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VP News

Inside

Astronomical Activities Workshop at Cambridge School, Noida (UP)

An astronomical activity workshop for selected teachers from different schools of NOIDA (UP) was organized at Cambridge School, Sector 27, NOIDA from 28 August-1 September 2006. The purpose of the workshop was to develop awareness and enthusiasm towards the astronomy in school-going childrens. The total number of participants was 30. A large numbers of school students also attended the workshop. During the workshop the participants assembled 30 simple 39-mm refractor telescopes, which were given away to the participating schools to start astronomical and sky watching activities in their respective astronomy clubs on a regular basis. Documentary films on Einstein's work, Transit of Venus, Prof. P.C. Vaidya, and Prof. A.K. Roychaudhuri were shown to the participants. On 30 August, the participants visited Vigyan Prasar's astronomy laboratory and enjoyed night sky watching from VP's terrace using VP's 11" Celestron CGE Schmidt-Cassgrain telescope. Arvind C. Ranade, Dr. T. V. Venkateswaran, Kapil Tripathi, scientists from Vigayn Prasar and eminent science writer Biman Basu conducted the workshop.

Sri Kapil Tripathi, Scientist, VP, demonstrating the Activity Kit on Astronomy to the participants

Workshop and Sensitization Programme at Trichy (Tamilnadu)

Vigyan Prasar and Tamilnadu Science & Technology Centre, Chennai, organized a three-day orientation-cum-training programme for teachers at the Anna Science Centre-Planetarium, Tiruchirapalli. This was second workshop of the series that Vigyan Prasar organised in Tamilnadu to sensitize school teachers and science communicators to form science clubs in their respective areas. A similar workshop was organised in Chennai in March 2006, which led to the formation of about 75 science clubs in and around Chennai. About 60 teachers representing 30 schools attended the three-day orientation-cum-training programme at Tiruchirapalli. Dr. R. Baskara Sethupathy, Chief Educational Officer, Tiruchirapalli inaugurated the programme. Resource persons for the workshop were drawn from the Tamilnadu Science Forum, besides the project officers and technical officers of the Anna Science Centre-Planetarium, Tricharapalli. During the

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

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Editor : Dr. V.B. Kamble

Asking Mosquitoes to Buzz Off

Every year the retreating monsoon brings a scourge of mosquitoes and leaves a trail of malaria, dengue and chikungunya claiming many lives and infecting thousands. The trail grows wider as every successive year the microorganisms causing the disease mutate into a more virulent form. Although malaria has been around for centuries, dengue and chikungunya are relatively new. Malaria is caused by a protozoan parasite of the genus Plasmodium. This parasite is transmitted from infected persons by the bite of a female *Anopheles* mosquito after it has developed in the body of this insect. *Anopheles* mosquito is thus called the vector (carrier) of malaria. While dengue is caused by any of the four closely related viruses (DEN - 1,2,3, and 4), chikungunya is caused by the chikungunya virus. Both, dengue and chikungunya viruses are transmitted from infected persons by the bite of a female *Aedes aegypti* mosquito. Thus the mosquito *Aedes aegypti* is a vector of *both* the diseases – dengue and chikungunya. This year, soon after the monsoon retreated, dengue has infected some 6,423 people across the country and claimed 107 lives, with Delhi alone reporting over 1,731 cases with 31 deaths till the second week of October. Suspected chikungunya cases exceed 1.35 million while those confirmed are about 1,651. Kerala has been the worst hit with dengue and chikungunya both. Nearly 60,000 people are being treated for chikungnya in Kerala alone, while the virus is believed to have claimed about 80 lives.

The first reported epidemics of dengue (also called dengue fever or DF) occurred in 1779-1780 in Asia, Africa and North America. The term dengue comes from the Swahili word “dinga” meaning sudden cramp-like seizure. It appeared in Cuba in 1827 and the name was popularly (but incorrectly) identified with the Spanish word dengue meaning “fastidiousness”. The dengue viruses and their mosquito vector have had a worldwide distribution in the tropics for over 200 years. Dengue fever was considered a mild, non-fatal disease and there were long intervals (10-40 years) between major epidemics. A pandemic of dengue began in South East Asia after World War II and has spread around the globe since then. In South East Asia, a more severe form of dengue – dengue haemorrhagic fever or DHF – first appeared in Philippines in 1950. The disease has since spread to many countries in South-East Asia, and has now become endemic in several countries of the region, including India. In terms of worldwide distribution, dengue is second only to malaria. Though dengue fever has been known to be in existence in India for a long time, dengue haemorrhagic fever was first reported in an outbreak which occurred in Calcutta in 1963, with major outbreaks of dengue in 1996, 2003 and in 2005. This year we have been facing yet another major outbreak.

A normal dengue fever is characterized by high temperature, body-ache, joint pain, vomit and rashes. People who suffer from dengue fever have no risk of death, but some of them develop dengue haemorrhagic fever or dengue shock syndrome (DSS). In some of these cases death can occur. These conditions are primarily characterized by low platelet count, bleeding from orifices, stomach ache and low blood pressure, but are controllable with adequate and timely medical care. The bleeding occurs due to damage to the blood vessels, which may range from increased permeability of the blood vessels, causing leakage of blood fluid/plasma into various organs to completely broken blood vessels that causes bleeding. The symptoms and signs of dengue haemorrhagic fever and dengue shock syndrome are related to damage caused to the blood vessels and derangement in functioning in components of blood that help it to clot. With platelet count going down, clotting of blood does not take place effectively. The disease is difficult to detect as antibodies produced take up to four days after infection to test positive in serology tests. With proper treatment, however, the patients with dengue haemorrhagic fever and dengue shock syndrome can recover fully. Like most viral diseases there is no specific cure for dengue fever. Antibiotics do not help. *Paracetamol* is the drug of choice to bring down fever and joint pain. *Aspirin* and *Brufen* are best avoided since they can increase the risk of bleeding.

Chikungunya was first officially identified in Tanzania, in 1953. Soon thereafter, epidemics were recorded in Thailand, Cambodia, Vietnam, India, Myanmar, and Sri Lanka. Incidentally, the name chikungunya comes from the word *chikungunde* in Makonde language of southern Tanzania and Northern Mozambique on the east coast of Africa meaning “that which folds up” and refers to the contorted (or stooped) posture of patients who are afflicted by severe joint pain, which is the most common feature of the disease. Chikungunya mainly occurs in Africa, India and South East Asia. Since 2003, there also have been outbreaks in Philippines and island nations of the Indian Ocean. Some European countries have also reported chikungunya cases. In India, a major epidemic of chikungunya fever was reported during 1963 (West Bengal, Tamilnadu and Andhra Pradesh) and 1973 (Maharashtra). Although it was recorded especially in Maharashtra during 1983 and 2000, chikungunya has struck India this time on a mass scale essentially after several decades.

Chikungunya resembles dengue fever, and is characterized by severe, sometimes persistent joint pain, as well as fever and rash. It is rarely considered to be life

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Paul Erdos

The Man Who Loved Only Numbers

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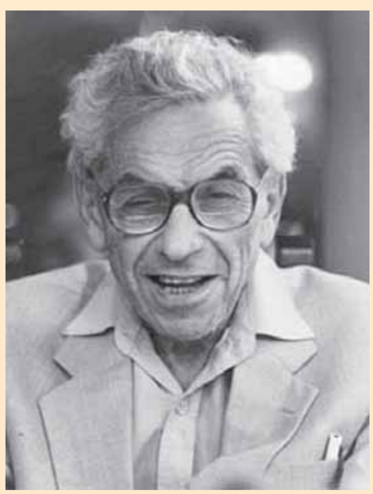
"Problems have always been an essential part of my mathematical life. A well-chosen problem can isolate an essential difficulty in a particular area, serving as benchmark against which progress in this area can be measured. An innocent looking problem often gives no hint as to its true nature. It might be a 'marshmallow', serving as tasty tidbit supplying a few moments of fleeting enjoyment. Or it might be like an 'acorn' requiring deep and subtle insights from which a mighty oak can develop."

Paul Erdos

"In our century, in which mathematics is strongly dominated by 'theory constructors' he has remained the prince of problem solvers and absolute monarch of problem poser….In many ways Paul Erdos is the Euler of our times. Just as the special problems that Euler solved pointed the way to analytic and algebraic number theory, topology, combinatorics, function spaces, etc., so the methods and results of Erdos's work already let us see the outlines of great new disciplines, such as combinatorial and probabilistic number theory, combinatorial geometry, probabilistic and transfinite combinatorics and graph theory, as well as many more yet to arise from his ideas."

Ernst Strauss, who worked with both Albert Einstein and Paul Erdos

Paul Erdos was a legend in his lifetime for various reasons. He was the most prolific mathematician of the 20th century, and was truly a pure mathematician. He was a problem solver. Problems were an essential part of his mathematical life. Throughout his life he posed and solved mathematical problems, not ordinary ones but the most difficult ones. For Erdos, a proof of a mathematical problem was not just a complicated sequence of steps. He believed that a proof of a problem must provide insight into why the result was true. Erdos epitomized the wit of the mathematical world. He was called a prince of problem posers. He encouraged other mathematicians to solve difficult mathematical problems. He believed that "mathematical truths are discovered and not invented."



Paul Erdos

Erdos was often called Euler (referring to the great 18th century German mathematician Leonhard Euler) of his times. He devoted his life to mathematics to an unequalled degree. Though he worked in many areas of mathematics, it was in number theory in which he excelled. He published a total of over 1,500 papers, publishing one paper a week even in his seventies. Erdos liked to quote one of his colleague's remarks, viz., "A mathematician is a device for turning coffee into theorems." He spent his life working up to 20 hours a day on mathematical problems, usually with colleagues.

Erdos's first significant contribution to number theory was his elegant proof for the theorem which stated that 'for each number greater than 1, there is always at least one prime number between it and its double.' He proved this theorem when he was 21 years old. The theorem which was first conjectured by Bertrand in 1845 was earlier proved by the Russian mathematician Chebyshev in 1850 but Erdos's proof was more elegant and elementary. His greatest achievement was the first elegant and elementary proof of the Prime Number Theorem, which was conjectured in the 18th century and had explained the pattern of prime numbers since 1896. The theorem had been earlier proved by Hadamard and de la Valee Poussin independently in 1896 by using complex analysis. Erdos developed his proof in 1949. The Norwegian mathematician A Selberg also developed a proof independently of Erdos in the same year.

Erdos did not have a permanent residence. He did not care for worldly success or personal comforts. To him any kind of property was a nuisance. He once said: "I never wanted material possessions. There is an old Greek saying that the wise man has nothing he cannot carry in his hands. If you have something beautiful, you have to look out for it, so I would rather give it away. I always say, 'Private property is a nuisance.' He did not keep his earnings as lecturing fees or prizes for himself. He spent his earnings mostly by giving prizes to those who solved difficult problems in mathematics posed by him. The prizes fixed by him for solving problems ranged from 25 US dollars (for a problem which he did not consider very difficult) to 10,000 dollars (for a problem in number theorem which he considered hopeless). The maximum amount that he paid as prize money for solving a problem was 1000 dollars. He also donated to students. Occasionally he also gave away his earnings to charities. In 1983 he won the most lucrative award for mathematicians, the Wolf Prize, with a prize money of 50,000 US dollars. He kept only 750 dollars for himself, the rest he gave away. He donated 30,000 dollars to a university mathematics department for the establishment of a memorial fund in the name of his mother. Most of the rest of the prize money he gave to his relatives for various reasons. He led a very simple life and he needed very little money to meet his requirements. He did not marry. Erdos was hardly interested in any kind of relationship 'which was not founded in shared intellectual curiosity'.

Leonhard Euler

Erdos refused to accept a permanent job because he thought a permanent job would limit his ability to focus on mathematical problems and to collaborate with mathematicians in distant lands. For his work in pure mathematics, he did not require any equipment, or laboratory or library. He stayed with friends or at conferences. He practically lived out of a suitcase and travelled from one mathematical centre to another. In fact he died while attending a conference in Warsaw. He travelled extensively. There was a saying in circulation among his co-workers and friends: "If you want to meet Erdos, stay where you are and wait; he will appear there soon." He was affiliated with the Mathematical Institute of the Hungarian Academy with the condition that he would receive his salary when he was in Hungary. He mostly lived on lecture fees, prizes and hospitality of collaborators.

Paul Erdos was born on 26 March 1913 in Budapest, Hungary. Both his parents, Lajos and Anna Erdos were mathematics teachers. His parents were of Jewish origin but they did not observe the Jewish religion. He was one of three children of his parents. His two sisters, both of whom died young of scarlet fever, were considered even brighter than Erdos. Erdos himself was a truly child prodigy. At the age of three he could multiply three digit numbers in his head. He also discovered negative numbers for himself at the age of three, when he subtracted 250 degrees from 100 degrees and came up with 150 degrees below zero. Erdos was a much protected child. His parents were very protective of him because they had lost two of their daughters and Erdos was the only remaining child. Someone said: "Erdos had never buttered his own toast till he was 21 years old." He was taken out of school just after a few years. He was taught at home by his parents and a German governess.

Erdos obtained his PhD degree in 1934 from the Peter Pazmany Catholic University in Budapest. After his doing his doctorate he went to Manchester in the UK as a Post Doctoral Fellow. He was in Manchester for four years. He used to visit Budapest at least three times a year during his stay at Manchester. However, with the rise of Hitler in Germany, Hungary was not a safe place for people of Jewish origin. He went to work at Princeton, USA. His initial fellowship was for a year. It was not extended because Erdos did not conform to Princeton's standards. The authorities of Princeton found him "uncouth and unconventional".

In 1943, Erdos accepted a part-time appointment at Purdue University in USA. He was totally cut off from his family members and friends in Hungary during the war. In August 1945, he got news of his family. His father had died of a heart attack in 1942. Somehow his mother and a cousin had survived. Four of his uncles and aunts were murdered. He could finally return to Hungary towards the end of 1948 to meet the surviving family members and friends. Before accepting a temporary appointment at the University of Notre Dame in USA in 1952, he travelled frequently between England and the USA. His terms of appointment were quite liberal. He was free to go anywhere in the world to do joint research work. He could have got his appointment on a permanent basis under the same liberal terms and conditions, but he did not want that way. In 1951, Erdos won the Cole Prize of the American Mathematical Society for his significant contributions to the number theory.

In 1955, while applying for a post of permanent visiting professor, Erdos described himself in the following paragraph. "I Paul Erdos was born on March 26, 1913. I studied at the University of Budapest, I got my PhD at the University of Budapest in 1934. From 1934 to 1938 I had a research fellowship at the University of Manchester. I got the degree of DSc at Manchester in 1939 (in absentia). From 1938 to 1948 I was at various American universities, including the Institute for Advanced Study, University of Pennsylvania, Purdue University, University of Michigan, Stanford University, and University of Syracuse. In 1948-49 I gave lectures at various universities in Holland, England and Hungary. In 1949-50 I lectured at various American universities and in 1950-51 I was at the University of Aberdeen in Scotland and 1951-52 I was at University College of London. (In) 1952-53 I was at the American University in Washington and was connected with the Bureau of Standards and the Institute of Numerical Analysis at Los Angeles. In 1953-54 I was visiting professor at the University of Notre Dame. I was supposed to be visiting lecturer there this year but was prevented to return there by circumstances beyond my control. I am supposed to be visiting lecturer at the American Mathematical Society in 1955-56 but it is not yet certain I will be able to take up the appointment." He wrote by hand and there are some grammatical oddities in the paragraph.

In 1954, he went to Amsterdam to attend a conference but on his way back he was interrogated by immigrant officials on his views on communism. In a response to a question what he thought of Marx he is supposed have replied: "I'm not competent to judge, but no doubt he was a great man." He was denied re-entry visa. The interrogation was not the only reason for denying him re-entry visa. Other reasons have been cited for the US Government's refusal to issue Erdos a re-entry visa. He had corresponded with a Chinese mathematician residing in USA but who had subsequently went back to China. Earlier, in 1941, Erdos earned an FBI record for no real fault of his. Erdos and two fellow mathematicians were rounded up by police near a military radio transmitter on Long Island. They landed up there because being absorbed in animated discussion on mathematical subject they failed to notice the "No Trespassing" sign.

Srinivasa Ramanujan

Most of the ten years following the US Government's refusal to grant him a re-entry visa, Erdos spent in Israel. In the early 1960s he made several request to the US authorities for a re-entry visa and eventually he was allowed back into USA.

Erdos collaborated with about 500 mathematicians. For a mathematician of Erdos' time, it was considered an honour to collaborate with him. The American mathematician Casper Goffman introduced a concept called "Erdos number" around 1965 as a symbolic demonstration of this honour. The Hungarian mathematician József Pelikán wrote: "Erdos undoubtedly had the greatest number of co-authors among all the mathematicians of all times – the number of his co-authors totalled about 500. It is not by chance that the mathematicians of the worlds introduced the concept of the "Erdos Number". Someone has Erdos number 1 if he/she has written common paper with Erdos, someone having a common paper with someone who has Erdos number 1 (but not with Erdos himself) has Erdos number 2, etc. A huge number of today's mathematicians have a very small Erdos number. Erdos himself sometimes jokingly mentioned functional Erdos numbers: someone having n common papers with himself has Erdos number 1/n. Two mathematicians (A. Hanjal and A. Srkzy) have Erdos number less than 1/50 and the number of people having Erdos number less than 1/10 is close to 30."

Erdos himself valued collaboration with other mathematicians. Commenting on his work with the Polish mathematician Mark Kac he said: "This collaboration is a good example to show that two brains can be better than one, since neither of us could have done the work alone."

He maintained regular correspondence with his collaborators. He wrote about 1,500 letters every year. One of his collaborators, Dr. Joel H. Spencer of the New York University's Courant Institute of Mathematical Sciences said: "He was always searching for mathematical truths…Erdos had an ability to inspire. He would take people who already had talent and had had some success, and just take them to an entirely new level. His world of mathematics became the world we all entered."

Erdos was greatly influenced by the work of the great Indian mathematician Srinivasa Ramanujan. He said, "Unfortunately I never met Ramanujan. He died when I was seven years old, but it is clear from my papers that Ramanujan's ideas had a great influence on my mathematical development. I collaborated with several Indian mathematicians. S Chowla, who is a little older than I, has co-authored many papers with me on number theory and also have several joint papers with K Alladi on number-theoretic functions."

Regarding Erdos' visits to India C. S. Yoganand wrote in the journal *Resonance*: "Erdos visited India in 1974 when he was invited for a conference at the Indian Statistical Institute, Calcutta; after the conference he visited Madras and Bombay. He came back to India a few more times to visit ISI, Calcutta and to take part in the Number Theory Conferences organized by The Institute of Mathematical Sciences, Madras. He has written 23 papers with 15 Indian mathematicians."

Erdos died on 20 September 1996 in Warsaw, Poland, where he went to attend a conference. He was 83. Erdos had his own vision of perfect death. Gina Kolata wrote in the *New York Times* on 24 September 1996: "He (Erdos) would also muse about the perfect death. It would occur just after a lecture, when he had just finished presenting a proof and a cantankerous member of the audience would have raised a hand to ask, 'What about the general case?' In response, Dr. Erdos used to say, he would reply, 'I think I'll leave that to the next generation,' and fall over dead.'"

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Gordon Moore, His Law, and Integrated Circuits

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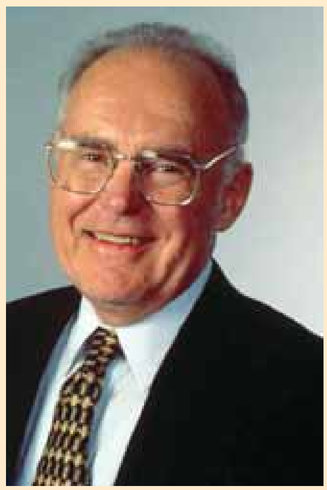
Introduction

Observations become prophetic when they possess insightful value and essence. Such profound observations remain memorable when history proves them right. Moore's Law, published four decades ago in the *Electronics* magazine, (volume 38, number 8) dated 19 April 1965, as a simple thought by Gordon Moore, the co founder of Intel, is one such prophetic observation. Moore's vision about integration, made just four years after the first planar integrated circuit (IC) was discovered, has now become a reality. This has happened as a result of ever-evolving innovations in IC design, modern manufacturing technologies, investments, research in digital electronics and communication technologies. Moore himself did not articulate his ideas as a law; rather he titled his paper "Cramming more components on to integrated circuits". He wrote, "The future of integrated electronics is the future of electronics itself. The advantages of integration will bring about a proliferation of electronics, pushing this science into many new areas. Integrated circuits will lead to such wonders as home computers – or at least terminals connected to a central computer – automatic controls for automobiles, and personal portable communications equipment". Today as the world commemorates the 41st year of Moore's law, his thoughts have continued to shape modern electronics, communication and information technologies yielding never-ending benefits to humankind.



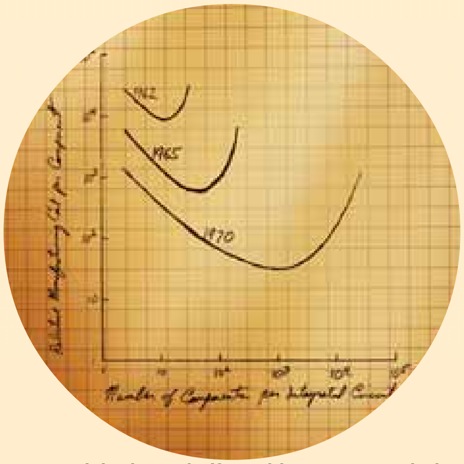
Gordon Moore

Since Robert Noyce and Gordon Moore founded Intel in 1969, Moore's Law has become a target that has driven product development within the company. In fact, not just Intel, the entire semiconductor industry is striving to keep pace with the famous Moore's curve. Special technology road maps are designed by technology working groups in the industry that define in detail the course for future developments over a 15-year period, driven by the desire to continue the past trends of Moore's Law. Thus making Moore's Law a self-fulfilling prophecy.

The all-pervading IC's

Integrated circuit (IC) is a tiny electronic circuit that is used to perform a specific pre-designed electronic function. It is usually combined with other components in the circuitry to perform a highly complex task. Single-crystal silicon units diffused with impurities serve as a semiconductor material. A semiconductor has electrical conductivity that is greater than an insulator but less than a conductor. The term is more commonly used to refer to an IC of various functions, manufactured by arranging resistive material on to a semiconductor substrate. An IC chip is a piece of silicon on which transistors and diodes are embedded by microfabrication processes and are interconnected to function as an electronic circuit. Silicon is abundantly available on the surface of the Earth as sand on the beaches and therefore is highly cost effective. Several hundred identical integrated circuits (ICs) are made at a time on a thin wafer several centimetres wide, and the wafer is subsequently sliced into individual ICs called chips. In large-scale integration (LSI), as many as 5,000 circuit elements, such as resistors and transistors, are combined in a square of silicon measuring about 1.3 cm on a side. Hundreds of these integrated circuits can be arrayed on a silicon wafer 8 to 15 cm in diameter. Larger-scale integration can produce a silicon chip with millions of circuit elements. Individual circuit elements on a chip are interconnected by thin metal or semiconductor films, which are insulated from the rest of the circuit by thin dielectric layers. Chips are assembled into packages containing external electrical leads to facilitate insertion into printed circuit boards for interconnection with other circuits or components. IC's popularly called 'chips' have a ubiquitous presence in almost all modern electronic and communication gadgets, which form the basis of information technology (IT). IT influences our lives at many levels. We use it to collect, process, communicate and present information. IT controls high-tech processes as well as medical diagnostic instruments and everyday home appliances. IT is viewed as a prime mover in the economic upswing our society has experienced specially during the past decade. Computers are linked in a global network that manifests itself through the Internet, which has helped in bridging the digital divide between the haves and have-nots.

A look at the performance of microelectronic circuits and chips reveals that the number of transistors integrated into an IC has increased almost one hundred-fold every ten years, almost following Moore's Law, and that too at unchanged prices. If steel was the raw material for the 20th century, it is silicon for the 21st century. And the silicon semiconductor industry has delivered a dramatic spiral of rapid cost reduction and exponential value creation, which



Gordon Moore's original graph (from his 1965 paper) that shows his forecast of increasing components and decreasing cost of an IC over the years

conform to the Moore's law. Because of the cumulative impact of these spiralling increases in capability, silicon powers today's economy running everything from digital phones and PCs to stock markets and spacecraft – and enables today's information-rich, converged, digital world. But if silicon technology's past has been dramatic, its future promises to be even more spectacular and far-reaching. Moore's prediction of cramming more components into ICs is now a virtuous and pleasant reality. Fulfilling the predictions of Moore's Law means accomplishing the near impossible – again and again. Silicon chip designers in the industry continue to make transistors smaller and smaller, which means reducing process geometries, scaling (or shrinking) the nominal feature size of the devices populating and powering the silicon chip. Scaling the process geometries makes more space available to bring more transistors, as well as to converge different types of devices and functions, onto the chip.

Moore's Law: The number of transistors on a chip doubles annually

The Moore's Law was never thought to be a law *per se* nor could it be categorized as a scientific law. Gordon Moore never used the word "law" to predict an annual doubling of the number of transistors that could be fabricated on a semiconductor chip. Carver Mead, then at the California Institute of Technology (Caltec), in Pasadena, coined the term "Moore's law" and he did so many years after Moore's paper was published. (Mead is better known for developing the Metal Oxide Semiconductor Field effect Transistor, the MOSFET, and a host of other inventions.)

During one of his interviews, when asked where did the Moore's law come from Gordon Moore said "For their 35th anniversary issue, the editor of *Electronics* magazine asked me to write an article on the future of semiconductor components for the next 10 years. I wanted to get across the idea that integrated circuits will be the way to make things cheap. So I made this extrapolation. The biggest circuit available then had something like 30 components on it. I looked historically and saw we had kind of gone four; eight, sixteen and we were about doubling every year. I didn't think it was going to be especially accurate; I just was trying to get the idea across that things are going to be significantly more complex and a lot cheaper, and it turned out to be much more accurate than I had any reason to believe".

Moore was Director of the research and development laboratories at the Fairchild Semiconductor Division of Fairchild Camera and Instrument Corp, when he articulated his vision on the newfound technology in his famous article. The entire article was a mere three and a half pages, including two charts and a cartoon-like drawing of a shopper eyeing a sales booth for handy home computers. In addition to his prediction of the number of transistors on a chip doubling every year, Moore also predicted about the emergence of home computers in his article. He also noted the historical trend in fabricating transistors, then rather brief; observed that no technical barriers stood against further improvements in the enabling technology, photolithography; and reasoned that the trend in fabrication would continue for at least another decade, raising the chip transistor count to 65,000 by 1975. Moore updated his prediction in 1975, stating that engineers can double the number of transistors every two years. Overall, the process has allowed chip designers to double the performance of the products on an average every 20 months or so.

From the beginning, Moore concentrated on the economic underpinnings of the trend, a focus he has always maintained, in contrast to the view that only what is technologically possible determines how long it takes for transistor density to double. The paper noted that the cost per electronic component was inversely proportional to the number of those components in simple circuits, but that diminishing returns occurred as the circuit grew more complex. In other words, eventually there would come a time when it just wouldn't be economically worthwhile to put more transistors on a chip. When asked to comment on the future of Moore's law Dr. Moore said "With any materials made of atoms there is a fundamental limit where you can't go any smaller, and before that there will be some kind of a limitation. To me, that'll really change the slope again. I changed it once from doubling every year to doubling every two years, and maybe we'll slow down to doubling every three to four years. After that they'll really make bigger chips. So there is a way out. At that time, we'll be putting several billion transistors on the integrated circuit."

Despite the hype surrounding the so-called Moore's law, technology has rarely conformed exactly to Moore's law; rather the number of components on chips has tended to rise remarkably fast. To give an idea of what this means in numbers of transistors, consider this example: In 1965, chips contained about 60 distinct devices; The original 4004 IC, the first ever microprocessor invented in the year 1971 by Ted Hoff, while working for Intel, contained just over two thousand transistors; the Intel Pentium 4 microprocessor, which now forms the brain of all modern home and business computers released in 2000, contains over forty million transistors. Intel's latest Itanium chip has 1.7 billion transistors. Now there are scores of companies like Alcatel, AMD, Analog Devices, Fairchild Semiconductor, IBM, Siemens, Mostek, NEC, National Semiconductor, Philips, Samsung, Texas, and a host of other companies all across the globe that manufacture a plethora of ICs. IC researchers and engineers continue to achieve the next evolution of computing architectures and platforms to achieve the vital trajectory predicted by Moore's law.

Copy of the **Electronics** *magazine in which Moore's article appeared*

Engineers predict that the number of transistors on a chip will continue to roughly follow Moore's Law throughout the current decade. The number of transistors and other components integrated into the chips has almost taken an exponential path ever since Moore articulated his ideas. However, no exponential trend can last forever, but forever can be postponed. If the exponential increase in the transistors is to continue well past the first decade of the 21st century scientists predict that designers will have to go in for some sort of a nanotechnology, with self-assembly of molecules, and so on, so as to carry the current trend for at least another decade or two.

Gordon Moore

Gordon E. Moore was born in San Francisco, California, on 3 January 1929. His parents lived in Pescadero, a small farming community about 70 km south of San Francisco. Moore's early interest in science was stimulated by a chemistry set, which his neighbour gifted for Christmas when he was about 11 years old. He was stimulated by the experiments that one could perform, especially those related to explosives. He went on to build a large home laboratory in which he produced quantities of nitroglycerine and other explosives while deepening his chemical knowledge. He attended local schools including two years at San Jose State College before moving to the University of California in Berkeley, where he received his Bachelor of Science degree in chemistry in 1950. He obtained his PhD in chemistry and physics from the California Institute of Technology in 1954.

In 1953 Moore joined the technical staff of the Applied Physics laboratory at Johns Hopkins University, where he did basic research in chemical physics. He received his first exposure to semiconductors and to silicon processing technology at the Shockley Semiconductor Laboratory, which he joined in 1956, the hard way under the eccentric genius guidance of William Shockley, who shared the Nobel Prize for Physics with John Bardeen and Walter Brattain for their research on semiconductor and discovery of the transistor effect, in 1956. Moore considers himself to have been in the right place at the right time. He entered the semiconductor industry just as silicon transistors were being developed. He was at Fairchild for the birth of the integrated circuit and at Intel to see the development and growth of the microprocessor.

In 1957 Moore and seven other engineers and scientists left Shockley and founded Fairchild Semiconductor Corporation with the goal of developing and manufacturing diffused silicon transistors. While laboratory samples of such devices had been made previously, no such devices were available commercially. All eight of them who deserted Shockley were called the "traitorous eight" by Shockley. The Silicon Valley, as it stands today, has been a creation of Shockley and his "traitorous eight" disciples. Moore held the position of Director of R&D at Fairchild from 1959 until leaving to co-found Intel in 1968.

At Fairchild Moore was responsible for the group that developed the first double-diffused silicon transistor to go into production. This included the first use of photolithography for transistor manufacture, a process developed under the direction of Noyce. During this timeframe Jean Hoerni, one of the eight men who founded Fairchild Semiconductor, invented the planar transistor structure, a version of the diffused transistor that retained the silicon oxide over the junctions resulting in a much more reliable transistor. In 1968 Moore and Robert N. Noyce left Fairchild and founded Intel Corporation. Moore was initially Executive Vice-president of Intel and became President and CEO in 1975 and Chairman of the Board and CEO in 1979. He was CEO of Intel until 1987. Moore remained Chairman of the Board of Intel for several more years and now, having passed the mandatory retirement age for directors at Intel, is Chairman Emeritus.

Commemorating the 40th anniversary of "Moore's Law," in 2005, the Marconi Foundation at Columbia University has bestowed its Lifetime Achievement Award on Moore. Columbia's Guglielmo Marconi International Fellowship Foundation, named after the radio pioneer and Nobel Prize winner, chose Moore for the award to honour "his innovative contribution to the technology that drives our daily lives, his entrepreneurial spirit and his devotion to the collaborative genius that inspired the genesis and success of Intel." The Lifetime Achievement Award was presented on 4 November 2005. This award has been given to only two other people in the foundation's 32-year history. The foundation is better known for the annual fellowships it bestows, recipients of which have included Google's Sergey Brin and Larry Page, Internet pioneer Tim Berners-Lee, and the famous science fiction author Arthur C. Clarke, who articulated the concept of global satellite communication.

A Brief History of the ICs

Moore's law can best be appreciated when we know the historical developments that led to the invention of IC's. Our world is full of integrated circuits. You find several of them in computers. They are also found in almost every modern day today usage devices such as cars, television sets, CD players, mobile phones, wrist watches, calculators, washing machines, refrigerators, microwave ovens etc. The integrated circuit is nothing but a very advanced electric circuit. It is built up of transistors and other components like resistors, capacitors and diodes in a single piece of semiconductor material, where they are connected together to form an electric circuit. The most important of all the components that are embedded in the IC are transistors. The transistor acts like a switch. It can turn electricity on or off, or it can amplify current. It is used, for example, in computers to store information, or in stereo amplifiers to make the sound signal stronger.

The discovery of the transistor effect and the subsequent invention of the transistor device by William Shockley, John Bardeen and Walter Brattain, was the prime mover, which formed the genesis for the future invention of the IC. The first transistor produced by them was made from germanium. Gordon Teal, a physicist at the Texas Instruments perfected the junction transistor made of silicon instead of the costly germanium. Silicon, incidentally, is the main ingredient of the ordinary sand and is the second most abundant element on Earth. Silicon now forms the backbone of the entire modern electronic, communication and IT industry.

Gordon Moore (in middle) is seen with Robert Noyce and Andy Groove. They founded the Intel Company.

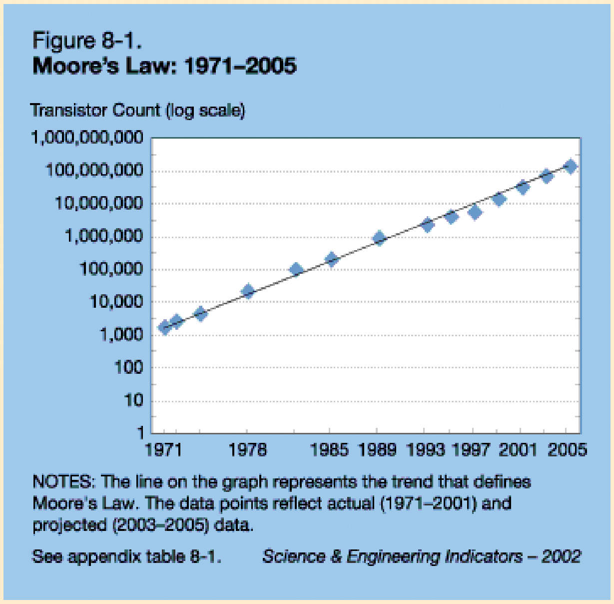
G W A Dummes, a British authority on radar, first proposed in 1952 the concept of an IC in which components like the transistor, resistors, etc., could be incorporated. But he could not succeed in his attempts to fructify his proposed concept. The first real research and investigations on IC and microelectronics technologies began in late 1950s. The objective was to miniaturise electronic equipments to include increasingly complex electronic functions in limited space with minimum weight. Several approaches evolved, including micro-assembly techniques for individual components, thin-film structures and semiconductor integrated circuits. Each approach evolved rapidly and converged so that each borrowed techniques from another.

The world's first IC was a thin wafer of germanium. The device had five components isolated electrically from one another mainly by shaping them in to L's, U's and other configurations. The tiny wires linking the components to one another and to the power supply were simply soldered on and the whole thing was held together by wax. Jack Kilby who had just joined the Texas instruments produced this device. Texas announced the birth of IC in January 1959. To demonstrate the potential of their newfound device, Texas built for Air Force a computer that used 587 ICs, which resulted in reduction of the size of computer by 1/150th the size of its predecessor. Kilby was awarded the Nobel Prize for Physics for the year 2000 for his works that lead to the development of IC. When asked to comment on his invention late Kilby said *"What we didn't realize then was that the integrated circuit would reduce the cost of electronic functions by a factor of a million to one, nothing had ever done that for anything before".*

Scales of integration

The ICs are now broadly categorised as digital (or logic) ICs and analog (or linear) ICs. The digital ICs are used in microprocessors and memories while the analog ICs are used as timers, amplifiers, and oscillators. There are, however, a few ICs that are a combination of both digital and analog ICs. Integrated circuits are further classified as Small Scale Integration (SSI), Medium Scale Integration (MSI), Large Scale Integration (LSI), Very Large Scale Integration (VLSI), Ultra Large Scale Integration (ULSI), and Wafer Scale Integration (WSI), etc., based on the scales of integration of electronic components on the chip.

The first integrated circuits contained only a few transistors. These early ICs are classified as SSI, they use circuits containing transistors and other components up to 100 components. These SSI ICs were very crucial to the early aerospace applications including the famous *Apollo* programmes. The next step in the development of integrated circuits came about in the late 1960s. It enabled introduction devices, which contained hundreds of transistors on each chip, and this was termed as MSI. It used 100 to 3,000 electronic components per chip. The increase in number of devices in the ICs was attractive economically because while they cost little more to produce than SSI devices, they allowed more complex systems to be produced using smaller circuit boards, less assembly work, and several other advantages. The economic factors continued to guide the IC industry leading to the development of LSI techniques in the late 1970s. The LSI can contain 3,000 to 100,000 electronic components per chip. The demand for computer memories and calculator rose during the 1970s resulting in production of large quantities of LSI circuits in the 1970s. The ever-increasing complexity and demand from the computing industry in the early 1980s brought about the next level of integration called the VLSI, which can contain from 100,000 to 1,000,000 electronic components per chip. To reflect further growth of



Graph shows Moore's law more or less conforming to his prediction from 1971 to 2005

the complexity, the term ULSI was proposed for chips of complexity more than 1 million electronic components. However, there is no qualitative leap between VLSI and ULSI, hence normally in technical texts the "VLSI" term covers ULSI as well, and "ULSI" is reserved only for cases when it is necessary to emphasize the chip complexity. International VLSI conferences are now routinely organised under the aegis of IEEE and other highly acclaimed world bodies to address issues related to limits of integration and for figuring out ways to continue to follow the Moore's law well into the next two to three decades.

The future

Intel CEO, Craig Barrett, has predicted that Moore's Law will boost chip abilities for many years to come. The momentum will be kept up first through conventional manufacturing processes, then for many years after that by other technology. Barrett predicted that traditional chip making technology would permit features as small as 5 nanometres – about the width of 50 hydrogen atoms – to be used on processors. Intel today is preparing to introduce processors with features measuring 65 nanometres, or billionths of a metre. Moore's Law, which has remained steadfast for 40 years, now is likely to stand ground for at least another twenty years and what holds thereafter will only be revealed as the years pass by.

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Asking Mosquitoes to Buzz Off

threatening, and is primarily found in urban areas. Like dengue, there is no specific treatment for chikungunya. The time between the bite of a mosquito carrying chikungunya virus and the start of symptoms could range from one to twelve days and can be diagnosed by blood test. The laboratory confirmation of chikungunya virus is important especially in areas where dengue also is present.

Since there is no specific treatment for dengue and chikungunya, what is the strategy to be adopted to control the spread of dengue and chikungunya? Even malaria has returned with a vengeance. Approximately 300 million people worldwide are infected by malaria and 1.5 million die every year. Dengue is endemic in more than 100 countries and the World Health Organisation believes that two-fifths of the world's population is at risk from that disease. The only strategy that is practical and somewhat successful in many parts of the world is the vector controlling, that is, control the breeding of mosquitoes.

DDT as anti-mosquito fumigating agent initially had a dramatic effect. But soon the *Anopheles* mosquito built up stiff resistance, returning with renewed vigour and numbers. What is more, the world had to deal with the DDT build-up and its harmful effects on fauna and the environment and the use of DDT was banned. Dengue mosquitoes breed in stored and exposed water. Favoured places for breeding are barrels, drums, jars, pots, buckets, flower vases, plant saucers, tanks, discarded bottles, tins, tyres, water coolers and so on, where water can collect. So, the best way to prevent the mosquitoes from multiplying is to drain out water from desert coolers/air coolers (when not in use), tanks, barrels, drums, and buckets. Further, it is better to remove all objects where some water is stored (say plant saucers, flower vases, etc.) from the house, and destroy all containers in which water collects – such as empty bottles, plastic bags, tins, and used tyres. Another simple strategy is to remain fully clothed as a protection against mosquito bites.

Vietnam and Australia have adopted a community based biological approach to control breeding of mosquitoes using mesocyclops, which are shrimp-like water creatures. When mesocyclops were introduced in mosquito breeding areas, they devoured 96-100 per cent of the mosquito population. These natural control agents feasted on mosquitoes and their larvae. It is important to point out that this became possible by involving people and teaching them to deal with the problem themselves instead of relying entirely on the government machinery. Biological methods to counter the bio-threats minimize the cost and harmful side effects.

What is more, it is imperative to reinforce the surveillance mechanisms for the breeding of mosquitoes and watch out for any mutation of the viruses. It is equally important to evolve treatment protocols and procedures to be put in place right down to the level of primary health centres. Otherwise, the history would repeat next year as well after the monsoon and the virus may return with a deadlier strain. Practitioners of medicine and the science communicators need to step out to educate the public on sound methods of coping with the diseases. This would be the best way to ask the mosquitoes to buzz off.

❒ **V. B. Kamble**

Wonderful World of 3-D Viewing and Holography

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We live in a 3-D (3-dimensional) world, and view and experience 3-D objects and scenes all around us. In every object that we see we can perceive length, breadth, and height. If the object is at a distance we can also perceive the distance. How do we see in three dimensions? How do we perceive depth? Can we create 3-D objects and scenes from 2-dimensional photographs and images? How does holography create 3-D objects and scenes? Let's try to find answers to these common questions.

When we look at something, each of our eyes provides a somewhat different perspective of a scene. This can be easily verified by alternately closing an eye and looking at the same scene, especially with relation to some object close-up in the foreground. Although the image formed at the two eyes are different, the brain blends the two images to form a 3-D image as shown in Figure 1.

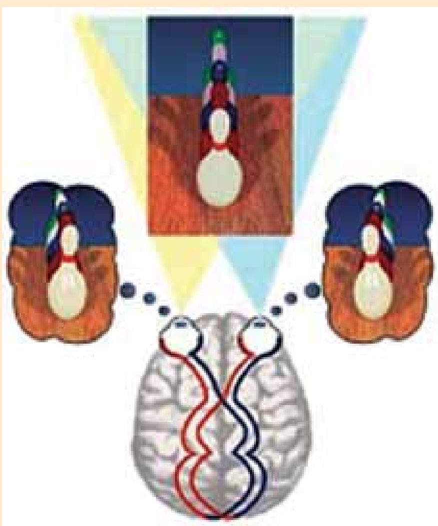

Figure 1: Each eye presents adifferent perspective of the object and the brain forms a 3-D scene.

As the distance of an object increases, the ability of eye to estimate depth decreases. For instance, our eyes can easily distinguish between distances of two objects – one placed at a distance of five metres and another at six metres. But if the two objects are placed at distances of 100 metres and 101 metres, respectively, the eyes may not be able to distinguish between their distances; to a pair of stationary eyes both would appear to be at almost the same distance. Of course, we must remember that we can perceive depth only if we use both our eyes. We can never perceive depth with only one eye. You easily find it out by trying to thread a needle with one eye closed; it will be almost impossible!

Here it may be worthwhile to digress a bit and understand the difference in the working of a telescope and a binocular of the same magnification. It is known that a telescope brings a distant object closer to the observer. But what do we mean by bringing it 'closer'? What happens when a distant object is brought closer? Well, the angle the object subtends at our eye becomes larger. In fact, the relative sizes of two objects depend only on the angles they subtend at our eye; larger the angle larger the object appears.

A telescope or a pair of binoculars does another thing. Since the diameter of the objective lens is much larger than the pupil of our eye, the amount of light gathered by the objective lens of a telescope or binoculars is much more, and so the object appears much brighter. If we look at the night sky, much fainter stars normally invisible to the unaided eye become visible. So, larger the objective diameter in relation to its focal length (also known as the 'f' number) the brighter the distant object would appear. The larger diameter of the objective also increases the resolution; that is, makes it easier to see two very close distant objects as separate objects.

Now if we compare a telescope and a pair of binoculars with objectives of the same f-number, the optical performance of the two would be identical. But a pair of binoculars would give the additional advantage of providing a 3-D view of the distant objects. Moreover, since the separation of the two objective lenses in a pair of binoculars is much more than the distance between our two eyes, the 3-D effect is more pronounced and the stereoscopic range is also more. The large separation of the objectives in a pair of binoculars also provides large difference in the perspectives of the images.

The Role of Parallax

Physics of 3-D viewing involves parallax, projections and perception. In order to create an illusion of depth, two images are slightly displaced. If, for example, two images are taken of the same scene simultaneously with two lenses separated by a distance equal to the distance between our eyes, then each of the images would be equivalent to what each eye sees separately. Now if some arrangement is made by which the right eye sees only the image taken by the right lens and simultaneously the left eye sees only the image taken by the left lens, then to the viewer the scene would appear to be in 3-D.

There are several techniques of viewing 3-D images from 2-D images. One of the most commonly used devices is called stereoscope, which allows only one image to be seen by an eye. Thus two slightly displaced images or photographs are presented in such a way that each eye sees only one image and the brain creates a 3-D picture. A simple form of stereoscope is View Master, which can be bought in any toy's store or a departmental store. This comes with a View Master reel – a circular wheel, which contains several transparencies- diametrically opposite being of the same scene but slightly displaced as shown in Figure 2.

An autostereogram is a single-image stereogram, designed to trick human eyes and brains into seeing a three-dimensional (3-D) scene in a two-dimensional image. In order to "see" 3-D shapes in these autostereograms, the brain must decouple focussing operations of the eyes from convergence; that is, the two eyes must be made to look at the two superimposed images separately. These images can be seen either as cross-eyed where the right eye sees the left image and the left eye sees the right image, or 'walled eyed' where right eye sees the right image and the left eye sees the left image.

Figure 2: View Master and its reel

The simplest type of autostereogram consists of horizontally repeating patterns and is known as a 'wallpaper autostereogram'. We can create autostereograms using computers. These are patterns on a plane sheet and generate 3-D images when viewed properly. These are also known as magic eye pictures. The first step in creating a magic eye picture is to create a 3-D gray scale image. This is the image that will be hidden later. This image then becomes the depth map. Next, a 2-D panel or a pattern is created. This pattern will then be repeated to cover the whole page. Using computer software this pattern is merged with the depth map of the object to create the magic eye picture. Figure 3 shows one such picture. To see the 3-D picture, keep it about 30 cm away and focus your eyes at a point behind the picture. When viewed with proper convergence (walled eyed), the 'object' appears to float in the air above the background. If viewed cross-eyed the object appears as a sunken depression against the background.


Figure 3: Magic Eye Picture

Filters to view 3-D

Another method makes use of the property of colour filters and of the fact that addition of red and blue gives rise to black or gray. Two slightly shifted photographs are made, one in each colour, say red and blue. A composite photograph is made by transferring these images in the respective colours but slightly shifted. When this composite photograph is viewed through a spectacle having red and blue filters, each eye would see the image meant for it. Through red filter only the image printed in blue would be visible while through the blue filter only the image printed in red would be visible. As a result the two eyes would see a slightly different view of the same scene. But in the brain the two images would be combined to give the viewer the perception of 3-D. Figure 4 shows a composite picture along with colour filter spectacle. Using colour filters, however, you can see only in black-and-white; you cannot see 3-D images in colour. To do that you have to use polarizing filters.


Figure 4: Colour composite scene

The peculiarity of polarized light is that its waves oscillate in only one plane – the plane in which it is polarized. A polarizing filter allows polarized light to pass only if the plane of polarization of the light passing through is parallel to its own plane of polarization. It would completely cut off light with a plane of polarization perpendicular to its own plane of polarization. So if two images with slightly different perspectives, as seen by the two eyes, were projected on a screen using polarizing filters on the projector set with polarizing angles perpendicular to each other, and the combined image is looked at through two perpendicularly polarized filters placed on the two eyes then each eye would see only one image; the polarizing filters would allow only one image through. Here again, the brain would fuse the two images and the viewer would perceive a 3-D image. Of course, a special screen has to be used which does not depolarize the incident light. Since no colour filters are used here, 3-D images in full colour can be seen. The giant-screen 3-D IMAX allows you to view such images using special goggles you have to wear – these are transparent glass goggles but allow only the orthogonal polarizations to pass through.

Another active device known as shuttered glasses makes use of liquid crystal display. This is worn just like a spectacle. Images on liquid crystal displays before each eye are displayed in quick succession. These images are slightly displaced to create 3-D depth perception. If the frequency with which these images are displayed is high enough, flicker is not noticed. These shuttered glasses are used for virtual reality.

In the methods described above the impression of 3-D is created by combining two 2-D images with slightly different perspectives using various viewing techniques. In all the examples given, each eye sees a slightly different perspective of the scene and the brain blends these perspectives as is common in normal 3-D viewing. However, in this kind of 3-D perception you cannot change your viewpoint; that is, you cannot see the same scene from a different angle because here the image is frozen.

Holography

In photography an image of an object (a 3-D scene) is made on a film/detector (2-D) using an imaging system. The scene is illuminated and the scattered waves are captured and manipulated by the imaging system using a lens to form an image. Different perspectives of the object are imaged by capturing scattered waves in different directions. Holography does not use any imaging system, but involves direct recording of the scattered waves. A wave is defined in terms of its amplitude and phase: amplitude could be related to the reflectivity or brightness of the object, and phase to the depth with respect to any datum. In normal photography the detectors – film or CCD detectors – can only respond to energy/intensity of light, and hence phase information is lost. The phase information can be converted into intensity information by interferometry, but that requires coherent illumination such as provided by a laser.

The main difference between ordinary sources of illumination and laser is that in the former the light waves produced are not in phase; actually the waves have random phases. It is like a crowd of people walking – they are not in step. But light waves produced by a laser have the same phase. It is like soldiers marching together in step. When a 3-D object is illuminated with laser light, the scattered light goes out of phase. Now if a beam of un-scattered coherent reference beam from the same laser is superimposed on the scattered waves interference patterns of bright and dark rings are produced which can be recorded on a photographic plate. The photographic plate after development and fixing (processing) is called hologram. The photographic plate is of very high resolution and records very fine interference fringes. Since the scattered field from a point on the object falls over the whole surface of the photographic plate, the recording is carried out over its whole surface. Any portion of the hologram or its broken piece will create the whole object or scene unlike in photography where recording is highly localized.

The hologram when illuminated with the reference wave, generates several waves, one of them is identical to the one that was recorded. If we look through the hologram such that this diffracted wave enters the eye, the object is seen in its full glory though it may not be there. The scene appears in the colour of the reconstruction beam. If we look from different portions of the hologram, different perspectives of the object are seen. A hologram is often called a window with a memory. Figure 5 shows the recording of a hologram and reconstruction of scene from the hologram.

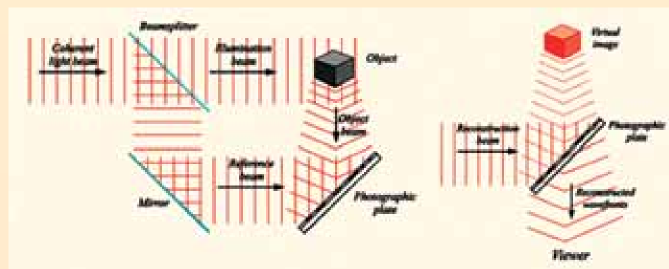

Figure 5: Hologram recording (Left) and reconstruction (Right) process

There are various kinds of geometries for recording holograms. These geometries provide holograms with distinctive features. Some holograms can be seen in normal illumination (white light illumination), and therefore make very interesting exhibits wherein 3-D objects/scenes can be seen suspended in space.

We have seen above that holography involves two steps: i) the recording of wave from the object of interest, called the recording step, and ii) reconstruction step in which the hologram is illuminated to generate the desired image. The recording medium plays an important role, and results in holograms of different types like amplitude, phase, reflection, transmission, thick and thin. But for almost all applications, the recording medium is assumed to be linear. It may be interesting to note that holography can be carried out with computers, and holograms of objects which do not physically exist can also be made provided the object is described mathematically. Certain tricks could be employed to record holograms that create unrealistic images.

Obviously holography was not invented only to record and reconstruct 3-D objects/scenes. Dennis Gabor, the inventor of holography, was assigned the task of improving the resolution of electron microscope in early 1940's, which was limited due to poor performance of electron lenses. Gabor looked into the imaging process in depth, and came up with a solution using a two-step process. Unfortunately it has not been applied to electron microscopy, but otherwise has plenty of applications, which have advanced our understanding of many physical phenomena.

Applications of Holography

We will not delve in all or many applications of holography but mention a few, particularly those related to 3-D viewing and also to storage. Holography has been used as a powerful display tool. Holograms find important applications in museums, aquariums, drawing rooms, display windows and laboratories. A new class of artists called holography artists or holographers can create holograms of unparalleled beauty and essence. Unusual objects like a watch in a black opaque cube but otherwise visible can be created. The objects are real, suspended in space and are very tempting occasionally.

Security is another major application of holography. Security holograms in multi-colour are created with several layers, having security features and multi-colour features. You can often find these as stickers on any branded product. Some currency notes also carry these security holograms.

Holograms are immune to scratches, local surface contamination, etc., as the information is distributed. They form excellent device for storing data and playing it or reading it with random access. Earlier Fourier transform holograms were used to store data – more than 10,000 pages can be put on 100 mm × 100 mm size hologram. Producing holographic CD storage is under intense research, and it is estimated that over 300 GB data can be stored on a holographic CD.

One of the most important applications of holography has been in hologram interferometry. It was a chance discovery by a number of groups around the world in 1965. For the first time it became possible to carry out holography on real working objects. Deformations of objects subjected to external forces have been measured. Vibration studies to measure vibration amplitudes and phases of various modes have been carried out. Both string and percussion musical instruments have been studied. Figure 6 shows the vibration pattern of a guitar. The sensitivities can be varied over a wide range. Non-destructive testing of objects has been carried out. The technique yields the location of defects on the objects as both are seen simultaneously.

Figure 6 : Vibration pattern of a guitar

Applications of hologram interferometry have resulted in the improvement and reliability of products.

Acknowledgement

This is an article, which draws on the works/researches of large number of researchers. I acknowledge their contributions for the advancement of science. The editor has done a very satisfying job and his help is greatly appreciated.

Professor R S Sirohi is Vice Chancellor, Barkatullah University, Bhopal, and Former Director, Indian Institute of Technology, Delhi. He is also interested in science popularisation.

VP News

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Workshop and Sensitization Programme...

workshop, the participants received training on how to form science clubs and to develop the activities for them.

A number of activities were demonstrated to the participants that could be taken up by the clubs. After the formation of the clubs, same will be affiliated under the VIPNET Scheme of Vigyan Prasar. The third workshop of the series will be organised in Coimbatore during November 2006. It is expected that about 300 clubs would be formed in Tamilnadu State after these workshops.

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Eating Right!

Some Prescription Diets

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Let thy kitchen be thy apothecary;
and, Let foods be your medicine.
— Hippocrates

When you are first diagnosed with a chronic disease, you feel a twinge of fear. You begin to think, 'Oh no, I'll have to live with several do's and don'ts. Perhaps, you may also have a whole lot of questions about what you may eat and what you must not! Some may also react with severe dejection, feeling that they may never get to eat anything decent again!

If you feel that way, here are some food-facts you could cut out and keep.

Low sodium (salt) diet

If you suffer from high blood pressure, a failing heart, chronic kidney failure or accumulation of fluid in the body, you may need to limit sodium in your diet. This may help reduce the blood pressure and the tendency to retain fluids. Limiting sodium also may help your heart work more effectively.

Processed foods are the worst culprit. Salted snacks, convenience foods, pickles, and sauce contain especially high amounts of salt (sodium chloride). If you wish to go on a sodium-controlled diet, avoid or limit the following foods:

- Table salt
- Pickles, olives
- Chutneys
- Sauces, especially soy sauce, mustard sauce and tomato ketchup
- *Namkeen bhujiya*, *dalmoth*, *mathri*
- *Chat-pakori,* French fries, and fast food
- Potato chips and popcorn
- Cow's milk
- Processed cheese
- Salted butter and peanut butter
- Salted crackers and biscuits
- Pastries, cakes, and ice-creams
- Salted nuts
- Canned foods (except fruit)
- Amaranth, litchi, and melon
- Cured meats
- Sausages, ham, bacon
- Sea fish
- Commercial salad dressings
- Instant cooked cereals
- Frozen foods
- Antacids

Coronary heart disease prevention diet

Keeping the body's serum cholesterol low is one way to keep your coronary circulation in good health. Diet can play a major role in this. A healthy diet can reduce your risk of coronary heart disease by good one-quarter.

Fruits and Vegetables

- Eat plenty of fresh fruits and vegetables. If the fruit skin is edible, do not waste it.
- Eat potatoes, sweet potatoes and parsnips in moderation.

Cereals

- Eat wholemeal flour, wholegrain bread, wholegrain cereals, oats, wholegrain rice, legumes, and sprouted gram.
- Restrict white flour (*maida*) preparations, such as bread, *kulcha* and *nan*.

Dairy Products

- Take skimmed milk, low-fat cheese, yoghurt, and curd.
- Pass up full cream milk, condensed milk, cream, and full-fat cheese.

Eggs and Meat

- You may take up to 200 gm of meat, preferably rabbit and poultry.
- Lean meat, liver, kidney can also be eaten in moderation.
- Take no more than two whole eggs per week.
- Avoid visible fat in meat, pork, duck, fried meat, sausages and burgers.

Fish

- Eat white fish (cod, mackerel, salmon); 200-400 gm of oily fish per week is ideal.
- Avoid fried fish.

Fats and Oils

- Keep all fats and oils to minimum; limit visible fats to 20 gm/day.
- Use olive, safflower, sunflower, sesame, cottonseed, corn, and groundnut oil in moderation.
- Keep away from hard fats like *vanaspati*, butter, ghee, palm oil, coconut oil, regular cheese, margarine and lard.

Cakes and Desserts

- You may eat low-fat puddings, *kheer* and *jalebi*.
- Restrict cakes and desserts.
- Avoid *khoya* sweets, dairy ice cream, and chocolates.

Salt

- Use minimum salt.

Diabetic diet

Contrary to popular belief, having diabetes does not mean that you have to follow a highly detailed diet plan. For most people, having diabetes simply translates into variety and moderation — eating more of certain foods, such as grains, legumes, fruits, and vegetables that are high in nutrients and low in fat and calories, and less of others, such as sweets, junk food, processed foods and animal foods. There is also need to bring in discipline. It would be best if you could eat at the same time during the day, the same amount of food, carrying about the same proportion of carbohydrates, protein and fats. This would help keep your blood sugar at a steady level.

It is more difficult to control your blood sugar if you eat a big supper one day and a small one the next. Also, the more food you eat at one meal, the higher your blood sugar would rise. Eating at regularly spaced intervals — meals spaced four to five hours apart — reduces large fluctuations in blood sugar and also allows for adequate digestion of food.

You need to avoid all such foods that only provide calories and no nutrients. The list includes:

- Sugar
- Glucose
- Jam, marmalade, syrup, and treacle
- Honey
- Tinned fruits
- Sweets and confectionaries
- Chocolates
- Lemonade and glucose drinks
- Proprietary milk preparations and similar foods which are sweetened with sugar
- Cakes, sweet biscuits, chocolate biscuits, pies, puddings, thick sauces
- Jam, marmalades, and tinned foods
- Alcoholic drinks

Low-purine diet for people with gout

A low-purine diet is advisable for people who suffer from gout, uric acid urinary stones or hyperuricaemia. It can help lower the uric acid level in the blood by up to 10 per cent. The following foods cause a rise in serum uric acid and are better avoided:

- Spinach, cauliflower, peas and beans
- Mushrooms
- Whole pulses (*saboot dhals*)
- Dried beans (*chana*, *rajma* and *lobia*)
- Lentils (*masur ki dhal*)
- Organ meats: liver, kidney, sweetbreads (pancreas of calves), meat extracts, poultry, ham, and sausages.
- Seawater fishes including sardines, shrimp, mackerel
- Alcoholic beverages
- Tea, coffee and cola drinks

At the same time it would advisable to go for a low-calorie low-fat diet, and reduce your weight. Uric acid rises if a person is overweight or obese. It is also a good idea to keep your hydration good. Drink lots of water, at least ten to twelve glasses a day. This will help flush the uric acid out of your body.

High-fibre diet

A high-fibre diet offers several benefits. It keeps you free from constipation, irritable bowel, diverticulosis (a disorder characterised by the presence of small, usually multiple saclike protrusions through the wall of the colon), and colon cancer, reduces cholesterol, improves blood sugar control, and reduces the risk of heart disease. You need to tuck more fruits and vegetables into your daily diet, leaving the skin on whenever possible. At the same time, avoid processed food as far as possible. You may also consider partaking the following foods which have a rich to good fibre content.

The very high-fibre foods

- Peas and red beans (*lobia*)
- Psyllium husk (*isabgol)*
- Wheat bran, cornflakes
- Almonds
- Dried apricots, figs and prunes

The high-fibre foods

- Spinach and baked beans
- Whole meal flour/whole wheat bread
- Groundnuts
- Raspberries, black currants and blackberries
- Dates and raisins

The medium-fibre foods

- French beans, carrots, cabbage, beetroot and sweet corn
- Lentils and sprouts
- Apples, bananas, pears, plums and strawberries
- Walnuts

• • •

Earthquake Tip 5

What are the Seismic Effects on Structures?

Inertia Forces in Structures

Earthquake causes shaking of the ground. So a building resting on it will experience motion at its base. From Newton's First Law of Motion, even though the base of the building moves with the ground, the roof has a tendency to stay in its original position. But, since the walls and columns are connected to it, they drag the roof along with them. *This is much like the situation that you are faced with when the bus you are standing in suddenly starts; your feet move with the bus, but your upper body tends to stay back making you fall backwards!!* This tendency to continue to remain in the previous position is known as 'inertia'. In the building, since the walls or columns are flexible, the motion of the roof is different from that of the ground (Figure 1).

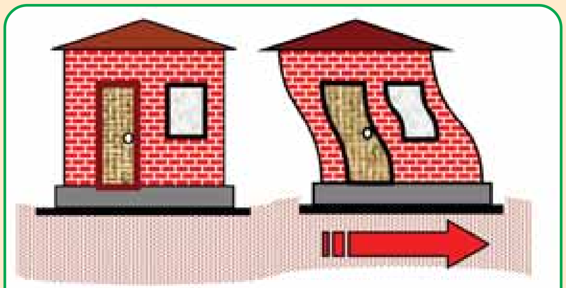

Figure 1: Effect of Inertia in a building when shaken at its base

Consider a building whose roof is supported on columns (Figure 2). *Coming back to the analogy of yourself on the bus: when the bus suddenly starts, you are thrown backwards as if someone has applied a force on the upper body.* Similarly, when the ground moves, even the building is thrown backwards, and the roof experiences a force, called 'inertia force'. If the roof has a mass M and experiences an acceleration a, then from Newton's Second Law of Motion, the inertia force F_I is mass M times acceleration a, and its direction is opposite to that of the acceleration. Clearly, more mass means higher inertia force. Therefore, lighter buildings sustain the earthquake shaking better.

Effect of Deformations in Structures

The inertia force experienced by the roof is transferred to the ground via the columns, causing forces in columns. These forces generated in the columns can also be understood in another way. During earthquake shaking, the columns undergo relative movement between their ends. In Figure 2, this movement is shown as quantity **u** between the roof and the ground. But, given a free option, columns would like to come back to the straight vertical position, i.e., columns resist deformations. In the straight vertical position, the columns carry no horizontal earthquake force through them. But, when forced to bend, they develop internal forces. The larger the relative horizontal displacement **u** between the top and bottom of the column,

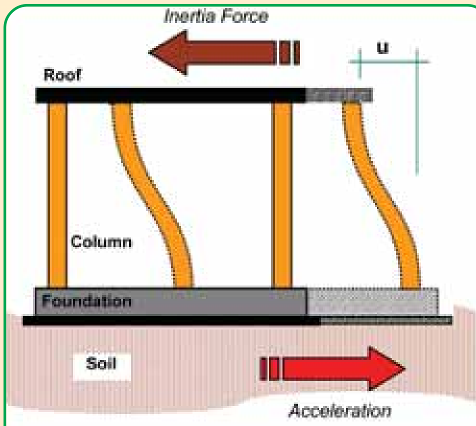

Figure 2: Inertia force and relative motion within a building

the larger is this internal force in columns. Also, the stiffer the columns are (i.e., bigger is the column size), larger is this force. For this reason, these internal forces in the columns are called 'stiffness forces'. In fact, the stiffness force in a column is the column stiffness times the relative displacement between its ends.

Horizontal and Vertical Shaking

Earthquake causes shaking of the ground in all three directions – along the two horizontal directions (X and Y, say), and the vertical direction (Z, say) (Figure 3). Also, during the earthquake, the ground shakes randomly 'back and forth' (- and +) along each of these X, Y and Z directions. All structures are primarily designed to carry the gravity loads, i.e., they are designed for a force equal to the mass

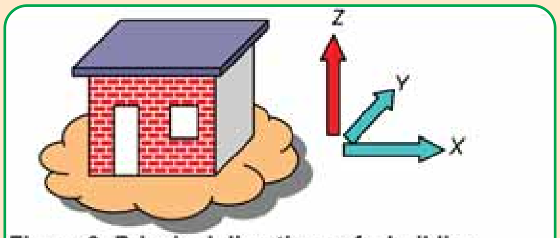

Figure 3: Principal directions of a building

M (this includes mass due to own weight and imposed loads) times the acceleration due to gravity g acting in the vertical downward direction (-Z). The downward force *Mg* is called the 'gravity load'. The vertical acceleration during ground shaking either adds to or subtracts from the acceleration due to gravity. Since factors of safety are used in the design of structures to resist the gravity loads, usually most structures tend to be adequate against vertical shaking.

However, horizontal shaking along X and Y directions (both + and – directions of each) remains a concern. Structures designed for gravity loads, in general, may not be able to safely sustain the effects of horizontal earthquake shaking. Hence, it is necessary to ensure adequacy of the structures against horizontal earthquake effects.

Flow of Inertia Forces to Foundations

Under horizontal shaking of the ground, horizontal inertia forces are generated at level of the mass of the structure (usually situated at the floor levels). These lateral inertia forces are transferred by the floor slab to the walls or columns, to the foundations, and finally to the soil system underneath (Figure 4). So, each of these structural elements (floor slabs, walls, columns, and foundations) and the connections between them must be designed to safely transfer these inertia forces through them.

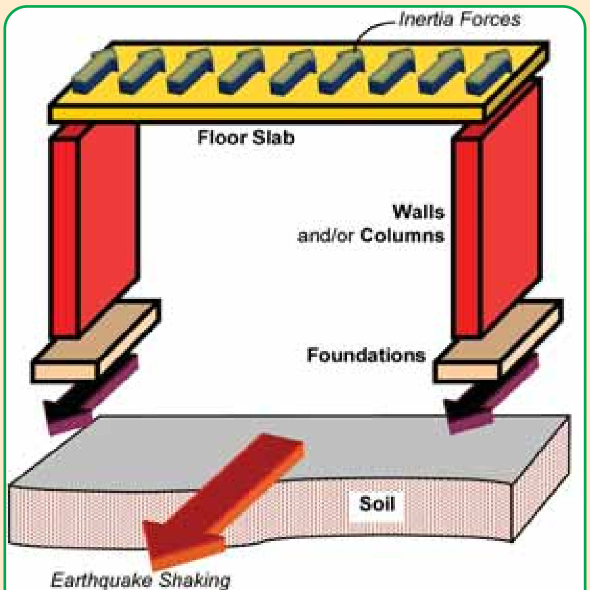

Figure 4: Flow of seismic inertia forces through all structural components.

Walls or columns are the most critical elements in transferring the inertia forces. But, in traditional construction, floor slabs and beams receive more care and attention during design and construction, than walls and columns. Walls are relatively thin and often made of

(a) Partial collapse of stone masonry walls during 1991 Uttarkashi (India) earthquake

(b) Collapse of reinforced concrete columns (and building) during 2001 Bhuj (India) earthquake

Figure 5: Importance of designing walls/columns for horizontal earthquake forces.

brittle material like masonry. They are poor in carrying horizontal earthquake inertia forces along the direction of their thickness. Failures of masonry walls have been observed in many earthquakes in the past (e.g., Figure 5a). Similarly, poorly designed and constructed reinforced concrete columns can be disastrous. The failure of the ground storey columns resulted in numerous building collapses during the 2001 Bhuj (India) earthquake (Figure 5b).

Resource Material

1. Chopra, A.K., (1980), *Dynamics of Structures - A Primer*, EERI Monograph, Earthquake Engineering Research Institute, USA.

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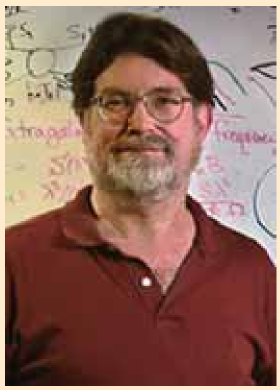
Recent Developments in Science and Technology

Nobel Prizes 2006

Physics

The Nobel Prize for Physics for 2006 has been awarded jointly to two American astrophysicists John C. Mather of NASA Goddard Space Flight Center, Greenbelt, Maryland, and George F. Smoot of Lawrence Berkeley National Laboratory, Berkeley, California, "for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation." The two scientists were the chief architects of a NASA satellite

John C. Mather

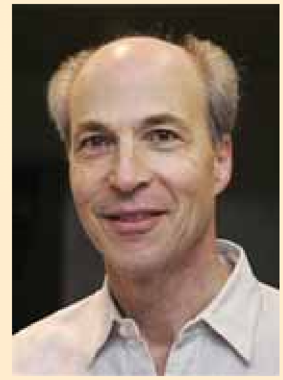


George F. Smoot

observatory named *COBE* (*CO*smic *B*ackground *E*xplorer). Launched in 1989, the spacecraft measured feeble remnants of light that originated early in the history of the universe, about 380,000 years after the Big Bang. Until then the universe was opaque to light, making it impossible to directly observe anything older. The *COBE* data provided increased support for the Big Bang scenario for the origin of the Universe. Mather and Smoot's findings revealed the ancient seeds of stars, galaxies, and other celestial objects and have played a major role in the development of modern cosmology into a precise science.

Chemistry

The Chemistry Nobel for 2006 has gone to the American biochemist Roger D. Kornberg of Stanford University, California, USA, "for his studies of the molecular basis of eukaryotic transcription". Roger is the son of Nobel Laureate Arthur Kornberg who won the Nobel Prize for Physiology or Medicine in 1959 for his studies of how genetic information is transferred from one DNA-molecule to another. Arthur Kornberg had described how genetic information is transferred from a mother cell to its daughters. What his son has now done is to describe how the genetic information is copied from DNA into what is called messenger-RNA, which carries the information out of the cell nucleus so that it can be used to construct the proteins. Roger Kornberg has been able create of detailed crystallographic pictures describing the transcription apparatus in full action in a eukaryotic cell, making the visualisation of the transcription process possible.



Roger D. Kornberg

Physiology or Medicine

The 2006 Nobel Prize in Physiology or Medicine has been awarded jointly to two Americans, Andrew Z. Fire of Stanford University School of Medicine, California and Craig C. Mello of University of Massachusetts Medical School, Worcester, Massachusetts, for their discovery of "RNA interference – gene silencing by double-stranded RNA." In 1998, Fire and Mello published their discovery of a mechanism that can degrade mRNA from a specific gene. This mechanism, called 'RNA interference', is activated when RNA molecules

Craig C. Mello

Andrew Z. Fire

occur as double-stranded pairs in the cell. Double-stranded RNA activates biochemical machinery, which degrades those mRNA molecules that carry a genetic code identical to that of the double-stranded RNA. When such mRNA molecules disappear, the corresponding gene is silenced and no protein of the encoded type is made. RNA interference occurs in plants, animals, and humans. It is of great importance for the regulation of gene expression, participates in defense against viral infections, and keeps jumping genes under control.

Sky Map for November 2006

Full Moon

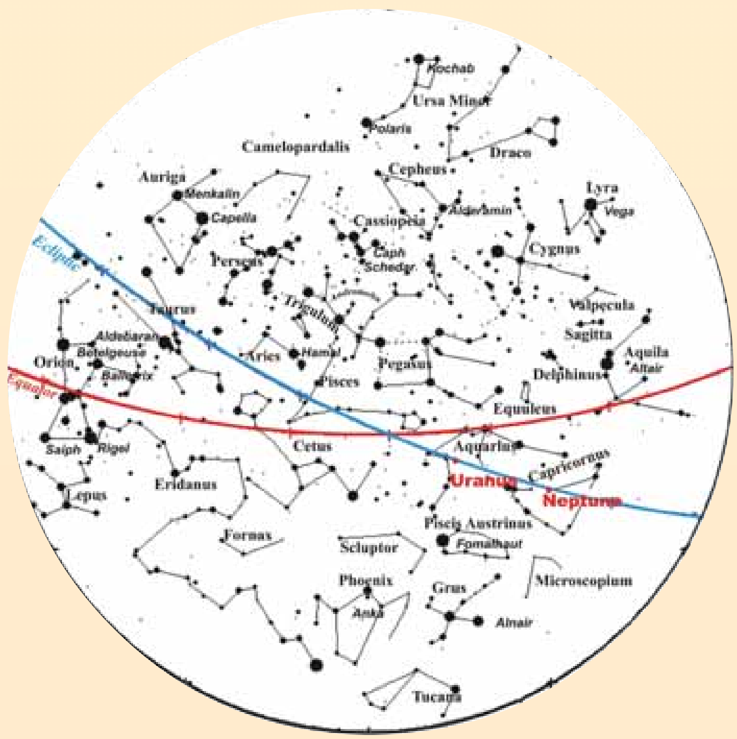
5 November

Moon - Last Quarter

13 November

North

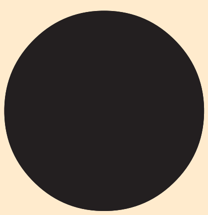
East



West

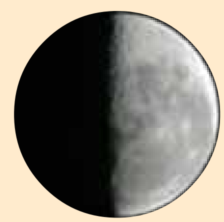
South

New Moon



20 November

Moon - First Quarter



27 November

The sky map is prepared for viewers in Nagpur (21.09° N, 79.09° 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 November, at 9:00 PM on 15 November and at 8 PM on 31 November.

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 :

Jupiter: In the constellation *Libra (Tula Rashi)* at Western horizon.
Uranus, Neptune & Pluto: Not a naked eye object. Hence not visible.

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

Eastern Sky : Auriga (Capella) / *Sarthi (Brahmaridhay)*, Eridanus /*Yamuna*, Lepus / *Shashak*, Orion (Betelgeuse) / *Mrigah (Aardhra)*, Taurus / *VrishabhRashi*

Western Sky : Aquila (Altair) / *Garuda (Sravan)*, Capricornus / *Makar Rashi*, Cygnus (Deneb) / *Hansa (Hansa)*, Lyra (Vega) / *Swaramandal (Abhijeet)*

Southern Sky : Grus / *Bak*, Phoenix, Piscis Austrinus, Tucana

Northern Sky : Draco / *Kaleey*, Cassiopeia / *Sharmista*, Cepheus / *Vrishaparv*, Ursa Minor (Polaris) / *Dhruvamatsya (Drhuvataraka)*

Zenith : Andromeda / *Devyani*, Aries (Hamal) / *Mesha Rashi*, Aquarius / *Khumba Rashi*, Cetus (Deneb, Katos) / *Timingal*, Pegasus / *Mahashav*, Perseus (Mirfak, Algol) / *Yayati*, Pisces / *Min Rashi*

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