Coming Intellectual Shifts to Asia: The Indic Possibilities[1]

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The new century will be marked by several dramatic changes that will leave their effect on knowledge, science and technology. One would be the shift of the centers of gravity of the world in economic and political terms away from its present Eurocentric moorings to Asia, a process that will occur amidst pervasive globalization. Another set of changes is in the science and technology field, primarily with a shift to information technology and biotechnology, both of which are heavily culture-impregnated. These changes will deeply influence geopolitical relations in science and technology.

The Shift to Asia

The fastest growing economies over the last few decades and into the foreseeable future are those of Asia. The rapid growth of East Asia and South East Asia has been well documented. And South Asia though lagging behind till recently has had much higher historical growth rates than those of Europe during its periods of industrialization in the 19th century. Thus, India grew at a rate of 3.7% and 5.6% from 1965 to 1990,[1] while for the period 1980-90 it grew at 5.3%.[2] And during recent years it has grown around 6% a year. This should be compared with a growth rate of around 2-3% in 19th century Britain, the first industrial nation.[3]

This economic shift is occurring with a redivision of work. It replaces the earlier relocation of brawn work towards cheaper Asian countries with a new relocation of brainpower, and a shift in science and technology towards the Asian cultural region[4]. Thousands of Asians today man research facilities in the West symptomized by the large number of South and East Asian graduate students in American universities. A considerable proportion of scientific personnel in Silicon Valley, the initial breeding ground of information technology are Asians. And software production has emerged as a major growth point in India paralleling the growth of computer hardware in South East and East Asia in the earlier years.

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This shift of science and technology to Asia is occurring amidst a shift in less measurable cultural spheres where the earlier hegemonic blanket of Eurocentricism is being lifted. Thus some of the best novelists in English, the primary carrier of globalization, are today those of Asia. Designers from Hong Kong and Japan set clothing fashions. And, the Philippines are the capital of the cartoon film world.

The erosion of European hegemony in science and technology is also seen at deeper structural and philosophical levels. The seeming epistemological and ontological certainty that followed the Scientific Revolution and solidified in the Enlightenment, is being queried on several fronts. First is a purely quantitative one.

The output of science has grown exponentially doubling every ten years or so since the mid 17th century and is soon expected to reach figures far beyond the capacity of humans[5]. Projects such as the Human Genome Project and the Hubble Telescope are throwing out so much data that the metaphor used to describe it is that of mere human mouths attempting to drink out of a fire hose[6]. The solution is increased automation of the scientific process including data collection and processing together with those of discovery through such devices as "Knowbots and Discovery Machines [7]. Prefiguring such developments programs have rediscovered such laws as Ohm s Law and Snell s Law and a respectable branch of mathematics today searches for proofs for theorems using software[8]. And because of the explosion of vast databases the comprehensive access to all existing knowledge, - Diderot s dream in the Enlightenment - is fast becoming a reality.

Because of this automation, a significant portion of the 17th century Scientific Revolution' s agenda will be given over to machines. This raises questions on the qualitative bases of the epistemology of science. Even now there is no one epistemology. For example the epistemological underpinnings of molecular biologists, taxonomists and evolutionists — all biologists- are different. Newtonian physics as used in most mechanical engineering and astronomy assumes time to be reversible, but not so in thermodynamics which brings in an arrow of time. Greek logical assumptions break down in the new physics where C + C is still C, the single speed of light, as it does in quantum physics where a particle both exists and is not.

In quantum physics the neat division of subject and object, which Descartes brought about, again breaks down. Galileo and others brought about key advances by mathemetizing knowledge; the latter later considered the queen of science, the bulwark of certainty. However with Goedel mathematics lost its foundational certainty. And because of the strain on the environment, Bacon s project of getting at knowledge by torturing nature has broken down, nature refuses to be tortured any more.

Today s sciences lack hegemony. A variety of epistemological and even ontological positions thus jostle. New approaches can therefore be sought for a coming Post Enlightenment science. With the increasing automation of knowledge such new post Enlightenment approaches bring added urgency. With the new culture embedded technologies of information technology and biotechnology, they become imperative.

Fresh approaches in ontology, epistemology, logic and culture to replace the shattered hegemony are required. The readily available civilizational source for these is Asia.

Such Asian inputs become more vital in the case of the newer technologies - information technology and biotechnology — that are more socially responsive than the earlier ones. They can be "cut" and shaped socially in many more and variegated ways than the earlier technologies. As the two technologies are very flexible to social and cultural pressures, the question then would be which cultures' and which society's values will be mapped within these technologies as they further unfold in the future.

A great Asian imprint on science and technology could come from Asian answers to some of the troubling questions raised by these new technologies. The latter put doubt on some of the most cherished self-perceptions of humans. Biotechnology raises key questions on traditional concepts of what it is to be a living being, including what it is to be uniquely human, biologically.[9] On the other hand, information technology, especially Artificial Intelligence (AI) in mimicking human mental processes, raises questions on what it is to be uniquely human in a cultural sense. A real Asian imprint would require searching answers for these within Asian cultural contexts.

Because of such key questions, debates on ethical and cultural issues are shaping both technologies. Thus, releasing of biotechnological products to the atmosphere has been debated within a framework of its potential impact on other organisms[10]. And, advances in medicine relating to say the onset of life and its termination have been hotly discussed and have influenced conventional medical technology. Developments in the new biotechnology stretch these questions very much further, raising fresh and very complicated ethical issues.[11] These discussions and controversies in the cultural and social sphere influence and continuously shape the new technology.[12]

However, the social and medical implications of biotechnology have as yet been largely discussed only in Western countries.[13] These debates have unfolded within a context that assumes as universal, western cultural and social givens, the imprint of the West's religious traditions for example being unconsciously brought in.[14] In Asian countries there has been little debate on these matters.[15] Yet, workers in the field have pointed out that Asian traditions could well give different answers to these questions[16] as for example reflected in the Japanese response to definitions of clinical death[17].

Advances in biotechnology including gene therapy could reshape and reformulate among others, life, death, health and beauty.[18] The ethical as well as esthetic criteria on which these are decided upon are deeply culture bound and if debated within the Asian region's different cultural traditions would give different answers from those of the West. And this act of self-reliance would tend to give different directions to the technology.

Advanced information technology especially AI related ones, aims at cloning the partial behavior of the mind. This again would raise deep questions for those parts of Asia that have strong cultural and religious traditions emphasizing the importance of the

mind and mind culture. Asian inputs into debates on the ethics and nature of AI could also strongly influence the direction of information technology.

In addition to these specific issues relating to the two new technologies, the Asian region is also rich in non-European derived intellectual activity including aspects of technology and the sciences. Some recent research indicates that these indigenous Asian aspects could also become a useful adjunct to developing new technology in Asia. Let me point out the possibilities by taking examples of the knowledge elements that are held by presumably the simplest of societies say, hunter gatherers and then move on to more formal, 'civilizational' stores of knowledge.

Civilizational Knowledge

The new scientific ways of knowing the world were built up initially in Europe from the assembly of cultural elements from within Europe itself as well as from those transmitted to it from outside. Since then, external contributors to this stock of knowledge have diminished. Yet, useful extra European knowledge still exists as exemplified by "lost" knowledge in regional civilizations and say, ethno biology. Bringing in knowledge to the dominant knowledge tree can be accomplished in two broad ways, - one is to splice-in directly existing material that has demonstrable direct validity. The second would be to bring as metaphors, elements from other traditions that could nudge the imagination and give rise to new concepts. The first attempt would be like the splicing-in to the European tradition of say the knowledge of the compass, gunpowder, or mathematics and knowledge of flora and fauna that occurred during Renaissance and immediately after. The second attempt would be like the many transfers of metaphors that have been constantly used in building the scientific enterprise.

The field of ethno biology alone provides a large reservoir for enlarging the knowledge base by "splicing-in" techniques. Plants that are unknown in developed countries have many uses that have been identified over the centuries by farmers, pastoralists and traditional healers across the globe in their ethno biology. Thus it has been said of even the simplest of such groups, "if all their knowledge about their land and its resources were recorded and published, it would make up a library of thousands of volumes".[19] In these small traditions scattered around Asia are veritable walking encyclopedias.

Already some of this knowledge on plants is being used in biotechnology, a frontline field where access to a variety of useful genes is vital. The ethno knowledge held by local groups is gathered by among others, multinational corporations, the plants and their properties identified, and later the particular gene responsible for a desired property isolated to be incorporated in a new genetically engineered plant.[20] The knowledge that is in the bioengineered plant therefore comes from two sources, the original knowledge of the farmer that had over the centuries identified and shaped the plant's useful properties and the multinational corporation that isolated and incorporated the gene. Often the relationship of the two knowledge carriers has been unequal and predatory and subject to major debates recently[21]. Yet, it is an example where the globalizing S&T culture can be encroached upon by the knowledge of the simplest of social groups.

A large reservoir of both empirical knowledge, as well as metaphors and theoretical constructs is present in the civilizations outside the European area. One could point to the potential of this store by briefly referring to South Asia. Other regions such as West and East Asia could bring in similar, if not greater possibilities. Of the more formal knowledge systems - civilizational knowledge, many examples already exist. In a recently published book *Toward Global Science: Mining Civilizational Knowledge* (Indiana University Press 1999), I have given details drawn from a variety of disciplines including medicine, mathematics, physics, psychology etc of Asian items taken and incorporated into recent modern science.

As indicative of the possible uses of South Asian metaphors and knowledge, one should note here Glasenapp's remarks that ancient South Asian discussions on fundamental issues had several parallels with those in modern science.[22]. Some of these parallels are: (1) an infinite number of worlds exist apart from our own (in Buddhism, and Puranas), (2) worlds even in an atom (in Yoga, Vasistha), (3) the enormous age of the universe (in Buddhism and the Puranas), (4) infinitely small living beings like bacteria (in Jainism), (5) the importance of the subconscious in psychology (in Yoga), (6) doctrines of matter in Samkhya and Buddhism similar to modern systems, (7) the world that appears to the senses is not the most real, and (8) truth manifests itself differently in different minds allowing for a multiplicity of valid truths.[23]

Below I list a few of the examples I have given to indicate the richness in store. They are examples taken from a few disciplines of innovations based on the Asian past.

Medicine

References to curative plants in the Indian tradition go back to the Rigvedic period (3500-1800 B.C.). Some of these have been fixed with certainty and include the *Semal, Pithvan, Palash and Pipal*. The *Rigveda's* few references increased in the later *Atharvaveda*. The *Charaka Samhita* and the *Susruta Samhita*, two compendia which are a summary of earlier works, brought to light large collections. *Susruta Samhita* deals with about 700 drugs, some of them outside the sub continental region. Through the centuries the number of medicinal herbs in the Indian collections increased to 1,500 [24].

In the South Asian classical literature, especially in the medical one, large areas of potentially useful empirical knowledge exists. Classical texts like those of Charaka, Atreya and Susruta deal deeply with diagnosis, therapies and surgery. Some of these are already being researched into by the contemporary Western medical tradition. Many examples already exist in the medical field of items taken from the Asian pharmacopoeia and used successfully. Other attempts in medicine also include the fields of bio-feed back, and recent work on the relationships between body and mind, which followed well-established Asian approaches and techniques, including those using classical Asian meditation methods. A few examples follow.

The first tranquilizer Reserpine was based on an ancient ayurvedic medicine. A recent study documented the use of honey and sugar as treatment for wounds and ulcers in both the ayurvedic and contemporary biomedicine. Susruta had given detailed examples of their efficacy that are confirmed by modern practice[25]. The plant *Psoralea corylifolia* (Sanskrit *Vakuchi*) has been used in Ayurveda for leucoderma or viligo. An oral treatment derived from this, Psoralen, is now used widely throughout the world [26]. *Centella Asiaticea* (*Gotu kola*) a commonly found compound in health stores in the U.S., has been shown to be a good sedative and have beneficial effects on the nervous and circulatory systems [27] It also is shown to help with skin afflictions and leprosy [28].

Hoechst, the West German pharmaceutical company used Ayurvedic literature to help identify useful medicinal plants. Among the medicines that came out of the research were "Foskolin" from the root of the turnip shaped *Coleus foscoli*. This medicine acts as a hypertensive and has the ability to intensify heart contractions. Another medicine came from *Stephania glabra* out of which an active ingredient came that could dilate blood vessels and acts as a preventive against heart attacks. By the early nineteen eighties over two hundred Indian medicinal plants were being tested every year in this program [29].

A recent study has evaluated the effect of "*Rasayana*" therapy that aims at promoting strength and vitality, and healthful longevity. The study covered six drugs from over 40 drugs mentioned in the classical Ayurveda literature. Extensive assessments at clinical, biochemical, psychological and anthropometric levels were performed on the subjects before and after a six months trial period. The clinical studies indicated that the drugs toned up the cardiovascular and respiratory systems and improved physical stamina. Statistically significant increases were seen in finger dexterity, work output, and visual reproduction. There was increased eye hand coordination, and improved short-term memory and mental performance. A significant drop in lipids was noticed. Uric acid also decreased, suggesting an effect on gout [30].

A term "*Chittodvega*" is mentioned in Ayurvedic literature whose rough modern rendering would be "anxiety neurosis". In the ayurvedic sense it is said to arise from both mental and physical causes. Modern scientific tests for the efficacy of some of the ayurvedic drugs used for anxiety that have not yet reached the world pharmacopoeia have been carried out. The findings were that the ayurvedic drugs were more effective than the other two control drugs (a placebo and diazepam - Valium) in enhancing perceptual and psychomotor discrimination and in controlling somatic and psychic anxiety [31].

A collection of Ayurvedic medicinal plants whose efficacy has been verified by pharmacological and other experimental work was listed in a study in the late sixties [32]. One of the features that struck the authors of the study was how few of the medicinal plants available had been subjected to pharmacological experiments or clinical trials. A study done twenty years later confirmed how only "a small fraction of the vast reservoir of plant remedies in the Aurvedic system was subject to investigation by even the Indian (Western oriented) R&D agencies [33]. Clearly, a vast reservoir of explorable scientific knowledge exists.

Psychology

One of the areas of study with a very long tradition in South Asia is the study of the mind and mental processes. It is natural that many of these approaches could find uses in the contemporary world. One can classify such uses into several categories. One would be those studies of contemporary Western psychologists that show parallels to those of the Asian traditions. Second, would be the use of specific techniques in particular medical areas. Third, would be in broader areas that transcend disciplinary boundaries.

There is potential for a fruitful interaction between Asian discussions and the contemporary study of the mind and mental phenomena, including the philosophy of language, methodology, ontology and metaphysics [34] That search for useful Eastern empirical and conceptual seeds would not be a spurious exercise, is seen also in the existing comparative studies literature which has brought out many parallels between Asian and Western concepts[35].

Memory, motivation, and the unconscious are shown to have parallels in the theories of Freud and Jung, as well as in Patanjali. Similar parallels have been noted between the psychoanalytical theorists Heinz Hartmann and Erik Erikson, and the Hindu theory on the stages of life as well as between Buddhism and early twentieth century analytical thought[36]. Strong parallels between the concept of self realization used in sub continental traditions such as Vedantic Hinduism, Theravada, and Mahayana Buddhism and the concept of self-actualization as developed in humanistic psychology by A. H. Maslow and Carl Rogers have been demonstrated [37].

An examination of the views of the psychologist/philosopher Otto Rank reveals a strong parallel with Hindu ideas. Burt Kahn has pointed out that there is a school of Theravada meditation that has remarkable similarities with Reich in both its theory and practice [38]. De Silva finds resemblance between the Western behavioral techniques and the Buddhist ones in concepts and practices[39]. Elbert Russell after examining several Eastern and Western means of understanding the mind finds that the two traditions can act synergistically to increase human growth[40].

Western medical personnel who have renamed the techniques after themselves have taken sometimes Asian derived techniques wholesale. Thus, in the thirties a Harvard based physiologist Dr. Edmund Jacobson developed a system of relaxation - the "Jacobson Progressive Relaxation" method - based essentially on yoga. Many recent practitioners have used meditation and imagery, ancient Indian techniques.

The psychologist Mary Jasnoski discovered that although relaxation alone increased protection against upper respiratory diseases, if imagery was added on, the effect was enhanced. The Lamaze breathing technique used as an aid to childbirth has origins in yoga type techniques. Athletes are using the slow stretching exercises of yoga to reduce sport injuries. Other sports persons are using visualization techniques and meditation to

improve their performance[41]. Studies in several research centers in the United States and England demonstrated that Indian derived meditation techniques lower blood pressure, reduce cholesterol, and decrease the frequency of irregular heart rhythms[42]. Herbert Benson's pioneering work on the benefits of meditation found that it lowers blood pressure, inhibits secretion of gastric juices, decreases premature heartbeats, and gives many other beneficial results.

Dr. Dean Ornish of Harvard University, who developed the only system that has been proved to reverse heart disease, uses yoga as an integral component. The yoga he uses is not just stretching exercises, but the yoga where patients are encouraged to look into themselves and be aware of what goes on inside them. And, the US National Institutes of Health is sponsoring research into use of yoga in some obsessive compulsive disorders and in beating heroin addiction[43]..

Cognitive Sciences and Artificial Intelligence

Francisco Varela, a leading theoretical biologist and student of cognitive science and artificial intelligence, and co workers have used Buddhist insights in extending the limitations of both the neo-Darwinian adaptation in biological evolution and of the current paradigm in cognitive sciences. Having noted that in Buddhist discourse, classical Western dichotomies like subject and object, mind and body, organism and environment vanishes, Varela applies these discourses to several areas where these dichotomies had traditionally appeared. These include cognitive psychology, evolutionary theory, linguistics, neuroscience, artificial intelligence, and immunology, in whose subject matter issues of organism and environment, body and mind, and subject and object have structured discourse[44].

Their position is that if cognitive science is to incorporate human experience, it must have a means of exploring the dimension that is provided by Buddhist practice. Buddhist experiences of observing the mind are in the tradition of strict scientific observation. They can lead to discoveries about the behavior and nature of the mind, a bridge between human experience and cognitive science[45].

A central tenet in Buddhism, Varela notes, is the process of "codependent arising" (*pratityasamautpada*), which expresses how transitory yet emergent properties arise. The Buddhist category of psychological causality is central to understanding how this process of codependent origination occurs. Self knowledge depends on being in a world that is inseparable from one's body, language, and history. In such a situation mind and world, the knower and the known are in a process of codependent arising.

A technological embodiment of the cognitivist approach is in artificial intelligence. It dawned on AI practitioners that it was easier to program higher mental activities such as scientific problem solving than "perceptual or lower abilities such as visual recognition. This generated a new paradigm in looking at the cognitive world, where the brain became the seat of the metaphors and ideas of cognitive science.

Another area of interest is that of adaptation in evolutionary biology. In the conventional view it is assumed that the environment exists prior to the organism, into which the latter fits. This is not so. Living beings and the environment are linked together in a process of codetermination or mutual specification. In this light, environmental features are not simply external features that have to be internalized by the organism as both the viewpoints of represnationism and adaptation would have it. Environmental features are themselves results of a long history of codetermination. The organism is both the subject and object of evolution. The processes of coevolution result in the environment brought into being through a process of coupling. Taking the world as pregiven and the organism as adapting can be categorized as dualism. Buddhism transcends this duality in its codeterminative perspective.

This approach is found in newer AI experiments and in some recent robotic research. Varela et al give as example the attempt of Rodney Brooks to develop "Intelligence without Representation" in robotics. Instead of representing the world in the form of an internal program in the computer Brooks approach is to use "the world as its own model." His aim is to develop a class of autonomous robots that will coexist in the world with humans. He does not break down the system into functions; instead he breaks it down to its component activities[46].

In another practical of the use of South Asian concepts in AI, Indian and American researchers have successfully used the approaches of the fifth century B.C. grammarian Panini to develop software for machine translation, transforming knowledge representation techniques in grammatical Sanskrit to the Artificial Intelligence field [47]. The original Paninian concepts as applied to Sanskrit have been carried over to similar analyses for existing Indian languages. These machine translation efforts at the Indian Institute of Technology at Kanpur are the most comprehensive in India. Already a basic system as a working model has been demonstrated for translation between Hindi and Kannada using the technique. These efforts are to be extended to several Indian and other languages[48].

Mathematics and physics

The possibilities of starting from where earlier Asian mathematical explorations left off are only just being attempted. One such attempt has extended the work of Bhaskara 1 (600 A.D.) who developed second order rational approximations to the Sine function. The extended and modified result has yielded accurate rational approximations that were computationally efficient. This procedure was then generalized and applied to yield efficient rational approximations for some other functions. These were ex, log x, and tan-1 (x). These were compared with existing methods for these problems and found to be satisfactory [49].

Raja Rammanna - responsible for the first Indian atomic explosion over twenty five years ago- has used insights obtained from Buddhist concepts and logic to derive some of the characteristics of elementary particles using the mathematical theories of Cantor. The

Buddhist concepts he uses are Conditioned Reality, Kshana and 'Nothingness'[50]. Ramanna has applied the approach to energy levels in atoms, to the distribution of masses in elementary particles, and to the wave particle duality in elementary particles. He has derived results in the three fields that have been validated by other more conventional methods.

The standard arithmetic that we use today based on the decimal place system and the use of zero is a transmission through the Arabs from South Asia. It entails certain standard procedures, 'algorithms', to perform the various operations. But are these the only such operations that exist and are these the ones that are computationally the most efficient? These are the ones that have become legitimized and standardized. Could there be algorithms that did not get transmitted from India through the Arabs, or those that were developed after the transmission?

Many such has been "discovered" recently by Ashok Jhunjhunwala, a professor of electrical engineering in the Institute of Technology, Madras. He has examined everyday practices in arithmetic in areas not yet influenced by "European" techniques, such as those used by artisans and businessmen in the non Europeanized sector. He came across simple but fast methods of calculation. He described eight of these old methods that are faster than conventional methods. These included means of finding areas, multiplication using the methods of *Nikhilam* and the *Urdhva Tiryaka*, squaring and division using these methods, evaluation of powers, square roots of numbers, divisibility of numbers, and factorization. They also include methods to catch errors.

Jhunjhunwala has tested the speed of some of these old approaches with the conventional ones and found significant increases in processing speed. He has applied these general methods to speed up calculations in computers.

These results appear astonishing to those trained in conventional methods. But as Jhunjhunwala points out, they are based on a deep understanding of the place value system and some elementary algebra, which had been worked out long ago. In this light, the modern system becomes just one of a set of arithmetical techniques known in the region. Jhunjhunwala emphasizes that the material he has uncovered is only a small part of the hidden mathematical heritage.

Jhunjhunwala's collection of mathematics at the local level shows the proliferation of methods possible once the decimal system is understood. Local groups, discovered new tricks, a process of grass roots creativity very much like that one gets in different responses to changing agroclimatic conditions across the world and the resultant variations in agricultural practices.

If the above are some illustrative examples of already existing applications of South Asian elements, can one speculate on further future possibilities?

Some Speculative Possibilities

As a nodal point of growth, the Greeks set some of the problems, tone and nature of discussion on key foundational issues such as logic, and the nature of matter and time. With a different set of such nodal orientations one could have different knowledge explorations and trajectories. The non-Greek traditions have many such sets, many foundational variations existing in South Asia alone.

There is a very long tradition, in the South Asian knowledge system of very complex and sophisticated debates and discussions on epistemology.[51] It has been suggested that there exists the potential for a fruitful interaction between these and the contemporary study of the mind, including the philosophy of language, methodology, ontology and metaphysics.[52] South Asian discussions in psychology have also given a wide variety of constructs that rival in their richness and empirical spread the contending systems, that came to being in the West in the 19th and the 20th centuries and associated with such writers as William James, Freud, Jung or with schools such as the Humanist Psychology one and the more recent Artificial Intelligence (AI) influenced, cognitive science approaches. That a search for Eastern empirical and conceptual seeds would not be a spurious exercise, is seen also in the existing comparative studies literature that has brought out many parallels between Asian and Western concepts.[53]

Thus, memory, motivation and the unconscious are shown to have parallels in both the theories of Freud and Jung, as well as in Patanjali.[54] Similarities have also been observed between Vedanta and Existentialism;[55] Heidegger and the thought of Krishna in the Bagavad Gita;[56] Husserl, Sartre and Vedanta on consciousness;[57] Descartes and Sankara; [58] Kant, Hegel and Nagarjuna;[59] and Kant, Heidegger and the Upanishad philosophers[60]. Similar parallels have been noted, between the psychoanalytical theorists, Heinz Hartmann and Erik Erikson, and the Hindu theory on the stages of life;[61] Buddhism and early 20th Century analytical thought,[62] psycho-analysis, existentialist theory, and Humanistic Psychology;[63] - Maslow the most prominent Humanistic psychologist flatly declaring of his psychology - 'our goal is the Eastern one'.[64]

Apart from direct uses in epistemology, ontology, psychology, Artificial Intelligence, and cognitive sciences, theories of mental phenomena can also have a powerful impact on a host of disciplines as illustrated by the case of David Hartley's (1749) concept of the association of ideas and its impact on the development of the human and biological sciences. This gave a mechanism for the concepts of adaptation and utility, which when extended beyond the individual experience, was a useful mechanism for ideas of evolution and progress. These ideas influenced a large number of theorists in a variety of fields, including Joseph Priestley, Jeremy Bentham, Adam Smith, James Mill, J. S. Mill, Condorcet and William Paley in their various social, psychological and economic theories; Lamarck and Erasmus Darwin in evolution and directly and indirectly the psychologists William Mc Dougall, C. S. Sherrington, I. P. Pavlov, Freud, W. Wundt, William James and George H. Mead. Clearly, a core idea can infiltrate several domains and have a strong ripple effect.[65]

Western logic is defined today generally as the "principle of valid inference" or as a "science of necessary inference." It appears as "the symbolic transposition of semantic

contents into a mathematical framework." Yet, this traditional western, algebraic logic is not the only one around. A new vocabulary of logic could emerge by enlarging the field..

Aristotelian logic is twofold, 'X' is either 'A' or not 'A'. In South Asia, there are four-fold logics in the Buddhist tradition and a seven-fold logic in the Jain tradition. In the four-fold logic, there are four categories. "X is neither A, nor non - A, nor both A and non-A, nor neither A nor non - A." Jain's seven-fold logic is an expansion of these categories by adding three other categories.

The expansion of the Western twofold category into four and seven could provide for a range of possibilities. One could speculate that Boolean algebra on which computers are based and which has a substratum of yes-no logic, could be transformed into four-fold or seven-fold logics. Another area might be the field of quantum physics. There, epistemological problems arise with such statements as a particle said to both exist as well as not-exist at a given point and at a given moment.

Time is yet another rich area to explore in the Asian tradition. There are many different *philosophical* discussions on *Samsara* (as opposed to the popular ones) concerning on what could be termed the nature of long duration processes[66]. According to some Jain views, time was one of the casual factors in the evolution of nature. And Buddhism alone has a very large tapestry of conceptions of time.

One of these approaches developed an elaborate theory not only of atoms but also of moments - some schools recognizing four types of moments and others three. Chronons in some discussions were related to atoms and "moments of thought." Other theories were also proposed by different schools to relate the theory of moments to the fact of continuity of temporal events.

These varied discussions on logic, matter, and time illustrate that a dense seed bed of fertile ideas and metaphors exists in the South Asian tradition that could provide new conceptual elements for future growth.

Social theory for new technologies

The march of science since the Renaissance challenged several held beliefs. In the western world this included a questioning of the anthropocentric world derived from Judeo-Christian roots of Creation. Significant challenges were those of the Copernican Revolution, the Darwinian evolutionary system, and the discovery of the unconscious.

In the new world of information technology and biotechnology there are ethical challenges that have not been met before. These belong to the class of problems raised by the technologies where parts of the body and the mind are cloned. These dilemmas are the subject of intense discussion on the essential nature of the human that is being intruded upon by these technologies.

Derek Parfit, in the influential book *Reasons and Persons*, [67] raises some of these ethical issues. Among those is the nature of persons and their continuity. The position he arrives at is in considerable agreement with the Buddhist position. He wonders about what would happen in hypothetical instances such as surgical intervention in the brain with implantation of memories, or of brain transplants. All these circumstances raise questions regarding personal identity.

Parfitt says, 'though persons exist, we could give a complete description of reality without claiming that persons exist.' .[68] Recognizing that these views may be difficult to be felt subjectively although they can be argued theoretically he says, "Buddha claimed that, though this is very hard, it is possible. I find Buddha's claim to be true."[69]

New developments in medicine and biotechnology are increasingly allowing intervention in the brain apparatus through genetic interventions or transplants. There is another intrusion to human identity in the form of computing. With intimate interfacing devices like Virtual Reality, the gap between what goes inside and outside the subject is so intermingled that the internal intrusions of prostheses become very intimate. Virtual Reality also brings into question the constructor and the constructed. These types of questions are regularly dealt with in Buddhist and other South Asian philosophies. They mirror Buddhists' discussions on how the mind constructs realities. In the Virtual Realities that use visual representations, parallels also exist with visualization techniques in certain branches of Buddhism[70]. The author of a general non technical text on the topic, Howard Rheinhold, puts it as follows, the Virtual Reality "experience is destined to transform us because it's an external mirror of something that Buddhists have always said, which is that the world we think we see 'out there' is an illusion. We build models of the world in our mind, using the data from our sense organs and the information-processing capabilities of our brain - only we are hypnotized from birth to ignore and deny it" [71] .

The ethical and conceptual knots of the future brought about by modern science and technology could have many uses for South Asian perspectives.

Using metaphors

I had already mentioned that there are two broad means of acquiring mined knowledge. First, was by splicing at crucial nodal points Asian knowledge directly into the contemporary knowledge structure. The second approach, was the uses of metaphor. When existing theory does not match reality, disciplines open up. At these crucial times, new views and new metaphors cross disciplines, and new theoretical perspectives are formulated. How such imported metaphors function, has been the subject of some recent work.

Metaphors have been considered as "the pregnant mother"1/to science and to all seminal thought[72]. Daniel Rothbart has argued that the formation of concepts in science is largely a metaphoric process. Thus, mechanical metaphors and models were imported to economics and economic models were imported to analysis of electrons[73] ; Clerk

Maxwell compared tubes of forces in electromagnetism as similar to muscles [74]; and Oersted's discovery of electromagnetism was influenced by the *Naturphilosophie* idea of polarity.[75] And, Pepper several decades ago argued that theories in science originate in metaphors.[76] Generally speaking, metaphors implicitly transfer semantic features from one semantic field to another, entirely different one.[77]

Judge[78] has suggested several guidelines for using such metaphors from other conceptual domains by "re-reading" them. Re-reading existing conceptual patterns as metaphors one could mine the South Asian intellectual past for useful "fossilized knowledge . This is exactly the manner by which the existing scientific tradition has regularly mined the Western past for fresh insights.[79]

In recent science, the inflows of metaphors to science have been primarily from the European heritage. However a vast soup of empirical knowledge, metaphors and theoretical constructs also exists in the non-European world. As we already noted these vary from sophisticated debates on the nature of ontology and epistemology, to discussions in psychology, the nature of mind, mathematics and medicine. Such an infusion would help enlarge our scientific horizons.

Disciplinary lineages in the modern sense are a recent, essentially in its modern format, a post 19th century phenomenon. But lineages of culture have existed from the beginning of humans. In simpler societies lineages consisted of knowledge being handed down from parent to off spring. In civilizational entities, with a greater division of labor and more sophisticated problems being addressed these took a form almost reminiscent of lineages in modern disciplines. Sometimes, they were for all purposes like disciplinary lineages, or more narrowly a disciplinary programme that followed a common research programme, having similar problems and a similar set of approaches.

In the South Asian case, these lineages take the form that stretches from teacher to pupil down the line. This is the *guru-shishya-parampara* (the teacher-pupil generational lineage) that has enriched all callings including for example specialized activities in mathematics and astronomy. One finds these lineages in all the traditions, whether it is in the various Vedic schools such as Sulbakaras, Jyotiskaras, the Kusumpura School, the schools of Asamkadesa or Ujjain, Jain or Buddhist schools. Varahamihira alone gives the names of twenty scholars that had come before him. This is equivalent to the practice of citations in contemporary scientific papers. One builds up through a chain of authorities, a frame of legitimacy for one′ s problem, methodology and approach[80].

Because such lineages search for what they believe is valid knowledge, some of the lineages split up to factions leading to sub lineages. Sometimes, the jealousy guarding these lineage boundaries can be so intense that there is no discourse between them, often metaphorically, sometimes, literally. Explorations within such lineages could be a potential rich source of metaphors (as well as of directly transferable, non metaphorical information) for enlarging the current lineages in the science disciplines.

Apart from lineages in subjects dealing directly with science, there are lineages and vast store houses in the humanities and philosophical traditions. South Asia is one of the largest store houses of literature in the world. Apart from works in the two classical languages of Sanskrit and Pali, there are large collections in the regional languages. Part of this humanistic literature consists of a large number of allusory texts, replete with

perhaps the largest storehouse of metaphors. In poetics, in the *Kavya Shastra*, this is studied and recorded in great volume and detail. If one wishes to catch the imagination roaming in controlled free fall, this, and its relations is one literature to jump into.

The act of scientific creation rarely takes the form of consciously transferring metaphors from one realm to another. The process takes place naturally, subconsciously, although clearly the approach can be cultivated. In such an unconscious mode, a Copernicus transfers the metaphor of a circle intuitively into the movements of the heavens. Later, he checks them against his figures. Once the geometrical pattern is given, and the *Gestalt* switch made, a Kepler can come at a different time and refine the broad *Gestalt* into an ellipse.

If one were to do the metaphor searching game unconsciously, then one would have to do it while being immersed in the South Asian culture. A person who is immersed in the culture, and is not restrained to think through his culture, taps the store house of metaphors without conscious effort. But, unfortunately, South Asians themselves doing science have been socialized completely into the western frame. They have - to use the title of an earlier book of mine - *Crippled Minds*[81]. They tend not to think in a free floating, unconscious manner. They are always inclined to look over their shoulder about what their mentors in the west say, or would say.

But those unconscious South Asians who do think on their own, can come up with major breakthroughs. The classic example is the Indian mathematician Ramanujan, who was "discovered by the British mathematician Hardy, and brought to England earlier in this century. Ramanujan is today considered one of the greatest mathematicians this century as a recent American book - (Robert Kanigel, *The Man Who Knew Infinity: A Life of the Genius Ramanujan*, Charles Scribner′ s Sons, New York, 1991) - readily testifies to[82]. Mathematicians are still poring over his notebooks to dredge for the nuggets he had discovered. But Ramanujan did not follow an imitative western method. A man fully rooted in his peculiar traditions, he would believe that his results came up on the tongue of his god *Narasinha*[83]. His was one clear example of unconscious tapping of his cultural roots.

Yet, even without unconsciously tapping the metaphorical database of a civilization, one can consciously train oneself to do so. So can also an outsider to a culture, train himself to be empathetic to a culture and tap its roots.

The metaphorical uses of non western sources are virtually limitless in their potential. Only the human imagination can put brakes on to its possible uses. Metaphors are an added tool in the arsenal of indirect approaches to mining civilizational knowledge. The other indirect approaches are related to philosophy.

Some potentials

But, do we have any inkling of the potential that exists in this other allusory approach of using philosophy? Here, one could get some hints from South Asia itself.

The Jains had discussions on all the permutations and combinations of theories possible[84]. One could presumably make calculations similar to those of the Jains, based on the soup of concepts from South Asia that could yield possible solutions and theories for given problems. This mechanical exhaustive approach would be roughly of the same class of dealing mechanically with knowledge that is found in the computer technique

called genetic algorithms. In the latter, solutions to problems are randomly selected, and then tested mechanically to fit into the criteria for a solution. So aspects of knowledge creation are partly automated. In a similar manner, a Jain type of exercise could yield an exhaustive list of theoretical positions to be selectively mined.

The South Asian region also has had extensive discussions on possibly all the variations in ontology and epistemology that the human imagination can think of, (an area which I treated in detail in a Chapter of *Towards a Global Science*). But such philosophical questions seemed to have been solved "for ever" in the 17th century by Descartes′ tight separation into a subject and object. Yet this seeming ontological and epistemological certainty has today broken down in many areas. It has broken down in quantum physics, where the relationship between the observer and the observed, between subject and object has spilled beyond the Cartesian dichotomy. As I discuss in detail in *Towards a Global Science* it also appears to have broken down in aspects of biology and cognitive sciences. Consequently some of the deeper philosophical questions are raised afresh, and once again shifted to the arena of science. It is also possible that similar philosophical questions lie lurking in other disciplinary areas too.

Now that the certainties of a Descartes and a Bacon constructed at the beginning of the scientific endeavor are breaking down, there could well be much deeper ontological and epistemological questions in store in the relationship of humans with nature, including those related to understanding the latter. Here, fresh insights drawn from other traditions could well be useful. An examination of ontological and epistemological questions drawn from the wide South Asian canvas could well give hints or directions for the pursuit of different areas of scientific interest. Can we formalize some of these ontological and epistemological positions?

All the variations in the chemical elements were set to order in Mendelief=s Periodic Table in the 19th century. It accounted for the chemical elements existing then, and through gaps in the table predicted hitherto unknown ones. In a similar manner it would not be a difficult task to have an equivalent "periodic table of all the positions in ontology and epistemology. The wide philosophical tapestry of South Asia could at least provide an initial scaffolding for such a table. Not only would it give a table of almost all possible >realities=, but also almost all the possibilities of apprehending them and knowing about them. An examination of such a table would help one locate existing positions in ontology and epistemology in the different scientific disciplines. (Like the Periodic Table helped locate different chemical elements in different slots.) Gaps in such a table when applied to existing fields of science, could provide for hints into further exploration, just like gaps in the Periodic Table gave rise to search for new chemical elements. A further examination could yield hints and guidelines for implications in the different scientific fields, even suggesting areas for new research. This again would be another exhaustive approach to examining various philosophical positions as these impinge on science.

Some estimates

The South Asian Indologists, it had been observed, have been only searching for 'occasional scraps of contemporary relevance from the remains of a civilization that for them, is perhaps as dead and as alien as it is for the West'[85]. But what we have been

recording in this paper are a few examples and techniques for making these civilizational stores relevant by splicing them to the modern knowledge enterprise. Can we have any measure of the potential that exists in splicing-in techniques?

A passage from Susruta stimulated the growth of modern plastic surgery in the nineteenth century in Europe. But as Krishnamurty points out that was only a stray reference in the many procedures described. It had the fortune of catching the imagination of a western expert. There could very well be, many other descriptions that could be rediscovered for modern medicine. Under treatment for mental diseases Susruta gives a very large list of plants. It is possible that screening of these plants could give rise to a much larger set of useful remedies. I had noted how only >a small fraction= of the vast reservoir in the Ayurvedic system has been subject to investigation. Clearly, a vast reservoir of explorable scientific knowledge exists.

Let us consider one more subject, mathematics.

The works of the Kerala school mathematicians (13^{th} to 18^{th} C) are mines of mathematical ideas and applications that have hardly being touched. The few correlations with more recent Western discoveries show the potential of this mine[86]. Only a very small number of their texts have been published as yet. Of these, only very few have been studied by professional mathematicians. A detailed study would undoubtedly produce, if past probabilities of results from this tradition are a guide, further useful outcomes [87].

But, the Kerala tradition is only a part of a much large tradition. One American estimate of manuscripts in *Jyothisastra*, the field roughly covering the areas of mathematics and astronomy, gives a figure of 100,000 manuscripts[88]. Yet, the recently published book *Source Book of Indian Astronomy* lists only 285 works[89]. Clearly, a large number of manuscripts still await to be explored. A still larger number to be imaginatively accessed and built upon.

But, that is only a crude indication of the potential in one subject area, mathematics.

During the last hundred years, probably two thousand catalogues and lists of known South Asian manuscripts written in the various languages of the sub continent have been compiled. Each of these catalogues gives about two hundred manuscripts. So, one is talking of about 400,000 manuscripts. Others have estimated that taking all the South Asian manuscripts today in all the languages, they must amount to some 500 million (fifty crores). But, hardly any of these are being read today[90]. This figure gives an idea of the huge potential in store.

Conclusion

The worlds of ideas were brought together and packaged in Europe in a fresh vigorous amalgam. The Renaissance, the Scientific Revolution, the Enlightenment and the great discoveries in the 19th and 20th centuries have been the resultant outcomes. Now, a new packaging is possible. A new historical moment has opened up where the world is increasingly being interconnected in a pervasive spread of globalization. As a

result, no single node can in the future act as a clearing house for all the world′ s knowledge. The role of a dominant center over a periphery is eroding as near-instant communication begins to spread information and knowledge creation across a wide network. Globalization is opening up centers of dominance away from one central place to a shifting web (sometimes resident as moving denizens on the Internet). Academic groups are spreading across the world. Further, new historical research is coming up across the world, bringing out hitherto cognitively hidden nuggets.

Inputs into science from different civilizational sources could occur because of this globalization. Already main stream R&D is getting relocated for considerations of cost in some cheaper Third World countries like India. Another science-related technological activity, software production has got relocated for similar reasons, and India′ s software production today rivals many developed countries. Globalization is thus opening up to different cultures. Consequently, cultural colonization is moving away from the classic mould, to niche marketing and niche production as has already happened in several industries across the world. Consequently, it will suck up cultural elements from the different global cultural systems and "remarket" them to global niches. As a result, there would be greater openness for knowledge than in the first cultural colonization period of the Mercantile period, or the second one of the Industrial Age.

The possibilities of enlarging the existing knowledge system by tapping into civilizational stores are potentially vast. Varela et al the authors of the book *The Embodied Mind* stated: "It is our contention that the rediscovery of Asian philosophy, particularly of the Buddhist tradition, is a second renaissance in the cultural history of the West, with the potential to be equally important as the rediscovery of Greek thought in the European renaissance"[91]. How far this may be true is for the future to decide. However, a strategic alliance of feminist approaches, ethno knowledge and regional civilizations= knowledge is probably in the making. Through their combined efforts the results of millennia of human enquiry that have been lost from the Euro-patriarchal view, could possibly be resurrected. A true global science taking into account multicultural politics of facts would occur[92]. This would undoubtedly make the knowledge system less chauvinistic, less parochial, whilst still maintaining the rigor developed in the last few centuries.

So what is the image of Asian science and technology that we are left with, considering the new tendencies visible on the horizon. Some of the dominant themes of science and technology have changed in the ensuing years. In production, a new set of flexible technologies that use either biological or computer information would be increasingly dominant. As these two information laden technologies interact with cultural information the ensuing "product mix" of technology and social and cultural arrangements could be very varied. It would result in a move away from mass production to niche production, niche marketing and niche consumption. The metaphor of the future is biological. It is the metaphor of flow and change responding to dynamic social and technological environments. The increasingly accessible globalized S&T system would also allow the partial end of intellectual dependency. Entwined in an increasingly interconnected global whole, the S&T system would be molded by different social, cultural and ethical factors, including indigenous Asian elements, as no previous knowledge systems or technologies have been.

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