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VP News

Science Popularisation in South Indian Languages

Vigyan Prasar organised a three-day seminar on Science Popularisation in South Indian languages in association with International Institute for Tamil Studies (IITS) during May 21- 23, 2003 at Chennai. Inaugurating the seminar, Hon'ble Minster for Health and Education, Government of Tamil Nadu, Shri Semmalai appreciated the efforts of Vigyan Prasar in popularising science in various Indian languages. He informed that 'Scientific Tamil' will be introduced along with prose and poetry in Tamil syllabus from school level beginning with next academic year. Dr V.C. Kulandaisamy, former Vice Chancellor, IGNOU, and Vice Chairman IITS, Chennai, in his presidential expressed concern over the expanding gap between rich and the poor nation owing to the lopsided distribution of economic resources and attributed it to developed nations' ability to make use of science and technology for their socio-political development. He noted that India's economic status is not commensurate with its status in scientific and technological fields and added that it was because the sprit of science and technology has not reached the masses. Education and popularisation in the language of the people, he averred, are prerequisites for nations development. Dr V B Kamble, Director Vigyan Prasar spoke on the multifaceted activities and programmes carried out by Vigyan Prasar. He noted that quality works in regional languages need to be translated into other Indian languages and that one cannot afford to confine to English alone for sourcing materials. He desired to establish a translation bureau either at Chennai or Bangalore. Dr. S Krishnamoorthy, Director, IITS proposed a vote of thanks in which he expressed their interest to undertake translation of VP books into Tamil.

Dr. VC Kulandaiswamy, former Vice Chancellor, IGNOU is delivering the presidential address in the seminar. On the dias (L to R); Hon'ble Minister for Education and Health, Govt. of Tamil Nadu, Sh. Semmalai, and Dr. VB Kamble, Director, Vigyan Prasar

The first technical session of the seminar was devoted to garner historical perspectives. Dr M P Parameswaran, one of the founders of Kerala Sasthra Sahithya Prarishad, (KSSP) and NCSTC award recipient for science popularisation, presented a paper elucidating the development and growth of KSSP and argued for tuning the science popularisation goals to the present day needs. Dr Hari Babu, in his presentation, spoke on the science popularisation activity under the aegis of Osmania Observatory at Hydrabad State during the early 20th century. In the second technical session, Sh Sentil Babu presented a paper, Singaravelor (a popularizer of science): his ideas and ideals. Sh K Balakrishnan, research scholar, Calicut University presented the history of Science literature in Malayalam during the 19th century. Dr Noel, CECRI, Karaikudi, presented a paper on 'Kundrakudi Matt and popularisation of science'.

On the second day, the third technical session commenced with a presentation on 'Social history of Science writing in Tamil during 19th Century' by Dr T V Venkateswaran, PSO, Vigyan Prasar. Dr Radha Chellapan presented a paper on Pe. Na Appusamy, who initiated science popularistion efforts in Madras Presidency during the early 20th century. Sh Rangarajan (Sujatha) a well known Tamil novelist, science fiction writer, NCSTC award winner elucidated on his experience in popularising science in Tamil. DR Iyyam Perumal, Director, Tamil Nadu Science and Technology Centre, Dr Ganga also spoke.

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Inside

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

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CMYK

Little Bumps under the Spreading Sky

It is fifty years since man set foot on the Mount Everest, the highest peak in the world. How did the interest in the Himalayas develop in the modern times? It all began with a daunting and an audacious scientific endeavour two centuries ago in our country called "the Great Indian Arc of the Meridian" (*Dream 2047* April 2002). It was the longest measurement of the Earth's surface ever to have been attempted. The idea was to map the entire Indian sub-continent and determine the exact curvature of the Earth. William Lambton had conceived the idea, and after his death in 1823, George Everest (Surveyor General of India,1830-45) and his intrepid band of surveyors took 50 years to traverse 2400 kilometres from Cape Comorin to Dehradun along the 78^0 East longitude. In 1843, Andrew Scott Waugh took charge of the project, and gave special attention to the Himalayan peaks. In 1852, Waugh's team succeeded in observing the highest peak in the world. Its height was calculated at 29,002 feet (accepted height now is 29,035 feet or 8850 metres). It was Radhanath Sickdhar, the Chief "Computer" who realized that it was the world's highest. Waugh named it Mount Everest immortalizing his "illustrious master of accurate geographical research".

The realization that Mount Everest (Sagarmatha in Nepali and Chomolungma in Tibetan) as the highest peak in the world fired the imagination of the people the world over – only no one knew how to get there. Further, the early climbers had to contend with the most primitive equipment. Nepal did not permit approaching the mountain from the south side until after the Second World War, and hence the only route to the summit was from the north side in Tibet. The first expedition to Mount Everest was in 1922 when Geoffrey Bruce and George Finch climbed to a record altitude of 8627 metres with rudimentary oxygen. In 1924, the mountain claimed the life of George Leigh-Mallory and Andrew Sandy Irvine who were climbing without oxygen (seventy five years later, on 1 May, 1999, Mallory's frozen corpse was found at a height of 8170 metres). Till the end of the Second World War, there were a few expeditions, however, none was successful. Climbers after the War came equipped with war-time technologies. After the war, Nepal opened its gates to the mountain offering the south-east ridge route. A Swiss team – consisting of Raymond Lambert and Tenzing Norgay - made it to 8598 metres.

Eventually, Edmond Percival Hillary and Tenzing Norgay reached the top on 29 May, 1953 via the south-east ridge route, equipped with oxygen and special nylon-weft suits which could withstand winds up to 100 kilometres an hour. Fifty years since they got there, some 1200 people have made it to the top. Appa Sherpa has made it 11 times - without supplemental oxygen. Another two have made it 10 times. Kushang Sherpa climbed the peak from all the four sides. The oldest to reach there was 70, the youngest 16. Even women have not lagged behind. Junko Tabei of Japan reached the peak on May 16, 1975.Then followed Bachendri Pal of India. Santosh Yadav climbed the peak twice. Handicapped men with artificial feet and even a blind man have reached the top. People have paraglided and skied down from there. The lure of the highest point in the world continues to draw hundreds soon after the winter season ends, despite the fact that 176 lives have been claimed by the mountain so far.

For Tenzing, it had been a long and weary road. Acting as a porter on Sir Eric Shipton's 1935 exploration of Everest, Tenzing became involved in more attempts to scale the peak than anyone else before him. In 1938, he climbed Everest to an altitude of 7,000 metres above mean sea level. In a 1952 attempt, he ascended to 8,600 metres. After Second World War, Tenzing Norgay became a "sardar" or supervisor of porters. He was both a "sardar" and a member of the British Everest Expedition in 1953. Although he spoke seven languages, he could never read or write! In contrast, Hillary read a book a day about adventures in his childhood. For many years he was a beekeeper. He was introduced to the Southern Alps of New Zealand since he was sixteen. He served the New Zealand Air Force in the Second World War. He was a participant in the 1951 and 1952 Everest expeditions. After the conquest of Everest, he trekked to the South Pole and up the river Ganga from the ocean to its source in the Himalayas. He served as the New Zealand High Commissioner to India for four years.

Over the past two decades, advances in the mountaineering equipments have made the climb much easier. Ice-axe is featherweight and made of titanium, the shoes are lightweight and do not freeze, oxygen cylinders that weigh only 3 kg, lighter and sturdier tents – everything has changed. Today's mountaineer has cutting edge technology with him. He has a satellite phone in one hand and is backed by detailed weather forecasts. Tenzing and Hillary carried some 30 kg. Today a mountaineer carries less than half that weight. What has this done to Mount Everest? Over the past few years, the traffic to the highest peak has gone up at an astonishing rate! On one remarkable day, 23 May 1991, 89 climbers reached the top! It has gradually been transformed into a tourist spot! Fiftieth anniversary has drawn record crowds this season. One can climb to the world's highest point by paying up to Rs. 30 lakhs! It is a big business. As a result, already enormous environmental degradation has been caused to the Everest. Global warming has added to the problems and the studies indicate that the entire Khumbu region faces long-term flood threats because of accelerated ice-melt. Excessive human activity only could make things worse.

Indeed, conquest of Everest was a turning point in history

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Albert Einstein

Founder of Theory of Relativity

❐ Subodh Mahanti

"A man can do as he will, but not will as he will"

Arthur Schopenhaur (1788-1860), the German philosopher

"For the most part, I do the thing which my own nature drives me to do. It is embarrassing to earn so much respect and love for it".

Albert Einstein

"One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike–and yet it is the most precious thing we have."

Albert Einstein

Einstein contributed more than any other scientist to the 20th-century vision of physical reality. In fact he contributed more than any other scientist since Sir Isaac Newton to our understanding of physical reality. In 1905 Einstein proposed his theory of relativity. While proposing this theory, Einstein discarded the concept of time and space as absolute entities, as they were regarded till then. In the same year he explained the phenomenon of photoelectric effect by postulating light quanta or photons comparable to energy quanta. In 1916 Einstein published his theory of general relativity considered by many physicists as the most elegant intellectual achievement of all time. It had vast implication especially on the cosmological scale. Einstein forever changed the way we contemplate the universe. Einstein was more than a scientist, more than a philosopher, and more than a world statesman. Einstein lived by a deep faith but then his was not a life of prayer and worship. His life-long pursuit was to discover the laws of Nature, to cultivate the fruit of pure learning.

Albert Einstein

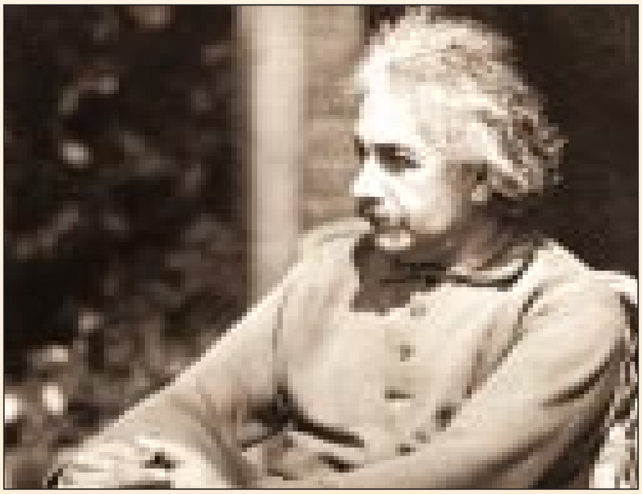
Einstein's life and his work have been well chronicled. In fact there is hardly any other scientist on whom so much has been written or who has received such public attention. The first scientific subjects that the newly emerging mass media of the 1930s tried for popularization were Einstein's theories of relativity. But the media found it extremely difficult to make people understand what Einstein had to say. This is because even the simplest explanations of the theories were counterintuitive and were hard to follow. But the media did not leave at that. Instead of Einstein's work, the media concentrated on Einstein, the person. The media hype on Einstein created something of a creature, which became the popular image of a modern scientist. Einstein became a peerless myth. Many people think that they understand Einstein's work but in reality they are familiar with the image of Einstein created by the media. In 1931 Einstein and Charlie Chaplin travelled together to Los Angeles to view the opening of the film "City Lights". They were recognised by the crowd and enthusiastically greeted. On this occasion, Chaplin noted: "The people applauded you (Einstein) because no one understands you, and me, because everyone understands me." What Chaplin said is largely true even today. Not many people really understand what actually Einstein did. In fact many physicists themselves may not be in a position to fully grasp Einstein's work and what to talk about laypersons. The statement, "In the last analysis, fame is only the epitome of all the misunderstandings which gather about a new name" by Rainer Maria Rilke is very true for Einstein. Even Einstein did not understand why he was so well liked but at the same time so little understood. By writing this it is not intended to mean that Einstein's work cannot be understood but it is to highlight the fact that one needs a thorough background in physics and mathematics to understand Einstein's work.

Einstein was born in a small town named Ulm in Germany on 14 March 1879 to Hermann and Pauline Einstein. The family moved to Munich when Einstein was an infant. At Munich, Hermann Einstein and his brother Jakob Einstein established a small electrical plant and engineering works. The family later moved to Milan. The business activities of Einstein's father were never very successful. Like in many other cases, there was no early indications of Einstein's genius. He did not begin to talk until the age of three and he was not fluent till the age of nine. Einstein received his first instruction at home from a woman teacher, when he was five-year old. At the same time he started taking lesson on the violin. He entered the public primary school (called Volksschule in Germany) at the age of seven. There is a popular myth that Einstein was a poor student in his early years. It is not true. His grades were excellent and he was consistently placed at the top of the class. He did not always get along with his teachers at primary school. He did not like the rigid discipline and the rote-learning techniques. Einstein was a quite child. He had a natural antipathy for sports or outdoor activities. He made few friends at school and felt isolated and alone. He did not enjoy in playing with his classmates. He did not even join other children for playing at home. Instead he preferred solitary games that required patience and persistence. His sister Maja wrote: "The children of family and relatives often got together in his parents' garden in Munich. Albert refrained from joining their boisterous games, however, and occupied himself with quieter things. When he occasionally did take part, he was regarded as the obvious arbiter in all disputes. Since children usually retain a very keen and unspoiled instinct for the exercise of justice, the general recognition of his authority indicates that his ability to think objectively had developed early." Among his favourite games was building a house of cards. However, his major recreational interest was music. Since his early childhood Einstein was taught to become self-reliant. "The boy was trained early in self-reliance, in contrast to the customary European child-rearing method which consists of over-anxious tutelage. The 3- or 4-year old was sent through the busiest streets of Munich; the first time he was shown the way, the second, unobtrusively observed. At intersections he conscientiously looked right, then left, and then crossed the road without any apprehension. Self-reliance was already ingrained in his character and manifested itself prominently on various occasions in his later life", wrote his sister. It may be noted here that the biographical sketch of Einstein written by his sister Maja Winteler-Einstein is the major source of information on their family and Einstein's early life.

Einstein entered the Luitpold Gymnasium (high school) in 1888 and he studied here until he was fifteen. The school placed more emphasis on classical languages like Latin and Greek than to natural sciences. Einstein did well in Latin and mathematics, but he disliked the harsh and pedantic regimentation. To quote his sister Maja : "Actually, he was very uncomfortable in school. The style of teaching in most subjects was repugnant to him….The military tone of the school, the systematic training in the worship of authority that was supposed to accustom pupils at an early age to military discipline, was also particularly unpleasant for the boy. He contemplated with dread that noted-too-distant moment when he would have to don a soldier's uniform in order to fulfill his military obligations. Depressed and nervous, he searched for a way out. Hence, when the professor in charge of his class (the same one who had predicted that nothing good would ever come of him) scolded him on some occasion, he obtained a certificate from the family doctor, presented it to the school principal and abruptly left to join his parents in Milan. They were alarmed by his high-handed behaviour, but he most adamantly declared that he would not return to Munich, and reassured them about his future by promising them most definitely that he would independently prepare himself for the entrance examination to the Zurich Polytechnical School in autumn. This was a bold decision for a 16-year-old, and he actually carried it out. His parents resigned themselves to the new situation with grave misgivings, but were persuaded to do all they could to further the plan."

In October 1895, Einstein took the Entrance examination to the prestigious Eidgenossische Technische Hochschule (the Federal Institute of Technology or ETH as it is usually referred to), in Zurich. Einstein failed the examination. He did quite well in science and mathematics but not well enough in languages, history, literature and art to qualify. This was a serious setback for Einstein. But considering his youth, the school authorities took a lenient view. They told Einstein's parents that they would admit him after he attended the final year of a Swiss secondary school. Thus Einstein got enrolled in the Cantonal school in Aarau, a small Swiss town. The school had a high reputation. It attracted students even from overseas.

While in school, Einstein had decided to embark on a life-long study of the "huge world". He would later say: "There was this huge world out there, independent of us human beings and standing before us like a great, eternal riddle, at least partly accessible to our inspection and thought. The contemplation of that world beckoned like a liberation." He also said: "I have never imputed to Nature a purpose or a goal, or anything that could be understood as anthromorphic. What I see in Nature is a magnificent structure that we can comprehend only very imperfectly and that must fill a thinking person with a feeling of humility. This is a genuinely religious feeling that have nothing to do with mysticism."



Albert Einstein (1731)

Einstein often talked about one story about his childhood-it was of a'wonder' he saw when he was four or five years old, a magnetic compass. Einstein was profoundly impressed by the needle's invariable northward swing, guided by an invisible force. By seeing it he was convinced that there must be "something behind things, something deeply hidden." Einstein learned geometry by himself before it was taught in class. He was impressed by geometry for its precision and definiteness. Einstein said: "At the age of 12, I experienced a wonder in a booklet dealing with Euclidean plane geometry, which came into my hands at the beginning of a school year. Here were assertions, as for example the intersection of the three altitudes of a triangle in one point, which–though by no means evident–could nevertheless be proved with such certainty that any doubt appeared to be out of question. This lucidity and certainty made an indescribable impression on me." He also studied differential and integral calculus on his own. Einstein's interest in mathematics was aroused and sustained by his uncle, Jacob Einstein. His sister Maja wrote: "In Gymnasium, the boy was supposed to begin the study of algebra and geometry at the age of 13. But by that time he already had a predilection for solving complicated problem in applied arithmetic, although the computational errors he made kept him from appearing particularly talented in the eyes of his teachers. Now he wanted to see what he could learn about these subjects in advance, during his vacation, and asked his parents to obtain the textbooks for him. Play and playmates were forgotten. He set to work on the theories, not by taking their proofs from books, but rather by attempting to prove them for himself. For days on end he sat alone, immersed in the search for solution, not giving up before he found it. He often found proofs by ways that were different from those found in the books. Thus, during this one vacation of a few months, he independently worked his way through the entire prospective Gymnasium Syllabus. Uncle Jacob, who was an engineer had a comprehensive mathematical education, reinforced Albert's zeal by posing difficult problems, not without good-natured expressions of doubt about his ability to solve them. Albert invariably found a correct proof; he even found an entirely original one for the Pythagorean theorem. When he got such results, the boy was overcome with great happiness, and was already then aware of the direction in which his talents were leading him."

Besides his uncle, Max Talmud, a medical student with little money, also influenced Einstein in his school days. Talmud used to take one evening meal each week with the Einsteins. Talmud used to give book on science and philosophy to young Einstein. The two used to discuss for hours together.

Paulin Einstein's Mother

Herman Einstein

Einstein's Parents

Einstein's power of mental concentration was proverbial. He could easily engross in deep thought in a corner of a noisy room. He could work without being disturbed by the conversations of others. Once Einstein said to one of his students: "I am always available to speak to you. If you have a question come to me without worrying. You will never disturb me because I can always break off my work at any moment and return it immediately after the interruption." One of his students actually witnessed how Einstein could concentrate without being disturbed by the surroundings. He described it in the following way: "He was sitting in his study in front of a heap of papers covered with mathematics formulae. Writing with his right hand and holding his younger son in his left, he kept replying to questions from his elder son Albert who was playing with his bricks. With the worlds, "Wait a minute, I am nearly finished," he gave me the children to look after for a few moments and went on working. It gave one glimpse of his immense powers of concentration."

Einstein graduated from the Swiss Polytechnic in the spring of 1900 as a secondary school teacher of mathematics and physics. After graduation his primary objective was to secure a job. He expected to get a position as teaching assistant but to his disappointment he did not get one. His disregard for authority in school and in college was responsible for his inability to secure a position. His mathematics teacher at the Polytechnic, Hermann Minowski, considered Einstein a "lazy dog", who seldom came to class. His other teachers did not hold good opinion of him. Heinrich Weber, his physics teacher at the polytechnic is supposed to have told him: "You are a smart boy. But you have one great fault, you do not let yourself be told anything." It is said that one of his teachers even suggested Einstein leave school, since his very presence destroyed the other students' respect for the teacher. So naturally his teachers refused to recommend him for a teaching position. Perhaps they thought that if he could not show enough enthusiasm for class work, he might not show it for professional work. After two years of struggling to eke out living as a tutor and substitute teacher, Einstein finally got a job. In June 1902 Einstein got an appointment, on a temporary basis, as a technical expert, third class, in the patent office in Berne, Switzerland. Einstein got this job through the efforts of his friend Marcel Grossman, whose father was a friend of the Director of the Swiss patent office. Einstein enjoyed his work at the patent office, where he worked from 1902 to 1909. Einstein wrote: "The work on satisfactory formulation of technical patents was a true blessing for me. It compelled me to be many-sided in thought, and also offered important stimulation for thought about physics. Following a practical profession is a blessing for people of my type. Because the academic career puts a young person in a sort of compulsory situation to produce scientific papers in impressive quantity, a temptation to superficially arises that only strong characters are able to resist."

Einstein's son-in-law Rudolf Kayser wrote: "Albert's work, though it was not too trying, was still a strain. He was not used to sitting eight hours over official duties which he could discharge with the some degree of faithfulness in three or four. He was much too young and too high-strung to perform his duties as slowly as the others. He soon discovered that he could find time to devote to his own scientific studies if he did his work in less time. But discretion was necessary, for though authorities may find slow work satisfactory, the saving of time for personal profit is officially forbidden. Worried, Einstein saw to it that the small sheets of paper on which he wrote and figured vanished into his desk-drawer as soon as he heard footsteps approaching behind his door."

Albert Einstein

While working at the Patent Office he completed an astonishing range of publication in theoretical physics. He had to do a lot of outside reading and analysis to keep up with modern physics. He worked in his spare time even during office hours as described by his son-in-law above. Einstein did not have the benefit of close contact with either the scientific literature or fellow scientists. In 1905 alone Einstein published four papers that changed the face of physics. These papers were to direct the progress of physics during the 20th century. Einstein achieved all this working alone in the backroom of his small apartment in Berne Perhaps the only period in the entire history of physics comparable to this one is Isaac Newton's stay at Woolsthrope during 1665-66. The four papers published by Einstein in 1905 were:

1. On the Motion of Small Particles Suspended in a Stationary Liquid According to the Molecular Kinetic Theory of Heat.
2. On a Heuristic Point of View about the Creation and Conversion of Light.
3. On the Electrodynamics of Moving Bodies.
4. Does the Inertia of a Body Depend on its Energy Content?

By seeing the titles of the papers a layperson would have no clue about their contents. Einstein's first paper, which he sent for publication in March 1905, was on Brownian motion, a phenomenon first described by Robert Brown in 1828. Einstein derived a formula for the average displacement of particles in suspension, based on the idea that a tiny particle in a fluid being constantly bombarded by surrounding molecules dart around in an erratic movement. Jean Perrin confirmed Einstein's formula in 1908. It represented the first direct evidence for the existence of atoms and molecules of definite sizes and thus he put an end to a millennia-old debate on the fundamental nature of chemical elements.

Albert Einstein at the blackboard

The second paper was on photoelectric effect. In this paper he gave a new understanding of light. Einstein proposed that light could act as though it consisted of discrete, independent particles of energy, in same ways like particles of a gas. It may be noted that Max Planck had earlier suggested discreteness in energy. Einstein showed light quanta or the particles of energy could explain many phenomena studied by experimental physics, for example ejection of electrons from metals by light. Einstein's theory of light formed the basis for much of quantum mechanics.

In the third paper Einstein first time introduced the concept of theory of relativity. It was called `special' theory of relativity because the theory is restricted to certain special circumstances like bodies at rest or moving with uniform relative velocities. It should be noted that the special theory of relativity does not state that everything in the universe is relative. It stated that time and space (which were thought to be absolute) are relative and the speed of light is absolute. The special theory of relativity had a number of seemingly unusual consequences:

i. The length of a body along its direction of motion decreases with increasing velocity.
ii. The mass increases as the velocity increases. And at the speed of light the mass of a body becomes infinite.
iii. Time slows down for a moving body.

In his fourth paper Einstein reported a remarkable consequences of his special theory of relativity–if a given body emits a certain amount of energy, then the mass of that body must decrease by a proportionate amount. Einstein concluded that if a body gives off energy (E) in the form of radiation, its mass (m) diminishes by E/c^2, where c is the velocity of light. He thus derived the equation $E=mc^2$, which unifies the concepts of matter and energy. It is certainly the best-known equation of all time. This equation accounts for the thermonuclear processes that empower the stars and it also accounts for the explosive power of the atomic bomb.

Even after publishing such papers having far reaching implications, Einstein did not get an academic appointment easily. In 1907 Einstein applied for a position of a Privatdozent, an untrained lecturer, at Berne University. A Privatdozen, however, was an official member of university who could give lectures on a subject of his choice, charging students a fee to attend. Einstein's application was turned down. It is said that one of the reasons for turning down his application was that the head of the department of physics of the Berne University terned Einstein's papers on special theory of relativity as `incomprehensible'. The next year he finally got a position of a privatedozent. But Einstein could not afford to resign from the patent office, as his position at the University did not carry any regular salary. His first lectures as a member of the university delivered in the winter of 1908/9 were not well-attended. However, within a short time Einstein's work on relativity was widely recognized to be original and profound. And then there was no dearth of important academic appointments.

After two years of publication of his special theory of relativity, Einstein started thinking of extending this theory to frames of reference, which are being accelerated with respect to one another. By doing this, restrictions imposed on the special theory of relativity would be removed. Einstein realized that on certain assumptions, accelerated motion could be incorporated into his new, general theory of relativity. The main consequences of the general theory of relativity are:

i. Gravity and inertia are two different words of the same thing.
ii. While thinking about space, four dimensions must be considered–length, width, height, and time. Every event that takes place in the universe is an event occurring in four-dimensional world of space and time.
iii. Space-time is curved or warped by the presence of large masses like the sun.
iv. Light would bend as it passes a large body like the Sun. Einstein had predicted in 1911 that starlight just grazing the Sun should be deflected by 1.7 minute of arc. During a total solar eclipse of the Sun, Eddington measured this and the deflection measured by him was 1.61 minute of arc.

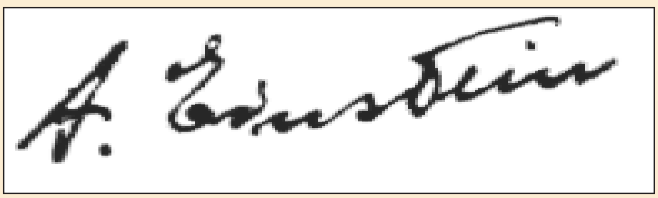
In 1919, when a student asked Einstein what would happen if the general theory of relativity was not validated by experimental measurement, Einstein replied: "I would have felt sorry of the dear Lord, because the theory is correct." Early in the twenties, Einstein started working on the unified field theory, which engaged his attention till the very end.

Einstein was awarded Nobel Prize in 1922. Interestingly he was given Nobel Prize for his contribution to mathematical physics and particularly for his discovery of the photoelectric effect. Einstein did not attend the award giving ceremony as he was on voyage to Japan. He did not mention it in his dairy or in his letters to friends. It is said that he even forgot to include it on a form listing honors he had received. However, it is interesting to note that when he divorced his first wife, Mileva, he had promised her the Nobel Prize money as alimony.

Albert Einstein and his sister, Maja

Einstein was not a mere pure abstract thinker. He tried to visualize the physical universe in concrete images. To quote Einstein: "The words or the language, as they are written or spoken, do not seem to play role in my mechanism of thought. The physical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be "voluntarily" reproduced and combined. The above-mentioned elements are, in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the mentioned associative play is sufficiently established and can be reproduced at will."

One common myth about Einstein is that he played a prominent role in making the atom bomb. In fact many consider Einstein as the father of the atom bomb. There are two apparent reasons for this kind of belief. First people think that his famous equation $E=mc^2$ has something to do with the atom bomb. Second Einstein wrote a letter to the US President Roosevelt. But the truth is that Einstein had no direct role in the atom bomb project. Explaining his role Einstein wrote: "My part in producing the atomic bomb consisted in a single act: I signed a letter to President Roosevelt pressing the need for experiments on a large scale in order to explore the possibilities for the production of an atomic bomb. I was fully aware of the terrible danger to mankind in case this attempt succeeded. But the likelihood that the Germans were working on the same problem with the chance of succeeding forced me to this step. I could do nothing else, although I have always been a convinced pacifist. To my mind, to kill in war is not a whit better than to commit ordinary murder. As long, however, all nations are not resolved to abolish war through common action and to solve their conflicts and protect their interests by peaceful decision on a legal basis, they feel compelled to prepare for war. They feel obliged to prepare all possible means, even the most detestable ones, so as not to be left behind in the general armament race."



Einstein worked for the world peace. He took up many social issues. But at the same time he did not feel strongly for direct contact with other human beings or communities. He built his inner equilibrium not upon the foundation of personal relationships but upon the foundation of his quest for understanding the laws of Nature. He once said: "My passionate sense of social justice and social responsibility has always contrasted oddly with my pronounced lack of need for direct contact with other human beings and human communities. I am truly a "lone traveller" and have never belonged to my country, my home, my friends or even my immediate family with my whole heart; in the face of all these ties, I have never lost a sense of distance and a need for solitude - feelings which increase with the years. One becomes sharply aware, but without regret, of the limits of mutual understanding and consonance with other people. No doubt, such a person loses some of his innocence and unconcern, on the other hand, he is largely independent of the opinions, habits, and judgement of his fellows and avoids the temptation to build his inner equilibrium upon such insecure foundations".

Einstein studied philosophy in great detail. He was fully convinced that science, mathematics and technology not only needed to be balanced with philosophy, ethics, spirituality, and the arts, but they were merely "different branches of the same tree." Einstein said: " All religions, arts and sciences are directed toward ennobling man's life, ennobling it from the sphere of mere physical existence and leading the individual toward freedom." Further according to Einstein: "Both churches and universities–insofar as they live up to their true function - serve the ennoblement of the individual. They seek to fulfill this great task by spreading moral and cultural understanding, renouncing the use of brute force." Einstein was deeply concerned with the way education is imparted in schools. He was of the opinion that a school's main goal always be to produce individuals who are "harmonious personalities", not specialists. He said: "... I want to oppose the idea that the school has to teach directly that special knowledge and those accomplishments, which one has to use later directly in life. The demands of life are much to manifold to let such a specialized training in school appear possible. Apart from that, it seems to me, moreover, objectionable to treat the individual like a dead tool. The school should always have as its aim that the young person leave it as a harmonious personality, not as a specialist. This in my opinion is true in a certain sense even for technical schools, whose students will devote themselves to a quite definite profession. The development of general ability for independent thinking and judgment should always be placed foremost, not the acquisition of special knowledge. If a person masters the fundamentals of his subject and has learned to think and work independently, he will surely find his way and besides will be better able to adapt himself to progress and changes than the person whose training principally consists in acquiring of detailed knowledge."

In 1940 Einstein became a citizen of the United States but

"What I see in Nature is a magnificent structure that we can comprehend only very imperfectly, and that must fill a thinking person with a feeling of humility. This is a genuinely religious feeling that has nothing to do with mysticism."
Albert Einstein

he retained his Swiss citizenship. In 1994 he prepared a hand-written version of his 1905 paper on special theory of relativity and put it on action for contributing to the war effort. It could raise six million US dollar. The manuscript subsequently found its place in the US Library of Congress. In 1952 Einstein was offered the Post of the President of Israel. He was to become the second President of Israel but he declined the offer.

Einstein died on 18 April 1955. He was cremated at Trenton, New Jersey. In his last letter, which he wrote to Bertrand Russel, one week before his death, Einstein agreed that his name should go on a manifesto urging all nations to give up nuclear weapons. He worked till the very end. Abraham Pais, who has written a scientific biography of Einstein, records that the day before Einstein died, he was studying the most recent pages of his calculations on the unified field theory.

We would like to end this article by quoting what Einstein had to say to school students: "Bear in mind that the wonderful things you learn in your schools are the work of many generations, produced by enthusiastic effort and infinite labour in every country of the world. All this is put into your hands as your inheritance in order that you may receive it, honour it, add to it, and one day faithfully hand it on to your children…If you always keep that in mind you will find a meaning in life and work and acquire the right attitude toward other nations and ages."

For Further Reading

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Letters to the Editor

I got your Vigyan Prasar "Dream-2047" monthly for February, 2003. The history of the DNA has been beautifully brought out.

V.I. Subramoniam
International School of Dravidian Linguistics
ISDL Complex, St. Xavier's College P.O.,
Thiruvananthapuram - 695 586, Kerala

I have received "Dream-2047" Newsletter. It is most useful for science students, teachers and other interested in science.

Lingaraju. R
S/o Ramachandrappa
Ujjui matt Road, Chitradurga - 577 501

I am impressed by your Newsletter "Dream-2047" of Jan 2003. This is just a bunch of knowledge, providing everyone, detail information of science.

Prof. Kharat H.J
Near Ganesh Mandir, Shastri Nagar, Sillod,
Dist Aurangabad , Pin- 431112

I read "Dream - 2047" for the first time and very much influenced by the scientific articles of great significance appeared therein. Really it is a mirror for the young scientists and academicians in which they catalyses themselves. It catalises the improvement of knowledge in science and technology. The presentation of articles in "Dream-2047" is excellent.

Dr. Kanhaiya Lal
Sugarcane Research Institute
Shahjahanpur - 242 001 (U.P.)

Digital Convergence

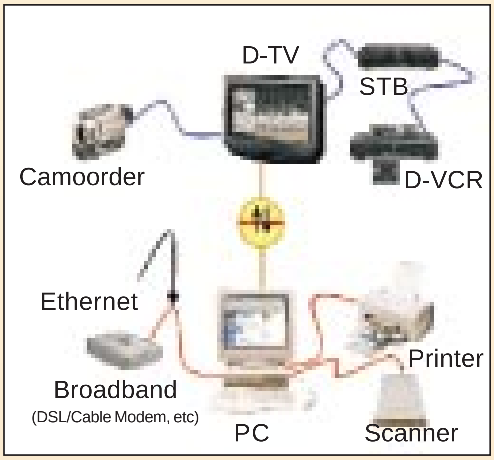
❐ Kinkini Dasgupta Misra

It is no wonder that soon you would be able to watch your email and read your movies! The amazing new options of watching television, doing Internet shopping, taking photos, playing with the kids, designing graphics are all made possible by the new technology of convergence.

Digital Convergence is the merging of digital communications technology, computing and digital media. It is reshaping the way individuals and organizations collaborate and share information. Audio, video, animations, voice and other kinds of media enhance existing digital communication and enable new forms of human interaction. This is a new platform for communication that will change not only how we conduct business, but how we learn and entertain ourselves as well.

In information technology, convergence is a term for the combining of personal computers, telecommunication, and television into a user experience that is accessible to everyone. Thus convergence is the coming together of the telecommunication infrastructure to provide services such as cable television, basic telephone services and Internet access services through a single infrastructure.

The digital convergence era was born in the 1990s with the embrace of the World Wide Web. The Web is the foundation of digital convergence technology. In the first phase of this phenomenon, the internet has taken center stage in a new world of global interaction and information sharing with an emphasis on the narrowband exchange of text and images. The web, email and databases are the foundation technologies of this phase of digital convergence. The next phase is characterized by two technological features -- rich media (audio, video, animation etc.) and mobile Internet access -- that promise to enhance the impact of convergence technologies in our lives significantly



With the increasingly widespread use of the Internet, personal computing is evolving into network-centric computing. Moreover, the rapid development of wireless communication technology and global reforms of telecommunication has also accelerated the development of network communication and network technology by consumers, households and offices. In other words we can say that digital convergence is the integration of the three larger sectors of information, communication and consumer electronics in industries. This has led to the creation of end-user oriented information appliance (IA) and Internet appliance system. In addition, parts of the network backbone will merge with technologies such as public service telephone networks (PSTNs), broadcast television, cable television (CATV), and wireless network. This will lead to the formation of a universal web linking all of the independent networks and a convergence of the various hardware and software technologies on the web. Through the expansion of the internet and digital convergence technology the integration will become a major trend and is already moving towards a significant technological and industrial revolution.

The benefits from the convergence of voice and data networks are causing a geometric acceleration in the innovation and growth of the overall network as improvements in packet-switching technologies allow voice communications to be transmitted over data networks. This in turn provides significant cost savings, facilitates information access, eases peer-to-peer connectivity and acts as a catalyst for the development of new enhanced services.

At one level, convergence between computing and telephony can be seen in Voice-over-Internet-Protocol (VoIP). Most computer users are now familiar with VoIP, using which people are making long distance calls inexpensively through the Internet. Convergence is simply uniting voice and data networks across a single infrastructure. VoIP uses the Internet Protocol to deliver voice traffic (telephone calls) over a converged network. (VoIP) is an emerging technology that allows telephone calls, faxes, or overhead paging to be transported over an existing IP data network topology. Traditionally, voice and data were carried over separate networks optimized to suit the differing characteristics of voice and data traffic. With advances in technology, it is now possible to carry voice and data over the same networks while still catering for the different characteristics required by voice and data. This provides for the addition of new voice communications products without the need for installing new cabling.

During the next five to ten years, voice traffic will increasingly shift to data networks and the traditional voice networks may simply fade away. Consequently, convergence will serve three roles:

- Provide an interface between traditional voice and data networks.
- Improve the data network to transmit voice and video (Quality of Service)
- Provide connectivity to various access networks (wireless, DSL, cable, satellite)

India is not far behind the West, especially in terms of connectivity, as least in the metros. An increasing number of people are exercising the option to get the cable connection for their Net, which gives them the bandwidth to handle convergence. And it does not cost too much, Rs 1,500 per month, and declining; in certain areas of Delhi it is Rs 800 only. And the speed is 10 to 12 times that obtainable through regular modems.

However, convergence is not simply an issue of technology, but also of culture and lifestyle. Generally speaking, TV is visual and it is not interactive-unless you do channel surfing. It is oriented primarily toward entertainment and news. Nowadays, many TVs have large screens and are easy to operate.

On the other hand, personal computers, in spite of their graphical user interfaces (GUI), tend to be more text-oriented, highly interactive, oriented in terms of purpose and content toward business and education uses. In most cases, computer screens are smaller and using them does take more intelligence than using a TV set.

One of the ways in which convergence is already seen is WebTV, which pipes the World Wide Web to a slightly-modified TV set with a set-top box from an ordinary phone line and provides a degree of interactivity. Then there are a number of interactive games designed for the TV environment that can also be played over the Internet. Broadcasting companies such as NBC have partnered with computer companies such as Microsoft for TV content. Wouldn't it be wonderful if we could access such programs when we want, what we want, rather than waiting? It would also be much better if we were to move to precisely the information/segment that we want.

On a number of Websites, you can see video content. This is another use, and the next stage would be to have streaming video that would allow live broadcasts. However, this is just one aspect. The aim is to combine entertainment, information and network home shopping/e-commerce services. Streaming media is a technology for playing audio and video files from a webpage. You can view audio or video files directly from the web server for immediate playback.

A major barrier to more rapid convergence is the large investment required to bring such cable TVs to households, both by cable access providers and individual households. Thus it is limited to areas in which there is high degree of demand, and as such it is only available in pockets. This is certainly a limitation, but one that time and rising demand can solve quite easily. In short, better services, more service-oriented functions rather than gadget-oriented ones. Thus, if you need a service, you would have a device perform it for you.

Thought the recent telecom reforms have brought increasing amount of bandwidth at an affordable level we are not quite geared for convergence-much more needs to be done. Content has to be created and adapted for multimedia applications that would enrich the convergence material.

In this many Indian companies are gearing up to provide training to creative individuals. They would make such multimedia presentations combining, text, video and sound, and a healthy dose of interactivity, as would make full use of the convergence. A major advantage that India has in convergence is the newness of telecommunications infrastructure and the adaptability of people. Computer usage has increased exponentially in the past few years and bandwidth is greater and cheaper. This helps the users and planners envision a richer fare for those who are connected on the information superhighway.

From a holistic viewpoint, the trend of merging the technologies onto a single development path will have the following characteristics:

- Technology convergence will result in a drawing together of many different kinds of transmission and connective media, such as broadcast and cable television, satellite communications, telephones, local area networks, etc. It will also lead to the higher degrees of multimedia, digitalization, interactivity, and user participation in technological development. Such developments will emphasize entertainment, demand responsiveness, high-value content and widespread applicability. Various types of network integration will drive information networks, and through the formation of data backbones, information networks will come to be characterized by complete connectivity, cooperative computing and total compatibility. All of these developments will result in even more integrated media and networks. Full integration of the three technology will utilize highly advanced, complex science and technology.
- The Convergence technology will further shrink the distances between members of the international community. Contacts will increase in frequency while problems of distances will matter less and less. Under these circumstances it is necessary to accelerate the international competitiveness of domestic technology and industries. Through commanding integration technology and product, a nation can speed internationalization through using data networks to interact with the global community. Internet shopping applications serve as a good example. Existing laws and regulations need to be soon modified to suit the needs of the integration. For example, regulations defining rights and interests pertaining to Internet shopping must be established.
- The development of convergence technology and Industry will induce information to circulate throughout all levels of society. The merging of technologies will urge technology and the humanities to work together, and thereby reduce the social impact of development. Reductions in the number of social problems can also be achieved.
- As the degree of convergence rises an even greater number of digital electronics products are being created to meet consumer demand. These new products have broken the barriers between the traditional information, communications, and consumer electronics industries. It is clear that in the future single products integrating traditionally divergent applications will give rise to a new mainstream of consumer electronics on the global market.

Source:

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3. Tribune India
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The Making of Pi

❒ Rintu Nath

I had a nice Easter celebration this time. All of our family went to our neighbour Samuel uncle's house in Easter Sunday to greet him and his family. To celebrate the occasion, Samuel uncle put a lot of food items in our disposal. There were eight or ten sweet dishes, apple pies, breads, cakes, four different tastes of ice creams and so on. I enjoyed very much the nice festive moods of the evening with those delicious foods and friendly gathering.

We returned home around 8 o' clock in the evening. I had already finished my homework for the next day's school. So I just prepared my next day's school bag and joined my uncle in the drawing room.

'I think that you've relished those sweet dishes, my dear Googol,' uncle smilingly said.

'Those were really nice, aren't they?' I was a bit ashamed.

'Indeed those were,' uncle said, 'so let me give you a riddle on food.'

'A riddle will be as good as those lovely foods,' I said.

'So here is the cryptic clue: *Perfect Food,'* uncle said.

'I understand all food items in the party were perfect,' I said.

'Well, no doubt that all food items were perfect, but *apple-pie* was the perfect food. Do you know why?'

'No, I don't have a clue.'

'I hope that there is no doubt that apple-pie is a *food* that you relished this evening.'

'But why it's a perfect one?'

'In informal English usage, the word *apple-pie* means something *perfect*. For example: *Put the books in the shelf in apple-pie order.'*

'Now I understand!'

'Well, this one is something related to the previous answer. This must be easier: *Take the end off chart number.'*

'We are talking about pie. So it must be related with *pie chart*.'

'So if you *take the end off* pie, what *number* do you get?'

'Yes, it is *pi*. I know it is a *number* represented by Greek symbol π and equals to 22/7.'

Uncle smiled at me and looked a bit disappointed hearing my quick reply.

'Dear Googol, if you say pi equals to 22/7, you are in fact making a wrong statement.'

'So pi is not equal to 22/7…'

'If you assume pi equals to 22/7, then you are making an error of 0.0004 time of actual pi value.'

'Then what should be the value of pi?' I wondered.

'Before coming into the actual value of pi, tell me what geometrical concept is represented by pi.'

'Pi (π) is the ratio of circumference to the diameter of a circle.'

'Good. Or in other words also, you may put it as the ratio of area to the square of radius of circle. But interestingly long long ago mathematicians used to think that these two values are different.'

'There is a story behind the calculation of the value of pi,' I got interested.

'Indeed, there is a long story,' uncle emphasized.

'Tell me something about this,' I could not resist hearing the story from my uncle.

'Well, the fact that ratio of circumference to the diameter of a circle is a constant was known from ages. However, the very first instance of mentioning something similar to pi seems still a mystery. Most probably Egyptians mentioned about this constant in their writings in papyrus scroll as early as 1650 BC. Of course that time it was not mentioned as pi as we do today, but they did mention about area of a circle using a rough estimate of a constant what we now say as pi. There are good evidence that value as 256/81 (that is equivalent to 3.16) was used a value for this constant. Babylonians around the same time used 25 / 8, or decimal equivalent of 3.125 as the value of this constant. In Bible also, this constant is mentioned and its value is written as 3.'

'In earlier times geometry was very advanced and the concept of pi was originated from geometry itself. So somebody must have tried to calculate pi from geometrical concept.'

'Archimedes seemed to provide the first theoretical calculation of pi around 200 BC. But once again let me remind you that though we are mentioning here the word pi, you should note that it was not represented by that specific Greek symbol ' π ' till the beginning of 18th century.'

'Ok, I understand that. But uncle, I have just a small query. Is this Archimedes was the same person with whom Archimedes principle in hydrostatics is related?'

'Yes. Archimedes was the man of many qualities. Apart from some excellent works in geometry, he devised many machines and developed theories in hydrostatics and number system.'

'So what was the approximation of pi according to Archimedes?'

'He said the constant takes the value between 223/71 and 22/7. The interesting thing is that he did not claim to know the exact value of pi, rather he mentioned about the boundary of values between which pi exists.'

'Archimedes mentioned that pi is not equal to 22/7 such a long time ago!'

'Indeed he did so. Following Archimedes statement, if you take the average of the upper and lower boundary values, and convert to decimal points, then you will get the value as 3.1418, which is an error of about 0.0002 times of actual pi value.'

'It seems that Archimedes was very close when nobody was sure about the value of pi.'

'When Archimedes derived the above boundary, you should remember that there was no concept of algebra or trigonometry. Neither the decimal number system was in existence. So he used the pure geometry using the concepts of circle and regular polygon in deriving his expressions in term of fractions.'

'It is really a great achievement!'

'In fact, historians found that no mathematician was able to improve over Archimedes' method for many centuries. A number of persons used his general method of polygonal measurement for more accurate approximations. Interestingly, Archimedes was also first to tell that both ratios that we have described for pi (i.e.. 1. circumference to the diameter of circle and 2. area to square of radius of circle) indicate the same value.'

'Did any other mathematician improve this value?'

'The Greek astronomer Ptolemy, who lived in Alexandria in Egypt during 150 AD, used a regular 360 polygon and followed the same method of Archimedes to approximate pi. He actually obtained the number 3+8/60+30/602, which if expressed as a decimal, comes as 3.1416666. This is accurate to the three decimal places.'

'Did anybody else use Archimedes methodology?'

'In the fifth century, Chinese mathematician Tsu Ch'ung used a variation of Archimedes' method to give the value of pi as 355/113, which is actually in the range between 3.1415926 and 3.1415927. This value of pi was correct up to 7 digits and mathematicians in Europe could not better this feat for approximately next thousand years.'

'What about our Indian mathematicians?'

'Aryabhata made the approximation of pi using regular polygon of 384 sides and he gave the value as 62832/2000, which is equal to 3.1416 and was correct up to four decimal places. Later Brahmagupta, who gave the operational concept of zero to the world, however gave the value of pi as square root of 10, which is correct to only one decimal place.'

'No other Indian mathematicians tried to calculate pi…'

'During the year 1400, another mathematical genius, Madhava, the mathematicians from Cochin, used a series to calculate pi. He used the following series:

$$\pi/4 = 1 - 1/3 + 1/5 - ...$$

And from this series, he calculated the approximate value of pi as 3.14159265359, which was correct up to 11 decimal places. Historically, this was a great achievement since his Europeans colleagues were still way behind this approximation during the same time.'

'Mathematics was also advanced in western Asia during that time as you have told me earlier how the concept of zero was taken by Arabic mathematicians *(see Dream 2047 March issue)*. So I suppose that somebody from there must have tried to calculate pi.'

'In 1430, an Iranian mathematician, Jamshid al-Kashi used the principle of regular polygon of Archimedes and obtained the approximate value of pi up to 14 decimal places.'

'What about the European mathematicians?'

'Another mathematician named Ludolph Van Ceulen used Archimedes methodology to calculate the value of pi. In 1596, he succeeded in giving the approximate value of pi up to 35 decimal places. There is an interesting story behind Ceulen's life. It is said that he was passionately engaged with the calculation of value of pi in most of his life. So as a fitting tribute to him, the value of pi up to 35 decimal places was engraved on his tombstone. In fact, in Germany, pi was called *'die Ludolphsche Zahl'* or Ludolphine number for a long time.'

'That means Archimedes method was continued till 16th century.'

'Around the mid of 17th century, John Wallis invented a method for calculating the value of pi by using the value of the area of the quadrant of a circle. To put it simply, if you divide a circle of unit radius in four equal part and get the area of one quarter, then the area of that quarter can be represented as pi / 4. So you can then obtain the value of pi easily.'

'It was a different method from Archimedes' methodology.'

'Well, it is indeed different from Archimedes' methodology of using polygon. In fact, in a sense it was closer to the concept of integral calculus that was invented sometime later. Wallis did a long series of interpolations and inductions and derived the following expression:

$$\frac{\pi}{2} = \frac{2.2.4.4.6.6.8.8...}{1.3.3.5.5.7.7.9...}$$

This is more commonly known as Wallis' formula.'

'So Wallis set another trend for another methodology for calculating the values of pi.'

'Yes, to some extent, it is correct. Apart from Madhava, Wallis was first to devise a series that did not involve irrational numbers. This expression was very easy one and one could easily expand the series to get more accurate approximation of pi. Moreover, this idea was later used by mathematicians when they were more equipped with the theories of calculus.'

'The 17th century marked the changing phase with the arrival of calculus.'

'Yes. During 17th century, with the invention of calculus by Newton and Leibniz, the Archimedes' methodology to calculate the value of pi was replaced with use of infinite series expansions as initiated by Wallis. In the meantime, the concept on algebra and trigonometry were also developed to great extent. Moreover the concept of zero and decimal system of number made huge advancement in mathematics. Therefore, it was easy to interpret the problem of pi taking help from all these branches of mathematics.'

'So pi came out of the closet of geometry and embraces the arithmetic, algebra, trigonometry, calculus and all modern mathematics fields.'

'Yes, you are right. For example, with the help of algebra, trigonometry and calculus, it can be proved that:

$$\sin^{-1} x = x + \left(\frac{1\times x^3}{2\times 3}\right) + \left(\frac{1\times 3\times x^5}{2\times 4\times 5}\right) + \left(\frac{1\times 3\times 5\times x^7}{2\times 4\times 6\times 7}\right) + \ldots\ldots$$

This is well-known Gregory-Leibniz formula. In this formula, substituting x = 1, gives rise to the series, which was already used by our own mathematician Madhava long ago.

$$\tan^{-1} 1 = \frac{\pi}{4} = 1 - \left(\frac{1}{3}\right) + \left(\frac{1}{5}\right) - \left(\frac{1}{7}\right) + \left(\frac{1}{9}\right)\ldots\ldots$$

'That's really interesting!'

'However, one drawback of the above series is that it converges very slowly and so one would require to complete the series up to few hundreds terms only to compute the value of pi accurately up to two decimal places.'

'When mathematicians were trying for getting the digits of pi, I wonder whether Newton himself proposed any series or not.'

'Isaac Newton also devised some series using the concept similar to Wallis under area of a semicircle. Of course, he could give more accurate expression using calculus and binomial theorem. In 1665, Newton used the following series of arcsin to calculate pi:

$$\sin^{-1} x = x + \left(\frac{1\times x^3}{2\times 3}\right) + \left(\frac{1\times 3\times x^5}{2\times 4\times 5}\right) + \left(\frac{1\times 3\times 5\times x^7}{2\times 4\times 6\times 7}\right) + \ldots\ldots$$

It is known that: pi/6 = sin-1(1/2). So you can put the value of x = ½ to compute pi. Considering approximately 40 terms in the above expression, Newton computed the value of pi, which was accurate up to 16 digits.'

'So one can put other values of x to get the value of pi differently. For example, if I take x equals to $\sqrt{3}/2$, then I can consider the left hand side as pi / 3.'

'You are right. In fact, that's what many mathematicians did in later years. In 1699, Abraham Sharp used Gregory-Leibniz series to compute the value of pi. He considered the value of x in the Gregory-Leibniz series as $1\sqrt{3}$. Now you know that: pi / 6 = tan-1(1/$\sqrt{3}$). Therefore he was also able to get the value of pi which was up to 71 decimal places using approximately 300 terms of the series.'

'Were there more series like these?'

'In 1700s, Leonhard Euler provided some interesting series involving pi. Some of these series involved expressions like (pi^2 / 6), (pi^4 / 90) and converged very rapidly. Later a faster and rapidly converged form of Gregory-Leibniz series was proposed by Machin in 1706. He used the following identity:

pi / 4 = tan-1(1/5) - tan-1(1/239)

Using the similar principle of Gregory series for arctan(x), Machin approximated the pi up to 100 decimal places. In 1874, William Shanks used the method of Machin and computed pi up to 707 decimals, which however later found to be accurate only up to 527th place.'

'Uncle, let me make a little interruption. As you said earlier that the ratio of circumference of circle to the diameter was not known as pi in earlier days, but some other names like *Ludolphine Number*. So when did we actually start associating the word pi with this constant?'

'Well, you got it right. In the meantime, in 1706, the English mathematician William Jones assigned the value of 3.14159 to the 16th letter of Greek alphabet. He adopted pi to represent this immensely significant value.'

'So from the beginning of 18th century pi came into existence what we still call so.'

'Yes. After Jones' abbreviation of the value, Eular mentioned about this symbol in 1737 and soon it became a standard notation.'

'Let's go back to our main story. First it was Archimides method and then it was series. What's next?'

'Until the advent of computer technology in the mid 20th century, the computation of pi was basically involved in calculation of the value in a series to the extent that is manually possible. Most of the calculation involved with series given by Gregory-Leibniz, Sharp and Machin. These series were not very efficient in computing the value of pi. However, those series were very elegant in nature and useful in obtaining the approximation of pi reasonably well to apply in practical circumstances. Moreover, those series gave many theoretical implications and research ideas, which are still being investigated by mathematicians around the world.'

'How the scheme of calculation of pi was changed with the arrival of computer?'

'During the mid of 20th century, with development of computers and simultaneously some advanced algorithms for mathematical calculations, it was possible to obtain some efficient and accurate values of pi and some other constants. However, until 1970s, all computer evaluations still used the classical formula like some variations of Machin's formula.'

'Still there was no advanced algorithm to calculate pi!'

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801}\sum_{k=0}^{\infty}\frac{(4k)!(1103+26390k)}{(k!)^4 396^{4k}}$$

'Well, it was not like that. Ramanujan discovered some new infinite series formula in 1910, but its importance was re-discovered around late 70s long after his death. One of his elegant formulas was like this:

'I always amazed hearing stories about our own mathematician genius Ramanujan. He was a mathematician of extraordinary calibre!'

'You are right. If he would not have died at younger age, he must have contributed to the world of mathematics a lot more.'

'Therefore, Ramanujan's series advanced the computation of digits in pi.'

'Yes, with each addition of term in Ramanujan's series could give approximately additional eight digits to pi. During the year 1985, 17 million digits of pi were accurately computed by Gosper using this formula. So it also proved the validity of Ramanujan's formula. In 1994, David and Gregory Chudnovsky brothers of Columbia University computed over four billion digits of pi in a supercomputer, using an algorithm, which was also similar in essence to the formula given by Ramanujan.'

'Could anybody improve Ramanujan's formula?'

'In 1976, Eugene Salamin and Richard Brent independently discovered a new algorithm for pi, which was based on arithmetic-geometric mean iteration or in short, AGM iteration. Their algorithm was faster than Ramanujan and with 25 iterations, 45 million digits of pi can be calculated accurately.'

'That's huge number of digits.'

'Well, there were still many to come. In 1985, Jonathan Borwein and Peter Borwein discovered some additional algorithms. Using their algorithm along with Salamin-Brent scheme, Yasumasa Kanada of the University of Tokyo computed 6.4 billion decimal digits of pi on a Hitachi supercomputer in 1999.'

'That must be a world record for calculation of digits of pi.'

'To be precise, that is history now! In December 2002, Kanada and his group broke their own world record and calculated value of pi for 1,2411 trillion places.'

'Wow! It's beyond my imagination! How big is it?'

'You can judge this gigantic feat by the fact that it will take almost 40,000 years to recite all digits. Professor Kamada used a Hitachi supercomputer that was capable of performing two trillion calculations per second and it took 400 hours to compute the calculation of those 1.2 trillion digits.'

'Was there any new algorithm after Borwein algorithm?'

'In 1990, another algorithm, called Rabinowitz-Wagon spigot algorithm, was proposed for computation of pi. The characteristic feature of the algorithm was that previously generated digits could be used in generation of next successive digits.'

'All these algorithm may be only applicable in a high speed computer like supercomputer as that of Kanada.'

'Yes, all these algorithms are computationally very exhaustive. Most of these algorithms require the computation of previous digits to get the next digit. For examples, to get the nth digit in pi, computer should first compute all previous (n-1) digits.'

'Is their any algorithm which can calculate nth digit without calculating (n-1) digit?'

'Mathematicians have found that this may be possible for binary (base 2) and hexadecimal (base 16) digits of pi. In 1996, D. Bailey, P. Borewein and C. Plouffe discovered a novel scheme of computing individual hexadecimal digits of pi. The uniqueness of their scheme is that it can produce modest length of binary or hexadecimal bits from any arbitrary position using no prior bits and it can be implemented in any modern computer without any multi-precision software or higher memory. More recently in 1997, C. Plouffe discovered another new algorithm to compute the nth digit of pi in any base.'

'So one can calculate any digit of pi in any position using this algorithm.'

'Using Bailey's algorithm, Colin Percival, a 17-year student from Simon Fraser University, calculated five trillionth and ten trillionth hexadecimal digit of pi. In the year 2000, he found that the quadrillionth binary digit of pi is zero. And more recently, to add another feather in their cap, Kanada group also finished computing 1,030,700,000,000 hexadecimal digits of pi.'

'It's amazing that mathematicians from ancient time to modern age were engaged with the calculation of digits in pi. But still I'm wondering about one thing! I agree that understanding digits of pi is important, but all these trillion of digits…'

'Well, pi was always a mystery to mathematician and so they might have tried to get to the bottom of it. A value of pi for just 37 places is sufficient to for mathematicians to calculate the radius of the Milky Way galaxy with a margin of error less than the size of a hydrogen atom. So it is really interesting to see that mathematicians all over the world are so fascinated and engaged to get trillion digits of pi when for the purpose of the most accurate measurement, it does not require even first hundred digits!'

'Yes, I have also the similar thoughts.'

'One reason is that calculation of digits of pi is an excellent way to judge the power and integrity of our modern days computer hardwares and softwares. If two computers compute the billionth digit of pi accurately, then we can assume that these two computers are reliable for doing millions of other calculations flawlessly. One can detect the problems in hardware after obtaining the results of pi digits. The similar kind of problem was once detected in Cray-2 supercomputers in 1986.'

'Well, that makes sense. It's indeed a great exercise to test the ability of minds of supercomputer!'

'Moreover, the challenge of computing pi has also stimulated researches in many advanced areas of science and engineering. The challenge has led to many new discoveries and many new algorithms in the field of mathematics. So these were the added benefits that we obtained from this mysterious constant. There are also academic interests to find any statistical abnormalities or irregularities in pi that could suggest that pi is not a normal number.'

As we were talking, the big wall clock in our drawing room told us that it is 10 o' clock in the night. Uncle stood up giving a look at the clock.

'My dear Googol, I think that we should stop now. You have to go to school tomorrow. So run to bed and have a good night sleep!'

I took uncle's word and started preparation to retire for the night. But by then, the magic of pi already mesmerised my mind completely.

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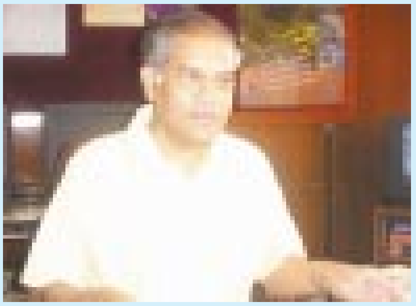
Interview with Dr. R. R. Kelkar

Dr. R.R. Kelkar is the topmost weatherman of our country today. He joined the Institute of Tropical Meteorology at Pune (now Indian Institute of Tropical Meteorology, an autonomous organization, under the Department of Science & Technology), after completing MSc Degree in Physics from University of Poona, Pune, in 1965. He has completed 38 years of long and illustrious service at India Meteorological Department (IMD). He is interested in spreading awareness about weather phenomena in the country. He is equally at ease in Hindi and Marathi.



Dr. R.R. Kelkar

Dream 2047 : Sir, can you share with our readers, a brief history of Indian meteorology?

Dr. Kelkar : The beginnings of meteorology in India can be traced to ancient times. Early philosophical writings of the 3000 B.C. era, such as the *Upanishadas*, contain serious discussions about the processes of cloud formation and rain and the seasonal cycles caused by the movement of the earth round the sun. Varahamihira's classical work, the *Brihatsamhita*, written around 500 A.D., provides clear evidence that a deep knowledge of atmospheric processes existed even in those times. It was understood that rains come from the sun (*Adityat Jayate Vrishti*) and that good rainfall in the rainy season was the key to bountiful agriculture and food for the people. Kautilya's *Arthashastra* contains records of scientific measurements of rainfall and their application to the country's revenue and relief work. Kalidasa in his epic, *Meghdoot*, written around the 7th century A.D., even mentions the dates of onset of the monsoon over central India and traces the path of the monsoon clouds.

Meteorology, as we perceive it now, may be said to have had its firm scientific foundation in the 17th century after the invention of the thermometer and barometer and the formulation of laws governing the behaviour of atmospheric gases. It was in 1686 that Sir Edmund Halley, a British scientist, published his treatise on the Indian summer monsoon, which he attributed to a seasonal reversal of winds due to the differential heating of the Asian land mass and the Indian Ocean.

India is fortunate to have some of the oldest meteorological observatories of the world. The British East India Company established several such stations, for example, those at Calcutta (now Kolkata) in 1785 and Madras (now Chennai) in 1796 for studying the weather and climate of India. The Asiatic Society of Bengal founded in 1784 at Calcutta, and in 1804 at Bombay (now Mumbai), promoted scientific studies in meteorology in India. Captain Harry Piddington at Calcutta published 40 papers during 1835-1855 in the Journal of the Asiatic Society dealing with tropical storms and coined the word "cyclone", meaning the coil of a snake. In 1842 he published his monumental work on the "Laws of the Storms". In the first half of the 19th century, several observatories began functioning in India under the provincial governments.

A disastrous tropical cyclone struck Calcutta in 1864 and this was followed by failures of the monsoon rains in 1866 and 1871. In the year 1875, the Government of India established the India Meteorological Department, bringing all meteorological work in the country under a central authority. The headquarters of IMD were first at Calcutta, later shifted to Simla, then to Poona (now Pune) and finally to New Delhi.

Dream 2047 : How does our infrastructure compare with the infrastructure of developed countries?

Dr. Kelkar : From a modest beginning in 1875, IMD has progressively expanded its infrastructure for meteorological observations, communications, forecasting and weather services and it has achieved a parallel scientific growth. IMD has always used contemporary technology. In the telegraph age, it made extensive use of weather telegrams for collecting observational data and sending warnings. Later IMD became the first organisation in India to have a message switching computer for supporting its global data exchange. One of the first few electronic computers introduced in the country was provided to IMD for scientific applications in meteorology. India was the first developing country in the world to have its own geo stationary satellite, INSAT, for continuous weather monitoring of this part of the globe and particularly for cyclone warning. Last year, IMD inducted state-of-art Doppler Weather Radars into its radar network.

IMD maintains a dense network of surface observatories to serve a variety of purposes. There are 559 Surface Observatories. India has 8500 Rain gange Stations, some ot these are under IMD and the rest belong to other organizations. There are

219 Agrometeorological Observatories.

IMD's present Upper air observational network comprises 35 radiosonde and 62 pilot balloon observatories spread all over the country. It has a network of 10 S-band cyclone detection radars covering the Indian coast-line. IMD's operational network of X-band radars consists of 9 wind-finding radars, 9 storm detection radars and 8 radars with dual capability.

With a view to documenting the long term changes in composition of trace species of the atmosphere as a result of changing land use pattern, WMO had commissioned a global programme called Background Air Pollution Monitoring Network (BAPMoN) which is now a part of the Global Atmospheric Watch (GAW) Programme. India had set up 10 such BAPMon stations.

Dream 2047: What role do we play as a part of the global community?

Dr. Kelkar : Exchange of global data is a pre-requisite for accurate weather forecasting. The meteorological services of the world have worked out arrangements for the high-speed transfer of meteorological data for this purpose under the aegis of the World Meteorological Organization. A Regional Telecommunications Hub is located at New Delhi as a part of the WMO Global Telecommunications System.

IMD has strong international linkages with the WMO. which has its headquarters at Geneva, and with the meteorological services of other countries through the WMO. India also has developed bilateral cooperation in the field of meteorology with many countries like the U.S., Australia, Russia, Sri Lanka, Maldives, etc and is a member of regional groupings such as SAARC and BIMST.

IMD's Central Training Institute at Pune and its specialized training centers at New Delhi are recognized by the WMO for imparting training to meteorologists from countries in Asia and Africa. A large number of trainees from these countries receive training from IMD each year.

The WMO Regional Specialised Meteorological Centre for Tropical Cyclones is operated by IMD at New Delhi. It is one of the six such centres recognised by the WMO under a global system for monitoring tropical cyclones. As an international commitment, through the WMO/ESCAP Panel on Tropical Cyclones, tropical cyclone advisories are issued by RSMC, New Delhi to the Panel member countries whenever there are cyclones in the Bay of Bengal and the Arabian Sea. The advisory messages are issued four to eight times a day. The ESCAP Panel countries are Thailand, Myanmar, Bangladesh, Pakistan, Sri Lanka, Maldives and Oman.

Dream 2047: Has weather forecasting has changed with new technology? What are the new technologies tried by IMD recently?

Dr. Kelkar : The process of weather forecasting has many components: observation and recording of data, communicating them to a central location, analysis of data over a region of interest, using models or prediction techniques, deriving the forecasts and communicating them to the users. Technology comes into the picture at every stage of the process.

There was a quantum jump in IMD's forecasting skill with induction of INSAT satellites into the observation system, particularly in the short range forecasting. Monitoring of moving systems like tropical cyclones, monsoon depressions and western disturbances, becomes very easy with satellites particularly over the oceans or mountains where there is no other data. The development of severe weather over a region, snowfall over the Himalayas, formation and dissipation of fog over northern India, are also easily watched with the help of satellite imagery.

Numerical modeling and prediction have become common worldwide and have also been introduced in IMD on a large scale. Depiction of the products of numerical prediction models through computer software and graphics and their dissemination has become much easier now through modern means of communication like the internet. IMD's numerical forecast products are available on the IMD web site and regularly updated. The IMD web site is a very popular internet site and it has registered 4.5 lakh hits in the last 2 years.

Dream 2047:How crucial is the role of weather prediction in our economy, especially agricultural planning and disaster management?

Dr. Kelkar : IMD's mandate is:

1 To take meteorological observations and to provide current and forecast meteorological information for optimum operation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, offshore oil explorations, etc.

2 To warn against severe weather phenomena like tropical cyclones, norwesters, duststorms, heavy rains and snow, cold and heat waves, etc., which cause destruction of life and property.

3 To provide meteorological statistics required for agriculture, water resource management, industries, oil exploration and other nation-building activities.

4 To conduct and promote research in meteorology and allied disciplines.

5 To detect and locate earthquakes and to evaluate seismicity in different parts of the country for development projects.

For the convenience of administrative and technical control, and for serving users locally, IMD has established 6 Regional Meteorological Centres, at Mumbai, Chennai, New Delhi, Kolkata, Nagpur and Guwahati and Meteorological Centres at other state capitals.

There are specialized Divisions, Offices and Centres dealing with

- Cyclone Warning
- Weather Forecasting
- Climatology
- Agricultural Meteorology
- Aviation Meteorology
- Hydrometeorology
- Instrumentation
- Meteorological Telecommunication
- Satellite Meteorology
- Seismology
- Training
- Positional Astronomy

IMD is thus contributing to all major sectors of the country's economy. The number of users requiring and using weather data and forecasts is constantly growing.

Dream 2047: What are the major weather calamities faced by this country and what role IMD played in weather warning activity in terms of saving property and human lives?

Dr. Kelkar : The four major disasters faced by this country are cyclones, droughts, floods and earthquakes. At present there is no scientific method of earthquake warning but IMD is responsible for seismic monitoring and dissemination of information about the occurrence of earthquakes.

The extensive coastal belt of India is very vulnerable to the deadly storms known as tropical cyclones. About 4 to 6 such storms originate in the Bay of Bengal and the Arabian Sea every year. Tropical cyclones, which are characterised by torrential rain, gales and storm surges, cause heavy loss of human lives and destruction of property. They also result in extensive damage to standing crops and loss of cattle. It has always been the endeavour of the India Meteorological Department to minimise the losses of life and property due to tropical cyclones by providing early warnings. Cyclone warning is one of the most important functions of IMD. The cyclone warning service of IMD is more than a century old. Cyclone warnings are provided by the India Meteorological Department from the Area Cyclone Warning Centres (ACWCs) at Kolkata, Chennai and Mumbai and Cyclone Warning Centres (CWCs) at Vishakhapatnam, Bhubaneshwar and Ahmedabad.

A constant watch is kept on the Arabian Sea and the Bay of Bengal for the likely genesis of tropical cyclones with the help of satellite imagery, particularly those from the Indian geostationary satellite, INSAT. Data from ships and ocean buoys is also very valuable. When the systems come nearer to the Indian coastline, their subsequent development and movement is monitored by a chain of Cyclone Detection Radars set up by IMD to cover the entire coastal belt. The likely movement of the storms is predicted with the help of track prediction models and by reference to past climatology and the intensity and velocity structure of the cyclones can be assessed with the help of the new Doppler radars.

The cyclone warnings are issued in four stages: First, a Pre-Cyclone Watch is issued to draw the attention of senior officials to the possible formation of a tropical cyclone. The second stage warning known as "Cyclone Alert" is issued 48 hours in advance of the expected commencement of adverse weather over the coastal areas. The third stage warning known as "Cyclone Warning" is issued 24 hours in advance. Lastly, a post-landfall outlook is issued for areas in the interior which may be affected by the cyclone as it continues to move inland and dissipate.

Drought is one disaster which creeps in slowly. India has a very extensive raingauge network and rainfall monitoring over the country is a stupendous task. IMD helps in monitoring the rainfall over the country during the monsoon season on a districtwise, sub-divisionwise and statewise basis. Maps showing weekly and cumulative rainfall figures in 36 meteorological subdivisions of the country are prepared. This information is very important to many user agencies, particularly for agricultural purposes.

Flood forecasting in India comes under the purview of the Central Water Commission. However, IMD provides crucial support to CWC during the flood season through its Flood Meteorological Offices (FMOs) which have been set up by IMD at ten locations viz., Agra, Ahmedabad, Asansol, Bhubaneshwar, Guwahati, Hyderabad, Jalpaiguri, Lucknow, New Delhi and Patna.

IMD provides design estimates of short duration rainfall in different sub-zones of the country for the purpose of railway and road bridge construction. Hydrometeorological data for a number of river catchments are analysed for computing probable maximum storms, return periods of very heavy rainfall and run-off relationships.

Dream 2047: Are there any special courses offered in our education system to produce weathermen or they are drawn from basic science background?

Dr. Kelkar : Andhra University, Waltair, and Cochin University offer post-graduate degree courses in meteorology and atmospheric sciences. A few other universities and IITs have research programmes leading to M.Tech/Ph.D. in these subjects as well as related subjects like environmental sciences, geophysics, oceanography, space sciences, etc.

In the olden days, IMD used to select people only with Physics or Mathematics degrees and train them as meteorologists. Nowadays, with the growing applications of meteorology, IMD is recruiting trainee-Meteorologists with background in agriculture, instrumentation, electronics and computer sciences also.

Dream 2047: If we cannot predict droughts or floods accurately, how safe is our society?

Dr. Kelkar : Predictions are, of course, important but we cannot depend solely upon predictions to ensure our safety. We must study our environment and be aware of the dangers around us. If we are living on the edge of a desert, like in Delhi, an occasional dust-storm should not take us by surprise, whether it is predicted or not. People constructing houses in low-lying areas should expect to get flooded once in a while. Fishermen should know the perils of going out in stormy seas. Those living on mountain slopes should be aware of the dangers of landslides.

Predictions of impending disasters cannot always be made in advance. Even in the U.S., the warning time for tornadoes is barely 15 to 20 minutes. People have to be prepared to act on that short time scale. Societies must assess their vulnerabilities to natural disasters and if they cannot do so on their own, government and non-governmental organizations should assist them in this effort. A lot is required to be done, and indeed can be done, to enhance the levels of community awareness and preparedness towards natural disasters.

Dream 2047: Sir, what is your advice to young meteorologists?

Dr. Kelkar : Meteorologists are fortunate to have the latest tools for research like supercomputers and satellites. In fact meteorology is driving technology in many areas. This is true in our country as well. Young meteorologists who want to work here will find the problems of monsoons and cyclones really challenging and rewarding. The science of meteorology is very exciting and there are new areas of applications opening up every day. The future is bright. However, the profession of meteorology is a very demanding one and user expectations run high and are difficult to meet.

Dream 2047: A personal question, Sir: Why did you choose meteorology as your profession?

Dr. Kelkar : My father, Ratnakar Hari Kelkar, was born in the year 1901 in a small town called Alibag, situated a little south of Mumbai. He used to tell me how he always had to study in candlelight in his school days. Reason: For the sake of IMD! One of the earliest observatories of IMD was set up in Mumbai for making geomagnetic measurements. Around 1900, when tramcars started plying in Mumbai, the city got covered by a mesh of overhead electric wires. Fearing that this would vitiate the geomagnetic measurements, the observatory was shifted to Alibag. This town was not allowed to have electricity until 1950, when instruments not so sensitive to electric noise were installed in the Alibag observatory.

My father naturally looked upon the Alibag observatory with a sense of wonder and awe. Years later, when I got my B.Sc. degree from the University of Pune, he advised me that if I really wanted to take up science as a career, IMD was the place for me to try. In 1964, I completed my M.Sc. in Physics from the University of Pune. Around the same time, IMD had set up a new Institute of Tropical Meteorology at Pune (now the IITM, an autonomous body under DST). ITM was looking for young research assistants, and I was lucky to get in there in 1965. Thus started my 38-year long career with the IMD. Call it destiny, call it circumstances. Today mediapersons refer to me as the topmost weatherman of the country and let me tell you, in this job there is never a dull moment.

Interviewed by : V. Krishnamurthy

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The fourth technical session was devoted to documenting the experiences of science movements. Dr A Vallinayagam (On Tamil Nadu Science Forum), Prof E R Subramaniyam (Chikimuki, science monthly in Telugu) Sh Madhavan (On the experiences of Thulir, Children's science monthly in Tamil), Dr Parimala (on the role of S&T institutions in science popularisation), Prof P Devadas (Astronomy popularisation) made presentations. The presentations were followed by a lively discussion initiated by Dr M P Parameswaran.

On the third day, the fifth technical session was on the theme of science and media, in which Dr Seyon, well known Radio producer, Mr Pon Danasekaran, reporter from Dinamani, and Dr N Krishnamoorthy made presentations. The Sixth technical session was on title 'reflections'; Nellai Su Muthu, Scientist ISRO, Shar, and Prof. Arul Dhalapathy made presentations that reflected upon the content and character of science popularisation.

The valedictory function was chaired by Sh A Raman, IAS, Secretary Science City, Chennai. In his speech he welcomed the initiative of Vigyan Prasar to undertake large scale science popularisation in various Indian languages. DR T V Venkateswaran, PSO, chaired the session, introductory remarks were made by Dr S Krishnamoorthy, Director IITS and vote of thanks was proposed by Dr S Jean Lawrence.

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of exploration. It is a saga similar to stepping on the South Pole by Roald Amundsen (1911) and Robert F. Scott (1912), or on the North Pole by Admiral Robert Peary (1909), or the famous "small" step on the Moon by Neil Armstrong (1969). We climb Mount Everest because "it is there" and travel to the Moon also because "it is there". But, once we get there, it is our duty to preserve it.

Tenzing and Hillary's has been a saga of a well planned, steady progression up the mountain until there was nowhere higher left to climb. Tenzing narrated his view from the top of the world in these words: "… For the closer peaks – giants like Lhotse, Nuptse, and Makalu – you now had to look sharply downward to see their summits. And farther away, the whole sweep of the greatest range on Earth – even Kanchanjunga itself – seemed only like little bumps under the spreading sky". Indeed, all our endeavours - scientific or social - are like climbing up the Mount Everest. The higher we reach, the smaller shall our earlier achievements appear to be, and farther shall we see.

❑ **V.B. Kamble**