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Monthly Newsletter of Vigyan Prasar

DREAM 2047

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VP News

VIPNET Activities

Vigyan Prasar Network (VIPNET) of science clubs has over five thousand clubs spread all over the country. An average of about 100 clubs join the network every month. The primary objective of VIPNET is to help develop a scientific outlook amongst the people along with dissemination of science and technology information in a manner suitable for easy acceptance by the masses. The clubs receive two newsletters published by VP every month, viz. *Dream 2047* and *VIPNET News*, to provide news about the activities of the clubs and information on important science and technology related issues. Training workshops are organised to equip clusters of clubs to imbibe in their working certain activities for popularizing science. In this context, Vigyan Prasar has conducted four workshops in 2002 till April.

The first of the series of workshops in 2002 was held at Rohtak (Haryana) in the month of January under severe cold conditions and winter rain. The workshop got underway on 18 January. The participants were primarily from the rural areas adjoining Rohtak town and from some schools of Rohtak. The local organizers were Haryana Science Club.

The programme was inaugurated by Dr. Sarla Malik, Former Director, Distance Education, Maharishi Dayanand University, Rohtak (Haryana). In her speech she emphasized the need to educate the girl child and to develop a scientific outlook in the rural youth so as to develop greater progressive attitude in the rural society of Haryana. Sh. Harvinder Singh Shergill

Rural Children of Haryana Conducting a low cost experiment under the guidance of an instructor during the workshop at Rohtak in Jan. 2002

Participants watching a demo of biodegradable waste management at VIPNET workshop at Piploda (Ratlam, MP) held in Feb. 2002

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Inside

...think scientifically, act scientifically ... think scientifically, act scientifically ... think scientifically, act...

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Scoring A Goal

The one-month World Cup Football fever is finally over. Football in India has attained global dimensions. Beginning with Senegal's opening victory over France to South Korea's defeat by Germany, and finally Ronaldo's phoenix – like rise in Brazil's triumph over Germany in the final – it was thrilling indeed. Gone was the nightmare of the defeat in the 1998 final and the injuries that had plagued Brazil and Ronaldo. Sadly enough, India was nowhere in the picture.

How is it that a tiny country like Senegal, a country arguably poorer than the State of Orissa could get so far as they did this year? How could South Korea make it to semifinals? Despite the fact that football is being played in our country for over a century, India does not figure into soccer map of the world. The scenario is really not very different in other sports or in any other fields or spheres of activity. Why is it so?

Where is the power of a billion-plus human beings in the country? How could it be unleashed? Indeed this is the theme of *"Ignited Minds"* – the latest book by India's man with the *"wings of fire"* and famous scientist-cum-technologist Prof. APJ Abdul Kalam. Let us consider the present scenario as regards science and technology in the country. The question is – why despite the abundance of skills and resources in the country, do we often settle for the worst? Prof. Kalam mentions that all through his career, he relied on the power and the potential of the youth. "Given the freedom to achieve and guided properly, I am convinced that the young of India can accomplish far more" he asserts. He wants his young readers to hear a voice that says "start moving". Constructive ideas should not be allowed to wither in the long wait for approval. The young should rise above the norms. His key to success can be summed up this way **– Thinking is the Capital, Enterprise is the way, Hardwork is the solution.** It is the inertia that has gripped the national psyche, the mindset of defeat. When we believe in our goals that we dream of, they can become reality and results will begin to follow. Indeed, *Ignited Minds* is about developing that conviction in ourselves and discarding the things that hold us back. Needless to say what Prof. Kalam asserts holds true for **every** sphere of human activity including football. Naturally, it becomes imperative to tap the potential during the childhood itself and ignite the minds of the children. And that is why Prof. Kalam keeps visiting schools, igniting in the minds of children a love for science, and through it a sense of mission for transforming our country into a developed nation.

Indeed, the need for tapping the potential while one is still a child was realized by a few enlightened scientists and educationists well over three decades ago which eventually got transformed into what is popularly known as Hoshangabad Science Teaching Programme (HSTP). The unique feature of the programme is the guided discovery – based approach encouraging students perform experiments to generate knowledge. HSTP changed the traditional architecture of the classroom from rows of children listening to a lecture to small groups interacting with each other while performing experiments. They are encouraged to conduct experiments and find their own answers. The programme initially started only in one district and then spread to a few more districts, and covered classes Six to Eight. HSTP was later on executed by Eklavya, a non-Government organisation in Madhya Pradesh. Students, teachers, educationists and all those involved in this innovative experiment viewed upon the entire programme as based on a strong pedagogic foundation. As a matter of fact, there have been attempts to replicate this novel experiment in a few other regions in the country as well. Alas! There is now a disturbing news that HSTP is likely to be wound up by the State Government! How shall we score a goal then? How shall we ignite the young minds?

On one hand we have scientists like Prof. Kalam, Prof. Yash Pal, Prof. Narlikar and several others trying to revamp the outmoded retrograde system, while on the other hand we are confronted with forces holding us back from scoring a goal. There is no gainsaying the fact that if we are to score a goal, we ought to play the game. Further, it is imperative that the game acquires the status of a national game, supported whole-heartedly by the citizens and the government together. Otherwise, we shall remain a nation without a goal.

❒ **V.B. Kamble**

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Isaac Newton

One of the Greatest Scientists of All Time

❒ Subodh Mahanti

If I have seen further it is by standing on the shoulders of giants.
Isaac Newton

Nature and Nature's laws lay hid in night
God said, "Let Newton be ! "
And all was light.
Alexander Pope

Nature was to him an open book, whose letters he could read without effort. The conceptions which he used to reduce the material of experience to order seemed to flow spontaneously from experience itself, from the beautiful experiments which he ranged in order like playthings and describes with an affectionate wealth of detail. In one person, he combined the experimenter, the theorist, the mechanic and, not least, the artist in exposition. He stands before us strong, certain, and alone; his joy in creation and his minute precision are evident in every word and every figure.

Albert Einstein in his foreword to a twentieth century edition of Newton's Opticks.

Isaac Newton, one of the foremost scientific intellects of all time, single-handedly contributed more to the development of science than any other individual in history. It may not be an exaggeration to state that Newton was the single most important contributor to the development of modern science. He surpassed the achievements made together by all the great scientific minds of antiquity by producing a scheme of the universe which was consistent, elegant, and intuitive.

Isaac Newton

Newton stated explicit principles of scientific methods which applied universally to all branches of science. His methodologies produced a neat balance between theoretical and experimental inquiry and between the mathematical and mechanical approaches. Newton mathematised the entire gamut of physical sciences. He reduced the study of the physical sciences to a rigorous, universal and rational procedure which marked the ushering in of the Age of Reason. The basic principles of scientific investigation stipulated by Newton have survived without any alteration until modern times.

Newton's methodology was strictly logical. He presented his methodology as a set of four rules for scientific reasoning : 1) We are to admit no more causes of natural things such as are both true and sufficient to explain their appearances; 2) The same natural effects must be assigned to the same causes; 3) Qualities of bodies are to be extended as universal; and 4) Propositions deduced from observations of phenomena should be viewed as accurate until other phenomena contradict them. These four concise and universal rules for investigation were truly revolutionary. By their application Newton was able to unravel virtually all the unsolved problems of his day. Commenting on his approach to science once Newton wrote : "The best and safest way of philosophising seems to be, first to enquire diligently into the properties of things and to establish those properties by experiments and then to proceed slowly to hypotheses for the explanation of them. For hypotheses should be employed only in explaining the properties of things, but not assumed in determining them; unless so far as they may furnish experiments."

Newton's methodologies led the natural philosophers to appreciate the "scientific method" – observation, generalisation and experimentation – above all other methods of inquiry. Francois Marie Arouet de Voltair (1694-1778), the French writer and philosopher, said : "Newton taught men to examine, weigh, calculate and measure but never to conjecture ... He saw, and made people see; but he did not put his fancies in place of truth."

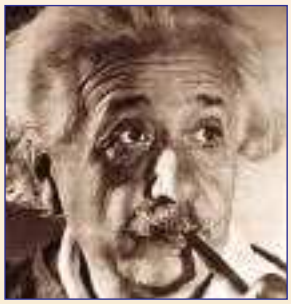
The scientific revolution that Galileo (1564-1642) had initiated at the beginning of the seventeenth century was triumphantly completed by Newton at the century's end. Newton's scientific work brought him great fame. He was idolised, almost deified, in his own lifetime. Newton was not right about everything. For example he thought that 'absolute motion' could exist, which Albert Einstein (1879-1955) later disproved with his theory of relativity. Newton was never on very cordial terms with any of his contemporaries. Since his childhood he remained a loner all his life. He did not marry. He was always slightly

paranoid and unquestionably contentious. Newton quarreled often and pettily. His quarrels with Robert Hooke (1635-1703), Christiaan Huygens (1629-95), Gottfried Wilhelm Leinbniz (1646-1716) and John Flamsteed are much discussed episodes in the history of science. Newton encouraged and prompted his friends and followers to join the fray.

Alexander Pope

Newton was born on 25 December 1642 at a village Woolsthorpe in Lincolnshire in Eastern England. Here it is important to note that when Newton was born, the British Calendar was ten days ahead than the Gregorian Calendar. This is because though the Gregorian Calender was introduced in Catholic countries in 1582 but it was not applied in Britain until 1752.

His father, also Isaac Newton, who was a farmer, died a few months before Newton's birth. Newton was born prematurely and christened Isaac in memory of his father. Newton's mother Hannah remarried in 1645 and left him under the care of his maternal grandmother at Woolsthorpe. After gaining the rudiments of education at the local school Newton joined the Grammar School at Grantham, where he lived with the family of an apothecary, called Mr. Clark. The Clarks were no ordinary apothecary's family. Mrs. Clark's brother Humphrey Babington was a Fellow of Trinity College who spent most of his time at Boothby Pagnell, near Grantham, where he was Rector. The School provided Newton a grounding in the classics mainly Latin with some Greek and a little mathematics. The knowledge of Latin proved to be very useful in Newton's scientific career. In those days academics across Europe used to communicate in Latin. Many important scientific books were available only in Latin. At the school Newton was a lonely boy. He was not a very good student. Nobody paid much attention to him. One incident at the school that had influence on his life was his fight with a larger lad. This lad was the school bully, who also happened to be first in studies as well. The fight ensued after Newton was punched by the bully. Newton fought back, he pushed the bully onto the ground and rubbed his face in the mud. The other students, who were watching the fight, cheered for Newton as they all hated the bully. Newton found that he could fight better than the bully and this made him think that he could do anything better than the bully. As a result he decided to pay attention to studies to compete. He stood first in his class. At school his greatest delights were solitary study and manufacturing mechanical devices. He made windmills, water-clocks, and sundials. It is said that he invented a four-wheel carriage which was to be moved by a rider. He also caused one of the earliest recorded UFO (Unidentified Flying Object) scares by flying a kite at night with a paper-lantern attached to it.



Albert Einstein

Francois Marie Arouet Voltair

After the death of her second husband in 1656, Newton's mother came back to Woolsthorpe. Towards the end of 1659 Newton's mother removed him from the school so that he might prepare himself for managing the farm he would one day inherit from his mother. However, Newton proved to be no good in farming. He neglected his work in order to read books. On several occasions he was fined for allowing animals in his care to wander and damage other farmers' crops. There is an interesting story linked to Newton during the period when he was supposed to practise farming. A steep hill is situated between Grantham and Woolsthorpe. It was a usual practice to dismount and lead one's horse to the top of the hill before remounting. It is said that one day Newton arrived home with a book in one hand and the bridle in the other, his horse trotting behind him, as he had forgotten to remount. Throughout his life he had this habit of forgetfullness. There are many stories about his forgetfullness. In one story he had invited some of his friends to his house for dinner. They had the dinner and then went to the lounge. After an hour Newton jumped up and announced "we have talked long enough – let's have dinner". It was only after finding lot of bones and other leftovers, he did realise to his great embarrassment that they had already taken dinner.

His maternal uncle William Ayscough, Rector of Burton Coggles, wanted Newton to go to Trinity College, Cambridge. Ayscough was a Cambridge graduate. Newton needed to prepare for getting admission in Trinity College. So he needed to go back to his school. Henry Stockes, the schoolmaster of the Grammar School offered to take Newton into his own home, without being paid for lodging. In the autumn of 1660 Newton went back to school mainly to prepare for entrance to Cambridge.

He was admitted to Trinity College of the Cambridge University on July 1661. Newton was certainly benefited by the advice and influence of Babington. In those days young gentlemen used to be admitted to the Cambridge University at the tender age of 14 accompanied by a servant to look after them. But Newton entered Trinity College at the lowest level, as a so-called subsizar, who paid for his keep by acting as a servant himself for the Fellows of the College and even for wealthy students. To be a subsizar was not at all a pleasant experience. Rather at its worst it could be extremely unpleasant. For Newton it was not so unpleasant. He was the servant to Humphrey Babington, who was seldom in residence in Cambridge and so Newton had few menial duties to perform. But at the same time Newton's status as subsizar was not at all enjoyable.

Newton graduated in 1665. He had displayed no special brilliance. Nobody had an inkling that Newton would become the great unifier of the scientific revolution, drawing from the ideas of Nicolaus Copernicus (1473-1543),

Johannes Kepler (1571-1630) and Galileo and others or that he would make great contribution to the fields of optics and mathematics. In 1665 the Great Plague hit London, virtually shutting that city down. Cambridge soon followed. The Cambridge University was temporarily closed. Some students alongwith their tutors moved to the nearby villages. Newton went to live at his mother's farm in Lincolnshire. The farm was purchased by his grandfather Robert Newton. Newton stayed 18 months at Lincolnshire before he permanently returned to Cambridge in April 1667. It was a forced vacation. This period was Newton's *annus mirabilis* (a year regarded as pivotal or crucial). Commenting on this period Newton said : "In those days (1665-67) I was in the prime of my age for invention and minded, Mathematics and Philosophy more than at any time since." Here Newton began putting together some of his ideas. The results marked the beginning of a long and a fruitful career in science. It is during this forced vacation Newton laid the foundations for the calculus, a mathematical method of calculation that revolutionised scientists' ability to handle complicated equations. It was also during this period that Newton noticed an apple falling to the ground. There is no evidence to indicate that the apple did hit him on the head as legend claims. Seeing the falling apple Newton started wondering whether the force that pulled the apple towards the Earth is the same force that kept the Moon in its orbit. It marked a major departure from earlier belief held by scientists followed by Aristotle, who insisted that the Earth and the heavens operated on two entirely different sets of laws. But Newton started thinking that there is only one set of universal laws and not two. At Lincolnshire, Newton also carried out a fascinating series of experiments with light.

Galileo

Gottfried Wilhelm Leibniz

The Cambridge University was among the best universities when it was founded in the thirteenth century. However, at Newton's time Cambridge was not a very good place for learning particularly for learning science. Its learning was church-oriented. The only scientific professorship, the Lucasian Chair of Mathematics, was established in 1663. Its first incumbent was Isaac Barrow, who was a Professor of Greek. Its only relevant courses were in theology and medicine. So Newton had to depend on his own study. Newton became so absorbed in his studies that often he would forget to eat and would stay up all night at his book. He did not care about his dress and hardly took a bath. He studied the writings of Galileo, Kepler, Rene Descartes (1596-1650) and Euclid (fl. 300 BC) among others. It is said that he turned to Euclid because he was bothered by his inability to comprehend certain diagrams in a book on astrology which he had bought at a fair. However, he thought its propositions as self-evident and thus he put it aside as "trifling book". He took it up again after being persuaded by his teacher, Isaac Barrow. He received a scholarship in April 1664 which ensured his stay at Cambridge till 1668. Newton received his BA in January 1665 and got his MA degree in 1668.

In 1667 Newton was elected a Fellow of the Trinity College and two years later he was appointed Lucasian Professor of Mathematics succeeding his teacher Isaac Barrow. The post of Lucasian Professor was one of the most desirable appointments in Cambridge. The professorship brought with it an income of 200 pounds a year with no tutorial responsibilities. It was a secure tenure for life. Its incumbent was to give only one course of lectures a year.

In 1672 Newton was elected a Fellow of the Royal Society of London and later that year he published his first scientific paper in the *Philosophical Transactions* of the Society describing his new theory of light and colour. The paper was titled "New Theory about Light and Colours." In this paper Newton demonstrated that the ordinary white light was a mixture of the various colours of the spectrum. Though the paper was well received but two leading natural philosophers, Robert Hooke and Christiaan Huygens rejected Newton's claim by stating that his theory was derived with certainty from experiments alone. Particularly they objected to what they took to be Newton's attempt to prove by experiment alone that light consists in the motion of small particles or corpuscles rather than in the transmission of waves of pulses. By publishing this paper Newton started a lifelong feud with Hooke.

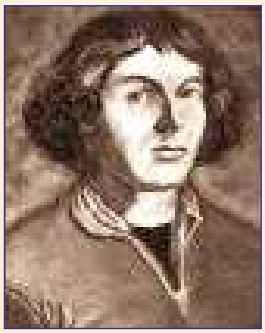
Christian Huygens

Newton was a mathematician of incomparable power. In 1696 the Swiss mathematician Johann Bernoulli (1667-1748) posed a problem to the mathematicians of Europe, allowing them six months to solve. Newton solved the problem in single night and published it in it *Transactions of the Royal Society*. Though the paper did not bear Newton's name but Bernouli was not fooled. He claimed to recognize the author as 'the lion by his claw'. In 1716 the German mathematician Gottfried Wilhelm Leibniz issued a difficult problem. It is said that Leibniz had devised the complicated problem for the express purpose of stumping Newton. However, Newton solved the problem before going to bed after a day's work at the Mint.

Newton discovered the generalised form of the binomial theorem. He wrote about his discovery to Henry Oldenburg in 1676. He did not publish this discovery. It was later published by John Wallis (1616-1703) with due credit to Newton. Newton laid the foundation for elementary differential and integral calculus. Calculus was also independently discovered by the German philosopher and mathematician Leibniz. However, Newton did not immediately publish it. His work on calculus, *Methodis fluxionum* (*Method of Fluxions*) composed between 1670 and 1671, was only published posthumously in 1736. Of

course, Newton showed his unpublished works to his friends and colleagues. In fact in 1676 Newton deposited with Oldenburg his *epistola prior* (first letter) claiming discovery of his method of fluxions in an anagram. The terminology arose from his considering the path of a continuously moving body as a curve made by a continuously moving point. The moving point Newton called a *fluent* and its velocity he called a *fluxion*. He denoted fluxion by $\dot{x}$ and its acceleration as $\ddot{x}$ However, presently the notation used are that of Leibniz. On the other hand Leibniz published his own work on the differential and integral calculus in 1684 and he did not acknowledge any unpublished work of Newton though he had seen some Newtonian manuscripts on a visit to London in 1673. This started a bitter dispute of priority between Newton and Leibniz. The dispute began in 1700 when Leibniz objected the practice of the followers of Newton referring to him (Leibniz) as the 'second inventor' of the calculus. Leibniz applied to the Royal Society in 1712 to conduct an inquiry into the matter. At that time Newton was the President of the Royal Society. He appointed the committee, decided what evidence it should examine and actually drafted the report himself. What is more he used to refer this report the *Commercium epistolicum* (1713. *On the Exchange of Letters*) as an independent justification of his position. Newton's behaviour was rather shameless. Leibniz and Newton bickered unbecomingly for some years as to who had the idea first. However, in this context it is worthwhile to note what Einstein had to say on this controversy. Einstein wrote : "The differential law is the only form which completely satisfies the modern physicist's demand for causality. The clear conception of the differential law is one of Newton's greatest intellectual achievements. It was not merely this conception that was needed but also a mathematical formalism, which existed in a rudimentary way but needed to acquire a systematic form. Newton found this also in the differential and the integral calculus. We need not consider the question whether Leibnitz hit upon the some mathematical methods independently of Newton or not. In any case it was absolutely necessary for Newton to perfect them, since they alone could provide him with the means of expressing his ideas."

John Flamsteed



Nicolaus Copernicus

Johannes Kepler

Newton's masterpiece *Philosophiae Principia Mathematica* (*Mathematical Principles of Natural Philosophy*) is considered to be the greatest scientific work ever written. The book originally written in Latin was published in 1687. It did not appear in English until 1729, forty-two years after its original publication and two years after Newton's death. The book is often referred to as *Principia Mathematica* or simply the *Principia*. Newton was very reticent in publishing and he was extremely sensitive to criticism. It was Edmond Halley (1656-1742) who persuaded Newton to publish the *Principia*. Halley played an important role in its publication. When the Royal Society could not afford to finance its publication it decided that "Mr. Halley undertake the business of looking after it and printing it at his own charges". Halley provided the necessary funds from his own pocket. He edited the text, corrected the proofs and saw it through the press.

The publication of *Principia* represented the culmination of the scientific revolution that had begun with Copernicus a century and a half earlier. In this book Newton presented an overall scheme of the universe, one far more elegant and enlightening than any of his predecessors had devised.

Newton's another famous prediction concerned comets. He stated that comets were not as mysterious as they appeared to be and like planets they also followerd elliptical path around the Sun. However, comet's path was far more flattened and elongated than followed by the planets and which probably take them far beyond the edges of the solar system. Based on the Newton's calculation, Halley predicted that the comet sighted by him in 1682 (Halley's comet) would return in 76 years in 1758 and it did return.

The book was divided into three parts. In *Book* I of *Principia*, Newton opened with definition of the three laws of motion, now known as Newton's laws – laws of inertia, acceleration proportional to force and action and reaction. Newton's first law of motion, which is also known as law of inertia, states that an object at rest tends to stay at rest and an object in motion tends to continue in motion at constant speed in a straight line. Newton's second law states that the more force is placed on an object, the more it accelerates but the more heavier it is, the more it resists acceleration. For example it is easier to throw a lighter object than a heavier one. Newton's third law states that for every action there is an equal and opposite reaction. For example a rocket exerts a downward push on the exhaust gases which push it upward. And when the upward push of the exhaust gases exceeds the weight of the vehicle, the rocket rises off the launch pad in the air. It was Newton who first differentiated between the mass and the weight of an object. Often these two terms are used interchangeably in everyday language. The mass of a body is its resistance to acceleration or in other words a body's mass is equivalent to its quantity of inertia. On the other hand the weight of a body is the gravitational force between it and another body. In *Book* II of *Principia* Newton presented new scientific philosophy which came to replace Cartesianism. The last part, Book III consisted of applications of the laws and conclusions derived in the first two sections. The *Book III* included an explanation for tides and a theory of lunar motion. Newton made some interesting projections. Newton had shown that the

gravitational forces of the Earth's various parts combined to form a sphere. But as the Earth spins around its axis, the additional force resulting from the spinning should prevent it to take up a perfect spherical shape there should be bulge at the equator. He even predicted the size of the bulge. In his life time efforts were made to verify the prediction but because of errors in calculation by mapmakers Newton appeared to be wrong. Today we know that Newton was right. In fact his predicted size of the bulge was accurate within one percent.


Johann Bernoulli

Newton's work in physics and celestial mechanics culminated in the theory of universal gravitation. Newton's great insight of 1666 was to imagine that the Earth's gravity extended to the Moon, counterbalancing in centrifugal force. From his law of centrifugal force and Kepler's third law of planetary motion, Newton deduced that the centrifugal force of the moon or any planet must decrease as the inverse square of its distance from the centre of its motion. Newton's law of universal gravitation states that every piece of matter attracts every other piece with a force proportional to the product of their masses and inversely proportional to the square of the distance between them. Given the law of gravitation and the laws of motion Newton could explain a wide range of hitherto disparate phenomena such as eccentric orbits of comets, the courses of the tides and their major variation, the precession of the Earth's axis and the perturbation of the moon by the gravity of the Sun. Newton's one general law of nature and one system of mechanics reduced to order most of the known problems of astronomy and terrestrial physics.


John Wallis

Newton's second great book *Opticks* was published in 1704, though it was completed in the mid-1690s. It is said that Newton had quietly waited to publish it until his arch rival Hooke had died. In *Opticks* Newton observed that white light could be separated by a prism into a spectrum of different colours, each characterised by a unique refractivity and proposed the corpuscular theory of light. While the *Principia* was a "hard book" in Newton's own words, the *Opticks* was written in easily intelligible language and dealt with ideas, such as light and colour, that everyone could relate to.


King Charles II

In 1669 the first earl of Halifax Charles Montague, Chancellor of the Exchequer, offered Newton the post of Warden of the Royal Mint. Newton, who wanted to leave Cambridge, readily accepted the offer. Newton's appointment was confirmed on 19 March 1696 and he moved to London by the end of April. Montague while informing Newton of his appointment wrote that the post was 'worth five or six hundred pounds (a year), and has not too much business, to require more attendance than you may spare'. But Newton took his work very seriously. As Warden he was the number two at the Mint. It was the Master of the Mint who was in charge. However, Thomas Neale, the Master of the Mint, was quite happy to leave all the work to Newton. It was Newton's duty to pursue the counterfeiters and clippers of his day. Between June 1698 and Christmas of 1699 Newton interviewed 200 witnesses on 123 separate occasions and 27 counterfeiters were executed. At the end of 1699 Thomas Neale died and Newton succeeded him as the Master of the Mint. He held the post until he died. Newton supervised the introduction of a union coinage in 1707 following the union of kingdoms of England and Scotland, the issue of new copper coins in 1718, the evaluation of the guinea to 21 shillings in 1717, and a general improvement in the assaying of the currency.

Newton had studied theology quite seriously. Newton strongly believed in the necessity of a God. His theological views are characterised by his belief that the beauty and regularity of the natural world could only "proceed from the counsel and dominion of an intelligent and powerful Being". He thought that "the supreme God exists necessarily and by the same necessity he exists always and everywhere".


Edmond Halley

He believed that God periodically intervened to keep the universe going on track. He believed that the foundation of established religion in England was based on corrupted form of the original biblical texts. Further he thought that the concept of the Holy Trinity, placing Jesus Christ on equal footing with God was a false concept. This idea was known as Arianism, after Arius who established the doctrine. This kind of religious belief came in the way of Newton's taking holy orders - a requisite condition for all Cambridge Fellows. And for Newton also a time came when without ordination he would not be able to continue the Fellowship. Losing Fellowship meant he would also require to relinquish the Lucasian Chair. But in any case Newton would not take the holy orders because to him worshipping Christ as God would mean idolatry, a moral sin that would put his soul in peril. By the beginning of 1675 Newton was almost sure that he would have to part with Cambridge University. In fact he wrote to Henry Oldenburg, the then Secretary of the Royal Society, requesting him to be excused from paying his subscription to the Royal Society. He wrote, "I am to part with my Fellowship, and as my income contract, I find it will be convenient that I contract my expenses".

Newton had only one chance that is to petition the king for dispensation from the requirement of ordination. So after obtaining permission of the then Master of Trinity Isaac Barrow Newton petitioned the King, Charles II. Newton sought such dispensation not for himself alone as a special case but for all the Lucasian

Professors. He argued that the requirement of ordination goes against the spirit of the bequest under which Henry Lucas had established the chair. It had a specific

Rene Descartes

Euclid

requirement that a holder of the post should not be active in the church. King Charles II, a patron of the Royal Society and lover of science, granted the dispensation in perpetuity, "to give all just encouragement to learned men who are and shall be elected to the said professorship".

Throughout his life Newton displayed a deep interest in religion and alchemy. Newton spent much of his time in later part of his life in theological speculation, astrology and alchemical research. Newton wrote extensively on religious matters. Among his religious writings discovered after his death were 1000 manuscript pages to nearly 1.5 million words and two completed books. For obvious reasons he kept his writings secret. Much of his life was spent on deep studies of church history, the Bible and the chronology. He wanted to show that the text of the Bible had been corrupted by later Trinitarian editors and a similar corruption was introduced by Athanasius in the fourth century.

In Newton's library were 138 books on alchemy and his own manuscripts on the subject contained more than 600,000 words. It cannot be said with certainty whether Newton was a genuine alchemist committed to dreams of the philosopher's stone or his chemical interests led him to practise alchemy. He had established a chemical laboratory in Trinity College. Though he was very much interested in chemistry but he published very little on his chemical works. He published one brief work on chemistry, *De nature acidorum* (1710 ; *On the Nature of Acids*). There were also several passages devoted to chemistry scattered among the *Queries* that Newton added to his *Optiks*.

On being asked by Halley that how he managed to make so many discoveries Newton said that he never relied on inspiration or serendipity to give him insight. Once he undertook a problem to solve, Newton did not rest until he found out the answers — he would think relentlessly and explore every angle during every available moment.

Newton became a Member of Parliament in 1689. In 1703, Newton was elected President of the Royal Society, a position he retained until his death. Newton was Knighted by Queen Anne in 1705. Newton was the first scientist to be honoured this way. However, it is interesting to note that Newton was not Knighted for his scientific achievements.

Newton died on 20 March 1727 and he was buried in Westminster Abbey, on 28 March 1727. Voltair, who witnessed the burial ceremony, said that it was like "the funeral of a king who had done well by his subjects."

The Latin inscription of Newton's tom reads " *Mortals! rejoice at so great an ornament to the human race* !" Perhaps no one will disagree that the inscription is fully justified. Newton was also a human like us and this fact alone should challenge the rest of us to reach for height like his.

We would like to end this article by quoting what Einstein wrote on the occasion of the two hundredth anniversary of Newton's death: "It is just two hundred years ago that Newton closed his eyes. We feel impelled at such a moment to remember this brilliant genius, who determined the course of western thought, research and practice like no one else before or since. Not only was he brilliant as an inventor of certain key methods, but he also had a unique command of the empirical material available in his day, and he was marvelously inventive as regards detailed mathematical and physical methods of proof. For all these reasons he deserves our deepest reverence. The figure of Newton has, however, an even greater importance than his genius warrants because destiny placed him at a turning point in the history of the human intellect. To see this vividly, we have to realise that before Newton there existed no self-contained system of physical causality which was somehow capable of representing any of the deeper features of the empirical world."

For Further Reading

1. David Brewster, *Memoirs of the Life, Writings and Discoveries of Sir Isaac Newton* (2 vols.). Edinburgh:Thomas Constable, 1855.
2. E. B. Jourdain, *Essays on the Life and Work of Newton*. Chicago: Open Court, 1914.
3. Louis Trenchard More, *Isaac Newton: A biography*. New York: Charles Scribenar's Sons, 1934.
4. J. W. N. Sullivan, *Isaac Newton,1642-1727*. London: Macmillan, 1938.
5. E. N. da C. Andrade, *Isaac Newton*. London: Parrish, 1950.
6. Gale E. Christianson. *In the Presence of the Creator: Isaac Newton and His Times*. New York: Free Press, 1984.
7. Frank E. Manuel. *Portrait of Isaac Newton*. Cambridge, Mass.: Harvard University Press, 1965.
8. Alexander Koyre. *Newtonian Studies*. Cambridge, Mass.: Harvard University Press, 1965.
9. D. T. Whiteside. *The Mathematical Works of Isaac Newton (2 vols)*. New York: Johnson Reprint Corp., 1964.
10. Carl B. Boyer, *The Concepts of the Calculus: A Critical and Historical Discussion of the Derivative and the Integral*. New York: Columbia University Press, 1939.
11. A. R. Hall, *Philosophers at War*: *The Quarrel between Newton and Leibniz*. Cambridge: Cambridge University Press, 1980.
12. A. I. Sabra. *Theories of Light from Descartes to Newton*. London: Oldbourne, 1967.
13. John Herivel. *The Background to Newton's 'Principia'*. Oxford; Oxford University Press, 1965.
14. B. J. T. Dobbs. *The Foundations of Newton's Alchemy: The Hunting of the Green Lyon*. Cambridge: Cambridge University Press, 1975.
15. Frank E. Manuel. *Isaac Newton, Historian*. Cambridge, Mass.: Harvard University Press, 1963.
16. Frank E. Manuel. *The Religion of Isaac Newton*. Oxford : Oxford University Press, 1974.
17. Margret Jacob. *The Newtonians and the English Revolution*, 1869-1720. Ithaca, N.Y.: Cornell University Press, 1976.
18. Richard S. Westfall. *The Life of Isaac Newton*, Cambridge: Cambridge University Press, 1993.

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National Bal Bhavan

Where Learning Science is a Joy

❒ Dr. Madhu Pant

National Bal Bhavan is a unique Institution which caters to the creative needs of children. Often, people associate art, craft, performing art and literature with creativity and think that science has nothing to do with creativity, whereas the fact is that there is as much creativity in sciences as is in art, craft, performing art or creative writing. That is why in Bal Bhavan preference is given to science subjects. The question arises, when science education is available in schools, what is the difference between science education provided by Bal Bhavan and schools? What is the speciality in science teaching methodology of Bal Bhavan?

Bal Bhavan believes in "Learning by doing" methodology. In the Bal Bhavan set up children are free to explore, innovate, create and recreate. Their exploratory instinct which is always full of questions like "What', `Why', 'How' is fully enriched and satisfied in the Bal Bhavan environment. According to Bal Bhavan methodology.

Children involved in making water conserving home models

"Curiosities of children are solved in playful ways when they themselves do the things. This is the Scientific way of finding reasons of various happenings".

In Bal Bhavan science is not a subject of class room or laboratory, it is a part of the biggest laboratory -the nature, which enables the child to relate various principle of science with day to day happenings of life. Bal Bhavan believes in explaining basic principles of science by directly involving the children in various activities. Another thing which is important in Bal Bhavan's science methodology is the concept of integrated approach where science has been made an integral part of other activities. For example when children do paintings with colours, they are indirectly told about science of colours, the primary and secondary colours, the science of light which enables us to see the colours. Similarly while learning music they get to know the science of `Sound', the concept of musical nodes and tones and Science behind various musical instruments. In conducting activities of art and craft, clay modelling, handicraft etc., due emphasis is given to the scientific aspects related with these activities.

Environment Rally on "WATER" 5 June, 2002

Environment education is given special emphasis in National Bal Bhavan. It gives importance to preservation of culture, craft, art, folk art, literature, rituals and historical monuments along with preservation of nature and natural resources.

Activities like "Massive Greenery Project" through "Harit Vahini" is taken up by children alongwith other projects related to `Environment'. To familiarise them with various issues of environment a news letter "Sulakshya" is produced in which children also contribute by writing stories, poems, articles, slogans etc. To reach out to maximum number of children from 1990 onwards a National Conference of Young Environmentalists has been initiated.In this unique and meaningful conference, children from different part of the country participate and discuss various issues related to their environment. It is not only related to their physical environment but also includes their social, emotional and cultural environment.

Inculcation of scientific temper is the main objective of science activities in National Bal Bhavan. The various sub-sections under the science section help children learn scientific laws and principles. They are introduced to science in everyday life besides the physical/natural sciences. Its activities include Radio Electronics, Aero Modelling, Machine Modelling and How & Why Club, Environmental Activities as well as field trips, treks, meeting with scientists, special film shows and camps are organised from time to time.

To opt for science activities in Bal Bhavan a child need not be a science student at school. What is needed is only the curiosity of the child to ask "How" & "Why" of things & keenness to learn. Following sub-sections work under the science Section of National Bal Bhavan.

Computers

This activity is immensely popular and is attracting more and more children everyday. Children learn the basic computer language and they also learn to do programming. A large number of software on science subjects and computer games are available to the children. The computer activity has started supplementing the school education. Bal Bhavan also provides information about internet so that children are aware of the latest technologies. Many meaningful and innovative workshops and symposa are also attraction of this section.

Radio Electronics

Membership in the Radio-Electronics Section is open to the children of 12 to 16 years age group. Basics of electricity, wiring and home appliances, new experiments with circuits, T.V. and Radio assembling are some of the activities of this section. Here children learn about the most complex circuits like, digital clock and new energy devices like solar power models.

Workshop on "Make your own Aquarium"

With the growing need of advanced communication in the world more and more Radio Amateurs are taking to the HAM Radio Club. At Bal Bhavan we intend to start a Club of Radio Amateurs so that the children who join the Club can pass the examination and establish a HAM Station at their home. By doing this the children of the world can come close to each other and establish a better communication.

Machine Modelling

In this section children are exposed to the basic system and principles of machines and engineering. They learn by fabricating working models with cardboard. They make models of existing machines as well as invent models of machines which can be used in day to day life. This is a unique activity that introduces children to a world of machines and technology with cost effective and low cost experimentation.

Aero Modelling

An expensive hobby like Aero Modelling is made accessible to the children of Bal Bhavan. From learning the basics of Aero dynamics to the making of models of planes of different varieties children enjoy flying their model planes. This activity is intended to encourage the children to cultivate an interest in aviation and joys of flying. This section also organises model rocketry workshops.

Environment

The Environment Section has as its members children who are concerned about the environment. The objective of this section is to make the children aware about environmental hazards and find solutions for the same.

The Harit Vahini Movement was launched by Sh. Rajiv Gandhi on 19th November,1985. Harit Vahini or Children's Green Force is part of Bal Bhavan's Environmental Programme. Some of the objectives of this movement are to create and inculcate in children love and care for nature and feeling of responsibility towards nature. Collections of seeds, nature's items, bird watching, scientific explanations creative writing and arts, poster making environmental marchers/rallies, lectures by guest scientists, film shows on environment, visit to natural history museum, zoo and tree plantations environmental campaign are some of the activities of this section. Fifty two Bal Bhavan Kendras have been actively involved in spreading the Environmental awareness message.

The Environment Section organises Environment Week programme during which rallies, debates, plantations, cleaning project are undertaken. National Conference for Young Environmentalists is also organised annually with different themes.

Astronomy

The sky above holds many an unsolved mystery about unknown galaxies. From time immemorial man has been striving to unfold this secret. In Bal Bhavan a low cost astronomical unit has been setup. The children enjoy this activity and they are curious to learn more about the sky above i.e., the planets and the stars.

The Astronomy Section conducts numerous training workshops/orientation programmes for children and resource personnel.

The purpose of conducting training workshops is to develop technical understanding, operational capabilities and practical teaching activities among the participants. All such activities are conducted in concurrence with the project material supplies to various State Bal Bhavans as part of centrally sponsored scheme of improvement of science education in Schools/Bal Bhavans. Telescope making workshops are organised to make low cost telescopes, teach its handling and maintenance as well as provide knowledge on optics to schools.

Night camps and sky watching sessions for teachers and children are also organised in National Bal Bhavan and Bal Bhavan Mandi.

In addition to the sectional activities the other attractions are How & Why Club, Aquarium and Mini Zoo wherein many innovative activities are conducted to enhance the knowledge of children and provide them joy of learning.

Learning is a Joyful Experience in National Bal Bhavan

A child is very curious, innovative, adventurous. His inquisitive mind always wants to experiment and create things of his own linking. He likes to do things with his own will, in his own way and at his own pace. Does our education system provide such an opportunity, where there is freedom of expression?.....where there is conducive environment for enhancing his creative abilities?.....where there is the joy of learning?

If there is any place, where all such opportunities are available, that is the National Bal Bhavan. This is the reason that throughout the year efforts are made as to how

innovative programmes can be made for children. That is why, that where on one side workshops like "Make your own Computer" are conducted, at the same time workshop on make your own computer is also conducted. Where on one side "Scientific Explanation of Miracles" is given to children, at the same time special programme on "Low Cost Scientific Equipments" is also conducted. If a subject like "Chemistry in Day-to-day Life" is chosen for discussion, at the same time special project work on "Water Conservation" is also taken up. Similarly when a symposium on "Alternative Energy Resources" is held at the same time innovative activities like "Animations through Computers" in also conducted.

In the most prestigious scheme of National Bal Bhavan- **"The Bal Shree Scheme",** due importance is given to science and "Creative Scientific Innovation" is one of the streams where children's creativity is judged. In Bal Bhavan science activities are conducted for children of special need also. Every year during the National Science Day special activity based science programmes are specially conducted for children of special categories so that children irrespective of their status, cast, sex and needs can experience the joy of Science Learning.

Befitting its national image, National Bal Bhavan provides academic and technical support to all the affiliated State and Union Territory Bal Bhavans, which are spread all over the country. It also provides financial support for specific programmes. Under one such scheme some of the affiliated Bal Bhavans were provided small **"Astronomy Units"** and so far twenty affiliated Bal Bhavans have been financially supported for establishment of Science Park in their respective Bal Bhavans. Through these Science Parks children very easily learn various scientific facts in a playful manner. In fact these joyful experiences act as a catalytic agent, which infill in children immense pleasure and motivate them to learn. It is a known fact that a child would learn, only when he is prepared to learn. On the outset, in the background of joyful science activities, where can there be a better place for learning other than **"The Bal Bhavan"?**

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(Fellow VIPNET) represented Vigyan Prasar. While introducing VP and its objectives, he emphasized that the clubs should function as a cluster and meet regularly to help each other with activities. As part of the technical sessions the resource persons of Haryana Vigyan Manch, Rohtak, provided scientific insight into the 'miracles' performed by Godmen. This was done to highlight the need to question rather accepting things blindly. It was also emphasized that it is in questioning that bulk of the learning takes shape. Apart from this there was a demonstration of low cost science experiments and understanding principles of physics with the help of a bicycle.

The second workshop was in February 2002 at Piploda (Ratlam, MP). The local organizers, Unique Society for All, have been amongst the first few members to have joined the VIPNET movement in 1998 and have been active ever since. They have been instrumental in popularizing science in this region which happens to be a tribal belt of Madhya Pradesh. The workshop commenced on 23 February, with a traditional inauguration by the Chairman of the Nagar Panchayat Piploda, Shri. Prahlad Sharan. Shri Harvinder Singh Shergill represented VP and emphasized on why VIPNET was needed in the country. The main emphasis of this workshop was to sensitize science teachers in making science an enjoyable pursuit in schools. Accordingly there were demonstration on low cost science experiments, biodegradable waste management, and techniques of plantation and grafting. The types of plants that could be planted in this region when the rainfall is scarce were described.

Dr. Sudershan Sasmal teaching student participants the art of soil-less culture (HYDRO PONICs) at the workshop at Cuttack(Orissa) in March 2002.

March 2002 was the month in which a two day workshop was organized at Cuttack, Orissa. The participants were teachers and coordinators of in-school science clubs. The local organizers were Supritiva, an NGO from Cuttack. The programme was inaugurated by Prof. G. Mahapatra, a pioneer in science popularization in Orissa. He spoke about the history of science popularization in Orissa. Among the resource persons were Dr. Nikhil Patnaik, Pushpashree Patnaik and Dr. Sudarshan Sasmal. The emphasis was on disseminating scientific information through enjoyable activities. A talk on health and hygiene was delivered by Dr. Sasmal. Prof. Nityananda Swain spoke on disaster management with an emphasis on Orissa.

Lucknow was the venue for the VIPNET workshop in April 2002. It was inaugurated by Dr. I. D. Ram, Joint Director, UPCST. Besides a demonstration on scientific explanation of miracles, demonstration on Ham Radio was arranged by Shri D. C. Sharma. A talk on Waste Management through Vermi Composting was delivered by Dr. Mukta Mittal. Also organised was a demonstration on Food Adulteration Testing methods by Dr. Savita Srivastava and an interesting session on Origami was conducted by Shri Raj Kamal Srivastava.

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Shaping the World Atom by Atom

❒ Kinkini Dasgupta Misra

Atoms are the building blocks for all matter in our universe. Everything around us is made of atoms. Our bodies are assembled in a specific manner from millions of living cells. Cells are nature's nano machines. Consumer goods that we buy are also made of piles of atoms together in a bulky, imprecise manner. Imagine, if we could manipulate each individual atom of an object and organise systematically! That is what is the nanotechnology – a new technology that has resulted in scientific and technological revolution.

Nanotechnology is about building things atom-by-atom, molecule-by-molecule; manufacturing at the molecular level. The trick is to manipulate atoms individually and place them in a pattern to produce a desired structure. The word nano comes from the Greek word "nanos" meaning dwarf. The compound term "nano"- is the factor 10^{-9} or one billionth. A nanometer is basic measuring unit in nanotechnology. It is the one billionth of a metre (3-4 atoms wide), that's a thousand, million times smaller than a meter.

In a world of information, digital technologies have made copying of data fast, cheap, and perfect, quite independent of cost or complexity of the content. What if the same were to happen in the world of matter? By treating atoms as discrete, bit-like objects, molecular manufacturing will bring a digital revolution to the production of material objects. Working at the resolution limit of matter, it will enable the ultimate in miniaturization and performance. By starting with cheap, abundant components—molecules—and processing them with small, high-frequency, high-productivity machines, it will make products inexpensive. It will help in designing the computers that will be able to execute more instructions per second than all of the semiconductor CPUs in the world combined.

Nanotechnology is a hybrid science combining engineering and chemistry. Atoms and molecules stick together because they have complementary shapes that lock together, or charges that attract. As millions of these atoms are pieced together by nanomachines, a specific product will begin to take shape. With a computer, once data is broken down and organized into combinations of 1s and 0s, it can be easily reproduced and distributed. With matter, the basic building blocks are atoms and the combinations of atoms that make up molecules. Nanotechnology lets you manipulate those atoms and molecules, making it possible to manufacture, replicate, and distribute any substance known to humans as easily and cheaply as you can replicate data on a computer. For example, Nanogears (Figure 1, source: NASA) that are not more than a Nanometer wide could be used to construct a matter compiler, that could be fed as raw material to arrange atoms and build a macro scale structure .

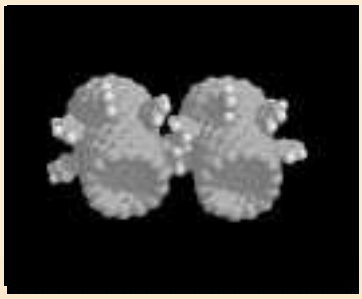

Figure 1

The central concept of nanotechnology is that almost any chemically stable structure that is not specifically disallowed by the laws of physics can in fact be built. The possibility of building things atom by atom was first introduced by Richard Feynman in 1959 when he said: "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom."

The goal of early nanotechnology is to produce the first nano-sized robot arm capable of manipulating atoms and molecules into a useful product or copies of itself. One nano assembler working atom by atom would be rather slow because most desirable products (medical equipment, cars, and the like) are made of trillions and trillions of atoms. However, such an assembler robot arm could make copies of itself and those copies can make more copies. Soon you have trillions of assemblers controlled by nano super computers working in parallel assembling objects quickly.

There are three steps to achieving nanotechnology produced goods :

- Scientists must be able to manipulate individual atoms. This means that they will have to develop a technique to grab single atoms and move them to desired positions. In 1990, IBM researchers showed that it is possible to manipulate single atoms. They positioned 35 xenon atoms on the surface of a nickel crystal, using an atomic force microscopy instrument. These positioned atoms spelled out the letters "IBM". Figure 2, shows the tip of Atomic Force Microscope, which is used to probe surfaces and manipulate molecules, symbolizes the nanotechnology revolution.

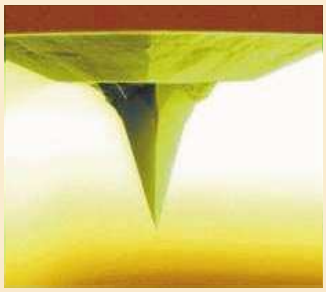

Figure 2

- The next step will be to develop nanoscopic machines, called **assemblers**, that can be programmed to manipulate atoms and molecules at will. It would take thousands of years for a single assembler to produce any kind of material one atom at a time. So, trillions of assemblers will be needed to develop products in a viable time frame.
- In order to create enough assemblers to build consumer goods, some nanomachines, called **replicators**, will be programmed to build more assemblers.

Trillions of assemblers and replicators will fill an area

smaller than a cubic millimeter, and still will be too small for us to see with the naked eye. Assemblers and replicators will work together like hands to automatically construct products, and will eventually replace all traditional labour methods. This will vastly decrease manufacturing costs, thereby making consumer goods plentiful, cheaper and stronger.

Precision is one of the keys to understanding of the development of this technology. In this application, precision means that there is a place for every atom and every atom is in its place. Schematics will be detailed, and there will be no unnecessary parts anywhere in the design. We will use machines of precision to create products of equal precision. With this precision, we should be able to recycle all of the waste products produced by the manufacturing processes and put them to good use elsewhere. Manufacturing will also become less expensive as a result.

Precise atomic-level fabrication has previously only been seen in the growth of crystals or in living biological organisms like the ribosome, which assembles all the proteins in living creatures, or DNA, which carries the instructions for creating a living being. If we incorporate similar processes during our development of nanotechnology, we will begin to gain a degree of complexity and control over systems that previously only evolution and nature have had.

Have you ever wondered how will the nanotechnology improve our life? One of the first obvious benefits is the improvement in manufacturing techniques. Research is going on taking familiar manufacturing systems and expanding them to develop precision on the atomic scale. This will give us greater understanding of the building of things, and greater flexibility in the types and quantity of things we may build. We will be able to expand our control of systems from the macro to the micro and beyond, simultaneously reducing the cost associated with manufacturing products.

Some of the most dramatic changes are expected in the realms of medicine. Scientists emisage creating machines that will be able to travel through the circulatory system, cleaning the arteries as they go; sending out troops to track down and destroy cancer cells and tumors; or repairing injured tissue at the site of the wound, even to the point of replacing missing limbs or damaged organs. The extent of medical repair systems is expected to be quite broad, with the cumulative impact being equally large.

Nanotechnology is expected to touch almost every aspect of our lives, right down to the water we drink and the air we breathe. Once we have the ability to capture, position, and change the configuration of a molecule, we should be able to create filtration systems that will scrub the toxins from the air or remove hazardous organisms from the drinking water. We should be able to begin the long process of cleaning up our environment.

In the computer industry, the ability to shrink the size of transistors on silicon microprocessors will soon reach its limits. Nanotechnology will be needed to create a new generation of computer components. Molecular computers could contain storage devices capable of storing trillions of bytes of information in a structure the size of a sugar cube

Space will also open up to us in new ways. Nanotechnology will help by allowing us to deliver more machines of smaller size and greater functionality into space, paving the way for solar system expansion. Some have suggested that application of medical nanotechnology might even go so far as to allow us to adapt our bodies for survival in space or on other worlds. While this is certainly a long way off, it provides a glimpse of the thorough control that nanotechnology may provide.

Taking all of this into account, it is clear that nanotechnology should improve our lives in any area that would benefit from the development of better, faster, stronger, smaller, and cheaper systems.

Much of the work being done in nanotechnology is taking place in universities across the globe, mostly in USA and Japan; however, commercial companies are beginning to emerge as the time horizon for nanotechnology narrows. One of the early entries into the race to build a molecular assembler and product assembly process was the Texas-based corporation, Zyvex Corp.Work is going on the construction of a molecular computer at Rice University, Texas. Research programmes in chemistry, molecular biology and scanning probe microscopy are laying the foundations for a technology of a molecular machine systems.

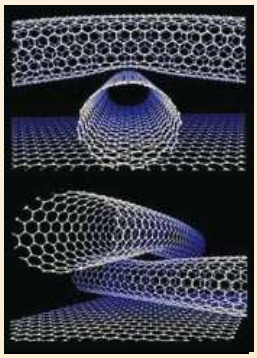

Figure 3

Scientists are working not just on the materials of the future, but also the tools that will allow us to use these ingredients to create products. Experimental work has already resulted in the production of molecular tweezers, a carbon nanotube transistor, and logic gates. Researchers were able to create carbon nanotubes (Figure 3, source: www.ibm.com), which is likely to become our primary structural element in the future.

Sources:

Books : 1. *Nanosystems: Molecular Machinery, Manufacturing, and Computation by K.Eric Drexler (Wiley 1992)*

2. *Self-replicaiton and Nanotechnology by Ralph C. Merkle*

3. *Foresight Guidelines on Molecular Technology*

Websites: *www.ibm.com*; www.zyvex.com, www.foresight .org.

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Amateur Astronomy in India

❒ Asis Mukherjee

The word AMATEUR means involvement for pleasure than as a profession. It may appear also as behaving like a novice unskillfully without a professional approach. For this precise reason, the amateur astronomers (AA) in very many places preferred to be called as nonprofessional astronomers. Reasonably the question comes, in spite of the glorious roles played by the AA in the past does there sufficient scope exist in the present age. Advances in science and technology are dominating the field with ever increasing number of astronomical observatories and research institutions with large number of scientists. Scope for exploratory space science is expanding fast. It is enormously sophisticated and prohibitively expensive too.

In India the history of amateur astronomy is quite bright. Different people throughout India got themselves involved in different sky observation projects of their own, formed astronomical institutions, wrote books on astronomy, took initiative in making telescopes and recorded data of different astronomical observations and endeavoured to popularize astronomy.

The two most important events on astronomy of the last two decades — the Total Solar Eclipse (TSE) of 1980 and apparition of Comet Halley in 1986 — necessitated the urge to form a National Federation of AA. Since 1984 after nine meetings at different places and by different groups in India, it ultimately culminated in the formation of CIAA (Confederation of Indian Amateur Astronomers) in 1994 at Calcutta mainly to get ready for the TSE of 1995 which was visible from most parts of India.

The TSE of 1980 for the first time in India brought the mass awareness among AA community to do something jointly in an organised manner. First efforts for the formation of a National Federation of AA were taken by Dr. Kulkarni of Baroda Planetarium in 1984. It was followed with three more meetings at Jaipur, Madras and Bangalore without any positive result. The apparition of Comet Halley in 1986 compelled the AA to interact for better observation. Indian amateur astronomers too shared the responsibilities as part of an effort coordinated by the International Halley Watch Committee. On 27-29 October, 1987, the Indian Institute of Astrophysics (IIA), Bangalore hosted a national seminar to discuss about the Comet Halley obsevation results. It was sponsored by IIA, Indian Space Research Organisation (ISRO), Advisory Committee for Space Science (ADCOS) and the Department of Science and Technology (DST) of the Govt. of India. This was for the first time where a full session was earmarked to AA for discussion. More than a dozen amateur astronomers were invited to participate.

In 1991, first All India Amateur Astronomers Meet (AIAAM) was organized at Pune when Jyotirvidya Parisansthanam of Pune, the oldest AA Association of India, came forward to host the meet in the collaboration with the Inter University Centre for Astronomy and Astrophysics (IUCAA). This meet offered a platform for as many as 200 AAs in different parts of the country to discuss their goals as well as to thrash out irritants in forming a national level organization. This AIAAM was the brain child of Prof. Jayanta Vishnu Narlikar who headed the IUCAA. He realised that the quality and potentiality of professional astronomers can be more meaningful and it would have been immensely beneficial had they been inducted from their childhood as AA. He gave a call to the AA community to form an organisation to further their interests and pledged all possible help and cooperation from IUCAA. Accordingly, Prof N.C. Rana was deputed to help in the formation of the AA federation.

Prof. N.C. Rana himself was an active AA in his school days getting inspired by his teacher Late Manindra Narayan Lahiri who guided him in sky observation. After joining IUCAA in 1992 from TIFR he took the initiative of organising the AA movement in India. On his advice and guidance, a survey was undertaken to study the existing Amateur Astronomy movements in India. Out of 200 organisations and individuals contacted with questionnaires, only 5% of them responded to the questionnaire. The study showed that there was only very few serious amateur astronomers in India. Second AIAAM was organised at Wardha in January 1992 where Kutuhal of Nagpur hosted the meet. Dr. Rana himself was present at the meet in spite of his ill-health. He initially opined that the AA movement in India was yet to mature and there was no need to form an AA association for the benefit of just a few members. It was felt we should get ourselves organised on a broader base for the 1995 TSE.

On his advice, an initiative was taken to form a national committee of 35 members and letters were dispatched to a number of people associated with astronomy inviting them to be a part of such a committee. The 3rd AIAAM was organised at Ahmedabad in February 1993.

At the 15th AGM of Astronomical Society of India (ASI) at Bombay on 2-3 March 1993, there was a parallel session on amateur astronomy. Subsequently, one ad-hoc committee was formed on the basis of replies received to the previous questionnaires. They were invited to the 4th AIAAM at Calcutta on the 23rd January, 1994 which was hosted by Manindra Narayan Astronomical Trust. The Indian body was named as The Confederation of Indian Amateur Astronomers (CIAA). After several meetings of the Adhoc Committee at IUCAA-Pune its constitution was formed and registered at Pune in 1995.

The 5th and 6th AIAAM meets were organised at Bhubaneswar and Madras respectively in January 95 and 96. The sudden and sad demise of Prof. N.C. Rana on the 22nd August, 1996 at Pune was a major blow to CIAA. For a national-level organisation, it is very difficult to operate without a permanent office and infrastructure and funds. But we succeeded mainly for selfless involvement of our AA community. The 7th, 8th and 9th AIAAM were organised at Delhi, Shillong and Hyderabad in 1997, 98 and 99 respectively. During the national meet, the confederation commenced the publication of its quarterly newsletter named *'Jyotishka'* with a dream of converting it later into a regular astronomy based national science magazine. Along with this several books have also been published by CIAA such as 'Jewels in the sky' (translated into six other Indian languages), 'The story of the comets', and 'The planetary guides for astronomers'. Besides these, different amateur astronomers' bodies in different states are also publishing their own journals and books for popularising amateur astronomy at their levels. For example,

the Sky Watching Guide, monthly journal, by Sky Watchers' Association of Kalkata for more than 15 years, and Directory of Astronomers by Akashmitra of Kalyan, in Maharashtra, have been playing important roles in the amateur astronomy movement in the country.

At present it discontinued individual membership and has about 50 Institutional members with the head office in Delhi. (Interested persons can contact Mr. Binay Pattanayak, General Secretary, CIAA, 10-B, I.P. Estate, New Delhi-110002.

The AIAAM has played an instrumental role in creating awareness about astronomy in the country. This is important considering that astronomy, along with astrophysics and space sciences, have assumed importance as major disciplines of modern science not only in India but world over.

If we look back at the history of civilisation we will find that initially any branch of science was developed with an amateurish zeal and this knowledge influenced other spheres of life. But as a particular branch of science got developed further and further, professionalism was brought in to enhance the quality. A good example is Olympic Games. Previously only amateurs were allowed to participate in Olympic Games and professional players were kept out of bound. But, subsequently, as it moved towards achieving excellence, its doors were thrown open to professionals too.

Nowadays astronomy is so much sophisticated and complicated that we get surprised whether an amateur astronomer has any thing to contribute. We need to look at this basic contradiction from a proper perspective. Take for example the Comet Halley Observation of 1986.

Professional astronomers used their sophisticated machines and gadgets to study the different aspects of the Comet as entrusted on them as part of their job and career obligation. But, on the other hand, amateur astronomers, for whom astronomy is a hobby, volunteered to get themselves involved in the Halley Watch, spending their own funds and energy as well as mobilising and developing their own resources. As the AAs are also professional in other spheres of life, their experiences are varied and valuable. The observational data may appear to be more perfect and dependable for the professional astronomers than the AA are due to the reason of easy availability of sophisticated instruments and as feed back channels remained open and was easy available to them with all other resources.

Nowadays the situation has changed drastically, thanks to the recent advances in Information Technology. Due to this, AAs are not very far behind in collecting the required data and other information.

At present an individual can communicate with the AA community elsewhere over the Internet, directly and with ease.

The interest pattern of non-professional astronomers changed too as follow:

General Observer : Recognising the constellations, stars and messier objects in the sky.

Special Observer : Who notes down special parameters like occultation of asteroids, timing of Solar or Lunar Eclipses, mapping moons of planets, observe their satellite occultation with the help of telescope or binoculars.

Variable Star Observer : Regularly notes the brightness of particular stars and forwards the record to Central Monitoring Body.

Comet Hunters : Should have comprehensive knowledge regarding the night sky with all messier objects to search for a new intruder with a pair of powerful binocular.

Satellite Observer : Observe the artificial satellites with their regular movement in the sky and draw its path.

Meteor Shower Observer : Observes and notes down the meteor path and numbers. Generally requires three persons in a group to keep a lookout around for the particular duration.

Telescope Maker : Their interest lies in the optics as well as in sky watching.

Astro Photographer : Their interest lies in photography as well as in observations.

Astro Artist : They draw astronomical objects with imagination and data available.

Astro Writers : They publish articles on astronomy or related subjects.

Interpretative Astronomers : They give lectures with the help of slides, cassettes, videos and models in schools and colleges & Clubs on astronomy and allied subjects.

People Science Movement (PSM) Activists - They use astronomy to educate the people and avail the sky as an easily available Laboratory to develop scientific awareness. and scientific temper.

The above 12 interest pattern scan broadly be divided into 3 groups

a) Observation (Interest pattern 1 to 6)
b) Instrumentation (Interest pattern 7 & 8)
c) Popularisation (Interest pattern 9 to 12)

In this changed perspective, certainly the AA are needed more effectively for the following reasons:

a) It is expected to produce better quality of professional astronomers if inducted through AA, who will be having a genuine interest in the subject while selecting astronomy as a career.

b) Research works are extremely expensive now. AA can share the burden of collecting obsevational data of astronomical observations from a greater area with minimum expenses or directly can help in a project under the guidance from professionals.

c) The sky is available everywhere. It is the easiest available science laboratory which can be used for popularisation of astronomy which will help greatly to develop scientific awareness among people in general to enhance the 'scientific temper' which is a fundamental condition for the development of an individual as well as the nation. The new literates countrywide can be indoctrinated with the astronomy knowledge of the daily life more easily which in turn will help in increasing the horizon of their mind.

d) Amateurs are appreciated for their selfless dedication and love for the subject, whereas professionals are paid to do the job. AA spend their money and energy for the pleasure. Galileo and Newton's discoveries are attributed as works of amateurs. Afterwards the research work became institutionalised. Here the motivational aspect is different. The voluntary zeal of AA can be generalised effectively in an organised manner, where it can help to enhance the 'Quality of Life' by getting and involving others too for a greater cause by widening our mental horizon.

Shri Asis Mukherjee is the President of Confederation of Indian Amateur Astronomers

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Recent Developments in Science and Technology

Pill does not increase risk of Breast Cancer

Breast Cancer kills 400,000 women each year world wide and 800,000 new cases are detected annually. Now a major study of women who use the contraceptive pill has found that it does not increase the risk of breast cancer, contradicting previous research findings, witch had shown that the women who takes contraceptive pills are more proms to breast cancer.

The women's Contraceptive and Reproductive Experiences (CARE) study involved 9,200 women aged between 35 and 65. This group included the first generation of women to have access to oral contraceptives. Approximately half of these women had breast cancer. The team found no link whatsoever between the use of an oral contraceptive whether an older or newer generation pill, and breast cancer.

These new findings conflict with the result of previous study published in 1996, which showed that women taking the oral contraceptive had a slightly increased risk of breast cancer.

Source : New Scientist, June 2002

Scientists Fashion First Single - Molecule Transistors :

Speed of the computer is a major issue for scientists. Every two years, advancements produce computers that process information twice as quickly as their speediest predecessors. At some point however, limiting factors such as space on a silicon chip and heat generated by intense electrical activity will present further computational acceleration. Luckily researchers working in the field of nanotechnology have been investigating another way to transmit information through the hardware of computer atoms. If these fundamental blocks could themselves act as transistors to control the flow of electricity many more circuits could be integrated on a silicon chip, resulting in exponential increase in computing speed.

Silicon chip laced with thousands of electrical circuits comprise the inner working of traditional computer. Each circuit contains transistors which allow electrons, or current to either pass through ("on") or remain where they are ("off"). These tiny switches have an ability to store information and perform calculations. Recently researchers at Cornell University and Harvard University have demonstrated that by using single cobalt atom in one case and two vanadium atom in the other, it will be possible to create transistor which has a property to switch "off" and "on" as well as amplify the current.

Soruce : Scientific American, June 2002

Scientists Add New Dimension to Supernova Simulations

Briefly exceeding the power of 100 billion stars, a supernova explosion ironically signifies the death of a massive stars. But these immense blasts are typically situated in galaxies far and far away, hence studying their intricate working is problematic. Scientists cannot go to the experiments so they instead must bring the experiment to them. Since 1966 researchers have developed increasingly more realistic computer simulation of these dazzling events. First one dimensional, then two, the model have gradually revealed key details behind supernova activity. New research takes this work one step further. Scientists unveiled the first three dimensional model ever created that depicted star collapse and subsequent tremendous explosion.

Source : Scientific American, June 2002

India to sequence Rice Chromosome on time :

Indian Scientists have sequenced six million base pairs of chromosome-11 of rice as part of the country's commitment to the International Consortium's initiative towards sequencing of rice genome.

"India will fulfill its obligation of sequencing 12 million base pairs that constitute the long arm of chromosome number 11 of rice by the long arm of chromosome number 11 of rice by the end of year. Akhilesh K. Tyagi, Head and Programme Co-ordiantor at the Centre for Plant Molecular Biology, Delhi University, Delhi.

Tyagi said that 12 million base pairs to be sequenced by India, researchers had already sequenced six million and the remaining tasks would be accomplished by the end of the current year.

PTI News, June 2002

Manganese Blocks AIDS Virus

Scientists at the Johns Hopkins University in the United States have found that by simply increasing manganese in cells can halt the replication of the human immunodeficiency virus (HIV) that causes AIDS. According to their study, manganese blocks HIV's unusual ability to process its generic information backwards providing a new way to target the process's key driver, an enzyme called reverse transcriptase. By measuring DNA produced by a related reverse transcriptase in yeast, the Hopkins team discovered that higher than normal levels of manganese, caused by a defective gene, dramatically lowered the enzyme's activity. The new work suggests that targeting a cell's manganese transporter could be an effective way to stop HIV from replicating, without targeting HIV's.

PTI News, May 2002

Compiled : Kapil Tripathi

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Letters to the Editor

Thank you very much for Monthly Newsletter "Dream 2047". Thank you also for choosing me for one of the interviews for 'Dream 2047'. I appreciate your thoughtful action. I enjoyed every minute of reading some of your issues of 'Dream 2047'.

Dr. K. Kasturirangan
Chairman, Indian Space Research Organisation,
Dept. of Space, Govt. of India, Antariksh Bhavan,
New BEL Road, Bangalore- 560 094

I find the newsletter Dream 2047, extremely interesting. The articles on the life and work of Scientists should be of immense value to our students. Please keep it up. The simultaneous publication of Hindi and English versions is also a very good idea. My heartiest congratulations.

L.S. Kothari
Dept. of Physics & Astrophysics, University of Delhi, Delhi

Why '2047'? Do you have any milestones? Really, the writings are a sort of an eye-opener. Salute to you all from the bottom of my heart.

Sarkar Soumen<soumens000@yahoo.com