and functions it is of five types: prana vayu (maintain the breath, transmit food), udana vayu (vocal sound, song, speech are depend upon it), samana vayu (causes digestion), vyana vayu (causes perspiration) and apana vayu (causes the downward movement of stool, urine, semen and menses).

Pitta: Pitta is the cosmic fiery principle. It is responsible for the creation in the body of heat, energy, all forms of radiant energy, pumping action of heart, skin temperature, vitality of blood. In the body, pitta is of five types: ranjaka pitta (colour producing fire), pacaka pitta (digestive fire), sadhaka pitta (motion giving fire), alocaka pitta (vision giving fire) and bhrajaka pitta (lustre giving fire).

Kapha: Kapha supplies the placid and cooling principles to the body. According to location and function kapha is of five kinds: kladaka (supply mucous to the system),

avalambaka (transport the blood fluids), vodhaka (tasting agent), tarpaka (irrigating agent) and slesmaka (binding agent).

Vyadhis (diseases) are caused by derangement of one or more of the three humours and also blood. According to Samhitas, vyadhi (diseases) may be four types: agantuja (extraneous), sarira (internal), manasa (mental) and svabhavika (natural).

CONCEPT OF TREATMENT

Direct observation is the most remarkable feature of Ayurveda but some times it is correlated with metaphysics. Samhitas accept this view and write that of all types of evidence, the most dependable ones are those that are directly observed by the eyes. In the Ayurvedic viewpoint successful medical treatment depends on four factors: the physician, substances (drug or diets), nurse and patient. Samhitas described these four factors properly. These four factors are the main mechanisms of Ayurveda. It describes four essential qualities of medical factors, physician, drugs or substance, nursing attendant and patient respectively. The qualifications of physician are: clear grasp of the theoretical content of the science, a wide range of experience, practical skill and cleanliness. Qualities of drugs or substances are: abundance, applicability, multiple use and richness in efficacy. Qualifications of the nursing attendant are: knowledge of nursing techniques, practical skill, attachment to the patient and cleanliness. And the essential qualifications of patients are: good memory, obedience to the instructions of the doctors, courage and ability to describe the symptoms.

INFLUENCE OF AYURVEDA ON EAST AND WEST

By 400 AD, Ayurvedic works were translated into Chinese; by 700 AD, Chinese scholars were studying medicine in India at Nalanda University. Indian thought, as well as

influencing Chinese spirituality and philosophy through Buddhism, greatly influenced Chinese medicine and herbology through Ayurveda. In 800 AD, Ayurvedic works were translated into Arabic. In 16th century Europe, Paracelsus, who is known as the father of modern Western medicine, practiced and propagated a system of medicine, which borrowed heavily from Ayurveda. In the following discussion, we would take a global view of Ayurveda.

Part II

Below we discuss the spread of the Indian medicinal knowledge to other parts of the world.

India has had cultural and trade relations with Mesopotamia, Gulf countries and Iran even in the III Millennium BC. Seals of Bahrain type have been found in Lothal, a Harappan town in Gujarat. With the Arab countries India's scientific and cultural relationship goes back to prehistory. During the medieval times such relations intensified a great deal.

No doubt Alexander's annexation of Gandhara region led to closer ties between Greece and India, but the mutual contacts go beyond to the Persian kings (Cyrus, Darius etc) of mid-I millennium BCE. These Persian kings employed both Greek and Indian scholars and physicians. Quoting Fillozat, Sharma (1992) suggests that both Plato and Hippocrates were influenced by Indian thought and concepts. Indian Wootz steel was equally popular with the Persian kings for both its hardness and rust-free properties (Tripathi 2001).

CONTACTS WITH CHINA AND TIBET

India was in contact with China even during the Kushana times. Bahlika was an important centre where traders from China, India and West Asia met and exchanged ideas and

goods. During the Gupta period the links between India and China were firmly established. Chinese scholars like Fahiyan, Ywan Chwang, and Itsing were great cultural ambassadors between the two countries. The University of Nalanda, established during the reign of Kumaragupta, attracted a large number of scholars and students from China. Several Ayurvedic texts were translated into Chinese (Sharma 1992).

The Bower Manuscript (mss), which is named after its discoverer, Lieutenant H. Bower, was found in 1890, in Kuchar, in Eastern Turkestan, on the great caravan route of China. It was then sent to Colonel J. Waterhouse, who was then the President of Asiatic Society of Bengal where the famous Indologist Hoernle edited it. Detailed studies of the mss indicated to Hoernle that the writers of Parts I-III and Parts V-VII were Indian Buddhist monks. The mss is written in Indian Gupta script. The use of birch-bark for writing shows that they must have come from Kashmir or Udyana. Hoernle thinks that they passed the mss into the hands of the writer of Part IV, who would seem to have been a native of Eastern Turkestan, or perhaps of China. But the ultimate owner of the whole series of manuscripts, Yasomitra, must have held a prominent position in that monastery. For this collective manuscript was contained in the relic chamber of the memorial stupa at the Ming-oi of Qum Tura, built in his honour. The large medical treatise called Navanitaka forms the second part of the Bower mss dated to about the second half of the fourth century AD. The Chinese medicine system has several parallels with the Indian system. The Chinese concept of Ying and Yang is comparable to Indian Prakriti and Purusa. So also the five basic elements of the Chinese and Indian systems are similar. It seems that the pulse reading system in India was derived from the Chinese.

The Tibetan and Indian medicine systems too had close relations. The most popular Tibetan medical text is Rgyud bzi (meaning Catus-tantra, four treatises). It was based on

Amrta Hrdaya Astanga Guhyopadesa Tantra. In the 8th Century AD Vairochana, a Tibetan scholar, translated it into Tibetan (Dash 1992). The Tibetan medicine system was greatly influenced by Ayurveda, but it is an integral part of Buddhism. Their materia-medica could provide many cures for the obstinate and incurable diseases.

CONTACTS WITH WEST ASIA

Rhazes (865-965 AD) and Avicenna (Ibn Sina) (980-1037 AD) were great scholars of Arabic medicine who influenced the global medical literature for a long time. The canon of Avicenna was translated into Latin in the 12th Century AD and was a textbook in European medical institutes for long. We will therefore go into greater detail into the scientific relations between the Indian and Arab worlds.

The names of several Indian products such as Indian sword, Indian spices and aloes-wood are often found even in pre-Islamic poetry. Names of the Indian drugs, like Kafur (Karpüra), Misk (Muska), Zanjabil (Srhgavera) and ud (Aguru) etc. occur even in the holy Qur'an and Prophet's traditions (Ahadith-i-Nabawi). Probably the Arabic words like Faniz, Tütia, Narjil, Bish and Sandal have probably been derived from Sanskrit language. Varma (1992) in his detailed article, "Indo-Arab Relations In Medical Sciences", gives several well-documented instances of such contacts.

Abu Sa'id, a companion of the Prophet, has related that an Indian Raja had sent an earthen jar containing dried ginger (Zanjabil) to the Prophet and he distributed it among all his companions to eat and that he also got a piece. Al Tabari, the author of the first comprehensive Arabic book, entitled 'Firdaus-ul-Hikmat' (Paradise of Wisdom) (c.850 AD) mentions, "If a person takes seven pieces of Zanjabil (dried ginger) in the form of jam, particularly prepared in honey, for seven days in a month for some time, he would be protected

from phlegmatic ailments like paralysis, rheumatism, etc., it would also sooth the stomach. It is a help in old age. Due to its medicinal properties, its use is very common not only in food preparations but also in Unani medicine and Ayurveda. The Prophet used to burn Aloes-wood ('Ud-Hindi) with camphor. Said the Prophet, 'In Aloes-wood, there are seven remedies'. As a snuff, it is good for the disease called al-Ghudrah. It is also efficacious for cases of pleurisy."

Several Indian tribes like Jats (Zutt) had settled down in Arabia even before the beginning of Islam and they were well-versed in different branches of ancient Indian traditional medicine. Many if them, such as Tantric medicine, and were using their clinical proficiency to cure the patients. Even some of the Indians are also said to have been in the company of the Prophet. The beloved wife of the Prophet was cured by an Indian Jat physician of Medina. It is also recorded that Harith bin Kalada, the trusted Hakim of the Prophet, studied in the medical school of Jundishapur (in Khuzistan, in South-West Iran) where Indian vaidyas and philosophers also taught sciences including medicine. At the end of his studies and before returning to Mecca, Harith travelled through India in search of more information about different branches of Indian Medicine. It is also mentioned that an Indian physician, Birzantin Hindi had migrated to Yemen and settled there presumably during Anusherwan's reign (530-580 AD). He had a fair knowledge of Indian Medicine and specialized in treating different diseases by administering Indian herbs particularly hemp (Cannabis indica Linn). He is responsible for introducing Indian hemp for curing various ailments and got the name and fame due to new mode of treatment in that area.

Zubayr (1960) says that a Chinese monarch sent a gift in the form of a book to the first Ummayyad Caliph (660-680 AD). The book contained some secrets and wisdom regarding Indian medicine, alchemy and astronomy. The

same book was received by his grand son, Abu Hashimn Khalid bin Yazid, who used to take keen interest in the acquisition of scientific knowledge from different countries. It is therefore believed that he might have extracted and assimilated a considerable material on medical sciences and on other subjects of Indian origin. It is stated that after conquering Sindh, 'Abdullah bin Sawwar 'Abdi (667 AD), the Governor of Sind, sent a number of rare gifts to the Caliph on behalf of the Raja Gigan (Qiqan). Al Tabari (c. 850 AD) mentions that the Indian hair dye (al-Khidab ul-Hindi) was also exported to Arabia and was very popular with the Arabs due to its peculiar quality for retaining the bright dark texture of the hair for minimum period of about a year. It was also used by the Arab caliphs like Hashim bin 'Abdu'l Malik (742 AD). In this context, Al Tabari mentions, "Many persons had told me about a wonderful thing for retaining black texture of hair for ever, quoting their ancestors. According to them, the buccal sucking of one piece of black chibulic myroba1 of Kabul (famous Indian drug) daily, continuously for one year was advised to retain permanent black texture of hair".

All the 'Abbasid caliphs from al-Mansur (754-773 AD) to al-Mutawakkil (847-886 AD) were patrons of arts and sciences. Al-Mansur, the second 'Abbasid caliph, received embassies from Sindh, one of which included some Indian pandits who presented him two Indian books on astronomy; the Brahmasiddhanta and the Khandakhadyaka, which by the orders of the caliph were translated into Arabic by Ibrahim al-Fazari (786-806 A.D). Caliph Harun al-Rashid's (763-809 AD) is well known for his literary and scientific interest. He established his famous Bait-ul-Hikmat (House of Wisdom), a combination of library, academy and translation bureau which in many respects, proved to be the most important educational centre since the foundation of the Alexandrian museum in the first half of the third century BC. When the

Arabs realized the high quality and value of Ayurveda as well as Indian culture, they got interested in translation of Indian medical and other scientific works from Sanskrit into Arabic. Thus works of Caraka-samhita and Susruta-samhita etc. were rendered into Arabic. The Arabic translation of these samhitas highly impressed the Arabs. They assimilated an enormous material in their Tibbi medical treatises.

The Barmecide (Barmaki or Barmak, after the Sanskrit word Pramukh, high priest) rose to the most influential position during the 'Abbäsid period, particularly in the reign of Caliph Harun al-Rashid. As a physician Barmak's claim to fame is the pill which was named after him (Habb-i-Barmaki). It was recommended by Ibn Sina (980-1037 AD) and later Hakims and a perfume which was widely used by prostitutes. Yahya bin Khalid, the Barmecide (c. 805 AD), the vizier of the Caliph Mahdi and the tutor of Harun al-Rashid, sent an Arab scholar to India to study and bring the Indian drugs and herbs etc. Yahya also invited Indian vaidyas and philosophers westwards so that he might learn from them. Once Harun al-Rashid was afflicted with a serious disease and could not be cured by his own physicians, so he sent for Manaka (Mankhaor Minikya) with precious gifts. He came to Baghdad and cured the Royal patient and the caliph granted him handsome pension and bestowed upon him great wealth.

Manaka was proficient in Ayurveda and other Indian sciences and had a sound knowledge of Indian and Persian languages. He was deputed as Chief of the Royal Hospital at Baghdad and translated several books from Sanskrit into Persian or Arabic language. Ibn Dhan (Dhanya or short form of Dhanvantari?) was another competent Indian vaidya who lived at Baghdad at the same time when Manaka was there. He was called there by Yahya bin Khalid, the Barmecid vizier and was appointed as the Director of his (Barmecid) hospital at Baghdad. At his behest, Ibn Dhan also rendered

a few Sanskrit texts into Persian or Arabic Language. Saleh bin Behla was another competent practitioner of Ayurveda, though he does not seem to have any official position. He is known to have cured Ibrahim bin Saleh of apoplexy, though he was declared dead by the Caliph's own physicians. After the advice of Säleh, the royal patient was removed out of his coffin, bathed and put in his usual dress. Then the Indian vaidya ordered to bring a blowing pipe and blew some snuff prepared of Kundush (Verartilum album) with the instrument into his nose. After about ten minutes, all of a sudden, his body quivered and he sneezed, sat in front of the caliph and kissed his hands. The caliph was much impressed by the clinical acumen of Indian doctor and rewarded him handsomely.

Düban was the last and fourth Indian vaidya who was mentioned by Maulana Shill Nu mani, the well-known Indian orientalist, in one of his scholarly monographs entitled 'A1-Ma'mun'. Duban, the Indian learned vaidya, was sent by an Indian Raja to the court of Caliph al-Ma'mun' at Baghdad. It seems clear that Burzoe, the well-known minister of Nausherwan (530-580 AD) came to India at the command of his king to collect more information on Indian arts and science. He brought Indian scientists and experts of Ayurveda along with the books on different subject of India.

Most of them were deputed to impart Indian medical education. Other scholars were appointed for rendering scientific books in Pehlavi language in the medical academy and translation bureau of Jundishapur. Beside the abovementioned four well-known Indian vaidyas there must have been several other Indian medical men at Baghdad; but no information is available about them. The Arab scholars were also acquainted with some other Indian vaidyas and masters of other allied sciences. These are:

I. Kanka (Ganga) was one of the most learned Indian scientists who also knew the healing art and drug

sciences. According to some Arab writers, Kanka was accepted by all the Indian savants to be the greatest authority in astronomy in ancient India. He was probably the author of the following books: (a) Kitab-ul Namudar fil-'Amar (The book of horoscopes of lives); (b) Kitab-ul Asrãri'l Mawalid (The book of the secrets of births): (c) Kitab-ul Qiranat (The book of conjuctions); Kabir wa Saghir (Major and Minor); (d) Kitab fi 'llm-ul-Tibb (The book on medical science); (e) Kitab fi'lm-Tawahhum (The book on mania); and (f) Kitab fi'l Ahdathi'Alamii fi l'Qirdn (The book on the incidents that may happen in the world under certain conjunctions of stars).

II. Sanjhal was the most learned man of India who wrote a book on nativity entitled, Kitab-ul-Mawalid (book of nativities).

III. Shanaq (Cãnakya) was one of the ablest vaidyas of India. He had versatile knowledge of various branches of science and philosophy. He excelled in astronomy and occupied a high position in the courts of Indian kings of his time. Varma thinks that Shanaq al-Hindi is to be identified as Canakya, Candragupta's minister, also called Kautilya. It is known to have been translated into Persian from an Indian language by Manaka. Then, it was rendered into Arabic from the Persian by Abu I (9th cent. AD). Shanaq was known to be author of the Fihrist, Ibn al-Nadim, and also of other books on the conduct of life, the management of war, and on cultural studies. His works mentioned by Ibn abi Usaibi'ya are on the stars, lapidary crafts, and one on veterinary medicine.

Abu Hatim of Balkh who translated books from Persian into Arabic is known only as a contemporary of Manaka and a translator who worked for Yahya bin Khalid the Barmecide.

Another translation of Shànaq's work was carried out by al-'Abbãs ibn Sa'id al-Jauharil, a contemporary of al-Ma'mün, and a well-known Islamic astronomer and commentator on the Elements of Euclid. Shãnaq divided his book into five chapters. The first deals mainly with poisons; the second is on veterinary science; the third is on astronomy; the fourth book was meant for the guidance of a certain king; the fifth is the book of nativities.

Besides the above ancient Indian scientists, there are many others mentioned by Ibn Nadim and Ibn abi Usaibi'ya, but it is not possible to identify them definitely. The following names of the Indian scientists have been mentioned:

(1) Bakhar

(2) Raha (or Raja)

(3) Dahir

(4) Saka

(5) Aikab

(6) Zankal

(7) Jabari

(8) Indi

(9) Jahar

(10) Ankü

(11) Manjhal.

Qazi Athar Mubarakpuri has further added these names:

(1) Vaidya Behla

(2) Qalbarqal

(3) Khãtif Hindii.

They were also invited by Yahya bin Khãlid, the Barmecide, during Harun al-Rashild's time.

The following Indian medical works were rendered into Arabic from Sanskrit or Hindi during the Abbasid Caliphate:

(1) Caraka-samhita was translated into Persian (Pehlavi) probably by Manaka Hindi and then it was rendered into Arabic by Abdu Habin;

(2) Susruta sanhita (susrud); Astanghrdaya; Nidana; Siddhyoga; the book of poisons; the book on treatment of pregnant women; the book on female diseases; the book on snake bites and incantations; there are other books on intoxicants, diseases, drugs etc.

Caliph Harun 'al Rashid used to levy heavy taxes on various kinds of Indian articles including spices and drugs. Caliph al-Ma'mun (813-33 AD) was also interested in different sciences. So he brought many scientists to his court from Jundishapür which had a large number of Indian scientists who had brought their sciences and wisdom from Indian subcontinent. After his return from India, Ibrâhim bin Fazârun brought a lot of information about Indian drugs and Ayurveda, its teaching and texts. Among the gifts sent by Indian Rajas to the Caliph al-Ma'mün, there was a special mat made of dragon's skin, which when used for sleeping or sitting purpose, was supposed to prevent and cure pulmonary tuberculosis or phthisis. Indian kings used to send rare and wonderful Indian gifts to Arab caliphs, which consisted of aloe-wood, musk, camphor, dried ginger, kostos, amber, fresh myrobalan of Kabul and precious stones.

Firdaus-ul-Hikmat (Paradise of Wisdom) was composed by Abu 'Ali bin Rabban al-Tabari (c. 850 AD). Al-Tabari has divided the book into a number of discourses. Its last and fourth discourse has discussed the different branches of ancient medicine (Tibb-i-Vaidik) and is in 36 chapters. Its first chapter starts with the genesis of Ayurvedic medicine as follows, "When I was about to complete this book, I thought it fit to add another discourse to it, with separate chapters

describing the merits of medical works of Indians and their reputed medicaments. I hope it will increase the knowledge of the student because when he comes to know where these two great nations (Greeks and Indians) agree and where they differ, he will naturally come to know the advantages and disadvantages of Hindu medicine. Out of these topics which I have written here very many things agree with what the Greek Hakims have mentioned, but most of the things do not."

Regarding the origin and transmission of Ayurvedic medicine, Al-Tabari further adds, "They say that, in remote antiquity, the earth was always bright, fertile, clean and its five fundamental sources or elements i.e. Mahabhuta's natures were moderate. These were counted as five, with the addition of a kind of air, i.e. Ether (Akash) to the other four, namely:

(1) Earth

(2) Water

(3) Air and

(4) Fire.

The people lived in harmony and love with each other. They had no greed, anger, jealousy or anything else which made their body and soul sick. But, later on, when jealousy arose among them, when they became greedy, they needed to find out the tricks and means to hoard up the riches,...grievances, scheming, weariness, causing pain to others, corrupted the community". Al-Tabari's account is however ambiguous and misleading on the subject and does not correspond with the modern texts of Caraka-samhita. This may be due to the fact that Al-Tabari's studies were presumably based upon the defective Arabic translation of Caraka-samhita by 'Al bin Zain of Tabaristan rendered during the days of Caliph Harun al-Rashid. The Atreya School of

Medicine believes that the first mortal who received the Ayurvedic Medicine was Bharadvãja. But the South Indian traditions credit Rsi Agastya, popularly known as Kundamalai Siddhar, to have been the first mortal to receive Ayurvedic science from the gods.

Among the simple and compound medicaments, al-Tabari described:

(1) Jauz Hindi (cononut);

(2) Tamar Hindi (tamarind);

(3) Ud 'Hindi (aloewood);

(4) Mileh Hindi (Indian salt);

(5) Kammun Hindi (Indian cumin);

(6) Shitraj Hindi (Indian lepidium);

(7) Qust Hindi(Costus indica);

(8) Halelaj (chebulic myrobalan);

(9) Balalaj (belleric myrobalan);

(10) Amlaj (Emblic myrobalan);

(11) Saddhij Hindi (Malabathrum indica) etc.

Hirq-ul-Dhahab (calces/bhasma of iron, silver and gold) apart from other medicaments of Indian origin. It is presumed that this is the first Arabic comprehensive book which contains the description of Ayurvedic medicine along with the mode of calces preparation of different metals. Another prescription used for improving memory was to take some pieces of al-Wajj (Vaca, Calamus asiaticus) dipped in cow butter-oil in a green container for some time and then burned in a heap of barley for not less than twenty days.

The medicine thus prepared should be taken in dose of one small piece daily. According to an Indian scholar, a member of his family used it for some time and his memory

was so sharpened that he recollected those incidents of his life which had happened fifty years ago and were forgotton by him.

In addition to references to Shanaq, abstracts from other Indian books on poisons were borrowed and assimilated by Ibn Wahashiya (9th cent. AD) in his Arabic text, entitled Kitab ul-Sumüm wa'l-Tiryaqat (book of poisons and their antidotes). Reference was also made to two Indian experts on the subject, Tammashah and Bahlindad and their medical treatises, in his Arabic work. Another Indian vaidya, called Bal, Nai or Tai, depending on the missing dots, is mentioned in the medical literature, but his treatise is not extant now-a-days.

Abu Bakr Muhammad bin Zakariya al-Rãzi (850-923 AD), the well-known and distinguished pupil of al-Tabari, also quoted the Indian Ayurvedic works in many of his medical treatises particularly in his al-Hawi.

The famous Ibn Sinã (980-1037 AD), the Prince of Physicians, wrote the Canon of medicine (al-Qanun-fil-Tibb), which has been used for the centuries as the authoritative text on Unani medicine. It is comprised of five parts. In this text, Ibn Sinã expresses his indebtedness to the Indian doctors and quotes verbatim from Ayurvedic treatises on leeches and combination of various articles of food. He says that:

(a) Sour things and fish are not be taken with milk, otherwise various types of diseases including leprosy may occur. In their opinion, curd should not be taken with radish nor bird's meat and flour of roasted barley with milk and rice. Similarly, fat-oil stored in copper utensil should not be used for cooking purpose. Kababs barbecued on charcoal of castor-wood should not be eaten;

(b) According to Indian vaidyas, some leeches are poisonous.

Ibn Sinã described about 792 simple drugs in his a1-Qãnun. Among these 49 have been stated as of Indian origin. Out of these Avicenna designated several of Indian origin but their identity can not be ascertained. In Kitab ul-Saidana fi'l-Tibb (Book of Pharmacology in medical science) Abu Rayhan al-Biruni (973-1051 AD) referred to the skill and wisdom of the Indian physicians and the marvellous cures which they achieved by using aconite to cases of haemorrhoids.

It may be concluded that the Arabs developed great respect and love for Indian medical scholars and its products as is evident from many historical references and panegyrics (Qasida) composed in reply to the carping of a critic by an Arab of Indian origin, Abu Dila' Sindhi (c. 9th cent. AD). We would like to conclude this section with his words:

"When Indian and its arrows were admired in the battlefield my friends disliked it, but this was not proper;

By my life, it is a land where, when rain falls, it turns into pearls and ruby for those who have no ornaments;

From here come musk, camphor, amber and aloe-wood, and various kinds of perfumes for those who require them;

Here grow all kinds of sweet-smelling substances and nutmeg, and andropogonnadus;

Here are found ivory and jaiphal, and aloes-wood, and sandal and here is found in abundance the mineral Tutia;

Here are found the lions, the leopards, the elephants and the bears

And here are found the cranes, and the parrots and the peacocks and the pigeons;

And here grow the coconut tree and the ebony tree and the pepper plant;

And here are made the unparallel swords which need not be polished, and the lances which when wielded, large armies are routed;

Who can deny the excellence of such a land except a fool?"

CONCLUSION

Today, Ayurveda is increasingly popular because it speaks of those elementary concepts of:

(1) contact with nature,

(2) holism, and

(3) we are what we eat.

Ayurveda forms an integral part of the daily regimen of hundreds of millions of people worldwide. Its principles are utilized not only to treat persons who are ill but also to prepare a balanced meal and to construct a harmonious environment. Ayurveda brings to life the concepts of preventive health care and health promotion. The goal of Ayurveda is to help the individual discover a personal knowledge of living.

7

ACADEMIC PROFESSION IN INDIA : MODERNISATION AND GLOBALISATION

Apparently the system of higher education and the academic profession in India are not very different from the academics in the Western world. It is mainly because the present system of higher education was established by the British and has a very strong colonial imprint. Therefore, the principles and procedures of recruitment and selection of the academics are based on meritocracy, rationality and objectivity. However, there are basic differences which are not so apparent and are rooted in the cultural, historical and social contexts.

The basic premise is that the faculty roles are not constructed in isolation of the cultural context which is complex and diverse. This paper will compare the similarities and differences in the values and characteristics of the academic profession in the historical past and the imprint of Guru (preceptor) on the "modern" academic profession in post independence India. It will carry this reflection over to the current phase of globalisation and its impact on the profession. Finally, it will look at the implications of interaction of the Indian faculty culture and international professional culture on research and knowledge. It may be

mentioned that I refer to tendencies because there are several exceptions to what is being said about the construction of the faculty role and functions.

INTRODUCTION

The universities are located in national contexts and react to external changes according to their internal economic, social and political conflicts (Arimoto 2006). Therefore, the academic profession is embedded in, not isolated from, the social, economic and political forces. For example, along with change in the expected functions of the higher education system (HES), the expectations from the profession have also changed and so have its traditional role and functions. Since the faculty role is essential to the functioning of the higher education system it is transformed along with the transformation in the functions of the system.

"The theme of the 'Guru...' and, more broadly, of the master/disciple (Shishya) relationship, is certainly crucial within all religious traditions. (Rigopoulos 2002: 3)

It is not specific to Indian academic culture since there are also parallels to the Guru in other cultures iii, for example, sensei in Japan iv or paideia in Italy. This presentation is limited to the Hindu tradition (Mukherji 1969) although the values and characteristics of the guru-shishya parampara (GSP tradition), i.e., the relationship between the preceptor and the disciple are not unique to it. Recently, the use and abuse of the word Guru has become very popular in common parlance and in the media, for example, the management Guru or Guru speak.

The discussion is confined mostly to the central and state universities-grounds where one could see the Guru image, with accompanying values and behaviour, superimposed over the 'modern' professional faculty role. Within the universities it is more applicable to the humanities and social sciences,

not that the science faculies in the universities remain untouched and unaffected. Within humanities, it operates very much like old times in the departments of music and fine arts, Sanskrit and Hindi. This is so because the higher education system is divided into 'small worlds, different worlds' (Clark 1987). The paper excludes the IITs, IIMs and other institutions of national importance assuming that they were provided with an environment which approximated to the international professional culture or cosmopolitanism. The colleges will also be left out of the purview of this paper since most do not provide facilities to their faculty for research. They are teaching only institutions.

This paper situates the Indian academics within the larger historical and cultural context and argues that the profession has not been able to develop fully in the western sense of the term because of this cultural context. Therefore, there is need to introspect and question the values, behaviours and habits which the Indian academics inherit from their culture and carryover into the professional world of higher education. "Interpreting the academic profession through the lens of culture provides insights into the manifest and latent functions of higher education in different countries" (Birnbaum 2005: 71) and within the same country across different historical periods. Birnbaum says that it also helps the academics to "understand the nature of their own ethnocentricities and become more reflective about previously unquestioned beliefs and values." (2005: 71)

At the risk of oversimplification, I would like to outline three models or paradigms of the academic profession in India. Historically, the three models performed different functions. The first model emanates from the Hindu tradition. It is drawn from the Hindu scriptures and from the oral and written tradition of Hinduism. For example, Upanishads are written in the form of intellectual discourse between the Guru and shishya. The presence of the preceptor or Guru

was essential not only for the transmission of religious tradition but also for the acquisition of knowledge. Vedic religious tradition and knowledge was initially imparted through oral tradition for centuries. the traditional Indian culture values group affiliation and identity, respects teacher as the elder of the family and expects unquestioned obedience from the disciple to the Guru's authority. Therefore, the Guru protected the interests of the disciple who became his family member and respected him as a father. Some of these values have shaped the academic profession in the modern times.

The second paradigm, introduced in the middle of the 19th century when the British established universities in India, focuses on developments in higher education after independence, i.e. from 1950s to 1991. After independence, higher education was seen as the engine of industrial and technological growth and also as an agent of modernisation and democratisation. Merit and objectivity became the criterion for admission of students and recruitment of teachers. They were expected to mould the relationship between the teacher and the student based on a certain distance between the two. Teaching and research were both considered important functions of the universities and environments were created to pursue them at will. It radically altered the contours of the academic profession.

The third phase begins post 1991 when economy was liberalised. Since then propelled by information technology and service based industry higher education is going through a second revolution. Academic profession is under great stress to perform according to corporate norms and there is hardly any space for research. Accountability is centre stage in the private for profit institutions at the cost of academic freedom and autonomy. Student evaluation of faculty has been introduced in the private sector. GSP does not seem to have much space here. In the public universities-state and

central-earlier conditions continue with some changes which will be discussed later. The changes have not affected the GSP relationship, if anything students have become more dependent on the faculty for educational and occupational sponsorship, though for different reasons. Central universities are in far better position to undertake research than the state universities.

The argument is that the role and functions of the Guru has influenced the construction of the role of the modern professor. In the process the professionalisation of the academic profession, especially the dimensions of merit, objectivity, rationality and neutrality along with quality are transformed in the name of tradition. Therefore, it is difficult to talk of the modern academic without reference to the cultural tradition.

While Gouldner talks of the academics as cosmopolitans and locals (1957, 1958) Birnbaum argues that it is not possible to divide them into two clear cut categories because of the different cultural contexts. He goes on to say that if we were to understand differing cultural contexts and social realities then we will discover alternative ways "in which faculty role may be constructed". (2005:75) Finkelstein also says that there is need to understand some of the unquestioned "habits of education thinking that dominate our discourse and our understanding (Finkelstein 1996 quoted in Birnbaum 2005:71) because professional behaviour is not culturally neutral.

What I am proposing to do is to compare the two models of modernisation and globalisation and the transition from the former to the latter in the backdrop of the traditional paradigm with specific reference to the impact of the transition for research and knowledge. It will also be interesting to see how will the Guru model, which is rooted in the local tradition and practices, and the modernisation

paradigm negotiate the converging effects of globalisation on higher education? (Mazawi 2005: 221)

THE GURU-SHISHYA PARAMPARA (GSP): THE INDIGENOUS ACADEMIC TRADITION

In India there have been formal systems of higher education since ancient times. References to the Guru Shishya Parampara are found in the Hindu texts and their interpretations and translations. However, in spite of the importance of education from early Vedic to modern times it is very difficult to get a concise and focused scholarly write up on it. (Scharfe 2002: 64) But it has always been a part of the educational discourse and has affected the construction of the ideal of a modern professor or faculty member in post independence India.

In the colonial period, the system was almost obsolete in northern states except in the world of music, dance and indigenous medicine, although it survived in the southern and western states, for example, in the southern states the role of the religious institution called math has been very important. These religious seminaries impart religious instruction to very young students who come to reside there. In Kerala the military gurukulas known as Kalaris still exist. In the world of art, specially in music and dance, this tradition is widespread and still continues all over the country. The best Indian musicians and dancers are the product of this system.

Guru Shishya Parampara is part of the popular discourse on education. It also means that learning, skill training and education are handed down from one generation to another. The word Guru refers to the preceptor or the master while shishya refers to the disciple. The male child left home at an early age to live in the ashram of the Guru, who was also a male, for the next few years and returned after acquiring

the necessary skills and in-depth knowledge. The teachers were generally Brahmins although the students came from the three upper social orders or varnas. Educational system was generally residential. The disciple lived in a Gurukul. Kula means an extended family. It was the duty of the pupil to respect and honour his Guru and his wife like his father and mother. There were prescribed regulations that he had to follow regarding his behaviour and dress. One of his duties was to go on a daily round of begging for collecting alms for the Guru's household.

Thus, when a student lived in the residence of the Guru or at the ashram he became a part of the family of the Guru and performed all the household chores as a member. It also ensured that a life long relationship was established. Therefore, in addition to imparting learning and education the Guru also imparted social and personal skills and values and also to socialize the shishya to the way of living of the Guru and the institution.

It is difficult to define the parameters of GSP but one can draw the characteristics for which it is known in the academic and popular discourse. It is something which is referred to as a benchmark, something to be emulated at the convenience of those who want to remind the contemporary teachers of the hoary past. For the purpose of this essay, 'it is inclusive of the processes and methods of knowledge creation and transmission, developed over thousands of years by indigenous peoples and ...are the result of careful observation and experimentation with natural as well as social phenomenon.' (Thaman 2006:5).

Education was handed down through an oral tradition. Learning was held in high esteem and so was the Guru. The Guru enjoyed a very exalted position in society-almost to the point of being revered. He enjoyed high prestige and respect because he was perceived as someone who possessed the

highest moral and spiritual qualifications. He is portrayed and viewed as the selfless preceptor, in addition to being the moral and spiritual guardian of the disciple. Simple living in pristine environment was the ideal. He was also known by his reputation. The preceptor expected unquestioned obedience from the disciple. Generally there was a one-to-one relationship between the Guru and the shishya. The Guru was autonomous and decided the curriculum, the timeframe and the methodology of transaction. The Guru did not receive a salary nor did the disciples pay any fees. The commitment of the Guru to pass on the religious traditions was exceptional. Besides, it was his duty to pass on sacred texts and customs. (Scharfe 2002:6) There was emphasis on self learning apart from the correct recitation and pronunciation of the verses.

MODERNISATION OF EDUCATION AND THE ACADEMIC PROFESSION

The modern, liberal and secular education introduced in the middle of 19 th century was very different from the existing system. The British transposed a uniform system on the existing system irrespective of religion, caste, socio-economic and cultural variations. The paradigm was expected to replace the indigenous academic traditions. While the GSP was rooted in culture and Guru centred the modern system was decontextualised. Indian social reformers, who also played a very critical role in the establishment of modern educational institutions, questioned the transplanting of colonial educational system with no cultural and local context. They argued for the need to contextualise the modern system.

However, an interface between the GSP and modernisation paradigm on a large scale has never been attempted because the former was suspect due to its "unscientific and cultural origins". (Thaman 2006:15) Independent India followed the same model in structure and

organisation but articulated the goals of HE which were: to be an instrument of economic and technological change, training of skilled manpower for an industrialising society-transmission of knowledge; for social engineering-to promote social justice and equality; and for generation of knowledge through innovative research to gain an edge in scientific research and discovery.

Higher education was public good and, therefore, the government took full financial responsibility to establish universities and higher educational institutions. While the transition from the traditional educational practices and ethos to the modern system was slow during the colonial times, there were radical changes after independence. Education began to take place in formal institutions with a common curriculum. Faculty became the paid servants of the government or private philanthropic trusts which established the institutions. Qualifications and jobs became linked.

As mentioned earlier, merit, objectivity and neutrality became important criteria in the recruitment and selection of faculty and also for admission. Elaborate procedures were established to ensure that these were implemented. It was expected that a reasonable social distance will be maintained between the students and faculty members, to ensure objectivity and impartiality in evaluation, selection and in formal spaces within the system of higher education.

In addition, universities and higher educational institutions were given autonomy and academic freedom for the pursuit of academic excellence. Academics, who enjoyed academic freedom and autonomy, were to deliver what was expected from them for national development, that is, to impart learning, skill training and knowledge to their students who would make a contribution to the expanding industrial economy. The faculty were also to undertake research, along with their students, of international standards

as inputs into technological and scientific advancement. According to Halsey, the professors were proud of their independence of thought. They were neither loaded with administration and committee work nor with teaching. Therefore, they could use their time in the pursuit of knowledge through reflection, research and publications. (1992) In India until about 15-20 years ago, being a university professor was prestigious and providing consultancy or working for international development agencies including the UN was not so.

Professors were employed on full time basis in an all tenure system with life time job security. Coupled with the prestige enjoyed by the teachers in GSP this made the profession relatively attractive, though comparatively less so in comparison to the doctor, engineer, bureaucrat, etc. Security of tenure was expected to provide an environment conducive to long-term basic research and for knowledge generation. Professors were expected to bring out world-class publications. The government also provided funds for research so that they do not seek funds from sponsoring agencies who have pre-set goals.

An important parametre which would have ensured that the ideal conditions created for research and knowledge generation and for promoting merit also required accountability of the faculty. This was missing in the universities where student evaluation of teachers or quality evaluation of institutions were not put in place. In addition, in order to train students in parliamentary democracy, unions of faculty and students were permitted to be formed.

DIFFERENTIATION AND STRATIFICATION OF HIGHER EDUCATION: IMPLICATIONS FOR ACADEMIC PROFESSION

The Indian higher education system is large and complex with diversity of institutions. Differentiation in the higher

educational institutions led to a wide variation in the quality and commitment of the faculty. Although it is difficult to generalise yet the features mentioned below characterise a majority of the universities and colleges.

For example, institutions of excellence such as IITs, IIMs etc. remained untouched by politics and also functioned as autonomous organisations based on merit. In these institutions, academic freedom, autonomy and accountability were operational and worked toward making the institutions excellent. Student evaluation of faculty and the courses was also operational. This was possible because in order to make them excel and be of international standards the government set high standards and ensured that competent faculty when appointed. The admission process was based on very well defined criteria and on all India entrance examination.

Additionally, these institutions were insulated from politics. Therefore, India has some internationally acclaimed scholars and professors with a huge majority of faculty who vary from not so well known researchers and scholars to poor and indifferent ones.

The universities vary in quality of teaching and research, physical facilities and there is a corresponding variation in the qualifications and quality of professors and as well as in the quality of research as reflected in the quality of the doctoral students as well as in the research output of the faculty.

The quality of the professoriate and of teaching and research is better in central universities than in the state universities. The former undertake teaching and research while the latter have been mostly teaching only universities in practice. There is correspondence between the lower quality of the institution and the professoriate, on the one hand, and the practice of following the guru model or paradigm.

Professor and Guru: the Construction of the Academic Role in India

The framework provided by the Guru-shishya relationship suited very well the dominance of parochial affiliations such as caste, tribe, region and religion, on the one hand, and political ideology, on the other, that began to operate implicitly and explicitly in higher education. While the alignments between faculty and students may be along either or both of these dimensions eventually the behaviour pattern and interaction between faculty and students is derived from the GSP. As a result, merit, academic freedom and autonomy acquired different meaning s on account of the traditional and cultural contexts superimposed over political and parochial affiliations. This had an impact on quality of education, of students, of faculty, of the selection process and the quality of research and knowledge.

The cultural assumptions underlying the two models and faculty roles are different. For example, the Guru was responsible for the overall growth of personality along with imparting skills and for knowledge dissemination whereas a professor is an actor in the mass education system consisting of state-supported formal institutions with given curricula, fixed time schedule, pedagogy and methods of evaluation and has to keep to all of them while these were left to the Guru to decide. The comparison of the professional culture with Indian culture highlights the fact that the former was focused on transmissional knowledge while the latter was expected to emphasise scientific temper and inquiry. Again, while professional culture puts emphasis on individual merit, universal standards and on advancing knowledge Indian culture respects collective affiliation and undisputed obedience to the teachers' authority. The difference in the values and behaviour patterns led to conflict in the academic profession and the consequences are reflected therein. For example, the unquestioned acceptance of the Guru's word

and behaviour reinforces and protects the status and hierarchy of university professors without being accountable. Therefore, "it is not surprising that a well-defined sense of professionalism did not develop." (Altbach 1991: 24)

Close correspondence between the values and behaviour patterns of GSP, on the one hand, and the privacy of parochial and collective affiliations, on the other, transforms the modern student-teacher relationship into that of sponsorship. It impacts the academic environment and the profession, e.g., emphasis on merit is diluted in admissions and recruitment and promotion. The students are expected to extend their interaction with the faculty outside the classroom and to their homes, more so in residential universities. They are expected to do sundry household chores as the disciples used to do in the gurukul or ashram. In the return, students are treated like family members and are rewarded with helping in completing assignments and dissertations, in evaluation and in the doctoral viva voce examination by appointing known examiners and promoting publications through networks. The professor also plays a critical role in the educational and occupational career of the students regardless of their merit and contribution to research. The grooming of students which starts from post graduation to professorship creates long lasting bonds of loyalty (Birnbaum 2005: 83). Thus, the academic relationship between the professor and the student also becomes social.

"Another reward, essentially a carryover from the feudal days, was the respect that students showed for their professors. Although in the classroom the professor taught specialised subjects, outside the classroom their relations with students often became much broader. Students looked upon their professors as men of great wisdom (calling them sensei), and sought their advice in matters ranging from career planning to the selection of an appropriate marriage partner. Even long after the students graduated, they might

return to visit and seek the advice of their professors." (Cummings and Amano 1979 quoted in Birnbaum 2005: 82)

Therefore, dilution of the quality of research starts right from the beginning of the career of a researcher. Academic freedom and autonomy are misused by a majority the faculty who do not produce good research nor good publications. In addition, merit and objectivity become victims in the recruitment and promotion process. Most professors have also not been motivated to publish because recruitment and selection were not entirely based on merit. Again, if they publish it is not in peer reviewed national and international journals. Or they with publish a local journals, magazines and newspapers. Some departments start their own journals for in-house publications. In most state universities what counts is quantity, not quality. Most of them do not participate in national and international conferences.

"The fact is that most academics work in the 'small worlds' of their departments and universities, are mostly, if not exclusively, involved in teaching, and are thus unaffected in their daily lives by the trends of international scholarship" (Altbach 2002: 5).

There has also been lack of accountability due to the way the student-teacher relationship has evolved. For instance, there has hardly been any evaluation of professors by students because it fitted in very well with the thinking that the Guru cannot be appraised by the disciple. Therefore, students have not complained about poor quality of teaching or lack of teaching. There has also been no peer evaluation of faculty performance because of the hierarchical nature of Indian society. The junior faculty cannot criticise or evaluate senior faculty. On the other hand, the emphasis on democracy and equality along with ideological fraternity prevents public criticism of one's colleagues (Birnbaum 2005:79). Referring to Wieck (1983) Birnbaum calls it 'the accuracy--cohesion

trade-off'. In the modernisation paradigm emphasis on accuracy will be higher to protect institutional reputation and to be known as a producer of valid knowledge. On the other hand, the main role of universities in India is certification and creation of knowledge and producing 'value-socialised graduates' to promote cohesion. Accuracy is in many cases "secondary to maintaining social interactions and relationships" (2005: 81). Clark (1987) differentiates between 'ideal-regarding ideology' versus 'other related ideology'.

The former gives precedence to accuracy and rewards merit and provides little space for social and human costs. The 'other related ideology', on the other hand, incorporates social concerns, rewards old members and loyalty irrespective of cognitive contributions. In fact, academic standards and merit becomes secondary in the context of an 'other related ideology'. Systems of higher education in which the 'other related ideology' is dominant "reward old members,... prevent defections to other groups, find jobs for loyal followers, and appoint facilitators who keep the group together and are rewarded for this even though their cognitive contributions might not warrant such rewards." (Weick 1983: 259)

Some of the prominent ancient values and behaviour referred to in the educational discourse which have been impacting the professors in the modern period are: touching the feet of the teacher. This gesture is part of the family tradition where the elders are greeted and paid obeisance by touching their feet. This tradition extended to the Guru since the disciple became a part of his family. This is a seemingly inconsequential cultural habit but has large implications for the inability of the international professional culture to be fully accepted and implemented in the Indian universities. This gesture on critical occasions, such as before the selection committee, is a reminder to the professor that 'I am not just a student but a shishya, a part of your extended

family and it is your obligation to advance my interests'. It demonstrates the influence of the local practices derived from the Guru model on the role and function of a professor.

This has a gender dimension too, Generally, men students would freely visit, spend a substantial part of the day, esp. on holidays, at the homes of their professors, a majority of whom are also male. Therefore, men students get rewards in terms of sponsorship of their Guru more often than women. This may also explain why so very few women faculty make it to the university especially to the top echelons.

Another facet of the guru syndrome relates to the demand for a raise in salaries. Whenever teachers have demanded raise in salaries, they have had to start a movement. At that time, media play a very critical role in spreading the message that teachers are well paid and so why do they want better salaries. Also why should Gurus (read professors), who used to live on alms, ask for monetary compensation? The thinking of the bureaucrats and ministers is also the same. Referring to the past questions are asked as to why they are asking for more or comparing their profession to others. Thus, lower salaries are justified on traditional grounds when a teacher lived on charity while the rules of the game have changed drastically. For example, faculty are expected to be change agents and be professionals and yet are not expected to compare salaries with other professions. Thus, the Indian academic profession has always lived with contradictions.

Globalisation and Academic Profession-from Public to Private Good

Governments all over the world are trying to expand higher education and allow the private sector to establish educational institutions. Simultaneously, they are trying to cut down costs, increase efficiency, profits and accountability in the economy. They are following this model across-the-board and higher educational institutions are not left

untouched. Higher education is moving away from its cultural and public good functions as well as from promoting social justice and social trust between higher education, state and society. (Slaughter and Leslie 1997)

This has affected the structure and organisation of the profession, namely, the way academic staff are employed, academic profession as a career, quality, academic freedom, autonomy, relationship between teaching and research, etc. Universally, the status of the profession seems to have declined. In the modernisation phase the major budget expenses were on the staff salaries considered necessary for providing security to the professors. In this phase, reducing the budget on staff salaries is receiving maximum attention. According to Altbach, colleges and universities are faced with 'severe environments'. (2000). These changes challenge the traditional position of the professors as the Guru but also as the 'modern' professor and his intellectual autonomy. In other words, the cultural values and expectations associated with being a university teacher are under threat.

For purposes of discussion, the universities in this phase can be divided into three categories, namely the central universities, the state universities and the private for-profit institutions. The working conditions in the central universities have not changed much after globalisation. If there is any change, it is for the better. The age of retirement of faculty is higher in the central as compared to state universities. These universities get full financial support from the University Grants Commission for introducing new academic programmes and courses, for hiring prominent faculty and also for infrastructure development. There is thus no pressure to procure funds, at least not for survival, as is the case with the state universities. There are varied sources of funds for attending international conferences and for research projects thereby increasing the visibility of professors and their chances of promotion. Consultancy and committee work and

membership, not only within the universities (perhaps less so in the universities), in the government, national and international NGOs have become prestigious and are grounds for expanding networks and increasing visibility. The time spent on them is taken out of teaching and supervision of research without any apparent ethical dilemma or pressure from students to meet their professional obligations. It is assumed that the professors who are good researchers, publish internationally or nationally in peer reviewed journals and are well known in academic world contribute more to the progress of their students than by teaching.

Since the faculty enjoy visibility and clout and have large-scale national and international networks they are also successful in procuring research funds more than ever before for themselves and for their students. GSP is now more relevant because faculty are not only a conduit for networks for the students to better educational and occupational opportunities in a dwindling market but also help in procuring funds for international travel and research etc. So the area of the influence of the guru has increased in the central universities. However, accountability of faculty in the central and state universities is still not on the agenda though assessment of institutional quality has been introduced on a voluntary basis.

Most of the state universities are not hiring permanent faculty since 1991 and are running the system with contingent faculty. The state governments are now reducing expenditure on staff salaries in order to balance their budgets. The nature of appointments has radically changed. While the working conditions for the permanent faculty remain the same as in the modernisation phase most of the post 1991 appointments are short term, contractual/temporary/ad hoc with very low salaries for a fixed term. Handy (1994) divides the academic community into a few core staff who have tenure track positions, freelancers and contingents or more broadly the

permanent and contingent ones. The proportion of the permanent one is decreasing and in the near future may dwindle to being very insignificant.

Thus, teaching is limited to the regular full time faculty and the contingent faculty in the state universities. The quality of teaching and research, already not of good quality, has been affected adversely. Academic freedom and autonomy are in greater jeopardy. Research production and publications are also declining in quality. Consultancy and committee work is also very important here for a few professors who can emulate those in the central universities. The GSP interaction has become more dominant because the permanent faculty are more powerful as regular jobs dwindle in higher education. Therefore, in a narrowing space for jobs and career the influence of the permanent faculty has increased while the contingent faculty are left out of the loop as faculty. They become part of the GSP as researchers under the permanent faculty.

Most of the expansion in professional education has taken place in the private for profit institutions which are very expensive. Privatisation has increased the size of the professoriate and provided an alternative model for faculty recruitment but marketisation determines its direction, e.g., interest only in teaching centred undergraduate programmes with the narrow perspective of job placement of their students in the corporate world.

In fact, the academic profession in the private for-profit higher educational institutions is seemingly acquiring some of the parametres of professional culture. Some of these are: student evaluation of staff is being introduced; accountability and efficiency; monitoring of teaching and the full-time workload. On the other hand, it is moving away from it, as for example, contingent service and lack of security of tenure; almost no emphasis on research; very high student teacher

ratio. Merit is sacrificed in recruiting faculty because they do not hire the best. In order to reduce costs, they hire a few retired faculty. Neither is tenure guaranteed nor is any kind of job protection available. Most of the faculty are young who are either doctoral students or those who have just finished PhD. In fact, the best scholars do not apply to these institutions because there is no transparency about conditions of tenure and salary.

In the private for-profit institutions, there are contradictions between the old and the new values and assumptions, e.g., between accountability, on the one hand, and academic freedom and autonomy, on the other. While in the modernisation paradigm academic freedom and autonomy became a handle not to implement accountability of professors now it is the other way round. In the name of accountability academic freedom and autonomy of the professor are being constrained or impinged upon by the private managements. Since the whole process lacks transparency merit also seems to be in jeopardy in the admission process. Therefore, in the private sector while accountability is important, academic freedom and autonomy have been eroded along with security of tenure and the environment for nurturing GSP and research is also not there.

From Modernisation to Globalisation

Worldwide there are attempts to redefine the full-time faculty role, that is, full-time positions are created which no longer require the 'integrated and the costly Humboldtian model' (Finkelstein 2003:7) expecting the teacher to perform teaching, research and service. Now full-time faculty can be divided as 'teaching only', 'research only' and the those who perform 'only administrative' roles (Enders 2001;Yamanoi 2003; Finkelstein 2003). Academic profession is no longer collegial and professional-it is increasingly managerialised.

In India, too, the redefining and revaluation of the faculty role with the concept of faculty tenure is receiving maximum attention (Chait 2002) although it is a silent change because there has been no meaningful nationwide discussion on this change.

Restructuring of higher education has meant 'reconfiguration of faculty work and faculty role' due to the changing technology and economy. According to Carol Twigg (2002) there were major historic differences in the function of the university in general and scholarly activity in particular in the two phases. For example, as per the modernisation paradigm, the creation, presentation, dissemination, and preservation of knowledge were based on the transaction of the book in the classroom. New methods and technologies for delivery of instruction are being used to supplement face-to-face instruction. Moreover, the full time professor was concurrently expected to teach, undertake research and render institutional and professional service. (Boyer 1990) All these have been affected through restructuring and reform.

Further, the traditional value in the modernisation paradigm is that a scholar and a professor is known for his scholarship, dedication and reputation and should not have to sell or market his knowledge and expertise. In this day and age, when the ability to negotiate for salary and to procure funds for research is an important criterion for recruitment and promotion there are scholars, especially of the older generation, who adhere to the traditional and modern thinking, that is, they do not publicise their work or negotiate for better terms and are reluctant to make themselves visible for consultancy, etc.

Those who do not, even if talented, are being left out of the race because the current situation demands repackaging one's expertise and qualifications in the market.

Implications for Research and Knowledge

Research has been considered critical in the functioning of modern universities and the quality of major universities has been adjudged mainly by their research output. To achieve this, the Indian government had made provisions for pursuing research, even though to a limited extent, in select institutions in the modernisation phase. However, quality of research suffered in the modernisation phase because of the influence of the values and behaviour patterns emanating from the GSP tradition as well as due to collective (parochial) and political affiliation. Universal affiliation and individualism could not achieve primacy in the profession. In the globalisation phase distance between teaching and research institutions is increasing and research and knowledge creation are taking a back seat in the public and private institutions. Again, permanent appointments with security of tenure, availability of research funds, ample time to do research with accompanying academic freedom along with teaching were expected to generate an environment for research and knowledge creation in the second half of the 20 th century. The ideal conditions still did not generate knowledge as was anticipated due to the interface of the professional and traditional culture. Now that the professional culture is moving away from these ideal conditions of research and knowledge production what will be the future of higher education and the academic profession in India?

The central universities have and are most likely to maintain the traditional staffing patterns. In comparison to the state universities, the central universities have ideal conditions of work. Faculty are able to procure the essential research grants. Others have to adjust to or become prepared to market their scholarship and expertise. Although quite a few have adjusted very well and changed their profiles as well as behaviour to suit the changed academic environment, there are still many who are unable to do so. Again, faculty

are not yet ready for assessment either of themselves or of the institutions and GSP remains strong.

The case of a large number of state universities is less clear. The state universities are transiting from a fully tenured faculty to a contingent one. In the absence of senior and experienced faculty members, the future of research is uncertain. Good scholars are reluctant to join as contingent faculty. At this rate, in the very near future, they may be in the same position as are the private for profit institutions. Private for-profit institutions are not expected to contribute directly to research and knowledge. They may do so indirectly through their undergraduates who are likely to join the corporate sector. Right now, research is not a priority for them.

THE FUTURE

One of the important refrains in the education-economy interface discourse is the need for universities which can meet international standards to produce not only world-class graduates for the service and IT led economy but also be leaders in knowledge creation and production through research. Additionally, the University Grants Commission is following the principle of differential funding. Universities are rated according to quality and if they are identified with 'potential for excellence' they are given extra grants for conducting research. The government is also thinking of starting new institutions of excellence. It means that the existing institutions of higher education will continue to be neglected and will be short of funds to undertake any worthwhile activity, leave aside undertake research.

There are two simultaneous trends which are impacting the academic profession. On the one hand, the difference between teaching and research is widening. On the other, research is increasingly becoming more important than

teaching. For example, what counts at the time of recruitment and selection in the elite central universities is international visibility, i.e., the number of foreign conferences attended and papers presented, papers published (not necessarily in refereed journals), number of conferences organised, committee work, etc--all of which depend on research.

Teaching and research supervision are generally not given weightage. Therefore, more and more faculty are spending time abroad, or outside the university or even when on the campus spend less time on teaching. The time spent on interaction with the research students while grooming them as future researchers is becoming minimal. Low salaries and casualisation of the profession have a very negative impact on the quality of teaching and research.

In the absence of ideal working conditions created under the modernisation paradigm, on the one hand, and also of the social relationships under the GSP paradigm, on the other, the brighter and intellectually oriented scholars do not see adequate compensation, intellectual and financial in the profession. Therefore, they move to other professions which provide a better deal. Moreover, most of the young research scholars no longer perceive teaching in higher educational institutions as a life long career. Additionally, they are unlikely to have loyalty to the professor and the institution.

The world over, casualisation of work leads to its feminisation. Given the fact that gender influences recruitment and selection, how are women and men distributed across universities and disciplines? Are women located in institutional settings which are considered elite and exclusive or are they encamped "on the margins or the marginalia of knowledge production" (Mazawi 2005: 224). How did the GSP influence the modern woman academic and how is she impacted by globalisation-questions that have to be left for now.

CONCLUSIONS

While demands are placed on the universities to be the instruments of social change they are limited by the local cultural contexts and history which impose constraints on their capacities to change society and to change themselves. (Brennan and Naidoo 2005).

In the early seventies, Edward Shils (1972) had divided the international knowledge system into the centre and the periphery. He asserted that in the hierarchy of academic knowledge, the research universities of the industrialised Western developed countries were at the centre while the research universities in the developing nations were on the periphery.

It is because standards of research are set by the former and the latter manage, at best, to emulate them and somehow never reach those standards. While Shils was referring to the modernisation phase Altbach has applied these categories to research and knowledge in the globalisation phase. Altbach (2002) carries this argument forward and says that now that the academic world and community is more interdependent the earlier hierarchy has been further reinforced. In other words, those on the periphery are being pushed further into marginality. If GSP has less primacy will the academic role become more professional?

Caught between the changes in the larger social, economic and political context, on the one hand, and the higher education system and the universities, on the other, academic profession has to carve out a new identity for itself.

How will the Indian academic profession readjust to its cultural context in this rapidly changing situation and still contribute to research and knowledge? Will the new developments in globalisation succeed in moving it away from GSP in shaping the contours of the academic profession?

What Birnbaum (2005) said about the Japanese situation may be applied to India. For example, it will be critical to reinforce the cosmopolitan character of the professor in the institutions which compete with international institutions, that is, making the Guru more like a professor. On the other hand, the professors in the undergraduate institutions should behave more like a Guru, that is, emphasising their commitment to teaching per se and commitment to their students.

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