How advanced were we?

by Ambica Gulati

The advances made by seers of yore should inspire Indians today who are once again making a mark in the cutting-edge fields of science and technology

Gazing at an endless blue sky, you must have often wondered at what makes the earth go round and the apple fall from a tree. Whenever such queries cropped up, you found the answers in school science books.

The word 'science' literally means knowledge or the state of knowing. When this knowledge is put to practical use, it creates technology. Today, we have most, if not all, science recorded for posterity in print and other media. But if the history of science is traced back to its origin, it probably starts from an unmarked era of ancient times. The phenomenal advances of ancient India, for example, in science and technology are the stuff that legends are made of-be it the oft-quoted example of the conception of zero or developments in the fields of astronomy, chemistry and metallurgy.

Science, in fact, was neither 'discovered' nor 'invented': it was 'revealed' to ancient Indian seers in their meditations, got codified in the four Vedas-Rig, Yajur, Sam, Atharva-and was passed on from generation to generation.

"The language of the Vedas," explains Dr Thomas Arya, a German psychologist and committed Indophile, "is symbolic and imagistic. It clothes all knowledge in symbols that a literal mind may comprehend only at the most evident level."

SCIENCE IN RITUALS

The Vedic cosmology evolved as part of a complex system of sacrificial ritual. Although the Rig Veda does not mention any temples, according to scholar Nundolal Dey in his book Civilization in Ancient India, "each house had a furnished room as a receptacle of the sacred fire". The daily havan (fire worship) preceded all rituals and particular emphasis was given to building the havan kund or altar. The agni cayana or flare of the fire linked sky and earth. So, square and round altars represented sky and earth respectively.

Every altar was different, with a specific shape and number of bricks based on astronomical and calendar calculations. For instance, the sky altar had five layers of bricks, each signifying the number of years.

"Probably these rituals led to the birth of various branches of mathematics," notes the book In Search of the Cradle of Civilization, written by George Feuerstein, Subhash Kak and David Frawley.

ASTRONOMY

The central position enjoyed by rituals demanded a proper comprehension of the skies and time. Although astronomy bloomed much later, thanks to the seminal work of Aryabhatta (499 AD), Latadeva (505 AD), Brahmagupta (628 AD) and Bhaskaracharya (1150 AD), "the earliest writer on astronomy is said to have been Parasara," says Dey. The primary aim of astronomy then was rectifying the calendar, ascertaining chronological epochs and calculating eclipses. "Although it is generally supposed that the Surya Siddhanta by Latadeva is the oldest astronomical text in India, some consider Brahmagupta's Brahama Siddhanta to be the earliest work," notes Dey. Aryabhatta is supposed to have compiled Aryabhita Sutra around sixth century AD.

Many theories postulated then have found uncanny support now. Take Bhaskara's Siddhanta Siromani, where he mentions a force of attraction resembling gravity, discovered centuries later by Newton. In Surya Siddhanta, Latadeva talked about the earth's axis and called it sumeru. The astronomers also divided the year into 12 months and six seasons.

Behind such amazing discoveries was a rigorous study of the sky and a mathematical precision in instruments used. Of note is the bhubhagola, an instrument composed of rings showing the positions of important circles of the celestial sphere. Its design was similar to the armillary sphere, an instrument popular among European astronomers. Obviously, a proper reading of these instruments demanded a separate stream of knowledge-mathematics.

MATHEMATICS

The Third Anniversary Discourse: On The Hindu, Indophile Sir William Jones wrote: "The ancient Indians can boast of three inventions-instructing by apologues, decimal scale and the game of chess."

Although the seeds of mathematics were present in Vedic rituals, including Vedic mathematics, a relatively simple method for complex calculations, they truly blossomed in astronomy. In fact, Indian mathematics' greatest contribution came, philosophically enough, in the form of zero, courtesy Aryabhatta. In the Kalpasutras, penned in 290 BC, the scholar Bhadrabahu even solved the Pythagorean theorem.

An extant book on arithmetic was the Lilavati by Bhaskara. Lilavati contains the common rules of science and applies them to motley questions on interest, barter, mixtures, combinations and permutations.

The development of mathematics was not restricted to astronomy. It was an integral part of trade and commerce much before the Vedic era. Says Dr Arya: "The weights used by the Indus valley civilizations of Harappa and Mohenjodaro followed a binary system and measurements were based on the decimal system." The pursuit of knowledge, therefore, was strong much before the Vedic times.

TOWN PLANNING

In Search of the Cradle of Civilization dates the Indus valley civilization to around 2500 BC. Almost all our knowledge about this civilization comes from a study of the two excavated towns of Harappa and Mohenjodaro, now in Pakistan.

Archaeologists discovered that both sites were roughly three miles in diameter and arranged in a grid. To the west lay a citadel, erected on a high mud and brick platform. A remarkable structure within the citadel at Mohenjodaro was what archaeologists term the Great Bath. This 39 ft-long, 23 ft-wide and 8 ft-deep bathing pool had been sunk into the courtyard and waterproofed with bitumen.

To the east of the citadel lay the lower city, with straight bricklined streets 30 ft-wide, which neatly divided the town into blocks. All the streets had brick-lined sewers fitted with manholes.

Till date, the layout of Mohenjodaro and Harappa are considered model town plans. But this civilization's innate sophistication is also evident in the arts and crafts unearthed.

ARTS AND CRAFT

The bronze and copper artifacts that are today considered 'ethnic' have a history dating back to the Indus valley civilization. Archaeologists found three major sculptures in its ruins. The first, made of

soapstone, depicts the bust of probably a senior priest. It shows a bearded man, with half closed eyes, wearing a headband and an ornament on the left arm. The second artifact is a male torso made of red stone.

But by far the most popular item is the copper figurine that scholars have named Dancing Girl. Another artifact of note is a life-size bronze head, identified as the sage Vasishtha. A thriving economy is indicated by stamp seals with animal motifs, pottery ware, jewelry, copper and bronze vessels. Till date, historians have failed to fathom how such an advanced civilization suddenly disappeared into the blue.

METAL WORKS

The use of metals and their production has been one of India's most ancient of sciences. According to the treatise Rasaratnakar, the first batch of zinc was made in India around 50 BC at Zawar, in the western Indian state of Rajasthan. Experts even claim that iron was part of the Vedic culture, roughly dating back to 1500 BC. This theory is based on the word ayas, which recurs in the four Vedas and is widely believed to denote iron. But the Atharva Veda and Yajur Veda speak of different colors of ayas, indicating that it may have been a generic term for metal.

Even metallic money—golden nishkas—has been mentioned in Rig Veda. Yet we find the ancients using cattle as exchange (pasu, pecus). Some historians consider the nishkas to denote gold coins worn as necklaces.

In his work Manusmirti, Manu gives details of estimating the value of a coin. For instance, eight trasarenus (motes) is equivalent to one licksha (poppy seed). Copper was weighed in suvarna. "From these evidences, it is clear that the value of ancient money depended on the weight it bore," writes Dey. This changed with the mastery of madhuchusta vidhanam or the lost wax process, which led to the Chola bronze coins during 800-1400 AD.

Metallurgy was closely linked to developments in chemistry. Here also, ancient India was far ahead of its times.

CHEMISTRY

Known as rasayan shastra, chemistry was initially part of the medical treatise Charak Samhita. "They (ancient Indians) knew how to prepare sulfuric acid, nitric acid, the oxide of copper, iron, lead, tin and zinc, the sulphate of copper, zinc and iron, and the carbonates of lead and iron," writes historian Elphinstone in his book History of India.

According to Dey, the weapons mentioned in the Indian epics Ramayana and the Mahabharata were actually products of chemistry. All warfare knowledge resided with the Brahmins, who later imparted it to the Kshatriyas. "The mantra the gurus gave their pupils was nothing but chemistry," argues Dey. "The arrowheads were probably coated with certain chemicals."

Dey goes on to state that even gunpowder, whose invention is traditionally ascribed to the Chinese, was known to ancient Indian chemists. "Gunpowder," he says, "was known as aurbagni, being the invention of Aurba, the preceptor of Sagara and the ancestor of Rama." The ingredients and power of the fire of aurba have been described thus in the work Nitichintamani: "Combining burnt wood (charcoal), saltpeter and sulfur by parts gradually lessened, a terrible fire is produced by which even water and others are burnt."

But not all of chemistry was warlike. Because of it being a part of Charak Samhita, chemistry also contained the knowledge of creating medicines by potentizing various metals. This near-extinct

healing science is still being practiced today by Vaidya Balendu Prakash in the north Indian valley town of Dehra Dun.

AYURVEDA
The Charak Samhita consisted of another science of healing—ayurveda, ancient India's most potent contribution to the world of medicine. Legend has it that Brahma, the creator of the universe, perceived this science and taught it to Prajapati Daksha, who transferred the knowledge to his twin brother Ashwini. In his turn, Ashwini taught ayurveda to Indra who passed on the science to various sages. Two of Indra's disciples—Bharadwaja and Deodas Dhanwantari—later became prominent physicians. Dhanwantari revealed this science to his pupil Susruta, who developed surgery.

Apart from providing a consummate healing technology, the ayurvedic savants also made some amazing discoveries about the human body. For example, they found that the number of bones in the human body actually equals the number of days in a year.

BOTANY
The Vedic era's emphasis on nature led to one of the world's earliest classification systems for plants and vegetables—perhaps because ayurvedic physicians looked into nature to find cures for various diseases. The Yajur Veda, for example, contains hymns that classify the plant kingdom into classes, orders, genus and species. According to Dey, this segregation was based on the plants' external appearances. All vegetables that originate either from seeds or from slips of branches were called aushadhi (herbs). The plants that do not bear flower or fruit were termed vanaspati (lords of the forest) and those that did, came to be known as briksha (trees).

YESTERDAY ONCE MORE
As is evident, most of these sciences were in tune with nature. The ancients did not plunder the earth to search for its natural treasures. It was a contemplation, which took years to manifest. It was the perfect marriage between science and spirituality where one complemented the other. The laboratories of the sages of yore were the open blue sky, the quiet of a virgin forest, the calm of their inner awareness. Here, wisdom dawned. From quantum physics to the Big Bang, the universe was explained in terms of a symbol—the *Nataraja*—and a poem—the Rig Veda. Here, beauty and knowledge mingled to create a harmony that was unique among all times.

Then, shouldn't we follow in the footprints of yesterday in search of a better tomorrow? Isn't it time we look back and seek the universal harmony that we lost somewhere along the race for existence?

Science, Medicine, Technology in Ancient India

Science and technology in ancient and medieval India covered all the major branches of human knowledge and activities, including mathematics, astronomy, physics, chemistry, medical science and surgery, fine arts, mechanical and production technology, civil engineering and architecture, shipbuilding and navigation, sports and games

Ancient India was a land of sages, saints and seers as well as a land of scholars and scientists. Ancient India's contribution to science and technology include:

- Mathematics - Vedic literature is replete with concepts of zero, the techniques of algebra and algorithm, square root and cube root. Arguably, the origins of Calculus lie in India 300 years before Leibnitz and Newton.
- Astronomy - Rig Veda (2000 BC) refers to astronomy.

- Physics - Concepts of atom and theory of relativity were explicitly stated by an Indian Philosopher around 600 BC.
- Chemistry - Principles of chemistry did not remain abstract but also found expression in distillation of perfumes, aromatic liquids, manufacturing of dyes and pigments, and extraction of sugar.
- Medical science & surgery - Around 800 BC, first compendium on medicine and surgery was complied in ancient India.
- Fine Arts - Vedas were recited and recitation has to be correct, which gave rise to a finer study of sound and phonetics. The natural corollary were emergence of music and other forms of performing arts.
- Mechanical & production technology - Greek historians have testified to smelting of certain metals in India in the 4th century BC.
- Civil engineering & architecture - The discovery of urban settlements of Mohenjodaro and Harappa indicate existence of civil engineering & architecture, which blossomed to a highly precise science of civil engineering and architecture and found expression in innumerable monuments of ancient India.
- Shipbuilding & navigation - Sanskrit and Pali texts have several references to maritime activity by ancient Indians.Sports & games Ancient India is the birth place of chess, ludo, snakes and ladders and playing cards.

Mathematics

Mathematics represents a very high level of abstraction attained by human brain. In ancient India, roots to mathematics can be traced to Vedic literature, which are around 4000 years old. Between 1000 BC and 1000 AD, a number of mathematical treatises were authored in India.

Will Durant, American historian (1885-1981) said that India was the mother of our philosophy of much of our mathematics.

It is now generally accepted that India is the birth place of several mathematical concepts, including zero, the decimal system, algebra and algorithm, square root and cube root. Zero is a numeral as well as a concept. It owes its origin to the Indian philosophy which had a concept of 'sunya', literal translation of which is 'void' and zero emerged as a derivative symbol to represent this philosophical concept.

Geometrical theories were known to ancient Indians and find display in motifs on temple walls, which are in many cases replete with mix of floral and geometric patterns. The method of graduated calculation was documented in a book named "Five Principles" (Panch-Siddhantika) which dates to 5th Century AD.A. L. Basham, an Australian Indologist, writes in his book, The Wonder That was India that "... the world owes most to India in the realm of mathematics, which was developed in the Gupta period to a stage more advanced than that reached by any other nation of antiquity.

The success of Indian mathematics was mainly due to the fact that Indians had a clear conception of the abstract number as distinct from the numerical quantity of objects or spatial extension.

Algebraic theories, as also other mathematical concepts, which were in circulation in ancient India, were collected and further developed by Aryabhatta, an Indian mathematician, who lived in the 5th century, in the city of Patna, then called Pataliputra. He has referred to Algebra (as Bijaganitam) in his treatise on mathematics named Aryabhattiya.

Another mathematician of the 12th century, Bhaskaracharya also authored several treatises on the subject one of them, named Siddantha Shiromani has a chapter on algebra. He is known to have given a basic idea of the Rolle's theorum and was the first to conceive of differential calculus.

In 1816, James Taylor translated Bhaskaracharya's Leelavati into English. Another translation of the same work by English astronomer Henry Thomas Colebruke appeared next year in 1817.

The credit for fine-tuning and internationalizing these mathematical concepts - which had originated in India goes to the Arabs and Persians. Al-Khawarizmi, a Persian mathematician, developed a technique of calculation that became known as "algorism." This was the seed from which modern arithmetic algorithms have developed. Al-Khwarizmi¹s work was translated into Latin under the title Algoritmi de numero Indorum, meaning The System of Indian Numerals. A mathematician in Arabic is called Hindsa which means from India.

The 14th century Indian mathematician Madhava of Sangamagrama, along with other mathematicians of the Kerala school, studied infinite series, convergence, differentiation, and iterative methods for solution of non-linear equations.

Jyestadeva of the Kerala school wrote the first calculus text, the Yuktibhasa, which explores methods and ideas of calculus repeated only in seventeenth century Europe.

Astronomy
Ancient India's contributions in the field of astronomy are well known and well documented. The earliest references to astronomy are found in the Rig Veda, which are dated 2000 BC. During next 2500 years, by 500 AD, ancient Indian astronomy has emerged as an important part of Indian studies and its affect is also seen in several treatises of that period. In some instances, astronomical principles were borrowed to explain matters, pertaining to astrology, like casting of a horoscope. Apart from this linkage of astronomy with astrology in ancient India, science of astronomy continued to develop independently, and culminated into original findings, like:

- The calculation of occurrences of eclipses
- Determination of Earth's circumference
- Theorizing about the theory of gravitation
- Determining that sun was a star and determination of number of planets under our solar system

The Pleiades hold a prominent place as the mothers or wet nurses of the newborn infant in one of the most ancient and central Hindu myths, that of the birth of the war-god Rudra/Skanda, who evidently represents, among other things, the victorious rising sun (and as vernal sun the new year). The Pleiades are said to have been the wives of the seven sages, who are identified with the seven stars of the Great Bear.

The Great Bear¹s Old Tamil name elu-meen ¹seven-star¹ corresponds to the combination of the pictograms '7' + Œfish¹, which alone constitutes the entire text of one finely carved Indus seal. The Satapatha-Brahmana states that the six Pleiades were separated from their husbands on account of their infidelity; other texts specify that only one of the seven wives, Arundhati, remained faithful and was allowed to stay with her husband: she is the small star Alcor in the Great Bear, pointed out as a paradigm of marital virtue to the bride in the Vedic marriage ceremonies.

Evidence for the Harappan origin of this myth is provided, among other things, by Indus seals which show a row of six or seven human figures; their female character is suggested by the one long plait of hair, which to the present day has remained characteristic of the Indian ladies.

Physics
The root to the concept of atom in ancient India is derived from the classification of material world in five basic elements by ancient Indian philosophers. These five ³elements² and such a

classification existed since the Vedic times, around 3000 BC before. These five elements were the earth (prithvi), fire (agni), air (vayu), water (jaal) and ether or space (aksha). These elements were also associated with human sensory perceptions: earth with smell, air with feeling, fire with vision, water with taste and ether/space with sound. Later on, Buddhist philosophers replaced ether/space with life, joy and sorrow.

From ancient times, Indian philosophers believed that except ether or space, all other elements were physically palpable and hence comprised of small and minuscule particles of matter. They believed that the smallest particle which could not be subdivided further was paramanu (can be shortened to parmanu), a Sanskrit word. Paramanu is made of two Sanskrit words, param meaning ultimate or beyond and anu meaning atom. Thus, the term "paramanu" literally means 'beyond atom' and this was a concept at an abstract level which indicated the possibility of splitting atom, which is now the source of atomic energy. The term "atom" however should not be conflated with the concept of atom as it is understood today.

Kanada, a 6th century, Indian philosopher was the first person who went deep systematically in such theorization. Another Indian, philosopher Pakudha Katyayana, who was a contemporary of Buddha, also propounded the ideas about the atomic constitution of the material world. All these were based on logic and philosophy and lacked any empirical basis for want of commensurate technology. Similarly, the principle of relativity (not to be confused with Einstein's theory of relativity) was available in an embryonic form in the Indian philosophical concept of 'sapekshavad', the literal translation of this Sanskrit word is theory of relativity.

These theories have attracted attention of the Indologists, and veteran Australian Indologist A. L. Basham has concluded that they were brilliant imaginative explanations of the physical structure of the world, and in a large measure, agreed with the discoveries of modern physics.

Chemistry

Ancient India's development in chemistry was not confined at an abstract level like physics, but found development in a variety of practical activities. In any early civilization, metallurgy has remained an activity central to all civilizations from the Bronze Age and the Iron Age, to all other civilizations that followed. It is believed that the basic idea of smelting reached ancient India from Mesopotamia and the Near East. Coinage dating from the 8th Century B.C. to the 17th Century A.D. Numismatic evidence of the advances made by smelting technology in ancient India.

Nataraja the God of Dance is made of five metals Pancha-Dhatu.

In the 5th century BC, the Greek historian Herodotus has observed that Indian and the Persian army used arrows tipped with iron. Ancient Romans were using armor and cutlery made of Indian iron.

In India itself, certain objects testify to the higher level of metallurgy achieved by the ancient Indians. By the side of Qutub Minar, a World heritage site, in Delhi, stands an Iron Pillar. The pillar is believed to be cast in the Gupta period around circa 500 AD. The pillar is 7.32 meters tall, tapering from a diameter of 40 cm at the base to 30 cm at the top and is estimated to weigh 6 tonnes. It has been standing in the open for last 1500 years, withstanding the wind, heat and weather, but still has not rusted, except very minor natural erosion. This kind of rust proof iron was not possible till iron and steel was discovered few decades before.

The advance nature of ancient India¹s chemical science also finds expression in other fields, like distillation of perfumes and fragment ointments, manufacturing of dyes and chemicals, polishing of mirrors, preparation of pigments and colours. Paintings found on walls of Ajanta and Ellora (both World heritage sites) which look fresh even after 1000 years, also testify to the high level of chemical science achieved in ancient India.

Medicine & Surgery

Ayurveda as a science of medicine owes its origins in ancient India. Ayurveda consists of two Sanskrit words - 'ayur' meaning age or life, and 'veda' which means knowledge. Thus, the literal meaning of Ayurveda is the science of life or longevity. Ayurveda constitutes ideas about ailments and diseases, their symptoms, diagnosis and cure, and relies heavily on herbal medicines, including extracts of several plants of medicinal values. This reliance on herbs differentiates Ayurveda from systems like Allopathy and Homeopathy. Ayurveda has also always disassociated itself with witch doctors and voodoo.

Ancient scholars of India like Atreya, and Agnivesa have dealt with principles of Ayurveda as long back as 800 BC. Their works and other developments were consolidated by Charaka who compiled a compendium of Ayurvedic principles and practices in his treatise Charaka-Samahita, which remained like a standard textbook almost for 2000 years and was translated into many languages, including Arabic and Latin. 'Charaka-Samahita' deals with a variety of matters covering physiology, etiology and embryology, concepts of digestion, metabolism, and immunity. Preliminary concepts of genetics also find a mention, for example, Charaka has theorized blindness from the birth is not due to any defect in the mother or the father, but owes its origin in the ovum and the sperm.

In ancient India, several advances were also made in the field of medical surgery. Specifically these advances icluded areas like plastic surgery, extraction of catracts, and even dental surgery. Roots to the ancient Indian surgery go back to at least circa 800 BC. Shushruta, a medical theoretician and practitioner, lived 2000 years bebore, in the ancient Indian city of Kasi, now called Varanasi. He wrote a medical compendium called 'Shushruta-Samahita. This ancient medical compendium describes at least seven branches of surgery: Excision, Scarification, Puncturing, Exploration, Extraction, Evacuation, and Suturing. The compendium also deals with matters like rhinoplasty (plastic surgery) and ophthalmology (ejection of cataracts). The compendium also focuses on the study the human anatomy by using a dead body.

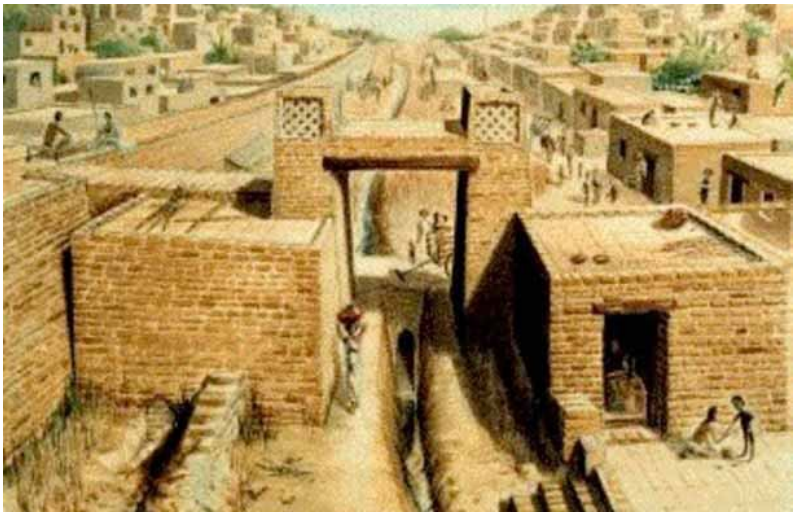
In ancient India Medical Science supposedly made many advances. Specifically these advances were in the areas of plastic surgery, extraction of cataracts, and dental surgery. There is documentary evidence to prove the existence of these practices.

An artist's impression of an operation being performed in ancient India. In spite of the absence of anesthesia, complex operations were performed. The practice of surgery has been recorded in India around 800 B.C. This need not come as a surprise because surgery (Shastrakarma) is one ofthe eight branches of Ayurveda the ancient Indian system of medicine. The oldest treatise dealing with surgery is the Shushruta Samahita (Shushruta's compendium). Shusruta who lived in Kasi was one of themany Indian medical practitioners who included Atraya and Charaka. He was one of the first to study the human anatomy. In the Shusruta, Samahita he has described in detail the study of anatomy withthe aid of a dead body. Shusruta's forte was rhinoplasty (Plastic surgery)and ophthalmialogy (ejection of cataracts). Shushruta has described surgery under eight heads Chedya (excision), Lekhya (scarification),Vedhya (puncturing), Esya (exploration), Ahrya (extraction), Vsraya (evacuation) and Sivya (Suturing).

Yoga is a system of exercise for physical and mental nourishment. The origins of yoga are shrouded in antiquity and mystery. Since Vedic times, thousand of years before, the principles and practice of yoga have crystallized. But, it was only around 200 BC that all the fundamentals of yoga were collected by Patanjali in his treatise, named Yogasutra, that is, Yoga-Aphorisms.

In short, Patanjali surmised that through the practice of yoga, the energy latent within the human body may be made live and released, which has a salubrious affect on the body and the mind. Now, in modern times, clinical practices have established that several ailments, including hypertension, clinical depression, amnesia, acidity, can be controlled and managed by yogic practices. The application of yoga in physiotherapy is also gaining recognition.

Civil Engineering & Architecture



Gateway At Harappa: Indus Valley Civilization

India's urban civilization is traceable to Mohenjodaro and Harappa, now in Pakistan, where planned urban townships existed 5000 years before. From then onwards, the ancient Indian architecture and civil engineering continued to develop and grow. It found manifestation in construction of temples, palaces and forts across the Indian peninsula and the neighbouring regions. In ancient India, architecture and civil engineering was known as sthapatya-kala, literal translation of which means the art of constructing (something).

During the periods of Kushan Empire and Maurya empires, the Indian architecture and civil engineering reached to regions like Baluchistan and Afghanistan. Statues of Buddha were cut out, covering entire mountain faces and cliffs, like Buddhas of Bamiyan, Afghanistan. Over a period of time, ancient Indian art of construction blended with Greek styles and spread to Central Asia.

On the other side, Buddhism took Indian style of architecture and civil engineering to countries like Sri Lanka, Indonesia, Malaysia, Vietnam, Laos, Cambodia, Thailand, Burma, China, Korea and Japan. Angkor Wat is a living testimony to the contribution of Indian civil engineering and architecture to the Cambodian Khmer heritage in the field of architecture and civil engineering.

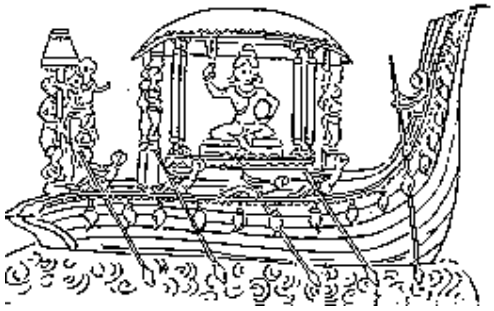
In mainland India of today, there are several marvels of ancient India¹s architectural heritage, including World heritage sites like Ajanta, Ellora, Khajuraho, Mahabodhi Temple, Sanchi, Brihadisvara Temple and Mahabalipuram.

Production Technology

Mechanical and production technology of ancient India ensured processing of natural produce and their conversion into merchandise of trade, commerce and export. A number of travelers and historians (including Megasthanes, Ptolemy, Faxian, Xuanzang, Marco Polo, Al Baruni and Ibn Batuta) have indicated a variety of items, which were produced, consumed and exported around that society's "known world" by the ancient Indians.

Shipbuilding & Navigation

A panel found in Mohenjodaro depicts a sailing craft, and thousands of years later Ajanta murals also depict a sea-faring ship. The science of shipbuilding and navigation was well known to ancient Indians. Sanskrit and Pali texts are replete with maritime references, and ancient Indians, particularly from the coastal regions, were having commercial relations with several countries of across the Bay of Bengal like Cambodia, Java, Sumatra, Borneo, and even up to China. Similar maritime and trade relations existed with countries across the Arabian Sea like Arabia, Egypt and Persia.



Even around circa 500 AD, sextants and mariner's compass were not unknown to ancient Indian shipbuilders and navigators. J.L. Reid, a member of the Institute of Naval Architects and Shipbuilders, England, at around the beginning of the 20th century has got published in the Bombay Gazetteer that "The early Hindu astrologers are said to have used the magnet, in fixing the North and East, in laying foundations, and other religious ceremonies. The Hindu compass was an iron fish that floated in a vessel of oil and pointed to the North. The fact of this older Hindu compass seems placed beyond doubt by the Sanskrit word 'Maccha-Yantra', or 'fish-machine', which Molesworth gives as a name for the mariner's compass".

Here goes a Sloka (couplet) from the Atharva Veda (one of the 4 Vedas - treatises on knowledge from ancient India) which embodies the true spirit of humanness expressed, not today, but four thousand years ago.

We are the birds of the same nest,

We may wear different skins,

We may speak different languages,

We may believe in different religions,

We may belong to different cultures,

Yet we share the same home - OUR EARTH.

Born on the same planet

Covered by the same skies

Gazing at the same stars

Breathing the same air

We must learn to happily progress together

Or miserably perish together,

For man can live individually,

But can survive only collectively

It is this spirit of humanness that has been the undercurrent of existence in a part of the world known by many names like Aryavarta, Jambudwipa, Bharatvarsha, Hindustan or India.
This spirit has also prevailed in many other parts of the world where the right thinking of humankind has prevailed.

Shiva-Nataraja - the Indian God of Dance. Shiva, along with Brahma and Vishnu forms the Hindu Trinity or Trimurti

In India, this spirit has found expression in the philosophy of non-violence, religious tolerance, renunciation - in non-temporal matters. In temporal matters, which are the subject of this book, it has found expression in achievements in all areas of science and technology. Achievements which did not remain limited to India alone, but were transmitted to many corners of our globe.

These achievements are not just a matter of pride for Indians alone. They represent the triumph of the human mind and hence are a matter of pride for the human species irrespective of nationality.

But over a period of one thousand years of a dark age, this spirit of humanness was dormant in India; eclipsed as it was under influences which came from the deep recesses of the malevolence in the human mind. That these influences were embodied in invaders from other parts of the globe is only incidental.

Buddhism preached non-violence towards all living beings It exercised a sobering influence over a large part of South-east Asia and Central Asia.

This setback could have as well been caused by internal upheavals that could have brought about malevolent influences to the fore as in imaginary cases if the Kauravas had triumphed over the Pandavas in the Mahabharat war or if Kansa had slayed Krishna at Mathura. These possibilities are hypothetical but what happened when the spirit of humanness was trampled under the feet of invaders who brought in intolerance, persecution, forced conversions of people, destruction of places of worship, penal taxes, and a general political tyranny; could have as well taken place in some altered pattern under domestic malevolent factors embodied in say Duryodhana or Kansa.

So rather than grieving in the fact that these malevolent influences came from beyond Indias geographic boundaries, we need to rejoice in the fact that even in these compelling circumstances, the spirit of humanness was only dormant but did not become extinct. As Arthur Basham, the famous Australian Historian says, "The ancient civilisation of India differs from those of Egypt, Mesopotamia and Greece, in that its traditions have been preserved without breakdown to the present day".

It is in temple panels such as this one that the splendour of Indian temple architecture has been immortalised into granite.

Today after a gap of one thousand years, the spirit of humanness can again breathe freely and it is about time that we recollect it and the successes it propelled the human mind to achieve. The human mind embodied in the ancient sages, rishis, munis and sanyasis - scientists in modern parlance.

We need to remember our past clearly and vividly, lest we forget, our capability to contribute to the repository of human knowledge, lest we forget our capability to activate the indomitable human mind residing within us, lest we forget our humane instincts that gave us a sagacious and charitable view of life along with progress - economic, technological and material. All that which goes under the term CIVILIZATION.

The human spirit in Ancient India has given to the world, the values of non-violence, religious tolerance, renunciation along with many elements of knowledge in fields like production technology, mechanical engineering, shipbuilding, navigation, architecture, civil engineering, medical science, physics, chemistry, logic, astronomy, mathematics and so on.

This panel is from Borobodur in Indonesia. Borobudur means "Big Buddha" Buddhism preached the values of charity, piety and renunciation in addition to Jivadaya i.e. non-violence towards all living forms.

The following paragraphs and pages of this book will take you into the various fields where this indomitable spirit had exercised itself, in what is geographically today India, to leave behind a legacy which belongs not to Indians alone but to all humans. A legacy that can help human beings in all corners of our globe to rejuvenate our spirit not to conquer one another, but to conquer oneself; not to destroy, but to build; not to hate, but to love; not to isolate oneself, but to integrate everyone into one global society and to achieve much more in the future to enrich human civilisation to result in:

"The maximum welfare of the maximum number" or as in Sanskrit it is called:

"Loka Samasto Sukhino Bhavantu"

This book will tell you how and why words (and the products behind those words) like Cash, Sugar, Camphor etc., originated from ancient India.

It is corroborated in the Oxford Dictionary that the English Word "Cash" originated from the Sanskrit term "Karsha". Sanskrit was the classical language of ancient India.

Coinage dating from the 8th Century B.C. to the17th Century A.D. Numismatic evidence of the advances made by Smelting technology in ancient India

Such words in the English language are for products like Sugar, Cotton (cloth), Camphor, Lac, Glass, Alloys of Metals(e.g. Brass). Now these products are not gifts of nature. Their manufacture requires machinery (apparatus), some knowledge of chemical engineering.

The fact that these products were manufactured in ancient India, presumes that in those times Indians had some apparatus in place, and some knowledge of chemical engineering.

This is a graphic depiction of the calculation of eclipses in a text called, Pancha-Siddhantika dated around the 5th Century A.D.

Other examples of elements of material culture and civilization that originated in ancient India and which the world owes to the genius of ancient Indian scientists and inventors include:

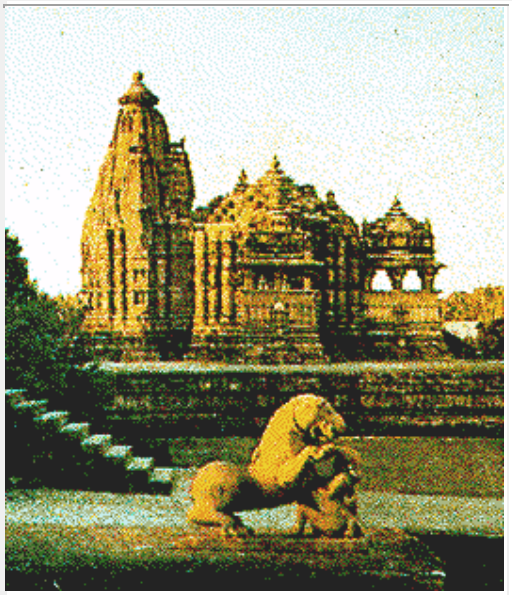
- the technique of algorithm used in computer science today.
- the science of algebra.
- the concept of zero - on which ultimately rests the binary code which has given us all software including the WWW through which you are accessing this site!
- the technique of manufacturing crystal (sugar)cane sugar (the word sugar is derived from the Sanskrit term "Sharkara").
- the making of camphor (this word is derived from the Sanskrit root word "Karpuram" according to the Oxford Dictionary).

- the making of tin (the technical English word for tin is Cassiterite which is said to have been derived from the Sanskrit term "Kasthira").
- The making of dyes like Anline and Indigo (the word Indigo comes from the term India and the word Anline is derived from the Arabic term An Nil which is derived from the Sanskrit term Neelam, according to the Oxford dictionary).
- the Gumbaz that we see on mosques all over the world originated as the interlocking dome in the "Stupa" of the Buddhist architectural tradition of India.

An artist's rendering of an operation being performed in ancient times

There are many such instances in the virtually all fields. Be it civil engineering, architecture, mechanical engineering, production technology, chemical engineering, physics, medical science, mathematics, logic, astronomy, or be it shipbuilding, navigation, the fine arts, etc.

There are evidences that many elements in all these varied aspects of today's global civilization owe their origin to ancient India!!



This temple at Khajuraho in Central India was built by the Chandella Dynasty. But out of the original 90 temples built, only 22 survive today -the rest having been vandalized by marauding iconoclastic saracens who despoiled India in the 11th Century

This book would satisfy the urge of students of the History of Science and Technology, Indologists, and NRIs (Non-resident Indians) who have distanced themselves from their roots and others who would like to know about the advances made in ancient India in the fields of science and technology and their transmission the world over.

This painting at Ajanta in Western India was completed 1500 years ago and used vegetable colours.

The arguments marshalled in this book draw from irrefutable sources like current western dictionaries, Encyclopedia Britannica, observations of ancient Greek, Roman, Persian, Arab and Chinese travellers. The advances made by Indians in ancient times have been noted and praised by these foreign travellers.

A lady from Thailand giving the traditional Thai salutation which is evidently derived from the Indian Namaste

The present book "India's Contribution to the World's Culture" is richly illustrated with over 100 photographs which give you a visual feast of the various aspects of Indian culture. The book began as a quest for knowing the foundations on which was built the edifice of India's glorious past. The book answers questions like:

- what attracted thousands of students from across the globe to ancient Indian universities like Nalanda and Takshashila?

- to what extent was science all over the world influenced by the masterly treatises produced by ancient Indian scholars like Aryabhatta, Bramhagupta, Varahamihira, Bhaskaracharya, etc.

- why was ancient India romanticized as a land where rivers flowed with milk and honey?

The book talks of advances made in ancient India in Mechanical Engineering, Civil Engineering, Chemistry, Physics, Mathematics, Astronomy, Medical Science, Shipbuilding and Navigation, Fine Arts, etc.

This book gives enough convincing material for a student of Indian culture to believe that India has not always been a nation dependent on other nations, has not always been ruled by aliens, and has not always borrowed everything from foreign sources.

No, we had universities like Nalanda and Takshashila, metropolises like Pataliputra and Ujjaini, emperors likeChandragupta Maurya and Vikramaditya, scholars like Pannini and Kautilya.

Today, though India has lagged behind in the race of progress, held back by the dead weight of a millennium of hostile alien rule, we have proved to the world that great Indians need not only be Kalidas, Shushruta or Adi Shankaracharya, but we still have a Bankim Chandra, a C.V. Ramanand a Swami Vivekananda to be proud of.

Next book on "A Search for - Our Present in History"

Shri Sudheer Birodkar is currently working on a book entitled "A Search for - Our Present in History". The curious title of this book describes the approach which the author has taken to study Indian Culture. He has begun from our customs, traditions, rituals, beliefs of today and has traced their evolution over the ages. Most of our customs and traditions have originated from some necessity of day-to-day life. Over the ages it has got social sanction and in most cases we have forgotten why the custom originated in the first place. But we continue to follow that custom.

The author has examined various symbols like Omkar and Swastika, etiquettes like our salutation Namaskara or Namaste, cultural traits like applying the caste-mark Tilaka, religious practices like Vegetarianism, Non-violence, Worship of the Cow and Bull; social practices like Untouchability, Sati, Child Marriage, the exchange of customs and traditions between the various religious communities in India, the origin of our various festivals, and many other related topics.

Center for further Studies in Indian Culture

Our aim is to set up a study centre for further studies into the subject of Indian Culture, The objective is to motivate other students and researchers to come forward and continue this study of the rich intellectual heritage of ancient India.

The site for this Study Center is near Mumbai (Bombay) at Village Dongaran Hawa in Murbad Taluka, in Thane District at the foot hills of the Western Ghats.

Yes read more about this in the book "India's Contribution to World Culture" bySudheer Birodkar

About the Author

The Author has been researchingon this subject since 1980. He has written articles on this topic in many Indian periodicals like The Illustrated Weekly, The Sunday Observer, The Free Press Journal, etc. He had earlier authored a bookon economics.