100th Issue

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Vigyan Prasar

DREAM 2047

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Top Science Stories of 2006

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

Dream 2047 scores a century

This is the 100th issue of *Dream 2047*. Initially, its main objective was to provide information and spread awareness about the programmes and activities of Vigyan Prasar (VP) among individuals and agencies engaged in the field of Science and Technology popularization, and those interested in this area. Popular science articles also continued to appear to cater to the needs of the general public. Over the years, however, it has gradually transformed into a newsletter-cum-popular science magazine. Today, it is regarded as one of the leading popular science magazines of the country. From a print order of only a few thousand when it was first launched, today it reaches fifty thousand schools, colleges, science communicators, science clubs, R&D institutions, scientists and individuals. Many more access it through Internet on our website.

The production of every issue has invariably posed a few problems and challenges – from the conceptual to the production stage. Articles may not be ready on time, English to Hindi translation or *vice versa* may not have been completed. A key member may be on leave when he/she is most needed. Or, the DTP system may refuse to cooperate! It could become maddening at times. Yet, there is a method in madness and a harmony within the group that eventually brings each issue to your hands – on time!

VIGYAN PRASAR WISHES ITS READERS
A VERY HAPPY AND PROSPEROUS 2007

On visit to a remote village school, we often find *Dream 2047* occupying a prominent place in the school library, and students and teachers enthusiastically discussing the articles published therein. Indeed, articles published in *Dream 2047* are being extensively utilized as resource or enrichment material or in co-curricular activities. The biographies of scientists have become an integral part of the magazine and are highly respected and sought after. A series of articles on Transits of Planets and Emergence of Modern Physics have provided the basic resource material for the national campaigns like the Venus Transit of 2004 and the World Year of Physics 2005. Regular columns on health, astronomy and earthquake tips have become immensely popular.

The editorials and articles have often dealt with current topics, events, trends, schemes, surveys and new approaches. Dream 2047 has always looked and would continue to look forward with a firm commitment to keep its readers abreast of VP's activities and acting as a two-way communication channel. One major problem we continue to face is that of translating the articles from English to Hindi. Besides scientific accuracy, we need to maintain a flow along with local nuances in order that reading the translated version becomes an enjoyable experience. This has been a challenge – even in other regional languages. VP is looking into ways and means to address this problem. The simultaneous publication of *Dream 2047* in English and Hindi, however, helps the readers understand articles even in areas where Hindi and/or English is spoken only in a limited manner.

Dreams transform into thoughts and thoughts transform into actions, says our President Dr. A. P. J. Abdul Kalam. We too have a few dreams and we would like to share them with you. It is our dream that the circulation of *Dream 2047* reaches 1,00,000 in near future. Another dream is to produce and air good quality science television programmes that would eventually transform into a full-fledged science channel. VP's radio and television programmes would be aired from various AIR stations and Doordarshan Kendras respectively – in all Indian languages. VP's Network of Science Clubs would extend to all parts of the country with 50,000 clubs. VP's software would become available in all major Indian languages throughout India including in digital format. We also intend to develop dedicated core-groups of resource persons in all states/major linguistic regions to promote S&T communication activities. VP would reach rural and isolated areas, and in particular the areas in the North-East, through a variety of programmes. Again, *Dream 2047* would be the two-way channel of communication with our readers helping us transform our dreams into thoughts and thoughts into actions.

The year 2007 marks sixty years of India's Independence – a landmark in the history of our country. Many of us have been actively engaged in a variety of societal problems and share a common dream – a dream to transform our country into a nation of literate and scientifically minded people. *This is the dream we all want to realize.* Shall we be able to do so before 2047 when we shall be preparing to celebrate the centenary of Independence? In this sense, the title *Dream 2047* is allegorical.

With this issue, *Dream 2047* comes to you with a new look. We do hope you like it. Ever since its inception, *Dream 2047* has been a common thread binding thousands of individuals and Government and non-Government organizations together. The interaction with readers has helped us not only in exchanging information, but also in evolving and formulating some of VP's projects and programmes. It has proved to be an effective two-way communication channel between VP and scientists, science communicators and social workers; and shall continue to be so in future.

❒ **Vinay B. Kamble**

Editor : **V.B. Kamble**

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DR. T. RAMASAMI
SECRETARY
Department of Science & Technology
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Government of India

January 08, 2007

MESSAGE

I am happy to note that this is the 100th issue of *Dream 2047*. Over the years, *Dream 2047* has gradually transformed into a leading popular science magazine, and reaches 50,000 schools, colleges, science communicators, science clubs, scientists and individuals. Besides helping its readers keep abreast of current topics and events, it has proved to be an effective two-way communication channel between Vigyan Prasar and scientists, science communicators and social workers and the general public. Further, the articles in *Dream 2047* – biographies of scientists, and those on contemporary issues and events have proved to be a useful resource material for several national campaigns on Science and Technology communication.

There is a need to involve the people in the developmental process by spreading awareness on various issues related to applications of Science and regards, S&T communication derives critical importance. Department of Science talent could be attracted to a scientific career. I am happy to note that *Dream 2047* is putting in efforts to expose our younger generation to the thrill and excitement of science.

I do hope that *Dream 2047* continues to serve as a two-way communication channel between Vigyan Prasar and the scientifically informed and attentive public in the years to come. I wish the readers of *Dream 2047* a very happy and prosperous 2007.

(T. Ramasami)

A Much - Prized Science Magazine

❑ M.V. Kamath

As a former president of Vigyan Prasar Society I deem it a great honour and privilege to make a contribution to the 100th issue of *Dream 2047*, which was first published in October 1998 and has continued to be in circulation since then, establishing a place for itself among the communities of students and scientists. *Dream 2047* reminds us of the dream that those who fought for freedom had as India, in the words of Jawaharlal Nehru, kept its tryst with Destiny on the midnight of 14 August 1947. We hoped to see the day when India would be a Great Power gifted with great scientists who would make their mark not only in India but the world over. At that point in time nobody dreamt of Silicon Valley and the role India would play in the field of software. Indeed, the very word 'software' was then not even in existence! Thanks to Jawaharlal Nehru's insight India was quickly to set up Institutes of Technology not to speak of Institutes of Management which, in due course, were to produce scientists and management experts to the gathering envy of lesser lands. Were Nehru to be alive today he would be pleasantly shocked to see how his dream has fructified.

Today India is a country that attracts a large number of science graduates and such is the standing of Indian scientists and their prowess that there is a saying in the United States that if a college does not have an Indian maths teacher it couldn't be much of a college anyway! We have come a long way since 1947. There is no doubt that by 2047, in another four decades, India would have produced men and women of such scientific standing as to merit Nobel Prizes. In all this the Vigyan Prasar Society has played its own small role. Small, yes, but not insignificant. *Dream 2047* reaches hundreds of students all over the country and is a much-prized publication for the sheer amount of information it provides.

Credit goes to two senior staffers of Vigyan Prasar: Dr. V.B. Kamble, editor of *Dream 2047* and Dr. Subodh Mahanti whose priceless contributions, month in and month out is something to behold. Many readers instinctively turn over to page 3 of *Dream 2047* to read Mahanti's long sketches of famous scientists, which are always illustrated with pictures that are a class in themselves. Just think of the last six issues and the subjects that Mahanti has dealt with: The short biographies are those of Marie-Sophie Germain, the great woman mathematician of France, Emmy Noether described, quite rightly, as "the greatest woman mathematician"; Euclid – it has been said by the *Cambridge Dictionary of Scientists* that while Euclid's work dominated mathematics for over 2,000 years, almost nothing is known of his life and personality, whose many books were lost a long time ago and are now only a memory. We are informed about the work of Paul Erdos, "the man who loved only numbers"; of Jean Baptiste Joseph Fourier whose contribution to mathematical physics will always be remembered. And the December 2006 issue of *Dream 2047* carries Mahanti's article on William Rowan Hamilton, "creator of a New Algebra". One can't think of any other journal of this kind anywhere else in the world.

It is not just for biographical sketches that *Dream 2047* is distinguished or makes enjoyable reading. B.S. Padmanabhan's a 'Towards Nutrition Security' should be must reading not only for physicians but any citizen interested in healthy living. And who on Earth is not interested? Prof. K.D. Abhyankar's two-part article entitled "How many planets in the sky?" makes fascinating reading even to the layman who knows little or nothing about astronomy. Prof. Abhyankar makes the intriguing assertion that "There are indeed planets around other stars and some of them may even have intelligent life. It will be remembered that soon after Copernicus introduced the heliocentric hypothesis of planetary motions, the Italian philosopher Giordano Bruno (1548-1600) argued that there might be planets around other stars in the sky, for which heresy the poor man was burnt at the stake. Stars are no ordinary physical masses. They may be as big as 100 times the Sun – and the Sun is huge enough by any reckoning – or they could be a tenth of the Sun's size. Those stars that are heavier than the Sun rotate very rapidly with equatorial speeds of more than 100 km per second. And just to think that in the Milky Way alone there are over 10 billion stars is mind-boggling.

What *Dream 2047* provides is not just biographies of the great – and frequently little known – scientists but scientific information, which is an education in itself. And what is so special about these articles is that they are written in a language that the layman can understand. In the circumstances *Dream 2047* is not meant exclusively for the scientists; it is meant for the layman as well like the article on 'Simple Exercises for your back' which tells you that "by stepping into a routine, you could be buying an insurance policy for a pain-free youthful back". The instructions are simple. Like, for instance: "Step 1: Lie face down on a firm surface. Keeping your knee bent, raise your leg slightly off the surface and hold for a count of five. Repeat five times". Or, "Sit in a chair. Slowly bend forward toward the floor until you feel a mild stretch in your back. Hold for 15 to 30 seconds. Repeat three or four times". Simple. You don't require a yoga teacher to give you lessons.

The range of issues discussed in *Dream 2047* is again a lesson in science journalism. Why does the

earth quake? What is the reason behind that phenomenon? The article is illustrated and one gets a clear understanding of how Nature functions. How many magazines – popular magazines, specifically – would provide such information? But a word of warning nevertheless has to be given. True, *Dream 2047* gives plenty of information on general subjects, as it should. But that does not mean that the editors are not conscious of the status of its readers, many of who surely would want articles to measure up their requirements? One notices this in an article (August 2006) on 'Partity – Nature's Broken Mirror' by U.C. Agarwal and W.L. Nigam. The scientists' requirements are fully met in explanatory diagrams and formulae, which makes the monthly in a class in itself. But that is not the only action-line, which makes *Dream 2047* standout. One half of the journal is in English but the other half is in Hindi which makes science assessable to the Hindi reader – and they number in millions. One wishes, though, that *Dream 2047* could meet the requirements of non-Hindi readers elsewhere in the country. After Hindi, Telugu is spoken by the second largest number of people and in a country like India where there are some twenty odd *major* languages; the Vigyan Prasar Society has a job cut out. But this calls for funding, for finding, for finding the exceptional translator and even more importantly, a proper market study. Given the encouragement, the necessary funding and infrastructure, the Vigyan Prasar Society can make it.

Another exceptional feature of *Dream 2047* is the monthly Sky Map. The journal warns that the sky map is prepared for viewers in Nagpur, possibly because the city is almost right in the middle of the country. The reader, however is told that for viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky and those of the northern sky will appear hearer the northern horizon. Similarly, for viewers north of Nagpur, constellations of northern sky will appear higher up in the sky and those of the southern sky will appear nearer the southern horizon. Even the timings of when the map can best be used in mentioned and tips are given on how to watch the night sky. Nothing is left for the imagination.

Vigyan Prasar, of course, does not limit its activities just to bring out a monthly scientific journal. Every year it organizes Hindi *Pakhwara* during the period from 15 to 30 September which is invariably attended by top scientists. 14 September 2006, incidentally, was observed as 'Hindi Divas' when a discussion was organized on development of a practical Science Dictionary for science communicators. That was an ambitious project under which 15,000 scientific terms were compiled by Vigyan Parishad, Prayag. It is amazing the amount of work that a small society like Vigyan Prasar puts in. Only recently Vigyan Prasar and Tamil Nadu Science and Technology Centre Chennai organized a three-day orientation-cum-training course for teachers at the Anna Science Centre Planetarium. About 60 teachers representing 30 schools attended the course, which was held in Tiruchirapalli. Such activities are only *indicative* of the work handled week after week and year after year by the devoted staff of the Vigyan Prasar, which has even established a satellite communication network using EduSat for science communication and disaster preparedness. Only recently it organised a National Conference for Science Fiction Writers – a unique event. May the Vigyan Prasar Society flourish like the proverbial Banyan Tree stretching its branches to every part of India carrying science knowledge to the millions, in a language and content unchallengeable. It is the greatest service the society can do to the country.

Shri M.V. Kamath is a veteran journalist and was till recently President of Vigyan Prasar Society. He was honored with Padma Bhushan for his services by Government of India in 2004. It was he who mooted the idea of Vigyan Rail.

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VP News

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activities undertaken by the GUJCOST at the grass-root level. The following presentations were made:

1. Science Communication: What it is and what it could be by Prof. A. R. Prasanna, Physical Research Laboratory, Ahmedabad.
2. Astronomy Popularisation by Prof. J. N. Desai, formerly of Physical Research Laboratory, Ahmedabad.
3. S&T popularization on Television by a team of DECU, ISRO, Ahmedabad.
4. Communicating Science by Dr. Subodh Mahanti, Vigyan Prasar
5. VIPNET Science club activities by Shri B. K. Tyagi, Vigyan Prasar.
6. Science Toys and Kits by Shri Abhay Kothari of Manthan Educational Society (MPES), Ahmedabad.

Shri B. S. Bhatia, formerly Director, DECU, ISRO and Member of the Governing Body of Vigyan Prasar shared his experiences of the various science communication activities undertaken by DECU. He promised his full support for making the activities to be undertaken in Gujarat successful. All the participants described the kind of activities they were engaged in and what they would like to do if necessary support is given. Based on the suggestions given by the participants a detailed plan was prepared for the activities to be undertaken in the next five years. The workshop provided an opportunity to the participants know about the kind of S&T popularization activities going on in Gujarat.

Gottfried Wilhelm Leibniz

A Universal Genius

❑ Subodh Mahanti
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" 'Jack of All Trades, Master of None' has its spectacular exceptions like any other folk proverb, and Gottfried Wilhelm Leibniz (1646-1716) is one of them. Mathematics was but one of the many fields in which Leibniz showed conspicuous genius: law, religion, statecraft, history, literature, logic, metaphysics and speculative philosophy all owe to him contributions, any one of which would have secured his fame and have preserved his memory."

E. T. Bell in *Men of Mathematics* (1937)

Gottfried Wilhelm Leibniz (also spelt Leibnitz) is the greatest polymath that ever lived. It seems Leibniz was determined to achieve the highest goal in every sphere of human activity. There is no wonder that he failed so often. But what he achieved was more surprising He succeeded so much because of his hard work and an unshakable faith in his own abilities. He was also receptive to the ideas of others. Leibniz's greatest achievement was undoubtedly his discovery of differential and integral calculus. This was also the work, which was to involve him in bitter priority dispute with Isaac Newton (1642-1727). Today it is generally believed that they both discovered it independently of each other. Newton's ideas on the calculus were developed first, as early as 1665, but they remained unpublished until 1687. Leibniz published his results in 1684 in *Nova methodus promaxims et minimis* (*New Method for the Greatest and the Least*). Leibniz's system of notations is superior to that of Newton and is still in use today. His notation was based on the letter *d* for 'difference', as in *dx/dy,* the symbol for a differential and the contemporary long *s* (∫) for 'sum' or 'integral'. It was Leibniz, who first introduced the terms 'differential' and 'integral'. The language used by Leibniz in describing calculus was more clear and precise compared to that of Newton.

Gottfried Wilhelm Leibniz

The differential and integral calculus formulated by Newton and Leibniz became the basis of modern mathematics. It is said that without the development of infinitesimal calculus (that is, differential and integral calculus) it would not have been possible to push the development in physics to a point beyond what Newton had achieved. Without calculus it was not possible to make curves and variable quantities amenable to mathematical treatment on the lines physicists were subjecting constants, straight lines and curves that are easily constructible from straight lines. As we know, most of the physical quantities are in a state of constant change and this requires a suitable general technique, which can make these variations amenable to mathematical treatment. Only then would it be possible to develop any kind of adequate physical science. The differential calculus has given the physicists a general technique for measuring the rate at any instant of a quantity, which is continuously varying with respect to another quantity of which it is a 'function'. The function is a quantity, the value of which can be uniquely determined by another variable. It is worthwhile to note that the term 'function' was first used by Leibniz. Integral calculus does the reverse of differential calculus. It constructs or integrates from a given value at an instant.

Leibniz established the foundation of symbolic logic, probability theory, and combinatorial analysis. He designed and built a practical calculating machine, which was shown to Fellows of the Royal Society of London in 1794. The machine designed by Leibniz was superior to the once designed by Wilhelm Schickard in 1623 and Blaise Pascal (1623-1662) in 1642. He had once given one of his machines to Peter the Great, Czar of Russia for sending it to the Emperor of China as an example of superior Western technology. Unlike the earlier versions, Leibniz's machine could serve as multiplier and divider. He also invented a number of devices for the machine, which later became standard technologies. Leibniz spent a considerable part of his time working towards technological innovation. He also worked on hydraulic presses, windmills, lamps, submarines, clocks, carriages, and water pumps.

Leibniz in one of his memoirs published in 1692 laid the foundation of the theory of envelopes. This he further developed in another paper published in 1694 and in this

paper he for the first time introduced the terms 'co-ordinates' and 'axes of co-ordinates.'

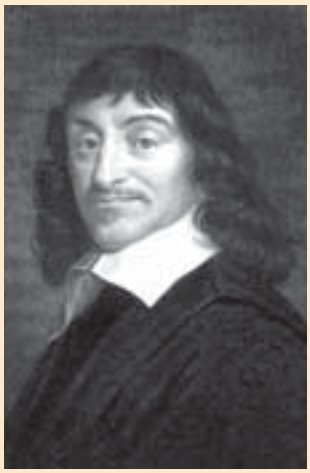
Although Leibniz was a German, he wrote mostly in Latin and French. George I of England described him as a 'walking encyclopaedia'. He had a lifelong interest in alchemy. He made a serious effort to formulate a sound philosophical and theological basis for reunion of Protestant and Catholic churches in 1683. He played an instrumental role in founding the Berlin Academy of Sciences in 1700.

Isaac Newton

Leibniz did not need any proper environment for working. He could work anywhere, at any time and under any circumstances. Throughout his life he read, wrote and thought incessantly. Together with Otto Mencke he founded the journal *Acta Eruditorium* in 1682. Many of his mathematical papers were published in this journal, which had a wide circulation in Europe.

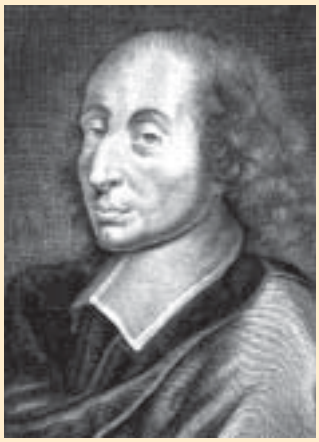
Leibniz was born on 1 July 1646 in Leipzig. His father Friedrich Leibnutz (1597-1652) was a professor of moral philosophy at Leipzig University. Leibniz changed the spelling of his surname from 'Leibnutz' to 'Leibniz'. However, in his lifetime the standard spelling of his name became 'Leibnitz', though he himself never used it. His mother was Catherina Schmuck (1621-64).

In 1661, Leibniz entered the University of Leipzig where he was registered for the traditional two-year arts course. He studied philosophy, rhetoric, mathematics, Latin, Greek and Hebrew. After graduation he had three fields before him for higher studies – theology, law and medicine. He could choose one of the three subjects. He chose law. Before starting his formal course in law, Leibniz went to the University of Jena for a summer term. He attended there a course on mathematics. After his coming back to Leipzig, he spent the next three years working at a series of 'disputations'. As per norms of the Leipzig University in those days, students had to publish and defend, a 'disputation' at each stage (or 'degree') of his career. This way he earned his bachelor's and master's degree of law. After he failed to get doctorate degree in law, he left Leipzig.



Rene Descartes

At the end of three years Leibniz also became qualified to lecture in philosophy for his dissertation 'On the Art of combination'. However, he did not accept the lectureship in philosophy. In those days such lectureships used to be purely honorary. A university had no provision for paying for such lectureship. Leibniz needed money very badly as he had borrowed money from his relatives for pursuing studies in the university. He wanted to secure one of the twelve established paid tutorships in law, in case any vacancy arose. However, a doctorate degree in law was a prerequisite condition for being considered for the law tutorship. Thus, he prepared a thesis to defend for his Doctor of Law degree. The authorities of the Law Faculty of the Leipzig University asked him to wait for submission of his thesis. Leibniz was infuriated. He thought it was a calculated conspiracy against him commenting, as mathematics historian E.T. Bell wrote: "The Leipzig faculty, bilious with jealousy, refused Leibniz his degree, officially on account of his youth, actually because he knew more about law than the whole dull lot of them". Whatever might be the reason, Leibniz left Leipzig in disgust and went to Nuremberg, where he registered with University of Altdorf for doctor of law degree on 4 October 1666. He immediately submitted his doctoral thesis on a new method of teaching law. The University of Altdorf did not delay in awarding him doctorate degree. In fact the faculties of the Altdorf University were so impressed with the scholarship of Leibniz that he was offered a professorship. However, by that time Leibniz had decided to try his luck outside the academic world. So he did not accept the offer.



Blaise Pascal

For a brief period Leibniz worked as a secretary of a society of Nuremberg intellectuals interested in alchemy. We have no idea about the exact nature of his duties as a secretary of the society. It is well known that Leibniz himself was much interested in alchemical quests. It is generally believed that unlike Isaac Newton, he did not carry out any experimental work in alchemy. However, Leibniz was considered an expert on theoretical questions related to the art of alchemy. Publicly he declared that his interests in alchemy were purely scientific, because if transmutation of matter, as alchemists laboured to achieve, became a practical possibility then it could divulge important information about the structure of matter. However, there is evidence to indicate that Leibniz wanted to make his fortune from alchemical quests.

Leibniz had entered into a formal profit-sharing agreement with two practising alchemists, viz., G.H. Schuller

and J.D. Craft. As per the agreement Leibniz was to provide funds and technical assistance for the project. Two other renowned alchemists whom Leibniz knew fairly well were J. J. Becher and Heinrich Brand, the discoverer of phosphorus. Leibniz once crossed Becher's way by stopping one of his useless alchemical projects. With a view to taking revenge, in his book *Foolish Wisdom and Wise Folly*, Becher ridicules Leibniz whom he describes as one who claims to have invented a coach capable of travelling from Amsterdam to Hanover in six hours! This meant the coach had to travel at the speed of 60 km per hour, unimaginable in those days. It is true that Leibniz discussed coach design in 1678.

Anton van Leeuwenhoek

Leibniz did not stay long with the alchemists of Nuremberg. After leaving Nuremberg, he accidentally came in contact with Baron Johan Christian Von Boineburg, the former Chief Minister of the Elector of Mainz. Persuaded by Boineburg, he accepted an appointment as an Assistant to the Legal Adviser of the Elector of Mainz. Leibniz joined the service in the 1667. Boineburg played an important role in shaping Leibniz's career as well as his intellectual development.

One of Leibniz's major ideas was his vision of a 'universal encyclopaedia'. He thought that for realising his goal it was necessary to prepare a master subject-catalogue of all the books scattered around the libraries of Europe. In 1670, he prepared a catalogue of the rich book collection of his mentor Boineburg. However, when subsequently he headed major libraries he was not allowed to take up similar exercise despite his repeated requests for the same. Today we see Leibniz's dream has been realised.

In 1672, Leibniz went to Paris. He was sent there with a specific objective of taking his plan to draw the attention of the French king away from Northern Europe with a more attractive scheme of French Conquest of Egypt. He stayed in Paris for four years. He did not succeed in his political objective, but established a wide range of contacts. Among his acquaintances were two philosophers Arnauld and Malebranche, and the mathematician Christiaan Huygens (1629-1695). With the help of his philosopher friends Leibniz could lay his hands on the unpublished works of Pascal and Rene Descartes (1596-1650). Some of Descarte's works survive only through the copies that Leibniz had made. Leibniz was greatly influenced by Descartes.

Bendedict Spinoza

In January 1673, while he was in Paris, Leibniz made a short trip to London and he utilised this opportunity to make personal contacts with the Fellows of the Royal Society of London, including its secretary, Henry Oldenburg. He could not stay long in London because of sudden deaths of both his mentor – Boineburg (December 1672) and the Elector of Mainz (February 1672). He went back to Paris in March 1673. He continued as the tutor of the young Boineburg till his appointment ended in September 1674.

Christiaan Huygens

Leibniz wanted a research post attached to the Paris Academy for pursuing his scientific interests. However, when he realised that it was not possible to get such an appointment, he accepted the post of court councillor at Hanover, which was offered to him earlier. He was to take charge of his duties with Hanover Council in January 1676. He somehow managed to get it deferred till the end of 1676. He left Paris in October 1676, but he did not go directly to Hanover. He visited London (for a very brief period) and then Amsterdam and The Hague. He met the pioneering microscopist Anton van Leeuwenhoek (1632-1723), who had recently made first microscopic observation of bacteria, protozoa and spermatozoa, in Amsterdam. He also met the famous lens-grinder and philosopher. Bendedict Spinoza (1632-1677) at The Hague.

Leibniz joined the Hanovarian service in December 1676. Besides carrying out normal Council duties, he also acted as Librarian and mining engineer. He undertook correspondence with hundreds of people from all over Europe. He corresponded on almost every subject – science, mathematics, law, politics, religion, philosophy, literature, history, linguistic, numismatics, anthropology and so on. More than 15,000 of his letters still survive. These letters are important sources for understanding Leibniz's work particularly in areas of philosophy, logic and mathematics.

Leibniz occupies a prominent place in the history of philosophy. Most of his philosophical writings were done in the last 25 years of his life. In the field of philosophy, Leibniz is well-known for his wide range of thought about fundamental philosophical ideas and principles among which included truth, necessary and contingent truths, possible worlds, the prin-

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Science Stories That Shaped 2006

❑ Biman Basu
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The year 2006 was an eventful year in the field of science and technology. In one of the most stunning developments in planetary science it saw the demotion of Pluto, which was known as a planet for 75 years, to the status of a 'dwarf' planet. The year also saw the vindication of the existence of 'dark matter', which is supposed to make up 90 per cent of the total mass of the universe; discovery of the first standing bodies of liquid outside Earth; discovery of the heaviest chemical element; success of grafted tissue-cultured bladder; the confirmation of the proof of the 100-year-old mathematical conundrum known as the 'Poincaré Conjecture'; and much more.

Pluto Dethroned

The science story that garnered the most headlines in 2006 was no doubt the decision of the International Astronomical Union (IAU) to dethrone Pluto as a planet and reclassify it as a 'dwarf' planet. Right from the day of its discovery on 13 March 1930 Pluto has been considered an odd ball among planets. It is not only much smaller than any other planet, its orbit is also more eccentric than any; Pluto's orbit is so elongated that it crosses the orbit of Neptune and when it does so it no longer remains the solar system's outermost planet. Yet for 75 years there was nothing substantial against it that could challenge its planethood. It had no rival contender.

But things started changing after the discovery of the first Kuiper Belt Object (KBO) in 1992. Soon, several KBOs with diameter more than 1,000 km were discovered. In 2002, Quaoar (1,280 km diameter) was discovered followed by the discovery of another KBO with a diameter of 1,800 km in 2004. Then in 2005, discovery of yet another object, at least as large as Pluto, in orbit around Sun struck the final blow to Pluto's claim as a planet. It became clear that Pluto was only one among a horde of objects that orbit the Sun beyond Neptune. Could they all be called planets?

Pluto and its moon Charon photographed by Hubble Space Telescope

Astronomers around the world were quick to act. At the 26th General Assembly of IAU in the Czech capital Prague they came out with a clear definition of a planet as a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit. Being one among several in similar orbits, Pluto failed to meet the last requirement. It was reclassified as a 'dwarf planet', leaving the solar system with only eight planets.

Evidence of Dark Matter Found

The year saw the first vindication of the existence of 'dark matter', which is supposed to make up 90 per cent of the total mass of the universe. It enters into many theories of the origin of the universe and its present large-scale structure and into models of gravitation and other fundamental forces between particles. Numerous candidates for dark matter have been proposed over the years, but none had been confirmed so far. Now, new studies with the *Chandra X-ray Observatory* offered clear-cut evidence that dark matter really does infuse galactic clusters and demonstrated beyond a reasonable doubt that dark matter exists.

In this composite image, the blue hues show the distribution of dark matter in the cluster. Otherwise invisible to telescopic views, the dark matter was mapped by observations of gravitational lensing of background galaxies

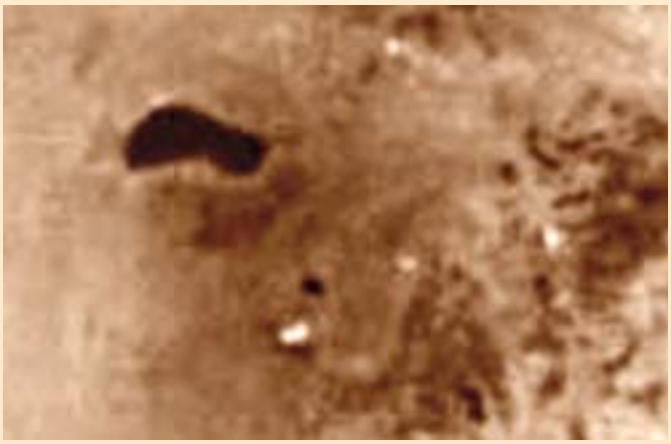
The evidence of the existence of dark matter came from images of a galaxy cluster called '1E0657-56', fondly known as the 'bullet cluster', which was created by an energetic collision of smaller clusters and lies 3.4 billion light-years away. According to astronomers, it is the most explosively violent such merger ever observed. *Chandra* X-ray images of the cluster showed clearly distinct areas

of normal matter and dark matter, which show up as a strong gravity field. Astronomers measured the cluster's gravitational influence by tracking its effect on the light from more distant 'background' galaxies, a phenomenon known as gravitational lensing in which the positions of the distant galaxies appear to shift under influence of gravity. The clear separation of dark matter and gas clouds in the images was taken as direct evidence that dark matter exists.

Methane Lakes on Titan

During the year, planetary scientists found the first evidence of standing bodies of liquid outside Earth on Saturn's largest moon Titan. After analysis of radar data sent back by the *Cassini* spacecraft, which has been in orbit around Saturn since 1 July 2004, researchers reported in August 2006 the discovery of lakes of liquid methane on Titan's surface. Titan, which is about 50 percent larger than the Moon, is the only satellite in the solar system with a dense atmosphere. This atmosphere is transparent to radio/radar waves and partially transparent at short infrared wavelengths but is opaque at visible wavelengths.

Located in Titan's north polar region, the lakes range in width from just under a kilometre to 32 km and extend up to 90 km. Not only are the dark areas in the radar images shaped like lakes, but they also have channels leading out of them. Titan's surface, at a frigid –180°C, is much too cold for liquid water. The lakes probably consist of methane, possibly mixed with ethane. Earlier, evidence of methane clouds, methane rain, and valleys cut by rivers of liquid



This radar image taken of the surface of Titan by Cassini shows dark areas shaped like lakes

methane had been found on Titan from *Cassini* data. The planetary radar specialist Donald Campbell of Cornell University, New York, USA and his team believe that the methane lakes may be last link in the 'methane cycle' of Titan, similar to the 'water cycle' on Earth.

New Look at Comets

Cometary scientists discovered astounding facts about comets during the year by analysing the dust particles collected from Comet Wild-2 and brought back

The Stardust spacecraft collected dust from the tail of Comet Wild-2 and brought it back to Earth for analysis

to Earth by the *Stardust* spacecraft. The common view till now was that comets are made up of cold material left over from the original solar nebula out of which the solar system was formed. They were dubbed 'dirty snowballs' and were thought to be mostly made up of water ice and dirt that boiled off as a comet approached the Sun, giving rise to the spectacular 'tail' of comets. New evidence from *Stardust* samples published in December show that comets are not all made of interstellar dust and ice, but instead may contain material shot from the heart of the solar system during its tumultuous birth. Some of the grains found in the sample are the product of extremely high temperatures, well over 1,500 degrees C, which could be only in the vicinity of the Sun. An isotopic analysis of the grains shows that a large chunk of Comet Wild-2 does indeed come from the beginnings of our own Sun. But how it got there remains a mystery. Probably some of the hot material that formed planets around the Sun spewed off into distant areas and become a component of distant comets.

NASA had launched *Stardust* in 1999, and the robot spacecraft met Comet Wild-2 beyond the orbit of Mars in January 2004. The craft flew within 240 kilometres of the comet's nucleus and trapped particles spewing from the body in a light, porous foam called 'aerogel'. After a 4.6-billion-kilometre journey, *Stardust* returned to Earth last January with a payload of thousands of tiny particles from Wild-2. More than 180 scientists from around the world examined some of the samples with specialized equipment to determine what makes up the icy, dusty comets that largely populate a vast area beyond the orbits of Neptune and Pluto.

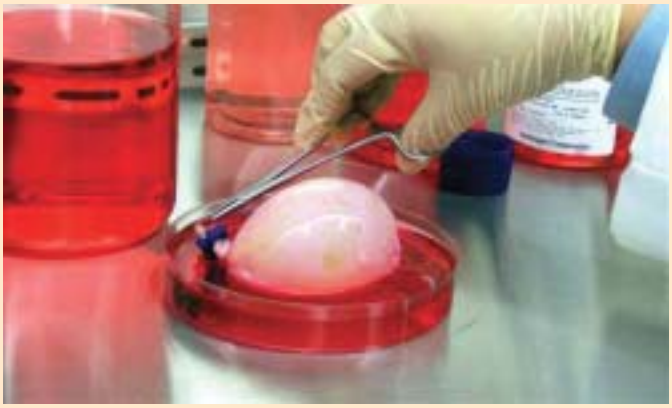
Element 118 discovered

The number of known chemical elements jumped by one during the year with the discovery of element number 118 (ununoctium, Uuo), the heaviest element yet. The discovery was announced in October by a team of American and Russian scientists from the Lawrence Livermore National Laboratory (LLNL) in California, USA and the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. Only three atoms of the new element, with an average lifetime of 0.9 milliseconds have been produced so far. The super-heavy element belongs to the same group as helium and neon and sits directly beneath radon on the periodic table.

Claim for the discovery of element 118 was first made in 1999, but it could not be substantiated. The present discovery came after months of relentlessly bombarding heavy atoms onto a radioactive target and searching for distinctive chains of radioactive decays. The researchers first saw a single atom of element 118 in 2002, but, again, the evidence was not conclusive. Then, between February and June 2005, the researchers fired a beam of calcium ions, each containing 20 protons, into a target of californium, a highly radioactive synthetic substance with 98 protons. The idea was to get one of each type of atom to stick together to become a single atom of element 118. Over many months, they fired some 10 million, million, million (that is, 10^{19}) such ions into the target. Just three atoms of element 118 were created. These lived for less than a thousandth of a second. However, the researchers could find a telltale chain of decaying atoms that established the existence of the new element.

Tissue-cultured Bladder

A landmark in medical history – the success of a transplanted tissue-cultured urinary bladder – was reported in April in the medical journal *The Lancet*. Seven children



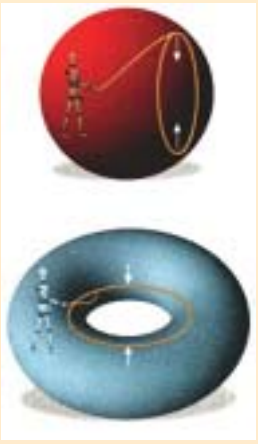
Human bladder grown from bladder cells by tissue culture behaves as natural bladder when implanted

aged between 4 and 19, all born with a condition known as spina bifida, which left them with shrunken bladders without normal nervous connections, were transplanted with lab-grown bladders and all have now been living with the engineered organs for an average of four years.

The artificial bladders were created by culturing bladder tissue cells taken from the individuals in a culture medium for a month, and then growing them on a bladder-shaped 'scaffold' made of collagen, a structural protein found in most of our tissues. After being grown for two months, the engineered bladders were grafted onto the patients' own. Since the engineered bladders were created out of cells takes from the patients themselves, there was no complication of rejection, as happens with transplants of foreign organs. After grafting of the engineered bladders the young patients gradually got back normal bladder capacity and the quality of life showed dramatic improvement.

Poincaré Conjecture Solved

One of the biggest breakthroughs during 2006 was the confirmation of the proof of the100-year-old mathematical conundrum known as the 'Poincaré Conjecture', which has been for a long time one of the most important questions in topology. First stated by the great French mathematician and physicist Henri Poincaré in 1904, the conjecture focusses on the relationship of shapes, spaces and surfaces.



The Poincare Conjecture

If we consider a ball, near each point on its surface it looks like a two-dimensional plane. But at a distance, of course, it is a round two-dimensional sphere. Mathematicians refer to the ball as a 'two-dimensional manifold that is compact and connected'.

Now if a rubber band is slid around the ball and held by a finger on a single point, then by pulling the rubber band around the ball, one can retract it to the point being held by the finger. Mathematicians call this property

Grigori Perelman

Henri Poincare

'simple connectedness', which applies to all two-dimensional spheres like a ball. It is for this reason mathematicians view a two-dimensional sphere as a 'compact, connected and simply connected two-

dimensional manifold'. Poincaré, almost a hundred years ago, knew that a two-dimensional sphere is essentially characterized by this property of simple connectivity, and asked the corresponding question for the three-dimensional sphere, as exemplified by a doughnut. This question, which came to be known as the 'Poincaré Conjecture', turned out to be extraordinarily difficult, and mathematicians have been struggling with it ever since. It is one of the seven Millennium Prize Problems for which the Clay Mathematics Institute had offered a $1,000,000 prize for a correct solution.

In late 2002 and 2003, Grigori Perelman of the Steklov Institute of Mathematics, Saint Petersburg, Russia, posted three papers on the open access web site arXiv.org, in which he sketched a proof of the Poincaré Conjecture and a more general conjecture. From May to July 2006, several groups presented papers that filled in the details of Perelman's proof of the Poincaré Conjecture. Finally, nearly four years after the Russian mathematician released the first of three papers outlining the proof, researchers reached a consensus that Perelman had indeed solved one of the subject's most venerable problems.

Perelman's proof has fundamentally altered two distinct branches of mathematics. First, it has solved a problem that for more than a century was the indigestible seed at the core of topology, the mathematical study of abstract shape. Most mathematicians expect that the work will lead to a much broader result, a proof of the Geometrization Conjecture: essentially, a 'periodic table' that brings clarity to the study of three-dimensional spaces, much as Mendeleev's table did for chemistry.

While bringing new results to topology, Perelman's work also has brought new techniques to geometry. It has cemented the central role of geometric evolution equations, powerful machinery for transforming hard-to-work-with spaces into more-manageable ones. Earlier studies of such equations always ran into 'singularities' at which the equations break down. Perelman dynamited that roadblock.

Pulsars Prove Einstein right

The year saw the strongest confirmation yet of Einstein's general theory of relativity – the theory that physicists believe best explains gravity. An international team of astronomers found the confirmation using an unusual double pulsar PSR J0737-3039A/B, lying some 2,000 light-years away from Earth, which was discovered by a team of radio astronomers at the Jodrell Bank Observatory in the UK in 2003. The double pulsar consists of two compact neutron stars, each a mere 20 km across yet weighing more than the Sun and separated by only a million kilometres. Given the tiny size, high mass density and very short orbital period of just 2.4 hours, the double-pulsar system has a gravitational field 100,000 times stronger that of our Sun – higher than anything else in the universe, apart from black holes. Relativistic effects in this system are therefore much more pronounced and space-time is far more curved than under normal conditions that exist in our solar system. This makes the double pulsar an excellent 'laboratory' for testing general relativity, particularly because both stars send out regular beams of radio waves, which can be captured by large telescopes and used to probe the curved space-time around such a system.

The researchers used the Lovell Telescope at Jodrell Bank – as well as the Parkes Radio Telescope in Australia and the Robert C Byrd Green Bank Telescope in West Virginia, USA – to carry out four separate tests on the pair of rotating neutron stars, and measured five mathematical parameters that bring out the relativistic effects as corrections to the simple Keplerian motion of stars. The conclusion from the four independent tests of the general theory of relativity was that the pulsars are indeed behaving as predicted by the general theory of relativity, to an unerring accuracy of 99.5%.

Neanderthal DNA Sequenced

The year 2006 was the 150th anniversary of the discovery of the early form of human species known as Neanderthals, the first remains of which were found in 1856 in a limestone quarry in the Neander Valley near Duesseldorf, Germany. The year also saw the sequencing of more than 1 million base pairs of Neanderthal DNA by researchers in Europe and the United States, which transformed the study of this ancient human species. The researchers isolated the entire DNA in the femur bone of a 38,000-year-old male Neanderthal specimen from Vindija, Croatia. Using a combination of the sequencing technologies deployed in the Human Genome Project, plus a new massively parallel pyrosequencing technology, in which enormous amounts of DNA sequence is rapidly and inexpensively generated, they were able to recover 65,250 base pairs of Neanderthal DNA from the approximately 6 million base pairs of contaminating DNA in the fossil. A critical factor in helping to confirm that the recovered DNA was Neanderthal rather than human was the short length of the individual Neanderthal sequences.

Neanderthal Man

In November, two groups, one decoding 65,250 Neanderthal DNA base pairs and the other a million base pairs, showed how closely related the Neanderthal species was to modern humans, *Homo sapiens* – differences that may reveal key steps in our evolution. The studies concluded that Neanderthals diverged from our own ancestors at least 450,000 years ago – approximately the time suggested by fossil and mitochondrial DNA studies. Preliminary analysis of the DNA showed the bundle of DNA responsible for maleness in the Neanderthal – its Y chromosome – is very

different from modern human and chimpanzee Y chromosomes; more so than for the other chromosomes in the genome. This might suggest that little interbreeding occurred between our own species and the Neanderthals.

The new data promise to reveal more about the genetic basis of differences between humans and Neanderthals – differences that presumably resulted in the success of modern humans as a species. The findings, they say, strengthen the argument that Neanderthals did not contribute substantially to the modern human genome.

Polar Ice Shrinking

One of the most distressing scientific discoveries of the year concerns Earth's crumbling environmental system. Glaciologists discovered to their dismay that the world's two great ice sheets – covering Greenland and Antarctica – are indeed losing ice to the oceans, and losing it at an accelerating pace. If this unexpectedly rapid shrinkage continues, low-lying coasts around the world – including New Orleans and South Florida in USA, much of Bangladesh, and many of the island nations like Maldives – could face inundation within a couple of centuries rather than millennia.

This disturbing revelation came after decades of measurements by airborne laser altimeters and orbiting radars, and, more recently, by a pair of satellites that measure ice mass directly by its gravitational pull. Although the different techniques used and even different analyses of

It is now proven that ice in the Earth's polar regions is melting fast

the same data sometime give conflicting values of just how much ice volume is changing, all of them show that both Greenland and Antarctica have been losing ice over the past 5 to 10 years. The data show that on average Greenland is losing at least 100 gigatonnes (billion tonnes) each year and Antarctica some tens of gigatonnes per year or more. Another startling finding is that the ice is not just melting faster; it is also moving faster. Radar mapping shows that in recent years, glaciers carrying ice away from the sheets have sped up by as much as 100%.

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Contd. from page...37 **(Gottfried Wilhelm Leibniz)**

ciple of sufficient reason (that is, nothing happens without a reason), the principle of pre-established harmony (that is, God constructed the universe in such a way that corresponding mental and physical events occur simultaneously) and the principle of non-contradiction (that is, that any proposition from which a contradiction can be derived is false). Leibniz made pioneering contributions to a number of classical topics of philosophy of mind including materialism, dualism, idealism, and mind-body interaction. He regarded the ultimate elements of the universe as individual percipient beings whom he called monads. He believed that principles of reasoning could be converted to a formal symbolic system like something of an algebra or calculus of thought.

Leibniz's contribution to the literature was as considerable as those of philosophy. It was he who overthrew the prevailing concept that Hebrew was the primeval language of the human race. Among his major works that were published in his life time were: *De Arte Combinatoria* (1666, On the Art of Combination), *Hypothesis Physica Nova* (1671, New Physical Hypothesis), *Nouveaux Essais sur L'entendement humaine* (1705, New Essays on Human Understanding), *Theodicee* (1705, Theodicy), and *Monadologia* (1714, The Monadology).

Leibniz died on 14 November 1716 at Hanover.

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(This article is a popular compilation of the important points on the life and work of Gottfried Wilhelm Leibniz available in the existing literature. The idea is to inspire the younger generation to know more about Leibniz. The author has given sources consulted for writing the article. However, the sources on the internet are numerous and so they have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article.)

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Arsenic
A Silent Killer

❑ A K Datta and Kshipra Misra
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"It is an uncanny thought that this lurking poison (arsenic) is everywhere around us, ready to gain unsuspected entrance to our bodies from the food we eat, the water we drink and the air we breathe."

Karl Vogel, 1928

Water is an essential element required for the survival of living systems. Water covers almost 70 percent of the Earth's surface in some form or the other. Even the life line flowing in the form of blood in living beings and the sap in plants, etc., is nothing but a solution of minerals and other chemicals dissolved in water. Even a slight imbalance in the concentration of these minerals and other required chemicals in the body can cause several adverse health problems. Water is the most abundant resource yet it is one of the most poorly managed resources on Earth. Yet, over a period of time in the name of development, the quality of available water has deteriorated to a great extent.

Water is also called a 'universal solvent' because it dissolves almost all kinds of chemicals and this property of water makes its contamination inevitable in technical sense. A large number of rivers, lakes, and even the oceans are getting increasingly polluted due to increase in population, unplanned urbanization and indiscriminate industrialization. Ground water, which was the only source of clean water left till recent times, has also been contaminated and is depleting fast due to constant use for drinking and irrigation purposes. Once contaminated, ground water may remain contaminated for hundreds of years. Arsenic contamination of ground water is an example of ground water pollution that is becoming one of the biggest calamities of the century in many parts of the world including India.

Arsenic is chemically categorized as metalloid and it is highly toxic. It is the 20th most common element in nature and is widely distributed in the Earth's crust in several parts of the world. It gets into water when water flows through arsenic-rich rocks. It is also released into the atmosphere from coal-based power generation plants, burning vegetation, and volcanic eruptions. It has been historically used in medicine. It has been used as an insecticide, rodenticide and herbicide. In addition it also finds use in semiconductor industry, glass production and wood preservation.

Arsenic lesions on hands and feet

The fact that arsenic acts as a slow poison has its long association with human culture by deformity of Hephaestus the Greek god of blacksmiths, craftsmen, artisans, sculptors, who became lame due to arsenic poisoning. Arsenic was added to bronze to harden it and most smiths of the Bronze Age would have suffered from chronic workplace arsenic poisoning. In subsequent period it was used to kill many aristocratic and noble gentlemen, terrorise others to influence the cultural and social developments in many parts of the world. It is believed that the French Emperor Napoleon Bonaparte suffered from arsenic poisoning. Sample of his hair did show high levels of arsenic. It is considered a silent killer since there is generally no smell or taste associated with its presence. Arsenic poisoning can easily go undetected because many of its symptoms are common with a number of other illnesses.

Arsenic can combine with other elements to form both inorganic and organic arsenic compounds. Inorganic arsenic is more toxic. Arsenic deposits in the body get concentrated over a period of time and cause long-term damage. The exposure to arsenic can occur by all the three common routes, i.e., contact, ingestion and inhalation. However, long-term ingestion from drinking water containing high arsenic levels is of most concern.

In India, one of the most devastating health crises arising out of arsenic poisoning has quietly unfolded in the lower Gangetic Plains covering some nine districts of West Bengal, and a few districts of Bihar, Chattisgarh, and Uttar Pradesh. It has affected neighbouring Bangladesh also where some 64 districts are affected. Arsenic problem has also come to light in several districts of Punjab and Sind in Pakistan. Reports of arsenic contamination in ground water have also come in from Nepal, and to a lesser extent, from other parts of the world including China, Taiwan, Mongolia, Ghana, Argentina, Chile, Mexico,

Britain and more recently from Northern Vietnam, Canada and USA. Arsenic poisoning was first reported in India during 1978 in West Bengal. Thereafter it has been reported in more areas since early 1990s.

Long-term exposure to arsenic in drinking water are known to pose a variety of health problems including several types of cancer, cardiovascular disease, diabetes, and neurological effects. The common valances of arsenic in raw water sources are +3 (arsenite) and +5 (arsenate). In waters polluted by human activity, other arsenic species may also be present. The health effects of arsenic has been reviewed by many authors and it is claimed that the toxicity of arsenic varies with the nature of chemical species in the following order:

As (III) > As (V) > organic-As

The lethal dose for humans is estimated to be 1 to 4 mg of arsenic per kg of body weight.

The predominant symptoms of arsenic poisoning are skin manifestations, which is called arsenicosis. Other most common manifestations of arsenic poisoning are melanosis, keratosis, leukomelanosis, hyperkeratosis, and also in some cases conjuctivitis, bronchitis and hepatomegally. Severe cases of skin cancer (squamous cell carcinoma and basal cell carcinoma) have also been reported.

Detection of Arsenic

Arsenic concentration in ground water ranges from 50 ppb (parts per billion) to 5 ppm (parts per million). The standard for arsenic in drinking water set by the World Health Organisation is .01 mg/l (10 ppb), whereas analysis of water collected by WHO, National Institute of Preventive and Social Medicine (NIPSOM), School of Environmental Science, Jadavpur University, Public Health Engineering Department, West Bengal, Harvard School of Public Health, and several other organisations in Bangladesh have indicated arsenic concentrations ranging from 0.05 mg/l - 5 mg/l, which is far above the permissible level.

Remediation Technologies

The common method of removing arsenic from water involves using chlorine or ozone. However, the waste products from this process are hazardous. Numerous other methods for removal of arsenic from water are also available. Some of these involve more than one type of chemical reaction, viz., oxidation, coagulation, sedimentation, etc. Of late, there has been considerable advancement in water treatment technologies worldwide. The general techniques used for removal of arsenic are summarized in Table 1.

High cost, problems of waste disposal and effect on environment are major limitations in the implementation of

Table 1
Available Technologies for Arsenic Treatment

Method	Advantages	Disadvantages
Co-precipitation:	Relatively low cost, simple chemicals. Low capital costs.	Serious short and long term problems with toxic sludge. Multiple chemicals requirement. Operation requires training and discipline.
Alum coagulation	Durable powder chemicals normally available	Efficient pre-oxidation is a must
Iron coagulation	More efficient than alum on weight basis	Medium removal of As (III)
Lime softening	Most common chemicals	Re-adjustment of pH is required
Sorption techniques:	No daily sludge problem.	Requires monitoring of break through or filter use. Requires periodical regeneration or medium shift.
Activated alumina	Relatively well known and commercially available..	Re-adjustment of pH is required
Iron coated sand	Expected to be cheap. No regeneration is required.	Yet to be standardized. Toxic solid waste.
Ion exchange resin	Well defined medium and hence capacity.	High-cost medium. High-tech operation and maintenance. Regeneration creates a sludge problem.
Membrane techniques:	Low space requirement. Capable of removing other contaminants, if any.	High running costs. High investment costs. High-tech operation and maintenance. Toxic wastewater. Re-adjustment water quality is required.
Reverse osmosis		Membrane does not withstand oxidizing agents.

Domestic filter developed by developed by NMRL, Ambernath, India

arsenic removal programmes. Most of the affected people in the developing world are poor villagers who cannot afford expensive technologies that have now started entering the market. Moreover, the sophistication and delicate nature of these technologies and the subsequent care and maintenance of the equipments required add to their

Household filter Jibon (Life) used in Bangladesh

expenses apart from causing inconvenience to the users. None of the arsenic mitigation projects has arsenic disposal programme. In general, different agencies have failed to give the people arsenic-free water and environmental consciousness education in a sustainable manner. No water-purification device is by itself capable of removing all of the toxics from drinking water. Many unscrupulous companies and sales persons sell water-purification equipment to cash in on people's fears about polluted water to make quick money.

Keeping the limitations and shortcomings of the aforesaid technologies in mind, a novel domestic arsenic removal filter has been developed at Naval Materials Research Laboratory, Ambernath, a laboratory under Defense Research and Development Organization. The filter has been successfully evaluated in the field in terms of its efficiency for the removal of arsenic, iron and bacteria from ground water. Villagers in arsenic affected areas of West Bengal and Bihar are using about 200 such filters for last two years. The filter is easy to maintain and does not require any power supply for its operation.

The main factors to be taken care of for large-scale use in villages and remote areas are simplicity of design, cost, efficiency, and user friendliness. The implementation and monitoring of remediation programmes needs close interaction and cooperation between members of communities, NGOs, public health agencies and government bodies at national, regional or even international level.

Dr. A.K. Datta retired from Defence Research & Development Organisation where he held several positions including Director, Centre for Fire and Explosive & Environment Safety and later Chief Controller, R&D.

Dr. Kshipra Misra is presently working as Scientist "F" in Department of Science & Technology, Government of India. Earlier she was in Defence Research & Development Organisation and has successfully developed an indigenous technology for arsenic remediation.

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Coronary Angioplasty

Restoring Your Heart's Lifeline

❑ Dr. Yatish Agarwal
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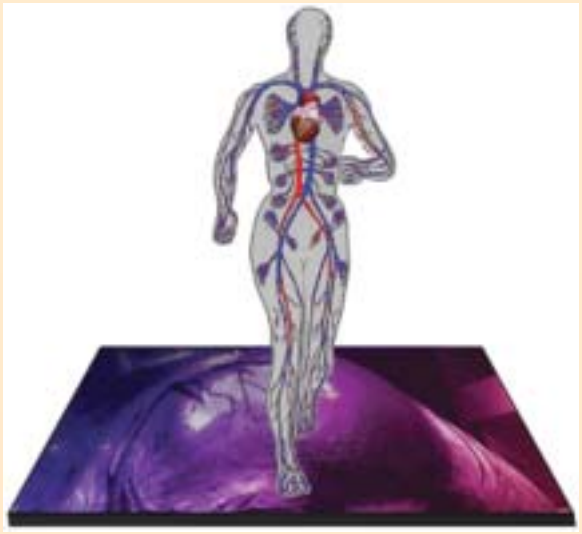
> Life is constantly providing us with new funds, new resources, even when we are reduced to immobility. In life's ledger there is no such thing as frozen assets.
> **Henry Miller in *Quiet Days in Clichy***

Coronary angioplasty is a truly amazing technique, which works at re-establishing the blood supply of the hardworking heart. It offers a chance of recovery to those patients of coronary heart disease, who find their life severely constrained despite taking anti-anginal pills or who are at serious risk of their life being cut short. Even though no technique is free of risks and complications, it is extremely useful in a definite category of coronary patients.

Coronary angioplasty

Beginning as a novel option in 1977, coronary angioplasty has today matured into a widely practised



alternative treatment to coronary bypass surgery the world over. The technique uses the simple concept of dilating (stretching) the narrowed portions of one or more coronary arteries to re-establish the normal blood supply of the heart.

The technique relies upon using a special balloon catheter, which is deftly manoeuvred into the narrow or blocked segment of the coronary artery and inflated to clear it of fat deposits. A brief procedure, done under local anaesthesia, it spares the patient a major surgery. In most cases, it only involves one- or two-day hospital stay, and ensures a quick return to normal life.

Who might benefit

Coronary angioplasty is today the preferred treatment for roughly 70 per cent of patients with symptomatic single vessel disease and roughly 20 per cent of patients with symptomatic three-vessel disease. It has come of age and is being fruitfully used in a wide variety of situations. Even totally blocked coronary arteries can be crossed and dilated effectively. A single procedure can clear multiple lesions. Its use is now no longer restricted to blocks which are close at hand, discrete, and do not occlude the vessel lumen completely.

The use of coronary stents – metallic tubes or scaffolds – that are inserted into a diseased vessel segment in their collapsed form and are then expanded to establish a normal-appearing vessel lumen, has made it possible to treat even calcified, or diffuse obstructions in the coronary tree with reasonably good results. Besides correcting constrictions in the native coronary

arteries, the technique is also being used to dilate obstructions in bypass grafts. This proves useful to people who have had bypass and again develop angina.

The decision whether to take the patient for angioplasty or bypass surgery is guided by several factors: the accessibility of the narrowed portions, the severity of disease, and the likely benefit that the two procedures might bring. There is evidence to suggest that people with diabetes generally do better with bypass surgery as compared to angioplasty. In all others, the survival figures are matchable, although repeat narrowing(s) are more common following angioplasties.

How it is done

Generally, you are admitted to the hospital a day in advance. You are permitted a light dinner, following which you will be asked to fast till after the procedure is complete the next day. You would be given a medication to help relax before going to bed. The procedure usually takes less than two hours, though it varies with the job at hand.

The procedure is much like a coronary angiogram, and is carried out in the cardiac cath lab. You rest on a motorised X-ray table, and your doctor would be dressed as in the operating room.

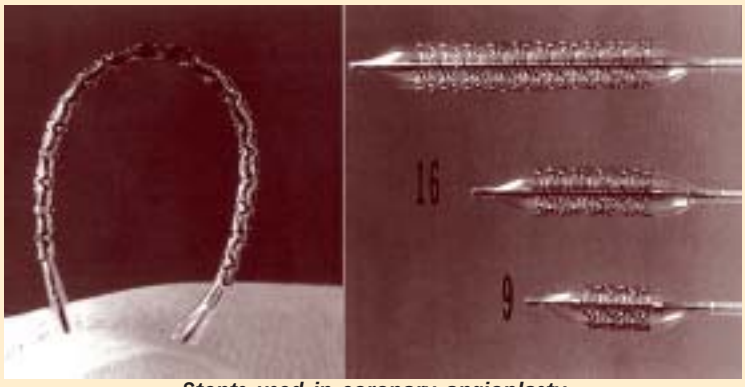
You will be given a quick jab of local anaesthesia over the upper leg or groin area. A tiny nick will be made, and a guide wire shall be inserted through the femoral artery, and up into the affected coronary artery. A balloon catheter is passed up the wire, and the balloon is inflated and deflated several times in the narrowed area to widen it. In more than half the patients, a coronary stent is inserted to keep the artery open. This reduces the possibility of the artery collapsing following the removal of balloon. The balloon catheter, having done its job, is then withdrawn. A set of X-ray images is taken by instilling a contrast dye before and after coronary angioplasty to check if the procedure has been successful.

Aftercare

After the angioplasty is over, you would be taken to the cardiac care unit, where your blood pressure, pulse and ECG would be regularly monitored. You would be asked to hold your leg straight and still for the next six or eight hours. You would also receive blood-thinning medication, vasodilators, and aspirin to keep the artery open and free of any clots. Once you feel better, and that is usually by the next day, you might receive your discharge and go home. Within a week or ten days, you can resume normal activities.

Results

In good hands, coronary angioplasty is a fairly safe and effective procedure. There is, however, a risk of



Stents used in coronary angioplasty

complications, requiring emergency bypass surgery in about one per cent of cases. A full operating surgical team and an operation theatre is therefore kept in readiness while angioplasty is under way. There is also a small risk of death in 0.4 to 1.0 per cent cases. It must be viewed as an invasive procedure whose risks and benefits for each individual patient need to be weighed before use.

Success rates of angioplasty exceed 95 per cent for dilating a narrowed artery. The follow up results are however not that good. Roughly 20 per cent of patients develop recurrent symptoms within six months, due to restenosis (recurrence of narrowing) of the dilated segment. By five years, 40 to 50 per cent will require a repeat angioplasty to maintain an equivalent level of symptom relief.

Aftercare

It is essential to make lifestyle changes and opt for a healthier living to stop the progression of coronary heart disease. Angioplasty is in no way a guarantee against the recurrence of disease.

Facilities in India

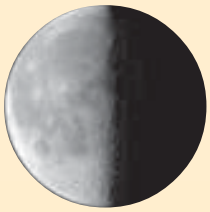
Most large heart care centres in bigger cities in the country are equipped with excellent angioplasty facilities. The results of these institutions match with the best in the world.

Sky Map for February 2007

Full Moon

2 February

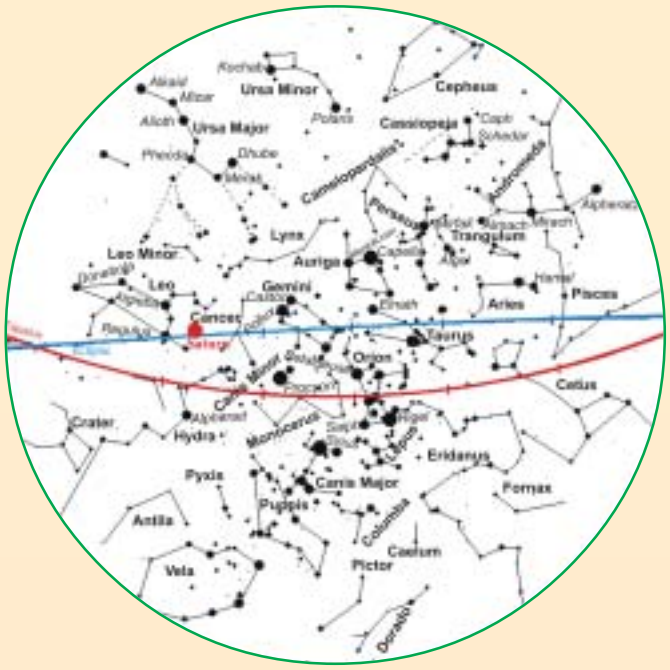
Moon - Last Quarter



10 February

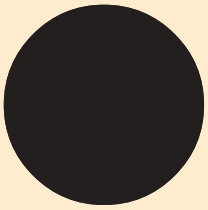
North

East



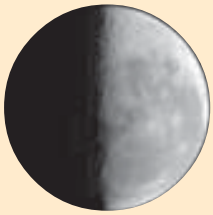
West

New Moon



17 February

Moon - First Quarter



24 February

South

The sky map is prepared for viewers in Nagpur (21.09^0 N, 79.09^0 E). It includes bright constellations and planets. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky, and those of the northern sky will appear nearer the northern horizon. Similarly, for viewers north of Nagpur, constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 February, at 9:00 PM on 15 February and at 8 PM on 28 February.

Tips for watching the night sky :

(1) Choose a place away from city lights/street lights (2) Hold the sky-map overhead with 'North' in the direction of Polaris

(3) Use a pencil torch for reading the sky map (4) Try to identify constellations as shown in the map one by one.

Planet Round up :

Saturn: In the constellation Leo *(Simha Rashi),* up in eastern horizon.

Prominent Constellations: Given below are prominent constellations with brightest star therein (in the parenthesis). Also given are their Indian names.

Eastern Sky: Crater, Hydra, Leo (Regulus) / *Simha Rashi (Magha)*, Leo Minor

Western Sky: Andromeda / *Devyani*, Aries (Hamal) / *Mesha Rashi*, Cetus (Deneb Katos) / *Timingal*, Fornax, Pisces / *Min Rashi,* Trangulum.

Southern Sky: Antila, Canis Major (Sirius)/Bruhalubdhak *(Vaydh),* Columba, Dorado, Eridanus/*Yamuna*, Fornax, Pictor, Puppis, Pyxis, Vela.

Northern Sky: Cassiopeia / *Sharmista*, Cameleopardalis, Cepheus / *Vrishaparv*, Ursa Minor (Polaris) / *Dhruvamatsya (Drhuvataraka),* Ursa Major/Saptarshi

Zenith: Cancer/*Karka Rashi*, Canis Minor (Procyon)/ *Laghulubdhak (Prashav)*, Gemini (Castor, Pollux)/*Meethun Rashi (Punarvasu, Purush)*, Lynx, Monocerus, Auriga (Capella) / *Sarthi (Brahmahridhay)*, Lepus / *Shashak*, Orion (Betelgeuse) / *Mrigah (Aardra)*, Perseus (Mirfak, Algol) /*Yayati*, Taurus / *Vrishabh Rashi*

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Earthquake Tip 8
What is the Seismic Design Philosophy for Building?

The Earthquake Problem

Severity of ground shaking at a given location during an earthquake can be *minor*, *moderate* and *strong*. Relatively speaking, minor shaking occurs frequently, moderate shaking occasionally, and strong shaking rarely. For instance, on average, annually about 800 earthquakes of magnitude 5.0-5.9 occur in the world while the number is only about 18 for magnitude range 7.0-7.9 (see Table 1 of IITK-BMTPC Earthquake Tip 03 at *www.nicee.org)*. So, should we design and construct a building to resist that *rare* earthquake shaking that may come only once in 500 years or even once in 2,000 years at the chosen project site, even though the life of the building itself may be only 50 or 100 years? Since it costs money to provide additional earthquake safety in buildings, a conflict arises: *Should we do away with the design of buildings for earthquake effects?* Or *should we design the buildings to be "earthquake proof" wherein there is no damage during the strong but rare earthquake shaking?* Clearly, the former approach can lead to a major disaster, and the second approach is too expensive. Hence, the design philosophy should lie somewhere in between these two extremes.

Earthquake-Resistant Buildings

The engineers do not attempt to make *earthquake-proof buildings* that *will not* get damaged even during the rare but strong earthquake; such buildings will be too robust and also too expensive. Instead, the engineering intention is to make buildings *earthquake-resistant*; such buildings resist the effects of ground shaking, although they may get damaged severely, they would not collapse during the strong earthquake. Thus, safety of people and contents is assured in earthquake-resistant buildings, and thereby a disaster is avoided. This is a major objective of seismic design codes throughout the world.

Earthquake Design Philosophy

The earthquake design philosophy may be summarized as follows (Figure 1):

(a) Under minor but frequent shaking, the main members of the building that carry vertical and horizontal forces should not be damaged; however building parts that do not carry load may sustain repairable damage.

(b) Under moderate but occasional shaking, the main members may sustain repairable damage, while the other parts of the building may be damaged such that they may even have to be replaced after the earthquake; and

(c) Under strong but rare shaking, the main members may sustain severe (even irreparable) damage, but the building should not collapse.

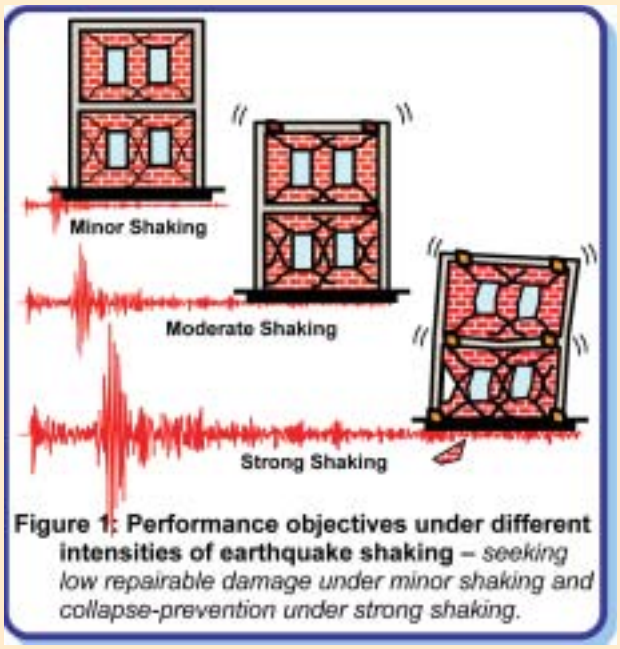


Figure 1: Performance objectives under different intensities of earthquake shaking – *seeking low repairable damage under minor shaking and collapse-prevention under strong shaking.*

Thus, after minor shaking, the building will be fully operational within a short time and the repair costs will be small. And, after moderate shaking, the building will be operational once the repair and strengthening of the damaged main members is completed. But, after a strong earthquake, the building may become dysfunctional for further use, but will stand so that people can be evacuated and property recovered.

The consequences of damage have to be kept in view in the design philosophy. For example, important buildings, like hospitals and fire stations, play a critical role in post-earthquake activities and must remain functional immediately after the earthquake. These structures must sustain very little damage and should be designed for a higher level of earthquake protection. Collapse of dams during earthquakes can cause flooding in the downstream reaches, which itself can be a secondary disaster. Therefore, dams (and similarly, nuclear power plants) should be designed for still higher level of earthquake motion.

Damage in Buildings: Unavoidable

Design of buildings to resist earthquakes involves *controlling the damage to acceptable levels at a reasonable cost*. Contrary to the common thinking that any crack in the building after an earthquake means the

building is unsafe for habitation, engineers designing earthquake-resistant buildings recognize that some damage is unavoidable. Different types of damage (mainly visualized though cracks; especially so in concrete and masonry buildings) occur in buildings during earthquakes. Some of these cracks *are* acceptable (in terms of both their *size* and *location*), while others *are not*. For instance, in a reinforced concrete frame building with masonry filler walls between columns, the cracks between vertical columns and masonry filler walls are acceptable, but diagonal cracks running through the columns are not (Figure 2). In general, qualified technical professionals are knowledgeable of the causes and severity of damage in earthquake-resistant buildings.

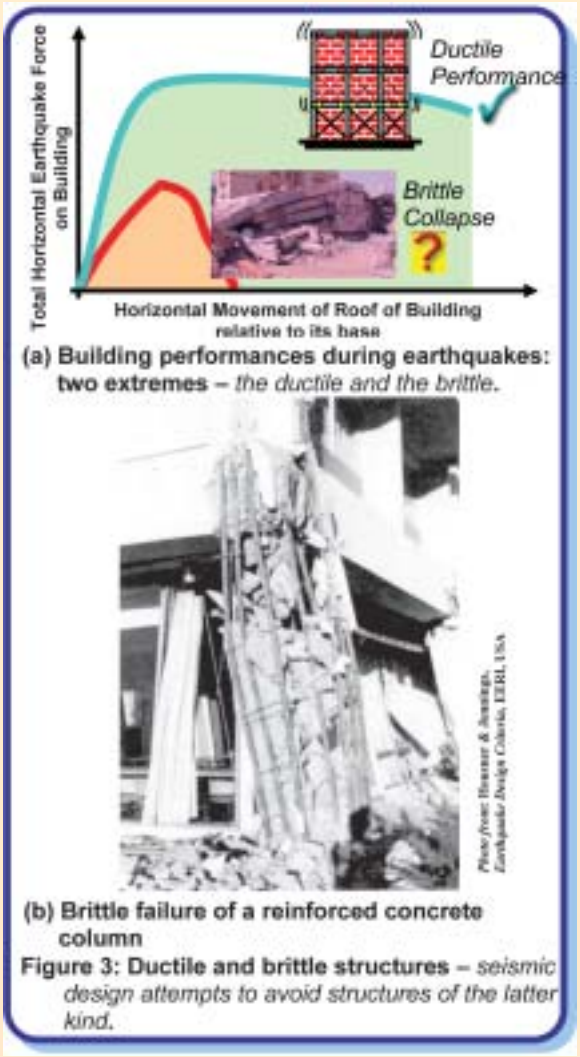
Figure 2: Diagonal cracks in columns jeopardize vertical load carrying capacity of buildings - *unacceptable damage.*

Earthquake-resistant design is therefore concerned with ensuring that the damages in buildings during earthquakes are of the *acceptable* variety, and also that they occur at the right places and in right amounts. This approach of earthquake-resistant design is much like the use of electrical fuses in houses: *to protect the entire electrical wiring and appliances in the house, you sacrifice some small parts of the electrical circuit, called fuses; these fuses are easily replaced after the electrical over-current.* Likewise, to save the building from collapsing, you need to allow some pre-determined parts to undergo the acceptable type and level of damage.

Acceptable Damage: Ductility

So, the task now is to identify acceptable forms of damage and desirable building behaviour during earthquakes. To do this, let us first understand how different materials behave. Consider *white chalk* used to write on blackboards and *steel pins* with solid heads used to hold sheets of paper together. Yes... a chalk *breaks easily*!! On the contrary, a steel pin *allows it to be bent back-and-forth*. Engineers define the property that allows steel pins to bend back-and-forth by large amounts, as *ductility*; chalk is a *brittle* material.

Earthquake-resistant buildings, particularly their main elements, need to be built with ductility in them. Such buildings have the ability to sway back-and-forth during an earthquake, and to withstand earthquake effects with some damage, but without collapse (Figure 3). Ductility is one of the most important factors affecting the building performance. Thus, earthquake-resistant design strives to predetermine the locations where damage takes place and then to provide good detailing at these locations to ensure ductile behaviour of the building.



(a) Building performances during earthquakes: two extremes – *the ductile and the brittle.*

(b) Brittle failure of a reinforced concrete column

Figure 3: Ductile and brittle structures – *seismic design attempts to avoid structures of the latter kind.*

Resource Material

1. Naeim, F., Ed., (2001), *The Seismic Design Handbook*, Kluwer Academic Publishers, Boston, USA.
2. Ambrose, J., and Vergun, D., (1999), *Design for Earthquakes*, John Wiley & Sons, Inc., New York.

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S&T Popularisation Activities in Gujarat

Vigyan Prasar jointly with Gujarat Science Academy organised a two-day (2-3 December 2006) workshop in Gandhi Nagar. About 50 participants from different parts of Gujarat attended the workshop. The workshop was the result of the initiatives undertaken by Professor S. P. Pandya, formerly Director of the Physical Research Laboratory, Ahmedabad. The idea was to make the science communicators of the state of Gujarat aware about the activities of Vigyan Prasar and identify S&T popularization activities that would be undertaken by Vigyan Prasar in Gujarat in association with Gujarat Science Academy, Gujarat Science City, Gujarat Council of Science and Technology (GUJCOST), and other organizations/individuals engaged in science popularization.

The keynote address was delivered by Dr. R. N. Vakil, President, Gujarat Science Academy. While emphasizing the importance of science popularization, Dr. Vakil briefly described present scenario in the state and what could be done. Dr. V. B. Kamble, Director, Vigyan Prasar made a presentation on the programmes and activities of Vigyan Prasar. Dr. Narottam Sahoo described the activities undertaken by the Gujarat Science City in the field of science popularization. Dr. Prabhakar talked about the S&T popularization

A view of the participants during the workshop

(Contd. on page...40)

Workshop in Mizoram to Develop Scripts in Mizo Language

A special initiative has been taken by Vigyan Prasar to enhance the activities in S&T communication in North-Eastern States. A series of preliminary rounds of meetings and discussions had been held earlier in Mizoram and Nagaland with officials of AIR, Doordarshan, and State Councils for S&T, science communicators and voluntary organisations working in the field of science popularization. As part of this initiative a science writers' workshop was organized jointly by Vigyan Prasar and Mizoram Council for S&T and Environment at Aizwal on 8- 9 December 2006. More than 25 science communicators representing Science Teachers Association of Mizoram, Mizoram Science Society, and the Post Graduate Science Teacher's Association attended the meeting. Representatives of AIR and Dr. Subodh Mahanti Scientist-F, Vigyan Prasar, B.K.Tyagi, Scientist-D, Vigyan Prasar, and Dr. Vanlal Zara, Principal Scientific Officer, Mizoram Council for Science, Technology, Environment were also present.

A view of the participants at the workshop

In an earlier a meeting during 3-6 May 2006 at Aizwal a decision was taken to produce a science serial in Mizo, the local language, for radio and Doordarshan. In that meeting it was decided to produce a 13-part radio serial on the topic 'Conservation of Environment and Sustainable Development in Mizoram' and a TV quiz show on general science. In that meeting the agencies and individual science communicators were identified to produce the scripts and develop the question bank for the quiz show. The responsibility of developing the question bank was given to Science Teachers Association of Mizoram and the development of script for radio serial was assigned to the members of Mizoram Science Society and the Post Graduate Science Teacher's Association under the overall supervision and guidance of Dr. Vanlal Zara.

During the first day of the meeting, participants were divided into two groups – one group for developing question bank for TV quiz, and another for developing scripts for the radio serial. During the two-day deliberations 13 radio scripts were critically examined and the sequence, format and treatment for each script was finalized. The final vetting is to be done by the subject experts of the Mizoram Science Society. The final scripts are to be handed over to AIR for production by the end of January 2007. Similarly the question bank comprising about 1,000 questions was finalized for the various rounds like preliminary, quarterfinal, semi final and final round, etc. Shri Amit Chakarborty, ex-DDG, AIR attended the meeting as an expert to examine the scripts and format of the quiz from the production point of view.